USDA Natural Resources
Conservation Service

Ecological site R066XY062NE
Shallow To Gravel

Last updated: 11/18/2024
Accessed: 05/10/2025

General information

Approved. An approved ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model, enough information to identify the ecological site, and full documentation for all ecosystem states contained in the state and transition model.

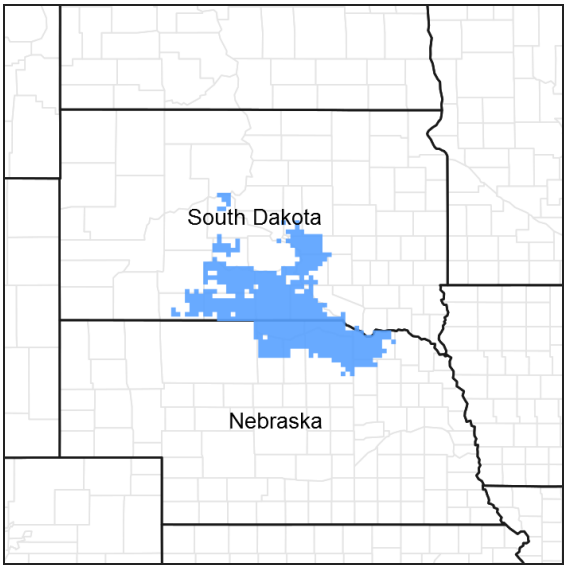


Figure 1. Mapped extent

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): 066X–Dakota-Nebraska Eroded Tableland

The Dakota-Nebraska Eroded Tableland (MLRA 66) occurs in north-central Nebraska (56 percent) and south-central South Dakota (44 percent). MLRA 66 is approximately 3.6 million acres and covers all or parts of twelve counties between the two states. The northern border of the MRLA bisects Tripp County, South Dakota, just south of the town of Winner. Valentine is in the northeastern corner of Cherry County, Nebraska and is located on the MLRA's southwestern border. From there, the MLRA stretches southeast to the northwestern corner of Antelope County, Nebraska and the town of O'Neil, Nebraska in Holt County its southeastern border.

The MLRA occupies a smooth fluvial plain primarily consisting of broad intervalley areas with terraces, river breaks, and local badlands along the well-defined major drainages. The slopes range from nearly level tablelands to steep ridges and drainages. The elevation ranges from 1,970 to 2,950 feet. The Keya Paha, Elkhorn, and the Niobrara Rivers flow through the MLRA. The Niobrara is a designated National Scenic River.

Layers of shaly chalk and limestone marine sediments overlaying the Cretaceous Niobrara Formation make up the bulk of the MLRA, though the western and southwestern portions exhibit surface eolian deposits. The floors of the major drainages are underlain by deposits of alluvial sand and gravel. The dominant soil orders in this MLRA are mesic, ustic or aridic Mollisols and Entisols. Loamy and sandy are the primary soil textures in this landscape.

Twenty-seven percent of the land in this MLRA has been broken out of native prairie and farmed, while sixty-six percent of the grasslands remain intact. The remaining acres are divided between forest, urban development, and other uses. Livestock grazing, primarily by cattle, is a major industry. Corn, winter wheat, and grain sorghum are the primary commodity crops but a significant number of acres are planted to forage sorghum and alfalfa for harvest as hay. With limited irrigation available, and annual precipitation averaging from 18 inches in the west to 25 inches in the east, crop production is marginal across most of the MLRA.

The historical matrix vegetation type is mixed-grass prairie. Big bluestem, sand bluestem, prairie sandreed, little bluestem, sideoats grama, and blue grama make up the bulk of the warm-season species. Western wheatgrass, green needlegrass, and needle and thread are the dominant cool-season grasses. Large- and small-patch vegetative communities are found primarily along the riparian zones, on lowland sites, and in closed depressions. Woodlands make up about 3 percent of MLRA 66 and consist primarily of green ash, bur oak, and hackberry. Ponderosa pines can be found on steeper sites in the western portion of the landscape.

Wildlife flourishes in this combination of crop and grassland environments. In a landscape historically occupied by bison herds, white-tailed and mule deer are now the most abundant wild ungulates. Pronghorns also number among the remaining native grazers. A variety of smaller species, including coyote, raccoon, opossum, porcupines, muskrat, beaver, squirrel, prairie dogs, and mink, thrive in the region. Grassland birds, including several upland game birds, are common across the MLRA.

This landscape serves as a backdrop for a disturbance-driven ecosystem, evolving under the influences of herbivory, fire, and variable climate. Historically, these processes created a heterogeneous mosaic of plant communities and structure heights across the region. Any given site in this landscape burned every six to ten years, with most of the MLRA experiencing a six to eight year fire regime. The fires were caused by lightning strikes and were also set by Native Americans, who used fire for warfare, signaling, and to refresh the native grasses. Indigenous inhabitants understood the value of fire as a tool, and that the highly palatable growth following a fire provided excellent forage for their horses and attracted grazing game animals such as bison and elk.

Land use patterns by post-European settlers have greatly altered the historical fire regime, allowing the expansion of woody species. Fragmentation of the native grasslands by conversion to cropland, transportation corridors, and other developments has contributed to disruption of the natural fire regime of this ecosystem. The most common encroaching woody species is eastern redcedar. While eastern redcedar is native to the landscape, the historic population in MLRA 66 was limited to isolated pockets in rugged river drainageways that were protected from wildfire. Widespread plantings of windbreaks with eastern redcedar as a primary component provide a seed source for the aggressive woody plant which further facilitates woody encroachment. Encroachment of native and introduced shrubs and trees into the native grasslands degrades wildlife habit and causes significant forage loss for domestic livestock. Aggressive fire suppression policies have exacerbated this process to the point that shrub and tree encroachment is a major ecological threat to grasslands throughout most of the MLRA.

Classification relationships

►EPA◄
Level IV Ecoregions of the Conterminous United States
43—Northwestern Great Plains:
43i—Keya Paha Tablelands.

►USDA◄
Land Resource Regions and Major Land Resource Areas (USDA-NRCS, 2006)
Land Resource Region: G—Western Great Plains Range and Irrigated Region:
Major Land Resource Area (MLRA): 66 Dakota-Nebraska Eroded Tableland.

Ecological site concept

The Shallow to Gravel ecological site is a run-off site located on uplands and valleys. Slopes range from 0 to 30 percent. The soils are formed primarily in loamy or sandy alluvium or sandy eolian materials deposited over gravelly alluvium and outwash. Soils are very shallow to very deep with surface layers typically ranging in thickness from 3 to 12 inches but may be as thick as 16 inches. The most significant characteristic of the site is the presence of more

than 15 percent gravel in the top 20 inches of the soil.

Vegetation in the Reference Plant Community (1.1) consists of warm-season, tall- and midgrasses and cool-season grasses. Dominant grasses include blue grama, sand bluestem, prairie sandreed, and needle and thread. Forbs are common and diverse. Shrubs include leadplant, prairie sagewort, broom snakeweed, and pricklypears. Lesser spikemoss is a common cryptogam present on this site.

