USDA Natural Resources
Conservation Service

Ecological site R064XY029NE
Sandy Lowland

Last updated: 12/16/2024
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.

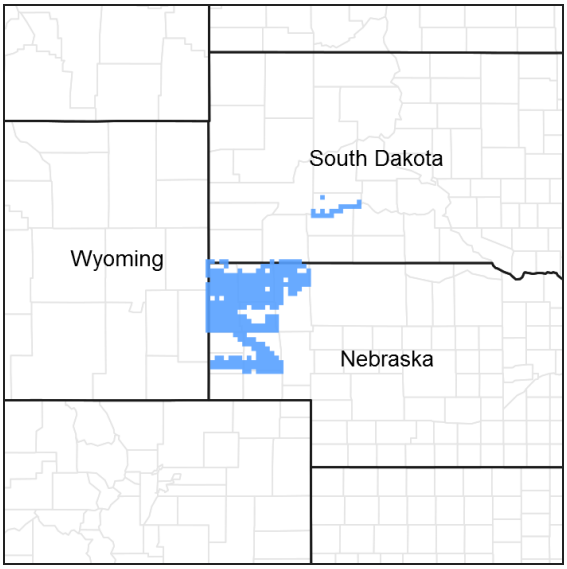


Figure 1. Mapped extent

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): 064X–Mixed Sandy and Silty Tableland and Badlands

The Mixed Sandy and Silty Tableland and Badlands (MLRA 64) is shared almost equally between South Dakota (42 percent) and Nebraska (41 percent). A small portion is in Wyoming (17 percent). The MLRA consists of 11,895 square miles. The towns of Kadoka and Pine Ridge, South Dakota; Chadron and Alliance, Nebraska; and Lusk, Wyoming, are all within the boundaries of this MLRA.

The following areas of special interest are in this MLRA: Agate Fossil Beds National Monument, Chadron State Park, Fort Robinson State Park, and the Pine Ridge Indian Reservation; parts of the Oglala and Buffalo Gap National Grasslands, which are in the Nebraska National Forest; and nearly all of Badlands National Park. The Badlands are internationally renowned for their Oligocene vertebrate fossils.
The northern section of the MLRA consists of old plateaus and terraces that have been deeply eroded by wind, water, and time. The southern section consists of nearly level to broad intervalley remnants of smooth fluvial plains. These two sections are separated by the Pine Ridge escarpment. Elevations gradually increase from 2,950 to 5,073 feet from east to west. The main drainageway through Badlands National Park is the White River. The headwaters of both the White and Niobrara Rivers are in MLRA 64. The Pine Ridge escarpment is at the northernmost extent of the Ogallala Aquifer.

Tertiary continental sediments consisting of sandstone, siltstone, and claystone underlie most of the area. Many of

the bedrock units in the southern third of the MLRA are covered by loess. Soils range from shallow to very deep and from generally well drained to excessively drained. They are loamy or sandy. The Badlands consist of stream-laid layers of silt, clay, and sand mixed with layers of volcanic ash.

Average annual precipitation for the area ranges from 14 to 20 inches. Most of the rainfall occurs as frontal storms in the spring and early summer. This area supports a mixture of short-, mid-, and tall-statured warm- and cool-season grasses. On the Pine Ridge Escarpment, these plants grow in association with ponderosa pine, Rocky Mountain juniper, western snowberry, skunkbush sumac, common chokecherry, and rose. Wyoming big sagebrush grows in minor amounts in the drier, far western portion of the MLRA; however, small remnant stands can be found in the eastern portion of the Oglala National Grassland in Nebraska.

Sixty percent of the MLRA is grassland, 11 percent of which is under Federal management. Twenty-two percent of the area is used as cropland, and 4 percent is forested. Major resource concerns include wind erosion, water erosion, and surface water quality (USDA-NRCS, 2006, Ag Handbook 296).

For development of ecological sites, MLRA 64 is divided into two precipitation zones (PZ): 14 to 17 inches per year and 17 to 20 inches per year. The wetter zone extends from the western end of the Pine Ridge Escarpment near Lusk, Wyoming, eastward along the escarpment through Nebraska and into the Big Badlands area of South Dakota. The drier zone extends from Wyoming eastward to Alliance and Oshkosh, Nebraska, south of the Pine Ridge Escarpment. MLRA 64 stops at the western edge of the Nebraska Sand Hills (MLRA 65).

A unique geologic area known as the Hartville Uplift is in the far southwest corner of the 14 to 17 inch precipitation zone. The Hartville Uplift is an elongated, north-northwest-oriented, broad domal arch of Laramide age (70-50 million years ago). It extends approximately 45 miles between Guernsey and Lusk, Wyoming, and is 15 miles wide at its widest point. Erosion has exposed a core of granite and Precambrian metasedimentary and metavolcanic rocks (Steele et al., 2018). In addition to the ecological sites in the 14 to 17 inch precipitation zone of MLRA 64, three unique ecological site descriptions were developed to describe the soils and plant community dynamics in the Hartville Uplift.

Classification relationships

USDA Land Resource Region G—Western Great Plains Range and Irrigated Region:
Major Land Resource Area (MLRA) 64—Mixed Sandy and Silty Tableland and Badlands

U.S. Environmental Protection Agency (EPA)
Level IV Ecoregions of the Conterminous United States:
High Plains—25:
Pine Ridge Escarpment—25a.
Flat to Rolling Plains—25d.
Pine Bluffs and Hills—25f.
Sandy and Silty Tablelands—25g.
Northwestern Great Plains—43:
White River Badlands—43h.
Keya Paha Tablelands—43i.

USDA Forest Service
Ecological Subregions: Sections and Subsections of Conterminous United States:
Great Plains and Palouse Dry Steppe Province—331:
Western Great Plains Section—331F:
Subsections:
Shale Scablands—331Fb.
White River Badlands—331Fh.
Pine Ridge Escarpment—331Fj.
High Plains—331Fk.
Hartville Uplift—331Fm.
Western Nebraska Sandy and Silty Tablelands—331Fn.
Keye Paha Tablelands—331Ft.
Powder River Basin Section—331G:

Subsection: Powder River Basin—331Ge.

Ecological site concept

The Sandy Lowland ecological site is located on river valley landscapes, on flood plains, and on low terraces. It can receive additional moisture from runoff or overflow. Typically, slopes range from 0 to 6 percent. The soils formed in stratified sandy alluvium. Soils are very deep (greater than 60 inches). The surface layer is loamy sand, sand, fine sandy loam, or loam and is 2 to 12 inches thick. Subsoils are loamy sand, sand, or fine sandy loam. The soils are slightly calcareous in places.

The vegetation in the Reference State (1.0) consists of warm- and cool-season grasses and grass-like species. Little bluestem, big bluestem or sand bluestem, prairie sandreed, and blue grama are dominant. Cool-season grasses and grass-like species include needle and thread and various sedges. Forbs are common and diverse. Shrubs can include leadplant, rose, and silver sagebrush. Trees include cottonwood, green ash, and boxelder.

Associated sites

R064XY026NE	**Loamy Overflow** The Loamy Overflow ecological site is adjacent to the stream channel below the Sandy Lowland ecological site.
GX064X01X028	**Loamy Terrace** The Loamy Terrace ecological site is on terraces above the Sandy Lowland ecological site. The Loamy Terrace community has more wheatgrass and lower forage production than the Sandy Lowland ecological site. The Loamy Terrace does not have regeneration of cottonwood.

Similar sites

GX064X01X028	**Loamy Terrace** The Loamy Terrace ecological site is on terraces above the Sandy Lowland ecological site. The Loamy Terrace community has more wheatgrass and lower forage production than the Sandy Lowland ecological site. The Loamy Terrace does not have regeneration of cottonwood.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Andropogon hallii* (2) *Calamovilfa longifolia*

Physiographic features

The Sandy Lowland ecological site is located on nearly level flood plains and stream terraces adjacent to streams.

Table 2. Representative physiographic features

Landforms	(1) Alluvial fan (2) Stream terrace (3) Flood plain
Runoff class	Negligible to very low
Flooding duration	Very brief (4 to 48 hours) to brief (2 to 7 days)
Flooding frequency	Rare to frequent
Ponding frequency	None
Elevation	2,900–5,000 ft
Slope	0–3%
Water table depth	36–80 in

Aspect	Aspect is not a significant factor

Climatic features

MLRA 64 has a continental climate consisting of cold winters and hot summers, low humidity, light rainfall, and ample sunshine. Extremes in temperature are common in some years. The climate results from MLRA 64 being near the geographic center of North America. There are few natural barriers on the Northern Great Plains. Air masses move freely across the plains and account for rapid changes in temperature.

Average annual precipitation ranges from 14 to 20 inches. The normal average annual temperature is about 47 °F. January is the coldest month with average temperatures ranging from about 21 °F (Wood, SD) to about 25 °F (Hemingford, NE). July is the warmest month with average temperatures ranging from about 70 °F (Keeline 3 W, WY: 1953–1986) to about 76 °F (Wood, SD). The range of normal average monthly temperatures between the coldest and warmest months is about 55 °F. This large annual range attests to the continental nature of the climate of this area. Wind speed averages about 11 miles per hour annually, ranging from about 13 miles per hour during the spring to about 10 miles per hour during the summer. Daytime winds are generally stronger than nighttime winds. Occasionally, strong storms bring brief periods of high winds with gusts to more than 50 miles per hour.

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. Cool-season plants may green-up in September and October if adequate soil moisture is present.

Table 3. Representative climatic features

Frost-free period (characteristic range)	92-120 days
Freeze-free period (characteristic range)	119-139 days
Precipitation total (characteristic range)	16-19 in
Frost-free period (actual range)	87-122 days
Freeze-free period (actual range)	110-149 days
Precipitation total (actual range)	15-20 in
Frost-free period (average)	107 days
Freeze-free period (average)	130 days
Precipitation total (average)	17 in

Climate stations used

- (1) HARRISON 20 SSE [USW00094077], Harrison, NE
- (2) GLENDO 6NE [USC00483936], Glendo, WY
- (3) ALLIANCE 1WNW [USC00250130], Alliance, NE
- (4) HARRISON [USC00253615], Harrison, NE
- (5) HEMINGFORD [USC00253755], Hemingford, NE
- (6) INTERIOR 3 NE [USC00394184], Interior, SD
- (7) MARTIN [USC00395281], Martin, SD
- (8) WOOD [USC00399442], Wood, SD
- (9) LUSK 2 SW [USC00485830], Lusk, WY
- (10) TORRINGTON 29N [USC00488997], Jay Em, WY
- (11) CHADRON 3NE [USC00251578], Chadron, NE

Influencing water features

The Sandy Lowland ecological site is located adjacent to terrace and overflow sites along stream corridors and drainageways.

Stream Type: B5, C5 (Rosgen System)

Wetland description

Not Applicable.

Soil features

The soils in this site commonly have a surface layer of sandy loam to loamy sand 2 to 12 inches thick. Slopes range from 0 to 8 percent. Thin to very strongly stratified alluvium is typical. The soils in this site are somewhat excessively drained. They formed in sandy alluvium. The subsurface layer is loamy sand, sand, or fine sandy loam and can tend to be calcareous. Subsurface soil layers are not restrictive to water movement and root penetration.

Soils Correlated to the Sandy Lowland Site: Bankard, Glenberg, and Munjor.

The Glenberg soil is also correlated to the Loamy Overflow (R064XY026NE) ecological site where it has a local, frequently flooded phase.

This site typically has no evidence of rills, wind-scoured areas, or pedestalled plants. Waterflow patterns are indistinguishable. The soil surface is stable and intact.

More information regarding the soil is available in soil survey reports. Contact the local USDA Service Center or use the Web Soil Survey online for details specific to your area of interest.

Table 4. Representative soil features

Parent material	(1) Alluvium–sandstone (2) Siltstone
Surface texture	(1) Fine sandy loam (2) Loamy fine sand (3) Loamy very fine sand
Family particle size	(1) Sandy
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderately rapid to very rapid
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-40in)	3–6 in
Calcium carbonate equivalent (0-40in)	0–10%
Electrical conductivity (0-40in)	0–4 mmhos/cm
Sodium adsorption ratio (0-40in)	0–6
Soil reaction (1:1 water) (0-40in)	5.1–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–6%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

The Sandy Lowland ecological site developed under Northern Great Plains climatic conditions; light to severe

grazing by bison and other large herbivores; sporadic, natural or human-caused wildfire (often of light intensities); and other biotic and abiotic factors that typically influence soil and site development. Changes occur in the plant communities due to short-term weather variations, effects of native and exotic plant and animal species, and management actions. Although the following plant community descriptions are typical of the transitions between communities, severe disturbances, such as periods of well below average precipitation and the introduction of non-native cool-season grasses, can cause significant shifts in plant communities and species composition.

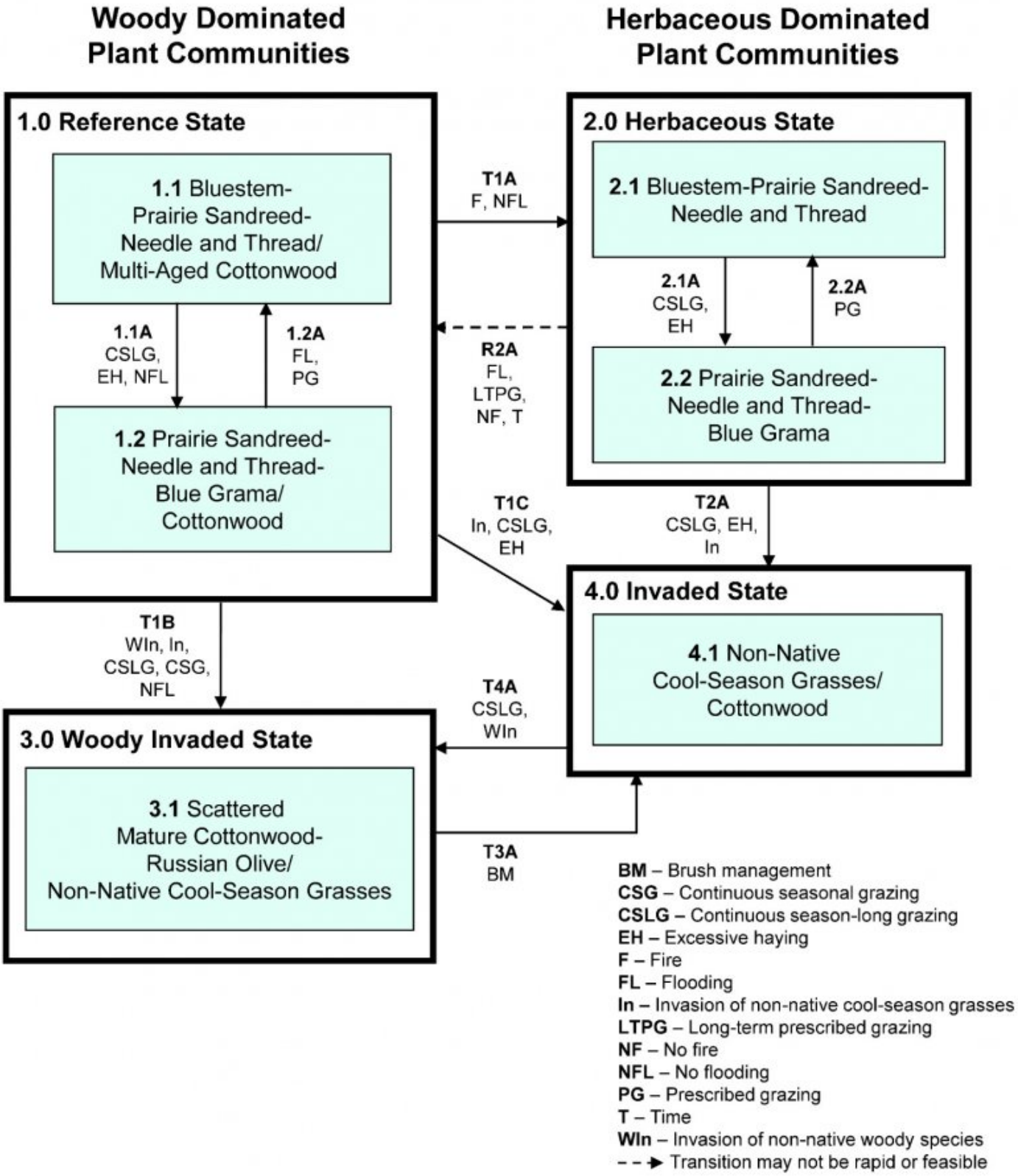
Sand sagebrush or silver sage grow more frequently in the western portion of the MLRA and are significantly less common in the central and eastern parts of the MLRA. Little bluestem grows mainly in the central and eastern parts of the MLRA and become less common going west. As this site deteriorates, species such as prairie sandreed, little bluestem, sand dropseed, and blue grama initially increase. Species such as sand bluestem and switchgrass decrease in frequency and production. With continued improper management, prairie sandreed and little bluestem also decrease and cool-season grasses and forbs significantly increase. This site is very susceptible to invasion of non-native cool-season grasses and can potentially be invaded by Russian Olive.