Associated sites

R066XY036NE	**Loamy 18-22 P.Z.** The Loamy 18-22 PZ ecological site is often found interspersed with Shallow to Gravel ecological sites throughout a given area.
R066XY054NE	**Sandy 22-25 P.Z.** The Sandy 22-25 PZ ecological site is often found interspersed with Shallow to Gravel ecological sites throughout a given area.
R066XY059NE	**Thin Upland** The Loamy 22-25 PZ ecological site is often found interspersed with Shallow to Gravel ecological sites throughout a given area.
R066XY032NE	**Sandy 18-22" P.Z.** The Sandy 18-22 PZ ecological site is often found interspersed with Shallow to Gravel ecological sites throughout a given area.

Similar sites

R066XY032NE	**Sandy 18-22" P.Z.** The Sandy 18-22 PZ and Shallow to Gravel ecological sites have similar soil textures but Shallow to Gravel sites contain 15 percent gravel within 20 inches of the soil surface while Sandy 18-22 PZ sites do not.
R066XY054NE	**Sandy 22-25 P.Z.** The Sandy 22-25 PZ and Shallow to Gravel ecological sites have similar soil textures but Shallow to Gravel sites contain 15 percent gravel within 20 inches of the soil surface while Sandy 22-25 PZ sites do not.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Andropogon hallii* (2) *Hesperostipa comata ssp. comata*

Physiographic features

This site typically occurs on stream terraces and uplands where gravelly sediments are deposited. Slopes range from 0 to 30 percent.

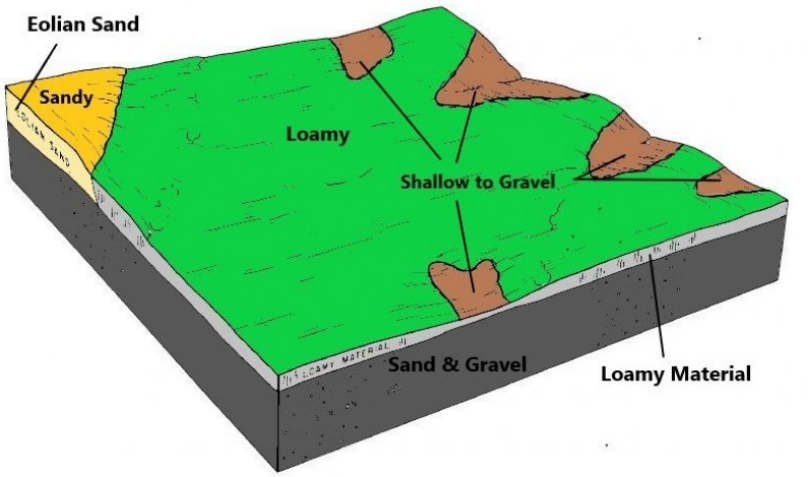


Figure 2. Block diagram for the Shallow to Gravel site

Table 2. Representative physiographic features

Landforms	(1) Hillslope (2) Plain (3) Terrace (4) Knoll
Runoff class	Negligible to medium
Flooding frequency	None
Ponding frequency	None
Elevation	1,900–3,000 ft
Slope	0–30%
Water table depth	80 in
Aspect	Aspect is not a significant factor

Climatic features

MLRA 66 is considered to have a continental climate with cold winters and hot summers, low humidity, light rainfall, and much sunshine. Extremes in temperature may also abound. The climate is the result of the location of MLRA 66 near the geographic center of North America. There are few natural barriers on the northern Great Plains and the winds move freely across the plains and account for rapid changes in temperature.

Annual precipitation ranges from 18 to 25 inches per year. The normal average annual temperature is about 48°F. January is the coldest month with average temperatures ranging from about 19°F (Bonesteel, SD) to about 23°F (Ainsworth, NE). July is the warmest month with temperatures averaging from about 73°F (Harrington, SD) to about 75°F (Gregory, SD). The range of normal average monthly temperatures between the coldest and warmest months is about 54°F. This large annual range attests to the continental nature of the climate this area. Hourly winds average about ten miles per hour annually, ranging from about 11 miles per hour during the spring to about nine miles per hour 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 miles per hour.

Growth of native cool-season plants begins mid to late March and continues to late June. Native warm-season plants begin growth in early May and continue to late August. 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)	113-126 days
Freeze-free period (characteristic range)	134-145 days

Precipitation total (characteristic range)	21-26 in
Frost-free period (actual range)	85-128 days
Freeze-free period (actual range)	96-148 days
Precipitation total (actual range)	20-27 in
Frost-free period (average)	115 days
Freeze-free period (average)	132 days
Precipitation total (average)	24 in

Climate stations used

- (1) KILGORE 1NE [USC00254432], Kilgore, NE
- (2) VALENTINE MILLER FLD [USW00024032], Valentine, NE
- (3) MISSION 14 S [USC00395638], Mission, SD
- (4) MISSION [USC00395620], Mission, SD
- (5) WINNER WILEY FLD [USW00094990], Winner, SD
- (6) GREGORY [USC00393452], Gregory, SD
- (7) SPRINGVIEW [USC00258090], Springview, NE
- (8) AINSWORTH [USC00250050], Ainsworth, NE
- (9) NEWPORT [USC00255925], Newport, NE
- (10) BUTTE [USC00251365], Butte, NE
- (11) FAIRFAX #2 [USC00392822], Fairfax, SD
- (12) LYNCH [USC00255040], Lynch, NE
- (13) ATKINSON 3SW [USC00250420], Atkinson, NE
- (14) O NEILL [USC00256290], Oneill, NE
- (15) EWING [USC00252805], Ewing, NE

Influencing water features

No significant water features influence this site.

Soil features

The soils associated with the Shallow to Gravel ecological site are shallow to very deep and well drained to excessively drained. Soils are formed in loamy or sandy alluvium or sandy eolian materials over gravelly alluvium. Soil surface textures are typically sandy loam, fine sandy loam or sand but may be loamy sand or loam. Slopes range from 0 to 30 percent. Permeability is moderate to rapid. The distinguishing feature of all soils correlated to the Shallow to Gravel ecological site is the presence of at least 15 percent gravel within 20 inches of the surface.

Runoff as evidenced by patterns of rill, gully, or other water flow is negligible to low, in spite of the steep slopes, due to the very high intake rate of these soils. Cryptobiotic crusts are present, but their function is not well understood. Pedestalling occurs on less than 5 percent of the plants and is not very evident on casual observation.

The primary soil series correlated to this site are Meadin and Simeon. More information can be found in the various soil survey reports. Contact the local USDA Service Center for soil survey reports that include more detail specific to your location. Contact the local USDA Service Center for soil survey reports that include more detail specific to your location or visit Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov).