Interpretations are primarily based on the Bluestem-Prairie Sandreed-Needle and Thread/Multi-Aged Cottonwood Plant Community (1.1). The community was determined by study of rangeland relic areas, areas protected from excessive disturbance, and areas under long-term rotational grazing regimes. Also studied were trends in plant community dynamics ranging from heavily grazed to lightly grazed areas, seasonal use pastures, and historical accounts. Plant communities, states, transitional pathways, and thresholds were determined through similar studies and experience.

The following state-and-transition diagram illustrates the common plant communities on the site and the transition pathways between communities. The ecological processes are discussed in more detail in the plant community descriptions following the diagram.

State and transition model

Sandy Lowland R064XY029NE 7/18/19



BM – Brush management
CSG – Continuous seasonal grazing
CSLG – Continuous season-long grazing
EH – Excessive haying
F – Fire
FL – Flooding
In – Invasion of non-native cool-season grasses
LTPG – Long-term prescribed grazing
NF – No fire
NFL – No flooding
PG – Prescribed grazing
T – Time
WIn – Invasion of non-native woody species
- - → Transition may not be rapid or feasible

Diagram Legend: Sandy Lowland - R064XY029NE

T1A	1.0 to 2.0	Fire that removes woody species; no flooding and no regeneration of cottonwood.
T1B	1.0 to 3.0	Invasion of non-native cool-season grasses and non-native woody species; continuous season-long grazing or continuous seasonal grazing, without adequate recovery; no flooding.
T1C	1.0 to 4.0	Invasion of non-native cool-season grasses; continuous season-long grazing without adequate recovery; excessive haying.
T2A	2.0 to 4.0	Continuous season-long grazing without adequate recovery; excessive haying; invasion of non-native cool-season grasses.
T3A	3.0 to 4.0	Mechanical and chemical brush management to remove non-native woody species.
T4A	4.0 to 3.0	Continuous season-long grazing without adequate recovery; the invasion of non-native woody species.

R2A	2.0 to 1.0	Flooding event which allows for establishment of cottonwood seedlings; long-term prescribed grazing; no fire; time.

1.1A	1.1 to 1.2	Continuous season-long grazing without adequate recovery; excessive haying; no flooding.
1.2A	1.2 to 1.1	Flooding; prescribed grazing with proper stocking, change in season of use, and adequate recovery time following grazing event.
2.1A	2.1 to 2.2	Continuous season-long grazing without adequate recovery or change in season of use; excessive haying.
2.2A	2.2 to 2.1	Prescribed grazing with proper stocking, change in season of use, adequate recovery time.

State 1
Reference State

The Reference State (1.0) represents the best estimate of the natural range of variability that dominated the dynamics the Sandy Lowland ecological site prior to European settlement. This site is dominated by warm-season grasses and plains cottonwood. Grazing by large ungulates and small mammals, infrequent fire, flooding, and drought are the major drivers between plant communities. Favorable growing conditions occurred during the spring and the warm months of June through August. Today, a similar state can be found in areas where proper livestock use has occurred. Cottonwood requires flooding to regenerate and, with long periods of no flooding, the plant communities eventually transition into an Herbaceous State (2.0). The invasion of non-native cool-season grasses, continuous season-long grazing, or excessive haying result in a transition to an Invaded State (4.0). The invasion of non-native woody species causes a transition to a Wooded Invaded State (3.0).

Community 1.1
Bluestem-Prairie Sandreed-Needle and Thread/Multi-Aged Cottonwood

Interpretations are primarily based on the Bluestem-Prairie Sandreed-Needle and Thread/Multi-Aged Cottonwood Plant Community. This is also considered to be the Reference Plant Community (1.1). This plant community is in areas that are properly managed with grazing and are subject to periodic flooding. The potential vegetation, by air-dry weight, is about 75 percent grasses and grass-like species, 10 percent forbs, and 15 percent woody plants. Tall and mid-statured warm-season grasses dominate this community. The major grasses include sand bluestem, big bluestem, little bluestem, prairie sandreed, and switchgrass. Other grasses and grass-like species in the community include blue grama, needle and thread, and western wheatgrass. Forbs and shrubs include goldenrod, dotted gayfeather, purple prairie cover, silver sagebrush, and rose. Scattered mixed-age stands of plains cottonwood are in almost all areas of this site. This plant community is diverse, stable, productive, and well adapted to the Northern Great Plains. Plant litter is properly distributed and subject to little movement. Natural plant mortality is very low. This is a sustainable plant community in terms of 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	900	2054	2375
Forb	125	195	275
Shrub/Vine	125	195	275
Tree	50	156	275
Total	**1200**	**2600**	**3200**

Figure 9. Plant community growth curve (percent production by month). NE6410, Pine Ridge/Badlands, lowland warm-season dominant. Warm-season dominant, lowland.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		3	7	15	25	25	17	6	2		

Community 1.2
Prairie Sandreed-Needle and Thread-Blue Grama/Cottonwood

This plant community develops under continuous season-long grazing without periodic rest, excessive haying, and no flooding. The extent of sand bluestem, big bluestem, and switchgrass is significantly reduced compared to the Reference Plant Community (1.1). Little bluestem may initially increase or decrease depending upon the season of use. Prairie sandreed, needle and thread, and blue grama are increased. Silver sagebrush may also increase. The site contains mature cottonwood trees. Little or no regeneration occurs. This plant community is at risk of losing tall warm-season grasses, palatable forbs, and shrubs. The potential vegetation, by air-dry weight, is about 75 percent grasses and grass-like species, 10 percent forbs, and 15 percent woody plants. Kentucky bluegrass and Russian olive have invaded some areas. Although plant diversity is reduced, the soil is stable. The water cycle, nutrient cycle, and energy flow are slightly reduced but continue to function adequately.

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	1475	1530	1565
Shrub/Vine	95	200	325
Tree	35	120	205
Forb	95	150	205
Total	**1700**	**2000**	**2300**

Figure 11. Plant community growth curve (percent production by month). NE6408, Pine Ridge/Badlands, lowland cool-season/warm-season co-dominant. Cool-season, warm-season co-dominant, lowland.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		5	12	20	25	19	11	5	3		

Pathway 1.1A
Community 1.1 to 1.2

Continuous season-long grazing without adequate recovery periods, excessive haying, and no flooding convert Plant Community 1.1 to the Prairie Sandreed-Needle and Thread-Blue Grama/Cottonwood Plant Community (1.2).

Pathway 1.2A
Community 1.2 to 1.1

Prescribed grazing that includes proper stocking rates, change in season of use, and adequate time for plant

recovery shift the herbaceous plant community to become similar to the Reference Plant Community (1.1). Occasional flooding events allow for cottonwood regeneration and establishment.

Conservation practices

Prescribed Grazing

State 2
Herbaceous State

The Herbaceous State (2.0) is much like the Reference Plant Community (1.1) but without the cottonwood overstory. The primary species in the Herbaceous State are sand bluestem or big bluestem, little bluestem, prairie Sandreed, and needle and thread. This state evolved as the result of stand-removing fire and no flooding to regenerate cottonwood. Grasses and grass-like species make up 85 to 95 percent of the plant community.

Community 2.1
Bluestem-Prairie Sandreed-Needle and Thread

This plant community develops where plains cottonwood has not been replaced by regeneration following a flooding event or has been removed during a fire. This plant community primary consists of herbaceous species and shrubs. The dominant grasses are similar to those found in the Reference Plant Community (1.1). Sand bluestem, big bluestem, little bluestem, and prairie sandreed are the dominant warm-season grasses. Needle and thread and western wheatgrass are the dominant cool-season grasses. The dominant shrubs are silver sage, western snowberry, and rose. The potential vegetation, by air-dry weight, is about 90 percent grasses and grass-like species, 5 percent forbs, and 5 percent woody plants. This plant community is diverse, stable, productive, and well adapted to the Northern Great Plains. Plant litter is properly distributed with little movement. Natural plant mortality is very low. This is a sustainable plant community in terms of soil stability, watershed function, and biologic integrity.

Table 7. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	1860	2125	2550
Forb	120	188	275
Shrub/Vine	120	188	275
Tree	0	–	–
Total	**2100**	**2501**	**3100**

Figure 13. Plant community growth curve (percent production by month). NE6410, Pine Ridge/Badlands, lowland warm-season dominant. Warm-season dominant, lowland.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		3	7	15	25	25	17	6	2		

Community 2.2
Prairie Sandreed-Needle and Thread-Blue Grama

This plant community developed under continuous season-long grazing without periodic rest or under excessive haying. When compared to the Reference Plant Community (1.1), the extent of sand bluestem, big bluestem, and little bluestem are significantly reduced. Prairie sandreed, needle and thread, and blue grama are increased. Silver sagebrush may also increase. This plant community is at risk of losing tall warm-season grasses, palatable forbs, and shrubs. The potential vegetation, by air-dry weight, is about 90 percent grasses and grass-like species, 5 percent forbs, and 5 percent woody plants. Kentucky bluegrass has begun to invade this plant community in some places. Although plant diversity is reduced, the soil is stable. The water cycle, nutrient cycle, and energy flow is slightly reduced but continues to adequately function.

Figure 14. Plant community growth curve (percent production by month). NE6408, Pine Ridge/Badlands, lowland cool-season/warm-season co-dominant. Cool-season, warm-season co-dominant, lowland.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		5	12	20	25	19	11	5	3		

Pathway 2.1A
Community 2.1 to 2.2

Continuous season-long grazing without adequate recovery periods or excessive haying convert this Plant Community (2.1) to the Prairie Sandreed-Needle and Thread-Blue Grama Plant Community (2.2).

Pathway 2.2A
Community 2.2 to 2.1

Prescribed grazing that includes proper stocking rates, change in season of use, and adequate time for recovery following a grazing event convert Plant Community 2.2 to Plant Community 2.1.

Conservation practices

Prescribed Grazing

State 3
Woody Invaded State

This State develops as a result of the invasion of Russian olive, non-native cool-season grasses, and, in some cases, saltcedar in combination with continuous season-long grazing or continuous seasonal grazing and with no flooding. Over time, the cottonwood becomes mature and little or no regeneration occurs. Grazing that limits regeneration also results in a reduction of the desirable native herbaceous species, commonly resulting in a dominance of species such as Kentucky bluegrass and smooth brome and forbs such as Cuman ragweed, Canada thistle, burdock, and hound’s tongue.

Community 3.1
Scattered Mature Cottonwood-Russian Olive/Non-Native Cool-Season Grasses

This plant community is the result of continuous season-long grazing or continuous seasonal grazing, no flooding, and the invasion of non-native woody species and non-native cool-season grasses. Kentucky bluegrass, smooth brome, and annual brome are dominant grasses. Mature cottonwoods, Russian olive, and, in places, saltcedar make up the overstory. Noxious weeds, such as Canada thistle and hound’s tongue, may invade. When compared to the Reference Plant Community (1.1), the extent of bluestem species, prairie sandreed, and needle and thread is significantly decreased. Russian olive and, in places, saltcedar have invaded and increased in extent. Plains cottonwoods have not reproduced, and those remaining are mature. The soil is protected from erosion. The watershed is functioning but may produce excessive runoff. The biotic integrity is threatened by invasive species. This community remains stable but has lost much of its productivity and diversity. The nutrient cycle is impaired due to the loss of warm-season grass species, deep-rooted forbs (legumes and others), and shrubs. Soil compaction can be a concern if the site is continuously grazed during wet cycles. This plant community is unlikely to return to the Reference State (1.0).

Figure 15. Plant community growth curve (percent production by month). NE6407, Pine Ridge/Badlands, cool-season dominant, warm-season sub-dominant. Cool-season dominant, warm-season sub-dominant, lowland.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		5	8	25	30	15	10	2	5		

State 4

Invaded State

This State is the result of invasion and dominance of introduced cool-season grasses. This state is characterized by the dominance of Kentucky bluegrass and smooth brome and by 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. Increasing plant litter decreases the amount of sunlight reaching plant crowns, thereby shifting competitive advantage to shade-tolerant, introduced grasses. Studies indicate that soil biological activity is altered, and this shift apparently exploits the soil microclimate and encourages growth of the introduced grasses. Once the threshold is crossed, a change in grazing management alone cannot cause a reduction in the invasive grass dominance. Preliminary studies 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. Plant communities dominated by Kentucky bluegrass have significantly less cover and diversity of native grasses and forbs (Toledo et al., 2014).

Community 4.1
Non-Native Cool-Season Grasses/Cottonwood

This plant community developed with continuous season-long grazing or excessive haying and the invasion of non-native cool-season grasses. Kentucky bluegrass dominates the community and can develop into a “sod-bound” appearance. Low-vigor western wheatgrass can be found scattered throughout the community. Needle and thread are greatly reduced. Cuman ragweed and verbena increase. Non-native grasses and forbs, such as annual bromes, thistle, and other invasive forbs, invade this plant community. Silver sagebrush, western snowberry, and rose may persist in the plant community if not removed during haying activities. Scattered plains cottonwood, Russian olive, and saltcedar may be present, but only in minor amounts. This plant community is resistant to change due to grazing tolerance of Kentucky bluegrass. A significant amount of production and diversity is lost compared to the Reference Plant Community (1.1). The dominance of non-native cool-season grasses and the loss of other desirable species negatively impacts energy flow and nutrient cycling. Water infiltration is reduced significantly, and soil loss may be accelerated where concentrated flows occur.

Table 8. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	1265	1288	1305
Forb	30	96	165
Shrub/Vine	75	120	165
Tree	30	96	165
Total	**1400**	**1600**	**1800**

Figure 17. Plant community growth curve (percent production by month). NE6407, Pine Ridge/Badlands, cool-season dominant, warm-season sub-dominant. Cool-season dominant, warm-season sub-dominant, lowland.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		5	8	25	30	15	10	2	5		

Transition T1A
State 1 to 2

A stand-removing fire that removes the majority of the tree species and an absence of flooding to regenerate cottonwood transition the Reference State (1.0) to the Herbaceous State (2.0).