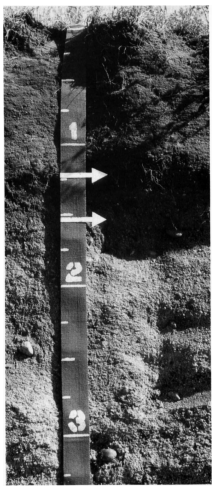


Figure 9. Meadin series profile

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Outwash
Surface texture	(1) Sandy loam (2) Fine sandy loam (3) Sand (4) Loamy sand (5) Loam
Family particle size	(1) Sandy
Drainage class	Well drained to excessively drained
Permeability class	Moderate to rapid
Soil depth	0–80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	1.2–4.4 in
Calcium carbonate equivalent (Depth not specified)	0–15%
Electrical conductivity (Depth not specified)	0–2 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (Depth not specified)	5.1–8.4
Subsurface fragment volume <=3" (Depth not specified)	9–44%
Subsurface fragment volume >3" (Depth not specified)	0–7%

Ecological dynamics

Shallow to Gravel ecological sites developed under Northern Great Plains climatic conditions, light to severe grazing by bison and other large herbivores, sporadic natural or man-caused wildfire, and other biotic and abiotic factors that typically influence soil and site development. This continues to be a disturbance-driven site with herbivory, fire, and variable climate being the primary disturbances. Changes occur in the plant communities due to short-term weather variations, impacts of native and exotic plant and animal species, and management actions.

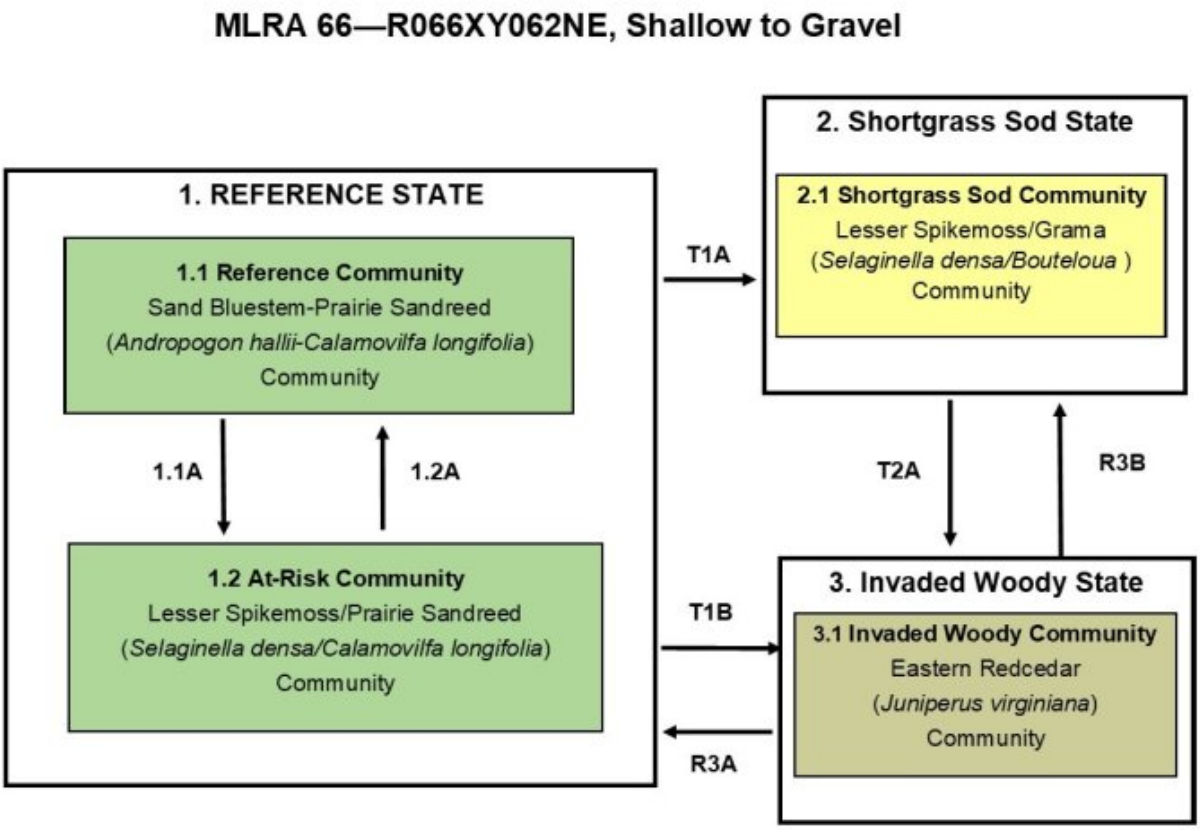
This site is extremely responsive to high moisture years when the additional moisture is received during the growing season. The associated coarse textured soils have low moisture holding capability which generally limits plant growth. With additional moisture, the interpretive plant community can significantly increase its production when compared to the production of a normal year.

The introduction of domestic livestock by European settlers along with season-long, continuous grazing had a profound impact on the vegetation of the Shallow to Gravel ecological site. Season-long, continuous grazing causes a repeated removal of the growing point and excessive defoliation of the leaf area of individual warm-season tallgrasses. The resulting reduction in the ability of the plants to harvest sunlight depletes root reserves, subsequently decreasing root mass. The ability of the plants to compete for nutrients is impaired, resulting in decreased vigor and eventual mortality. Species that evade negative grazing impacts through mechanisms such as a growing season adaptation (i.e., cool-season), growing points located near the soil surface, a shorter structure, or reduced palatability will increase. As this site deteriorates, species such as hairy grama, blue grama, and club moss will increase. Grasses such as sand bluestem, little bluestem, needle and thread, and sideoats grama will decrease in frequency and production. Perennial forbs increase and if management persists, annual forbs and shrubs will also increase as grasses decrease.

The State and Transition Model (STM) is depicted below and includes a Reference State (1), a Shortgrass Sod State (2), and an Invaded Woody State (3). Each state represents the crossing of a major ecological threshold due to the alteration of the functional dynamic properties of the ecosystem. The primary properties observed to determine this change are soil stability, vegetative communities, and the hydrologic cycle. Each state may have one or more plant communities that fluctuate in species composition and abundance within the normal parameters of the state. Within each state, communities may degrade or recover in response to natural and man caused disturbances such as variation in the degree and timing of herbivory, presence or absence of fire, and climatic and local fluctuations in the precipitation regime. The processes that cause the movement between the states and communities are discussed in more detail in the state and community descriptions following the diagram.

Interpretations are primarily based on the Reference Community (1.1). The composition of this community has been determined by the study of rangeland relic areas, areas protected from excessive disturbance, and areas under long-term rotational grazing regimes. The information associated with other plant communities, states, transitional pathways, and thresholds have been determined by studying trends in plant community dynamics on areas ranging from heavily grazed to lightly grazed areas, and seasonal use pastures, as well as historical accounts.