Transition T1B
State 1 to 3

Continuous season-long grazing or continuous seasonal grazing, the invasion of non-native cool-season grasses

and Russian olive, and an absence of flooding transition the Reference State (1.0) to the Woody Invaded State (3.0).

Transition T1C
State 1 to 4

Continuous season-long grazing or excessive haying, and the invasion of non-native cool-season grasses, transition the Reference State (1.0) to the Invaded State (4.0).

Restoration pathway R2A
State 2 to 1

Flooding, which allows for regeneration and establishment of cottonwood, followed by long-term prescribed grazing, no fire, and an extended period of time may transition the Herbaceous State (2.0) to the Reference State (1.0). This transition may take a long period of time and may not meet management objectives.

Conservation practices

Prescribed Grazing

Transition T2A
State 2 to 4

Continuous season-long grazing or excessive haying, and invasion on non-native cool-season grasses, transition the Herbaceous State (2.0) to the Invaded State (4.0).

Transition T3A
State 3 to 4

Removal of non-native invasive trees through mechanical brush management and possibly herbicide treatment can transition the Woody Invaded State (3.0) to the Invaded State (4.0).

Conservation practices

Brush Management

Transition T4A
State 4 to 3

Invasion of non-native woody species transitions State 4.0 to the Woody Invaded State (3.0).

Additional community tables

Table 9. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall & Mid Warm-Season Grasses**			1040–1690	
	prairie sandreed	CALO	*Calamovilfa longifolia*	390–650	–
	sand bluestem	ANHA	*Andropogon hallii*	260–520	–
	little bluestem	SCSC	*Schizachyrium scoparium*	260–520	–
	big bluestem	ANGE	*Andropogon gerardii*	130–390	–
	switchgrass	PAVI2	*Panicum virgatum*	0–260	–
2	**Cool-Season Bunchgrass**			260–650	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	260–650	–

	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	260–390	
3	**Rhizomatous Wheatgrass**			130–260	
	western wheatgrass	PASM	*Pascopyrum smithii*	130–260	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–130	–
4	**Other Native Grasses & Grass-Likes**			130–390	
	blue grama	BOGR2	*Bouteloua gracilis*	52–260	–
	threadleaf sedge	CAFI	*Carex filifolia*	52–260	–
	sedge	CAREX	*Carex*	0–130	–
	Grass, perennial	2GP	*Grass, perennial*	0–130	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–130	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	26–130	–
	sand lovegrass	ERTR3	*Eragrostis trichodes*	0–130	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–130	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–130	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	0–52	–
	Indiangrass	SONU2	*Sorghastrum nutans*	0–52	–
	scouringrush horsetail	EQHY	*Equisetum hyemale*	0–26	–
5	**Non-Native Cool-Season Grasses**			0	
Forb					
6	**Forbs**			130–260	
	dotted blazing star	LIPU	*Liatris punctata*	0–52	–
	goldenrod	SOLID	*Solidago*	0–52	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–52	–
	purple prairie clover	DAPU5	*Dalea purpurea*	0–52	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–26	–
	Forb, perennial	2FP	*Forb, perennial*	0–26	–
	Forb, annual	2FA	*Forb, annual*	0–26	–
	beardtongue	PENST	*Penstemon*	0–26	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–26	–
	Rocky Mountain beeplant	CLSE	*Cleome serrulata*	0–26	–
	vervain	VERBE	*Verbena*	0–26	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–26	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–26	–
	ragwort	SENEC	*Senecio*	0–26	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–26	–
	mint	MENTH	*Mentha*	0–26	–
	pussytoes	ANTEN	*Antennaria*	0–26	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–26	–
	scurfpea	PSORA2	*Psoralidium*	0–26	–
	evening primrose	OENOT	*Oenothera*	0–26	–
	false boneset	BREU	*Brickellia eupatorioides*	0–26	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–26	–
	[illegible]	ARCTI	*Arctium*		

	burdock	ARCTI	*Arctium*	–	–
	hound's tongue	CYNOG	*Cynoglossum*	–	–
	Canada thistle	CIAR4	*Cirsium arvense*	–	–
Shrub/Vine					
7	**Shrubs**			130–260	
	silver sagebrush	ARCA13	*Artemisia cana*	130–260	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–130	–
	rose	ROSA5	*Rosa*	0–130	–
	sand sagebrush	ARFI2	*Artemisia filifolia*	0–52	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	0–52	–
	western sandcherry	PRPUB	*Prunus pumila var. besseyi*	0–52	–
	leadplant	AMCA6	*Amorpha canescens*	0–52	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–26	–
Tree					
8	**Trees**			52–260	
	plains cottonwood	PODEM	*Populus deltoides ssp. monilifera*	52–260	–
	boxelder	ACNE2	*Acer negundo*	0–130	–
	green ash	FRPE	*Fraxinus pennsylvanica*	0–130	–
	willow	SALIX	*Salix*	0–130	–

Table 10. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall & Mid- Warm-Season Grasses**			800–1300	
	prairie sandreed	CALO	*Calamovilfa longifolia*	500–700	–
	little bluestem	SCSC	*Schizachyrium scoparium*	200–500	–
	big bluestem	ANGE	*Andropogon gerardii*	20–200	–
	sand bluestem	ANHA	*Andropogon hallii*	20–100	–
	switchgrass	PAVI2	*Panicum virgatum*	0–100	–
2	**Cool-Season Bunchgrass**			200–500	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	200–500	–
3	**Rhizomatous Wheatgrass**			100–200	
	western wheatgrass	PASM	*Pascopyrum smithii*	100–200	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–100	–
4	**Other Native Grasses & Grass-Likes**			200–500	
	blue grama	BOGR2	*Bouteloua gracilis*	200–400	–
	threadleaf sedge	CAFI	*Carex filifolia*	40–300	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	100–200	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–100	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–100	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–100	–
	Grass, perennial	2GP	*Grass, perennial*	0–100	–
	sedge	CAREX	*Carex*	0–100	–
	Scribner's rosette	DIOLS	*Dichanthelium oligosanthes var.*	0–40	–

	grass		*scribnerianum*		
	sand lovegrass	ERTR3	*Eragrostis trichodes*	0–20	–
	scouringrush horsetail	EQHY	*Equisetum hyemale*	0–20	–
	Indiangrass	SONU2	*Sorghastrum nutans*	–	–
5	**Non-Native Cool-Season Grasses**			0–100	
	Kentucky bluegrass	POPR	*Poa pratensis*	0–100	–
	smooth brome	BRIN2	*Bromus inermis*	0–40	–
	cheatgrass	BRTE	*Bromus tectorum*	0–40	–
	field brome	BRAR5	*Bromus arvensis*	0–20	–
Forb					
6	**Forbs**			100–200	
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–40	–
	goldenrod	SOLID	*Solidago*	0–40	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–40	–
	Rocky Mountain beeplant	CLSE	*Cleome serrulata*	0–40	–
	vervain	VERBE	*Verbena*	0–40	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–40	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–40	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–40	–
	mint	MENTH	*Mentha*	0–40	–
	pussytoes	ANTEN	*Antennaria*	0–40	–
	scurfpea	PSORA2	*Psoralidium*	0–40	–
	Forb, perennial	2FP	*Forb, perennial*	0–20	–
	Forb, annual	2FA	*Forb, annual*	0–20	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–20	–
	ragwort	SENEC	*Senecio*	0–20	–
	beardtongue	PENST	*Penstemon*	0–20	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–20	–
	purple prairie clover	DAPU5	*Dalea purpurea*	0–20	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–20	–
	Canada thistle	CIAR4	*Cirsium arvense*	0–20	–
	dotted blazing star	LIPU	*Liatris punctata*	0–20	–
	evening primrose	OENOT	*Oenothera*	0–20	–
	false boneset	BREU	*Brickellia eupatorioides*	0–20	–
	burdock	ARCTI	*Arctium*	–	–
	hound's tongue	CYNOG	*Cynoglossum*	–	–
Shrub/Vine					
7	**Shrubs**			100–300	
	silver sagebrush	ARCA13	*Artemisia cana*	100–200	–
	rose	ROSA5	*Rosa*	0–100	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–100	–
	sand sagebrush	ARFI2	*Artemisia filifolia*	0–60	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	0–40	