State and transition model



Transitions and Restorations:
T1A: Long-term (>10 years) heavy grazing or haying with inadequate recovery periods..
T1B: Woody encroachment and no fire or woody species management.
T2A: Woody encroachment and no fire or woody species management.
R3A: Prescribed burning, wildfire, timber harvest, brush management.
R3B: Prescribed burning, wildfire, timber harvest, brush management.

Community Pathways:
1.1A: Continuous season-long, continuous seasonal, or rotational grazing with inadequate recovery periods.
1.2A: Prescribed grazing with adequate growing season recovery periods.

Figure 10. State and Transition Model Diagram. MLRA 66, Shallow to Gravel Ecological Site.

State 1
Reference State

The Reference State (1) describes the range of vegetative communities that occur on the Shallow to Gravel ecological site where the range of natural variability under historic conditions and disturbance regimes is mostly intact. The Reference State developed under the combined influences of climatic conditions, periodic fire activity, grazing by large herbivores, and impacts from small mammals and insects. High perennial grass cover and production allows for increased soil moisture retention, vegetative production and overall soil quality. The Reference State includes two plant community phases which are the Reference Community (1.1) and the At-Risk Community (1.2). The Reference Community serves as a description of the native plant community that naturally occurs on the site when the natural disturbance regimes are intact or closely mimicked by management practices. The At-Risk Community results from management decisions that are unfavorable for a healthy Reference Community.

Dominant plant species

- sand bluestem (*Andropogon hallii*), grass
- prairie sandreed (*Calamovilfa longifolia*), grass
- needle and thread (*Hesperostipa comata ssp. comata*), grass
- blue grama (*Bouteloua gracilis*), grass
- lesser spikemoss (*Selaginella densa*), other herbaceous

Community 1.1
Reference Community

The Reference Community or Sand Bluestem-Prairie Sandreed (*Andropogon hallii-Calamovilfa longifolia*) Plant Community (1.1) serves as a description of the native plant community that occurs on the site when the natural disturbance regimes are intact or are closely mimicked by management practices. This phase is dynamic, with fluid relative abundance and spatial boundaries between the dominant structural vegetative groups. These fluctuations are primarily driven by different responses of the species to changes in precipitation timing and abundance, and to fire and grazing events. This site developed with grazing by large herbivores and is well suited for grazing by domestic livestock. The major grasses include blue grama, sand bluestem, prairie sandreed, and needle and thread. Other grasses occurring on this plant community include sand dropseed, prairie junegrass, little bluestem, and sideoats grama. The potential vegetation is 70 to 80 percent grasses or grass-like plants, 1 to 5 percent forbs, 5 to 15 percent shrubs, and 1 to 10 percent cryptogams. Natural fire played a significant role in the succession of this site by limiting woody species from becoming established. Wildfires have been actively controlled in recent times, allowing occasional eastern redcedar encroachment. This plant community can be found on areas that are managed with prescribed grazing, prescribed burning, and may be found on areas receiving occasional periods of short-term rest. This resilient community is well adapted to the Northern Great Plains climatic conditions. Plant diversity promotes strong tolerance to drought, site and soil stability, a functional hydrologic cycle, and a high degree of biotic integrity. This community phase is dynamic, with fluid relative abundance and spatial boundaries between the dominant structural vegetative groups. Plant communities fluctuate more than those on other ecological sites due to the high amount of gravel in the surface layers and the accompanying low water holding capacity of the soils.

Dominant plant species

- sand bluestem (*Andropogon hallii*), grass
- prairie sandreed (*Calamovilfa longifolia*), grass
- blue grama (*Bouteloua gracilis*), grass
- needle and thread (*Hesperostipa comata ssp. comata*), grass

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	910	1312	1700
Shrub/Vine	75	160	250
Microbiotic Crusts	0	80	165
Forb	15	48	85
Total	**1000**	**1600**	**2200**

Figure 12. Plant community growth curve (percent production by month). NE6637, Eroded Tableland, warm-season dominant, cool-season subdominant.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		5	8	15	24	23	15	5	5		

Community 1.2
At-Risk Community

The At-Risk Community or Club Moss/Prairie Sandreed (*Selaginella densa*/Calamovilfa-longifolia) Community (1.2) develops with moderate stocking rates and continuous season-long, continuous seasonal grazing during the summer, or with rotational grazing with inadequate growing season recovery periods. This community is dominated by warm-season grasses. Perennial forbs, sedges, shrubs, and cryptogams are also significant. Prairie sandreed, blue grama, and lesser spikemoss are the dominant species in this plant community. Grasses of secondary importance include little bluestem, prairie Junegrass, and sand dropseed. Common forbs include lacy tansyaster, goldenrod, sageworts, cuman ragweed, and hoary verbena. Significant shrubs include brittle pricklypear, broom snakeweed, plains pricklypear, and prairie sagewort. The potential vegetation is 70 to 80 percent grasses or grass-like plants, 5 to 15 percent shrubs, 1 to 5 percent forbs, and 5 to 15 percent cryptogams. When compared to the Reference Community (1.1), prairie sandreed and club moss have increased while little bluestem and needle and thread have decreased. Production from other cool- and warm-season grasses has also been reduced. Sedges have increased as a result of summer grazing pressure. This plant community is moderately resistant to change. The herbaceous species present are well adapted to grazing but species composition can be altered through long-term overgrazing. If the herbaceous component is intact, it tends to be resilient unless the disturbance is long-term.

Dominant plant species

- prairie sagewort (*Artemisia frigida*), shrub
- broom snakeweed (*Gutierrezia sarothrae*), shrub
- brittle pricklypear (*Opuntia fragilis*), shrub
- plains pricklypear (*Opuntia polyacantha*), shrub
- blue grama (*Bouteloua gracilis*), grass
- prairie sandreed (*Calamovilfa longifolia*), grass
- lesser spikemoss (*Selaginella densa*), other herbaceous

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	595	830	1070
Shrub/Vine	50	110	170
Microbiotic Crusts	50	110	170
Forb	5	50	90
Total	**700**	**1100**	**1500**

Figure 14. Plant community growth curve (percent production by month). NE6637, Eroded Tableland, warm-season dominant, cool-season subdominant.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		5	8	15	24	23	15	5	5		

Pathway 1.1A
Community 1.1 to 1.2

Continuous season-long, continuous seasonal grazing during the summer months, or rotational grazing with inadequate growing season recovery periods will convert the Reference Community (1.1) to the At-Risk Community (1.2).

Pathway 1.2A
Community 1.2 to 1.1

Prescribed grazing with adequate recovery periods during the growing season will return the At-Risk Community (1.2) to the Reference Community (1.1).

State 2
Shortgrass Sod State

The Shortgrass Sod State (2) has transitioned from the Reference State (1) and much of the native, warm-season, tall- and midgrass components have been replaced by less desirable plants. The loss of warm-season tall- and midgrasses has negatively impacted energy flow and nutrient cycling. Water infiltration is reduced due to the shallow root system and rapid runoff characteristics of shortgrass sod communities. The Shortgrass Sod State includes the Shortgrass Sod Community (2.1).