	western snowberry	SYOC	*Symphoricarpos occidentalis*	0–40	–
	western sandcherry	PRPUB	*Prunus pumila var. besseyi*	0–40	–
	leadplant	AMCA6	*Amorpha canescens*	0–40	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–40	–
Tree					
8	**Trees**			40–200	
	plains cottonwood	PODEM	*Populus deltoides ssp. monilifera*	40–200	–
	boxelder	ACNE2	*Acer negundo*	0–100	–
	green ash	FRPE	*Fraxinus pennsylvanica*	0–100	–
	willow	SALIX	*Salix*	0–100	–

Table 11. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall & Mid- Warm-Season Grasses**			1250–2250	
	sand bluestem	ANHA	*Andropogon hallii*	375–750	–
	little bluestem	SCSC	*Schizachyrium scoparium*	375–750	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	375–750	–
	switchgrass	PAVI2	*Panicum virgatum*	0–250	–
	big bluestem	ANGE	*Andropogon gerardii*	125–250	–
2	**Cool-Season Bunchgrass**			250–500	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	250–500	–
3	**Rhizomatous Wheatgrass**			0–125	
	western wheatgrass	PASM	*Pascopyrum smithii*	0–125	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–125	–
4	**Other Native Grasses & Grass-Likes**			125–375	
	threadleaf sedge	CAFI	*Carex filifolia*	50–250	–
	sedge	CAREX	*Carex*	0–125	–
	blue grama	BOGR2	*Bouteloua gracilis*	50–125	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–125	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	25–125	–
	sand lovegrass	ERTR3	*Eragrostis trichodes*	0–125	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–125	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–125	–
	Grass, perennial	2GP	*Grass, perennial*	0–125	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	0–50	–
	Indiangrass	SONU2	*Sorghastrum nutans*	0–50	–
	scouringrush horsetail	EQHY	*Equisetum hyemale*	0–25	–
5	**Non-Native Cool-Season Grasses**			0–125	
	Kentucky bluegrass	POPR	*Poa pratensis*	0–125	–
	smooth brome	BRIN2	*Bromus inermis*	0–50	–
	cheatgrass	BRTE	*Bromus tectorum*	0–50	–
	field brome	BRAR5	*Bromus arvensis*	0–25	–

Forb					
6	**Forbs**			125–250	
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–50	–
	dotted blazing star	LIPU	*Liatris punctata*	0–50	–
	goldenrod	SOLID	*Solidago*	0–50	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–50	–
	beardtongue	PENST	*Penstemon*	0–50	–
	purple prairie clover	DAPU5	*Dalea purpurea*	0–50	–
	Rocky Mountain beeplant	CLSE	*Cleome serrulata*	0–50	–
	vervain	VERBE	*Verbena*	0–25	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–25	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–25	–
	ragwort	SENEC	*Senecio*	0–25	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–25	–
	mint	MENTH	*Mentha*	0–25	–
	pussytoes	ANTEN	*Antennaria*	0–25	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–25	–
	scurfpea	PSORA2	*Psoralidium*	0–25	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–25	–
	Canada thistle	CIAR4	*Cirsium arvense*	0–25	–
	evening primrose	OENOT	*Oenothera*	0–25	–
	false boneset	BREU	*Brickellia eupatorioides*	0–25	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–25	–
	Forb, perennial	2FP	*Forb, perennial*	0–25	–
	Forb, annual	2FA	*Forb, annual*	0–25	–
	burdock	ARCTI	*Arctium*	–	–
	hound's tongue	CYNOG	*Cynoglossum*	–	–
Shrub/Vine					
7	**Shrubs**			125–250	
	silver sagebrush	ARCA13	*Artemisia cana*	125–250	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–125	–
	rose	ROSA5	*Rosa*	0–75	–
	sand sagebrush	ARFI2	*Artemisia filifolia*	0–50	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	0–50	–
	western sandcherry	PRPUB	*Prunus pumila var. besseyi*	0–50	–
	leadplant	AMCA6	*Amorpha canescens*	0–50	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–25	–
Tree					
8	**Trees**			0	

Table 12. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)

Grass/Grasslike					
1	**Tall & Mid- Warm-Season Grasses**			80–160	
	prairie sandreed	CALO	*Calamovilfa longifolia*	80–160	–
	little bluestem	SCSC	*Schizachyrium scoparium*	0–80	–
	big bluestem	ANGE	*Andropogon gerardii*	0–16	–
	sand bluestem	ANHA	*Andropogon hallii*	–	–
	switchgrass	PAVI2	*Panicum virgatum*	–	–
2	**Cool-Season Bunchgrass**			80–320	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	80–320	–
3	**Rhizomatous Wheatgrass**			80–160	
	western wheatgrass	PASM	*Pascopyrum smithii*	80–160	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–80	–
4	**Other Native Grasses & Grass-Likes**			160–480	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	160–320	–
	threadleaf sedge	CAFI	*Carex filifolia*	32–240	–
	Sandberg bluegrass	POSE	*Poa secunda*	32–160	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	0–80	–
	sedge	CAREX	*Carex*	0–80	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–80	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–80	–
	Grass, perennial	2GP	*Grass, perennial*	0–80	–
	scouringrush horsetail	EQHY	*Equisetum hyemale*	0–16	–
	sand lovegrass	ERTR3	*Eragrostis trichodes*	–	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	–	–
	Indiangrass	SONU2	*Sorghastrum nutans*	–	–
5	**Non-Native Cool-Season Grasses**			160–480	
	Kentucky bluegrass	POPR	*Poa pratensis*	160–400	–
	smooth brome	BRIN2	*Bromus inermis*	80–160	–
	cheatgrass	BRTE	*Bromus tectorum*	80–160	–
	field brome	BRAR5	*Bromus arvensis*	0–80	–
Forb					
6	**Forbs**			32–160	
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	32–240	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–80	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–80	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–80	–
	Canada thistle	CIAR4	*Cirsium arvense*	0–80	–
	vervain	VERBE	*Verbena*	0–80	–
	Forb, annual	2FA	*Forb, annual*	0–48	–
	burdock	ARCTI	*Arctium*	0–32	–
	hound's tongue	CYNOG	*Cynoglossum*	0–32	–
	Forb, perennial	2FP	*Forb, perennial*	0–32	–
	ragwort	SENEC	*Senecio*	0–32	–

	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–32	–
	mint	MENTH	*Mentha*	0–32	–
	goldenrod	SOLID	*Solidago*	0–32	–
	Rocky Mountain beeplant	CLSE	*Cleome serrulata*	0–32	–
	false boneset	BREU	*Brickellia eupatorioides*	0–16	–
	dotted blazing star	LIPU	*Liatris punctata*	0–16	–
	pussytoes	ANTEN	*Antennaria*	0–16	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–16	–
	scurfpea	PSORA2	*Psoralidium*	0–16	–
	evening primrose	OENOT	*Oenothera*	–	–
	beardtongue	PENST	*Penstemon*	–	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	–	–
	purple prairie clover	DAPU5	*Dalea purpurea*	–	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	–	–
Shrub/Vine					
7	**Shrubs**			80–160	
	silver sagebrush	ARCA13	*Artemisia cana*	80–160	–
	rose	ROSA5	*Rosa*	0–80	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–80	–
	sand sagebrush	ARFI2	*Artemisia filifolia*	0–48	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	0–32	–
	leadplant	AMCA6	*Amorpha canescens*	0–32	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–32	–
	western sandcherry	PRPUB	*Prunus pumila var. besseyi*	–	–
Tree					
8	**Trees**			32–160	
	plains cottonwood	PODEM	*Populus deltoides ssp. monilifera*	32–160	–
	boxelder	ACNE2	*Acer negundo*	0–32	–
	green ash	FRPE	*Fraxinus pennsylvanica*	0–32	–
	willow	SALIX	*Salix*	0–32	–

Animal community

Wildlife Interpretations:
MLRA 64 is in the drier areas of a northern mixed-grass prairie ecosystem in which sagebrush steppes to the west yield to grassland steppes to the east. Prior to European settlement, this MLRA consisted of diverse grassland and shrubland habitats interspersed with varying densities of depressional, instream wetlands and woody riparian corridors. These habitats provided critical life cycle components for many users. Many species of grassland birds, small mammals, reptiles, and amphibians and herds of roaming bison, elk, and pronghorn were among the inhabitants adapted to this semi-arid region. Roaming herbivores, as well as several species of small mammals and insects, were the primary consumers linking the grassland resources to large predators, such as the wolf, mountain lion, and grizzly bear, and to smaller carnivores, such as the coyote, bobcat, fox, and raptors. The prairie dog was once abundant and remains a keystone species within its range. The black-footed ferret, burrowing owl, ferruginous hawk, mountain plover, and swift fox are associated with prairie dog complexes.

Historically, the northern mixed-grass prairie was a disturbance-driven ecosystem in which fire, herbivory, and climate functioned as the primary disturbance factors, either singly or in combination. Following European

settlement, livestock grazing, cropland conversion, elimination of fire, energy development, and other anthropogenic factors influenced species composition and abundance. Introduced and invasive species further affected plant and animal communities. The bison was a historical keystone species but has been extirpated in this area as a free-ranging herbivore. The loss of the bison and the reduction of prairie dog populations and fire as ecological drivers greatly influenced the character of the remaining native plant communities and altered wildlife habitats. Human development reduced habitat quality for area-sensitive species.

Within MLRA 64, the Sandy Lowland ecological site provides upland grassland cover with associated forb, shrub, and tree components. It was typically part of an expansive grassland landscape that included combinations of Thin Breaks, Clayey, Claypan, Dense Clay, Loamy, Saline, Sandy, Shallow, Overflow, and Terrace ecological sites. This site provided habitat for species requiring unfragmented grassland. Important habitat features and components found commonly or exclusively on this site may include sharp-tailed grouse leks; upland nesting habitat for grassland birds; forbs and insects for brood habitat; and a forage source for small and large herbivores. Many grassland and shrub steppe nesting bird populations are declining. Extirpated species include free-ranging American bison, grizzly bear, gray wolf, black-footed ferret, mountain plover, Rocky Mountain locust, and swift fox.

The Sandy Lowland ecological site has remained relatively intact but may be subject to haying under drier conditions. Invasive species, such as Kentucky bluegrass, smooth brome, cheatgrass, and Russian olive, have impacted the biological integrity of the site for some grassland birds. Changes in historic fire regime and domestic grazing have impacted the relative composition of forbs, shrubs, and grasses.

The Reference State (1.0): The predominance of grasses plus a high diversity of forbs and shrubs in this community favors grazers and mixed-feeders such as pronghorn antelope. Insects, including pollinators, play a large role in maintaining the forb community and provide a forage base for grassland birds and other species. The complex structural diversity of plants provides habitat for a wide array of migratory and resident birds. Grasshopper sparrow, Savannah sparrow, lark bunting, western meadowlark, and sharp-tailed grouse are common and benefit from the structure and composition of this plant community. Diverse prey populations are available for grassland raptors, such as ferruginous hawk, Swainson’s hawk, golden eagle, and prairie falcon.

The diversity of grasses and forbs provides high nutrition levels for small and large herbivores, including voles, mice, spotted ground squirrel, desert cottontail, white-tailed jackrabbit, black-tailed jackrabbit, and deer. The moderately high stature of this plant community provides thermal, protective, and escape cover for herbivores and grassland birds. Predators using this plant community include coyote, American badger, red fox, and long-tailed weasel. This plant community provides limited habitat for amphibians, mostly toads (i.e., Great Plains, Woodhouse’s, and Plains spade-foot). Prey abundance and shade opportunities may attract multiple reptile species, such as gopher snake, milk snake, prairie rattlesnake, and western ornate box turtle. Several species of sand loving lizards, such as the lesser earless lizard, prairie lizard, many-lined skink, and six-lined racerunner, use this site.

When subject to continuous season-long grazing, the plant community shifts to medium height plants, such as little bluestem and needle and thread. The diversity of forbs and shrubs does not substantially change; however, the abundance of shrubs increases. The increase in shrub abundance and shift to medium height plant community does not significantly alter the wildlife community.

Non-Native Cool-Season Grasses/Cottonwod (4.1): When the site is subject to continuous season-long grazing or excessive haying, Kentucky bluegrass dominates. Both warm- and cool-season tall and medium height plant communities are removed or significantly diminished. Plant species from adjacent ecological sites may become minor components of this plant community. The community is susceptible to invasion of annual bromegrasses and other non-native species due to severe soil disturbances and relatively high percent of bare ground. The shorter cover favors shortgrass nesting bird species. Small mammals continue to use these sites due to the continued prevalence of grass and weed seeds. However, limited prey populations limit predator uses of these sites. Pollinators may increase use of these sites due to the increase in flowering forb abundance. Sharp-tailed grouse may use the sites as lek areas if adequate habitat is available at adjacent sites.

Grazing Interpretations:
The following list suggests annual, initial stocking rates for average growing conditions. These estimates are conservative and should be used only as guidelines in the initial stages of conservation planning. Commonly, 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 estimates of carrying capacity 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. In consultation with the land manager, a more intensive grazing management program that results in improved harvest efficiencies and increased carrying capacity may be developed.

The following suggested initial stocking rates are based on 912 lb/acre (air-dry weight) per animal-unit-month (AUM) with a 25 percent harvest efficiency of preferred and desirable forage species (refer to USDA-NRCS National Range and Pasture Handbook). An AUM is defined as the equivalent amount of forage required by a 1,000-pound cow, with or without calf, for one month.

Plant Community: Bluestem-Prairie Sandreed-Needle and Thread/Multi-Aged Cottonwood (1.1)
Average Production (lb/acre, air-dry): 2,600
Stocking Rate (AUM/acre): 0.71

Plant Community: Prairie Sandreed-Needle and Thread-Blue Grama/Cottonwood (1.2)
Average Production (lb/acre, air-dry): 2,000
Stocking Rate (AUM/acre): 0.55

Plant Community: Bluestem-Prairie Sandreed-Needle and Thread (2.1)
Average Production (lb/acre, air-dry): 2,500
Stocking Rate (AUM/acre): 0.69

*Plant Community: Non-Native Cool-Season Grasses/Cottonwood (4.1)
Average Production (lb/acre, air-dry): 1,600
Stocking Rate (AUM/acre): Variable

Plant Community: All other plant communities identified in this document have variable annual production values and require onsite sampling to determine initial stocking rates.

* Total annual production and stocking rates are highly variable and require onsite sampling.

Total onsite annual production 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 for livestock. During the dormant period, the forage for livestock likely has insufficient protein to meet livestock requirements. Added protein allows 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 herbage production on this site. The site is dominated by soils in hydrologic groups A and B. Surrounding upland areas tend to also have permeable soils, and surface inflow peaks on these sites are often muted. These sites are rarely to occasionally flooded. Refer to the USDA-NRCS National Engineering Handbook, Part 630, for hydrologic soil groups, runoff quantities, and hydrologic curves.