Dominant plant species

- brittle pricklypear (*Opuntia fragilis*), shrub
- plains pricklypear (*Opuntia polyacantha*), shrub
- broom snakeweed (*Gutierrezia sarothrae*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- blue grama (*Bouteloua gracilis*), grass
- hairy grama (*Bouteloua hirsuta*), grass
- lesser spikemoss (*Selaginella densa*), other herbaceous

Community 2.1
Shortgrass Sod Community

The Shortgrass Sod or Lesser Spikemoss/Grama (*Selaginella densa*/Bouteloua) Community (2.1) is often found near watering facilities under continuous, summer-long grazing with moderate grazing pressure, or pasture-wide under heavy grazing. Dominant plants include blue grama, hairy grama, and lesser spikemoss. Grasses of secondary importance include sand dropseed and prairie junegrass. Forbs commonly found in this plant community include Cuman ragweed, sageworts, lacy tansyaster, and goldenrod. The significant shrubs include brittle pricklypear, broom snakeweed, and prairie sagewort. The potential vegetation is about 45 percent grasses or grass-like plants, 10 percent forbs, 15 percent shrubs, and 30 percent cryptogams. When compared to the Reference Community (1.1), blue grama, hairy grama, and lesser spikemoss have increased while little bluestem and sand bluestem have been reduced to remnants or are absent. Production has been significantly reduced. In areas where gravel is very near the surface, lesser spikemoss is dominant. Lesser spikemoss also occupies bare soil areas which have developed due to long-term repeated disturbances. Spikemoss cover is often 30 percent or greater. Spikemoss creates an arid microclimate which results in extreme competition for available moisture. As spikemoss is more successful in capturing moisture, the vigor and production of other species is reduced dramatically. Runoff is initially low but once spikemoss has become saturated, runoff increases and infiltration decreases as compared to the Reference Community. Soil erosion is minimal.

Dominant plant species

- brittle pricklypear (*Opuntia fragilis*), shrub
- plains pricklypear (*Opuntia polyacantha*), shrub
- broom snakeweed (*Gutierrezia sarothrae*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- blue grama (*Bouteloua gracilis*), grass
- hairy grama (*Bouteloua hirsuta*), grass
- lesser spikemoss (*Selaginella densa*), other herbaceous

Table 7. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	265	451	635
Microbiotic Crusts	100	157	215
Forb	5	39	75
Shrub/Vine	30	53	75
Total	**400**	**700**	**1000**

State 3
Invaded Woody State

Figure 16. Shallow to Gravel Ecological Site, Invaded Woody State (3), Brown County Nebraska.

The Invaded Woody State (3) is the result of woody encroachment. Once the tree canopy cover reaches 15 percent with an average tree height exceeding five feet, the threshold to the Invaded Woody State has been crossed. Woody species are increasing due to the lack of prescribed fire, brush management, or other woody tree removal. Typical ecological impacts are a loss of native grasses, reduced diversity of functional and structural groups, reduced forage production, and reduced soil quality. Prescribed burning, wildfire, timber harvest and brush management will move the Invaded Woody State toward a grass dominated state. If the Invaded Woody State transitioned from Shortgrass Sod State (2), the land cannot return to the Reference State (1) as the native plant community, soils, and hydrologic function had been too severely impacted prior to the woody encroachment to allow the return to the Reference State through woody species removal alone. The Invaded Woody State includes one community, the Invaded Woody Community (3.1).

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree

Community 3.1
Invaded Woody Community

Figure 17. Shallow to Gravel Ecological Site Invaded Woody Community (3.1), Brown County, Nebraska.

The Invaded Woody or Eastern Redcedar (*Juniperus virginiana*) Community (3.1) has at least 15 percent woody canopy cover consisting of trees generally 5 feet or taller. Encroaching trees are primarily eastern redcedar. Additional woody cover from deciduous trees and shrubs may be present. In the absence of fire and brush management, this ecological site is very susceptible to eastern redcedar seedling invasion, especially when adjacent to a seed source. Eastern redcedar can eventually dominate the site resulting in a closed canopy monoculture which drastically reduces forage production and which has limited value for either livestock grazing or wildlife habitat. With long-term fire suppression, this plant community will develop extensive ladder fuels which can lead to a removal of most tree species with a wildfire. With properly managed intensive grazing, encroachment of deciduous trees will be minimal; however, this will not impact encroachment of conifer species. The herbaceous component decreases proportionately in relation to the percent canopy cover, with the reduction being greater under a conifer overstory. Eastern redcedar control can usually be accomplished with prescribed burning while the trees are six feet tall or less and fine fuel production is greater than 1,500 pounds per acres. Larger red cedars can also be controlled with prescribed burning, but successful application requires the use of specifically designed ignition and holding techniques (https://www.loesscanyonsburning group.com). Resprouting brush must be chemically treated immediately after mechanical removal to achieve effective treatment. The forb component will initially increase following tree removal. To prevent return to a woody dominated community, ongoing brush management such as hand cutting, chemical spot treatments, or periodic prescribed burning is required . This plant community is resistant to change and resilient given normal disturbances. In higher canopy cover situations, the soil erosion will increase in relation to most of the plant communities from which this plant community originated. The water cycle is also significantly altered under higher canopy cover. Infiltration is reduced and runoff is typically increased because of a lack of herbaceous cover and the rooting structure provided by the herbaceous species. Total annual production during an average year varies significantly, depending on the production level prior to encroachment and the percentage of canopy cover.

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- Kentucky bluegrass (*Poa pratensis*), grass

Transition T1A
State 1 to 2

Long-term (more than 10 years) heavy grazing or haying without adequate recovery periods will cause the Reference State (1) to lose a significant proportion of warm-season, tall- and midgrass species and cross a threshold to the Shortgrass Sod State (2). Water infiltration and other hydrologic functions will be reduced due to the root-matting presence of sod-forming grasses. With the decline and loss of deeper-penetrating root systems, soil structure and biotic integrity are degraded to the point that recovery is unlikely. Once this occurs, a return to the Reference State is highly unlikely.

Transition T1B
State 1 to 3

Disruption of the natural fire regime and the encroachment of invasive exotic and native woody species can cause the Reference State (1) to transition to the Invaded Woody State (3).

Transition T2A
State 2 to 3

Disruption of the natural fire regime and the encroachment of invasive exotic and native woody species can cause the Shortgrass Sod State (2) to transition to the Invaded Woody State (3).

Restoration pathway R3A
State 3 to 1

Prescribed burning, wildfire, timber harvest, and brush management will move the Invaded Woody State (3) toward the Reference State (1). The forb component may initially increase following tree removal. Ongoing brush management such as hand cutting, chemical spot treatments, or periodic prescribed burning is required to prevent a return to the Invaded Woody State. The heavier the existing canopy cover, the greater the energy input required to return to the Reference State by management practices. The amount of time required for this restoration to occur depends on the severity and duration of the encroachment. Land that transitioned to the Invaded Woody State from the Shortgrass Sod State (2) cannot be restored to the Reference State through removal of the woody species as the native plant community, soils, and hydrologic function have been too severely impacted for that restoration to occur.

Restoration pathway R3B
State 3 to 2

Prescribed burning, wildfire, harvest, and brush management will move the Invaded Woody State (3) toward the Shortgrass Sod State (2). The forb component may initially increase following tree removal. Ongoing brush management such as hand cutting, chemical spot treatments, or periodic prescribed burning is required to prevent a return to the Invaded Woody State. The heavier the existing canopy cover, the greater the energy input required to return to the Shortgrass Sod State by management practices. The amount of time required for this restoration to occur depends on the severity and duration of the encroachment. Land that transitioned from the Shortgrass Sod State into the Invaded Woody State cannot return to the Reference State (1) through the removal of woody species as the native plant community, soils, and hydrologic function have been too severely impacted for that restoration to occur.

Additional community tables

Table 8. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm-Season Tallgrass**			240–560	
	sand bluestem	ANHA	*Andropogon hallii*	160–400	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	80–320	–
2	**Warm-Season Shortgrass**			240–400	
	blue grama	BOGR2	*Bouteloua gracilis*	160–320	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	80–160	–
	threeawn	ARIST	*Aristida*	0–48	–
3	**Cool-Season Bunchgrass**			160–320	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	160–320	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–80	–
	green needlegrass	NAVI4	*Nassella viridula*	0–80	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–80	–

4	**Warm-Season Midgrass**			160–240	
	little bluestem	SCSC	*Schizachyrium scoparium*	80–160	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	80–160	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–160	–
	purple lovegrass	ERSP	*Eragrostis spectabilis*	0–48	–
5	**Cool-Season Rhizomatous Grass**			0–80	
	western wheatgrass	PASM	*Pascopyrum smithii*	0–80	–
7	**Grass-Like**			0–80	
	sedge	CAREX	*Carex*	0–80	–
Forb					
8	**Forb**			16–80	
	purple prairie clover	DAPU5	*Dalea purpurea*	0–32	–
	Forb, perennial	2FP	*Forb, perennial*	0–32	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–32	–
	goldenrod	SOLID	*Solidago*	0–32	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–32	–
	spiderwort	TRADE	*Tradescantia*	0–16	–
	hoary verbena	VEST	*Verbena stricta*	0–16	–
	tarragon	ARDR4	*Artemisia dracunculus*	0–16	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–16	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–16	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–16	–
	blazing star	LIATR	*Liatris*	0–16	–
	rush skeletonplant	LYJU	*Lygodesmia juncea*	0–16	–
	lacy tansyaster	MAPI	*Machaeranthera pinnatifida*	0–16	–
	scurfpea	PSORA2	*Psoralidium*	0–16	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–16	–
Shrub/Vine					
9	**Shrub**			80–240	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–80	–
	leadplant	AMCA6	*Amorpha canescens*	0–80	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–80	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–80	–
	brittle pricklypear	OPFR	*Opuntia fragilis*	0–80	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–80	–
	rose	ROSA5	*Rosa*	0–80	–
Microbiotic Crusts					
10	**Cryptogam**			0–160	
	lesser spikemoss	SEDE2	*Selaginella densa*	0–160	–

Table 9. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm-Season Tallgrass**			165–385	

1	**Warm-Season Tallgrass**			165–385	
	prairie sandreed	CALO	*Calamovilfa longifolia*	165–385	–
	sand bluestem	ANHA	*Andropogon hallii*	0–110	–
2	**Warm-Season Shortgrass**			165–440	
	blue grama	BOGR2	*Bouteloua gracilis*	110–275	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	55–165	–
	threeawn	ARIST	*Aristida*	0–88	–
3	**Cool-Season Bunchgrass**			55–110	
	prairie Junegrass	KOMA	*Koeleria macrantha*	55–110	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–55	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–55	–
	green needlegrass	NAVI4	*Nassella viridula*	0–55	–
4	**Warm-Season Midgrass**			11–165	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–110	–
	purple lovegrass	ERSP	*Eragrostis spectabilis*	0–55	–
	little bluestem	SCSC	*Schizachyrium scoparium*	0–55	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	0–55	–
5	**Cool-Season Rhizomatous Grass**			0–55	
	western wheatgrass	PASM	*Pascopyrum smithii*	0–55	–
7	**Grass-Like**			0–110	
	sedge	CAREX	*Carex*	0–110	–
8	**Non-Native Cool-Season Grass**			0–55	
	cheatgrass	BRTE	*Bromus tectorum*	0–55	–
	bluegrass	POA	*Poa*	0–55	–
Forb					
9	**Forb**			11–55	
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–33	–
	hoary verbena	VEST	*Verbena stricta*	0–22	–
	Forb, perennial	2FP	*Forb, perennial*	0–22	–
	goldenrod	SOLID	*Solidago*	0–22	–
	tarragon	ARDR4	*Artemisia dracunculus*	0–22	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–22	–
	lacy tansyaster	MAPI	*Machaeranthera pinnatifida*	0–22	–
	blazing star	LIATR	*Liatris*	0–11	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–11	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–11	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–11	–
	purple prairie clover	DAPU5	*Dalea purpurea*	0–11	–
	rush skeletonplant	LYJU	*Lygodesmia juncea*	0–11	–
	scurfpea	PSORA2	*Psoralidium*	0–11	–
	spiderwort	TRADE	*Tradescantia*	0–11	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–11	–
Shrub/Vine					
10	**Shrub**			55–165	

	brittle pricklypear	OPFR	*Opuntia fragilis*	0–55	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–55	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–55	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–55	–
	rose	ROSA5	*Rosa*	0–55	–
	leadplant	AMCA6	*Amorpha canescens*	0–33	–
Microbiotic Crusts					
11	**Cryptogam**			55–165	
	lesser spikemoss	SEDE2	*Selaginella densa*	55–165	–

Table 10. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm-Season Tallgrass**			35–70	
	prairie sandreed	CALO	*Calamovilfa longifolia*	35–70	–
2	**Warm-Season Shortgrass**			175–315	
	blue grama	BOGR2	*Bouteloua gracilis*	175–315	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	35–210	–
	threeawn	ARIST	*Aristida*	0–105	–
3	**Cool-Season Bunchgrasses**			0–35	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–35	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–35	–
4	**Warm-Season Midgrass**			35–105	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	35–105	–
5	**Cool-Season Rhizomatous Grass**			0–14	
	western wheatgrass	PASM	*Pascopyrum smithii*	0–14	–
7	**Grass-Like**			0–35	
	sedge	CAREX	*Carex*	0–35	–
8	**Non-Native Cool-Season Grass**			35–70	
	cheatgrass	BRTE	*Bromus tectorum*	35–70	–
	bluegrass	POA	*Poa*	0–70	–
Forb					
9	**Forb**			7–70	
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–35	–
	hoary verbena	VEST	*Verbena stricta*	0–21	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–21	–
	Forb, perennial	2FP	*Forb, perennial*	0–14	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–14	–
	tarragon	ARDR4	*Artemisia dracunculus*	0–14	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–7	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–7	–
	rush skeletonplant	LYJU	*Lygodesmia juncea*	0–7	–
	scurfpea	PSORA2	*Psoralidium*	0–7	–
	goldenrod	SOLID	*Solidago*	0–7	–

	goldenrod	SOLID	*Solidago*	0–7	
Shrub/Vine					
10	**Shrub**			35–70	
	brittle pricklypear	OPFR	*Opuntia fragilis*	0–35	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–35	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–35	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–35	–
	rose	ROSA5	*Rosa*	0–14	–
Microbiotic Crusts					
11	**Cryptogam**			105–210	
	lesser spikemoss	SEDE2	*Selaginella densa*	105–210	–