Recreational uses

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

Wood products

No appreciable wood products are present on the site.

Other products

Harvesting the seeds of native plants can provide additional income on this site.

Other information

Revision Notes: “Previously Approved” Provisional
This Provisional ecological site description (ESD) has passed Quality Control (QC) and Quality Assurance (QA) to ensure the it meets the 2014 NESH standards for a Provisional ecological site description.

This ESD is an updated “Previously Approved” ESD that represented 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 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 may not contain all tabular and narrative entries as required in the current “Approved” level of documentation, but it is expected that it will continue refinement toward an “Approved” status.

Site Development and Testing Plan
Future work, as described in an official project plan, is necessary to validate the information in this provisional ecological site description. The plan will include field activities for low-, medium-, and high-intensity sampling, soil correlations, and analysis of the data. Annual field reviews should be done by soil scientists and vegetation specialists. Final field review, peer review, quality control, and quality assurance reviews are required to produce the final document.

Inventory data references

Information presented here has been derived from NRCS clipping data and other inventory data. Field observations from range-trained personnel were also used. Those involved in developing this site include: Stan Boltz, range management specialist (RMS), NRCS; Jill Epley, RMS, NRCS; Rick Peterson, RMS, NRCS; David Steffen, RMS, NRCS; Jeff Vander Wilt; RMS, NRCS; Phil Young, soil scientist, NRCS; and George Gamblin, RMS, NRCS.

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Approval

Suzanne Mayne-Kinney, 12/16/2024

Acknowledgments

This ecological site was reviewed and approved at the Provisional Level by David Kraft, Regional ESS, Salina, KS on 2/15/2019.

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Rangeland health reference sheet

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

Author(s)/participant(s)	Stan Boltz, Mitch Faulkner, Emily Helms, John Hartung, Ryan Murray, George Gamblin, Rick Peterson, Nadine Bishop, Jeff Nichols
Contact for lead author	jeffrey.nichols@usda.gov
Date	12/12/2024
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** None. Rills should not be present.

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2. **Presence of water flow patterns:** None. Water flow patterns should not be present

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3. **Number and height of erosional pedestals or terracettes:** None. Pedestals and/or terracettes should not be present.

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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 less than 5 percent.

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5. **Number of gullies and erosion associated with gullies:** None. Gullies should not be present

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None. Wind scoured and/or depositional areas should not be present.

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7. **Amount of litter movement (describe size and distance expected to travel):** Litter should fall in place. Litter movement from wind or water is not expected on this site.

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. Surface organic matter adheres to the soil surface.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** A-horizon should be 2 to 12 inches (5.1 to 30.5 cm) thick. Soil colors range from yellowish brown , grayish brown, to light brownish gray (values of 5 to 6) when dry and from brown to dark grayish brown (value of 4) when moist. Structure is typically medium to fine granular in the upper A-horizon. Soils formed in stratified alluv

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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 and tall rhizomatous and tufted perennial cool season grasses) with fine and coarse roots positively influences infiltration. Invasion of introduced cool-season grasses such as Kentucky bluegrass, annual brome, and smooth brome may have an adverse impact infiltration and runoff.

    Relative composition is approximately 75 percent grasses or grass-like plants, 10 percent forbs, and 15 percent woody species. The grass and grass-like component is composed of C4, tallgrasses (30-45%), C3, bunchgrasses (10-30%), C4, midgrasses (10-25%), C3, rhizomatous grasses (5-10%), C4, shortgrasses (2-10%), and grass-likes (2-10%).

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None. A compaction layer should not occur on this site.

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

    Dominant: Phase 1.1
    1. Native, perennial, C4, tallgrass, 780-1170 #/ac, 30-45% (4 species minimum): big bluestem, sand bluestem, prairie sandreed, switchgrass, Indiangrass.
    2. Native, perennial, C3 bunchgrass, 260-780 #/ac, 10-30%, (1 species minimum): needle and thread, prairie Junegrass, Indian ricegrass, Sandberg bluegrass, Scribner panicum.

    Phase 1.2
    1. Native, perennial, C4, tallgrass, 500-1000 #/ac, 25-50% (3 species minimum): big bluestem, sand bluestem, prairie sandreed, switchgrass.
    2. Native, perennial, C3 bunchgrass, 300-500 #/ac, 15-25% (1 species minimum): needle and thread, prairie Junegrass, Indian ricegrass, Sandberg bluegrass, Scribner’s rosettegrass.
    3. Native, perennial, C4 midgrass, 300-500 #/ac, 15-25% (2 species minimum): little bluestem, sand dropseed, sand lovegrass.

    Sub-dominant: Phase 1.1
    1. Native, perennial, C4 midgrass, 260-650 #/ac, 10-25%, (1 species minimum): little bluestem, sand lovegrass, sand dropseed.

    Phase 1.2
    1. Native, perennial, C4 shortgrass, 200-400 #/ac, 10-20% (1 species minimum): blue grama.
    2. Native grass-like, 40-300 #/ac, 2-15% (1 species minimum): threadleaf sedge, sedge.

3. Shrubs, 100-300 #/ac, 5-15% (1 species minimum): silver sagebrush and other shrubs which will vary from location to location.

Other: Minor - Phase 1.1
1. Native, perennial, C3, rhizomatous grass, 130-260 #/ac, 5-10%: western wheatgrass, thickspike wheatgrass.
2. Native forbs, 130-260 #/ac: forbs present vary from location to location.
3. Shrubs, 130-260 #/ac, 5-10%: shrubs present vary from location to location.
4. Native, perennial, C4 shortgrass, 52-260 #/ac, 2-10%: blue grama.
5. Native grass-like, 52-260 #/ac, 2-10%: threadleaf sedge, sedges.
6. Native deciduous trees, 52-260 #/ac, 2-10%: plains cottonwood, box elder, green ash, willow.

Minor - Phase 1.2
1. Native, perennial, C3, rhizomatous grass, 100-200 #/ac, 5-10%: western wheatgrass, thickspike wheatgrass.
2. Native forbs, 100-200 #/ac, 5-10%: forbs present vary from location to location.
3. Native, deciduous trees, 40-200 #/ac, 2-10%: plains cottonwood, boxelder, green ash, willow.
4. Non-native, C3 grass, 0-100 #/ac, 0-5%: Kentucky bluegrass, smooth brome, cheatgrass, field brome.

Additional: The Bluestem-Prairie Sandreed, Needle and Thread/Multi-Aged Cottonwood Community or Reference Community (1.1) includes nine F/S groups. These groups, in order of relative abundance, are native, perennial, C4, tallgrass; native, perennial, C3 bunchgrass; native, perennial, C4 midgrass; native, perennial, C3 rhizomatous grass = native forbs = shrubs; native, perennial, C4, shortgrass = native grass-like = native, deciduous trees.

The Prairie Sandreed-Needle and Thread-Blue Grama/Cottonwood Community includes ten F/S groups. These groups, in order of relative abundance, are native perennial, C4, tallgrass; native, perennial, C3 bunchgrass = native, perennial, C4, midgrass; native, perennial, C4, shortgrass; shrubs; grass-likes; native, perennial, C3, rhizomatous grass = native forbs; native, deciduous trees; and 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):** Bunchgrasses 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 80 to 90 percent and at a depth of 0.50 to 1.0 inch (1.3 to 2.5 cm). Kentucky bluegrass excessive litter can negatively impact the functionality of this site.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Annual production is 2,600 pounds per acre in a year with normal precipitation and temperatures. Low and High production years should yield 2,200 and 3,200 pounds per acre respectively.

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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, Kentucky bluegrass, smooth brome, eastern red cedar, and Russian olive 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.

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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.