Animal community

LIVESTOCK - GRAZING INTERPRETATIONS:
Grazing by domestic livestock is one of the major income-producing industries in the area. Rangeland in this area may provide year-long forage for cattle, sheep, or horses. During the dormant period, the protein levels of the forage may be lower than the minimum needed to meet livestock (primarily cattle and sheep)requirements. The following table lists suggested stocking rates for cattle under continuous season-long grazing under normal growing conditions. These are conservative estimates that should be used only as guidelines in the initial stages of the conservation planning process. Often, the current plant composition does not entirely match any particular plant community (as described in this ecological site description). Because of this, a field visit is recommended, in all cases, to document plant composition and production. More precise carrying capacity estimates should eventually be calculated using this information along with animal preference data, 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.

Production and Carrying Capacity*
Community 1.1, Reference Community: 1,600 lbs/acre, 0.44 AUM/acre
Community 1.2, At-Risk Community: 1,100 lbs/acre, 0.30 AUM/acre
Community 2.1, Shortgrass Sod Community: 700 lbs/acre, 0.19 AUM/acre

*Based upon the following conditions: continuous season-long grazing by cattle under average growing conditions, 25 percent harvest efficiency. Air dry forage requirements based on 3 percent of animal body weight, or 912 lbs/AU/month.

WILDLIFE INTERPRETATIONS:
Major Land Resource Area (MLRA) 66 lies primarily within the Mixed-Grass Prairie ecosystem. Though European settlers have converted about a quarter of this landscape to farmland, the majority of the prairie is still intact. This area still consists of diverse grassland habitats interspersed with varying densities of depressional wetlands and limited woody riparian corridors. These habitats historically provided critical life cycle components for the grassland birds, prairie dogs, and herds of roaming bison, elk, and pronghorn. Bobcats, wolves, and mountain lions occupied the apex predator niche. Diverse populations of small mammals and insects still provide a bountiful prey base for raptors and omnivores such as coyotes, foxes, raccoons, and opossums. In addition, a wide variety of reptiles and amphibians thrive in this landscape.

The Mixed-Grass Prairie was a disturbance-driven ecosystem with fire, herbivory, and climate functioning as the primary disturbances. Following European settlement, elimination of fire, overgrazing, and some habitat fragmentation significantly altered the appearance and functionality of the entire ecosystem. Bison and prairie dogs were historically keystone species, but free-roaming bison herds have been extirpated in this region. The loss of bison and fire as ecological drivers greatly influenced the character of the remaining native grasslands and the habitats that they provide. Fragmentation has reduced habitat quality for numerous area-sensitive species, as highlighted by the decline of the greater prairie chicken.

Historically, an ecological mosaic of the sites provided habitat for species requiring unfragmented grasslands. Most

of these important habitat features and components are intact, providing upland nesting habitat for grassland birds and game birds; nesting and escape cover for waterfowl; forbs and insects for brood-rearing habitat; and a forage source for small and large herbivores. Disruption of the natural fire regime and lack of appropriate grazing management are the greatest threats to the ecosystem dynamics today.

Tree and shrub encroachment from lack of fire creates habitat that favors generalist species such as American robin and mourning dove, and provides perches for raptors, increasing the predation mortality on native bird populations. Introduced species such as smooth bromegrass, Kentucky bluegrass, nodding plumeless thistle (musk thistle), and Canada thistle further degrade the biological integrity of many areas of the prairie.

Hydrological functions

Water is the principal factor limiting forage production on this site. Runoff is expected to occur only during the most intense storms (refer to Section 4, NRCS National Engineering Handbook for runoff quantities and hydrologic curves).

Pedestals are only slightly present in association with bunchgrasses such as needle and thread. Litter typically falls in place on flat slopes. Chemical and physical crusts are rare to non-existent. Cryptogamic crusts are present but only cover 1-2 percent of the soil surface. This crusting is not significant for hydrologic considerations. Overall, this site has the appearance of being stable and productive.

Recreational uses

This site provides hunting opportunities for upland game species. The wide variety of plants which bloom from spring until fall have an aesthetic value that appeals to visitors.

Wood products

No appreciable wood products are present on the site.

Other products

None noted.

Other information

Field Offices (Counties)
Nebraska:
Ainsworth, (Brown, Keya Paha, and Rock)
Bloomfield, (Knox,)
Spencer (Boyd)
Neligh (Antelope)
O'Neill, (Holt)
Valentine, (Cherry)

South Dakota:
Burke, (Gregory)
Martin, (Bennett and Shannon)
Winner, (Tripp)
White River, (Mellette and Todd)

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 Dave Cook, Rangeland Management Specialist, NRCS; Dwight Hale, Engineer, NRCS; Stanley Boltz, State Rangeland Management Specialist, NRCS, South Dakota; Dana Larsen, State Rangeland Management Specialist, NRCS, Nebraska; Dave

Steffen, Rangeland Management Specialist, NRCS.

There are 5 SCS-RANGE-417 records from Boyd, Holt, Brown, and Knox counties in Nebraska. The sample period was from 1968 to 1982.

There are four ocular estimates from Keya Paha County, Nebraska and Todd County South Dakota. The sample period was 2002.

Other references

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to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

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)	Original Author: Stan Boltz Version V participants: Emily Helms, Nadine Bishop, Jeff Nichols
Contact for lead author	jeffrey.nichols@usda.gov
Date	11/18/2024
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Typically, none. There may be a slight presence of rills on slopes exceeding 15 percent. When rills are present, they are discontinuous.

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2. **Presence of water flow patterns:** Typically, none. A slight presence of water flow patterns may occur on slopes exceeding 15 percent. When present, water flow patterns are slightly visible, less than 0.5 inches (1.25 cm) deep, 6 inches (15.25 cm) wide, and 5 feet (15.25 meters) long.

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3. **Number and height of erosional pedestals or terracettes:** In the hill landscape position bunch grasses may be slightly pedestalled (0.5 inch / 1.25 cm) with no exposed roots; occurrence of pedestalled plants will be rare. This pedestalling will be rare and will occur on slopes exceeding 10 percent with less than 5% of the plants being pedestalled. Drought or wildfire can contribute to increased incidences pedestalled plants.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is typically 15 percent or less and patch sizes will be less than 3 inches (7.6 cm). Multi-year drought and/or wildfire can increase bare ground to 20 to 30 percent for up to two years following the disturbance.

   Bare ground is exposed mineral soil that is not covered by vegetation (basal and/or foliar canopy), standing dead vegetation, gravel/rock, and visible biological crust (e.g., lichen, mosses, algae).

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5. **Number of gullies and erosion associated with gullies:** None. Gullies are not expected on this site.

6. **Extent of wind scoured, blowouts and/or depositional areas:** None. Wind-scoured areas and depositional areas are not expected on this site.

7. **Amount of litter movement (describe size and distance expected to travel):** Small size litter classes will generally move short distances usually less than 12 inches (30 cm). Medium size class litter will move very short distances usually less than 6 inches (15 cm). Coarse litter is not expected to move. 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 stability ratings should typically be 5 to 6, normally 6. Surface organic matter adheres to the soil surface. Soil surface fragments will typically retain structure indefinitely when dipped in distilled water.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** The A-horizon should be 6 to 15 inches (15.25-38.1 cm) thick and contains 10 to 20 percent fine and medium gravel. Soil colors are dark grayish brown, brown or grayish brown (values 4 to 5) when dry and very dark grayish brown, dark grayish brown, or dark brown (values 3 to 5) when moist. Structure is weak fine granular to single grain in upper A-horizon and single grain, weak coarse prismatic, or weak subangular blocky in the lower A-horizon.

   Meadin and Simeon are the primary soil series correlated to the Shallow to Gravel ecological site.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** The functional/structural groups provide a combination of rooting depths and structure which positively influences infiltration. Combination of shallow and deep rooted species (warm-season rhizomatous tall- and midgrasses and cool-season bunchgrasses) with fine and coarse roots positively influences infiltration. Woody encroachment may negatively influence infiltration.

    The expected composition of the plant community is 70 to 80 percent perennial grasses and grass-likes, 1 to 5 percent forbs, 5 to 15 percent shrubs, and 1 to10 percent cryptograms. The perennial grass and grass-like component is made up of C4, rhizomatous, tallgrasses (15-35%); C4, midgrasses (10-15%), C3, bunchgrasses (10-20%), C4, shortgrasses (15-25%), C3, rhizomatous grasses (0-5%); and grass-likes (0-5%).

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None. A compaction layer should not 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: Phase 1.1
    1. Native, perennial, C4, tallgrass, 240-560#/ac, 15-35 percent (2 species minimum): prairie sandreed, sand bluestem.
    2. Native, perennial, C4, shortgrasses, 240-400#/ac, 15-25 percent (2 species minimum): blue grama, hairy grama, threeawn.

    Phase 1.2
    1. Native, perennial, C4, shortgrasses, 165-440#/ac, 15-40 percent (2 species minimum): blue grama, hairy grama,

threeawn.
2. Native, perennial, C4, tallgrass, 165-385#/ac, 15-35 percent (1 species minimum): prairie sandreed, sand bluestem.

Sub-dominant: Phase 1.1
1. Native, perennial, C3 bunchgrass, 160-320 #/ac , 10-20 percent (1 species minimum).
2. Native, perennial, C4, midgrass, 160-240 #/ac, 10-15 percent, (2 species minimum).
3. Shrub, 80-240 #/ac, 5-15% (2 species minimum): leadplant, prairie sagewort, broom snakeweed, brittle pricklypear, rose or other shrubs which will vary from location to location.

Phase 1.2
1. Shrub, 55-165 #/ac, 5-15% (2 species minimum): leadplant, prairie sagewort, broom snakeweed, brittle pricklypear, plains pricklypear, rose or other plants which vary from location to location.
2. Cryptogam, 55-165 #/ac, 5-15% (1 species minimum): lesser spikemoss.
3. Native, perennial, C4, midgrass, 11-165 #/ac, 1-15 percent, (2 species minimum): needle and thread, porcupinegrass, green needlegrass, prairie Junegrass.

Other: Minor - Phase 1.1
1. Cryptogam, 0-160 #/ac, 0-10%: lesser spikemoss.
2. Native forb, 16-80#ac, 1-5%: Forbs present vary from location to location.
3. Grass-likes, 0-80 #/ac, 0-5%: sedges.
4. Native, perennial, C3, rhizomatous grasses, 0-80 #/ac, 0-5%: western wheatgrass.

Minor - Phase 1.2
1. Native, perennial, C3 bunchgrass, 55-110 #/ac , 5-10 percent: needle and thread, porcupinegrass, green needlegrass, prairie Junegrass.
2. Grass-likes, 0-110 #/ac, 0-10%: sedges.
3. Native forb, 11-55 #ac, 1-5%: forbs present vary from location to location.
4. Native, perennial, C3, rhizomatous grass, 0-55 #/ac, 0-5%: western wheatgrass.
5. Non-native, C3 grass: 0-55 #/ac, 0-5%: cheatgrass, Kentucky bluegrass.

Additional: The Reference Community or Sand Bluestem-Prairie Sandreed Community (1.1) consists of nine F/S groups. These groups are, in order of relative abundance, native, perennial, C4, tallgrass; native, perennial, C4, shortgrass; native, perennial, C3, bunchgrass; native, perennial, C4, midgrass; shrub; cryptogam; native forb; grass-like = native, perennial, C3, rhizomatous grass. The Club Moss/Prairie Sandreed Community (1.2) includes 10 F/S groups. These groups are, in order of relative abundance, Native, perennial, C4, shortgrass; native, perennial, C4, tallgrass; shrub = cryptogam; native, perennial, C4, midgrass; native, perennial, C3 bunchgrass; grass-like; native forb; native, perennial, C3 rhizomatous grass = non-native, C3 grass.

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Bunch grasses have strong, healthy centers with few (less than 3 percent) dead centers. Shrubs may show some dead branches (less than 5 percent) as plants age.

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14. **Average percent litter cover (%) and depth (in):** Plant litter cover is evenly distributed throughout the site and is expected to be 40 to 60 percent and at a depth of approximately 0.25 inch (0.65 cm).

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** The representative value (RV) for annual production is 1,600 pounds per acre on an air dry weight basis. Low and High production years should yield 1,000 and 2,200 pounds per acre respectively..

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:** No non-native invasive species are present. Annual bromes (cheatgrass and Japanese/field), common mullein, smooth brome, and eastern red cedar are known invasives that have the potential to become dominant or co-dominant on this site. Consult the state noxious weed and state watch lists for potential invasive species. Note: species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants.

17. **Perennial plant reproductive capability:** All perennial species exhibit high vigor relative to recent weather conditions. Perennial grasses should have vigorous rhizomes or tillers; vegetative and reproductive structures are not stunted. All perennial species should be capable of reproducing annually.