USDA Natural Resources Conservation Service

Ecological site R065XY024NE
Subirrigated

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General information

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

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 065X–Nebraska Sand Hills

The Nebraska Sand Hills (MLRA 65) is located in Nebraska (98 percent) and South Dakota (2 percent) and encompasses approximately 13.2 million acres (534,201 hectares) or 20,625 square miles (53,420 square kilometers). The largest town in the MLRA is North Platte, Nebraska and numerous small towns and villages are located within the MLRA, including the county seats of Arthur, Bartlett, Bassett, Brewster, Greeley, Hyannis, Mullen, Thedford, and Tryon, Nebraska. The Niobrara River is near the northern boundary while the North Platte River flows along the southwest boundary of the area. The North Loup, Middle Loup, Calamus, Snake, and Dismal Rivers and Long Pine Creek occur in the central and eastern portion of the area.

Fort Niobrara, Crescent Lake, and Valentine National Wildlife Refuges and portions of the Nebraska National Forest, including the Bessey Ranger District and Samuel R. McKelvie National Forest, are located within this MLRA. The Bessey Ranger District includes the largest human-planted forest in the United States and is home to the Bessey Tree Nursery which is listed on the National Register of Historic Places.

This MLRA is defined by an 8,000 year-old landscape of sand hills dominated by rolling to steep sand dunes with narrow, elongated, nearly level to steeply sloping valleys between the dunes. Dune heights range from 10 to 400 feet (3 to 130 meters) and slopes may exceed twenty-five percent. Dune complexes often extend for several miles in a northwest to southeast direction. These Quaternary sand dunes are derived from the underlying Tertiary

Ogallala and Arikaree Groups, which formed when rivers deposited sediments from erosional detritus after the uplift of the Rocky Mountains to the west. The Nebraska Sand Hills are the largest sand dune area in the Western Hemisphere and one of the largest grass-stabilized dune regions in the world. The soils of the MLRA are principally derived from deep eolian sand.

The Ogallala aquifer underlies the MLRA and is the most extensive and heavily used aquifer of the high plains between the Rocky Mountains and Mississippi River. The aquifer is at its thickest in the Sand Hills which are a primary recharge are for the aquifer. Numerous small permanent and intermittent lakes and wetlands occur in the MLRA. While the dominant source of water for these lakes is precipitation, groundwater discharge is important to maintaining these lakes especially in drier years. A number of these lakes, especially in the western portion of the MLRA are alkaline.

Considered to be a western extension of the tallgrass prairie, the matrix vegetation is a unique mix of species that is sometimes identified as sandhills prairie. Sand bluestem, prairie sandreed, Indiangrass, switchgrass, sand lovegrass, little bluestem, and needle and thread are the primary grasses. Porcupinegrass is a significant cool-season grass in the eastern portion of the MLRA while blue grama and hairy grama are important warm-season grasses in the western portion due to differences in precipitation. Soils which have a high water table support a tallgrass prairie dominated by big bluestem, switchgrass, Indiangrass, prairie cordgrass, and a variety of grass-likes. The endangered plant blowout penstemon (Penstemon haydenii) is found in this MLRA.

More than ninety percent of the land in MLRA 65 is native grassland utilized by grazing livestock. Areas along streams and in subirrigated valleys are utilized for prairie hay. Wetlands, legume hay, and irrigated cropland make up the balance of the land area with corn being the principal irrigated crop.

Wildlife flourishes in this native grassland environment. Historically large bison herds occupied the landscape. White-tailed deer, mule deer, pronghorn, black tailed jackrabbit, and coyote are now the major mammalian species. Upland sandpiper, lark bunting, grasshopper sparrow, western meadowlark, long-billed curlew, sharp-tailed grouse, and greater prairie chicken are common avian species. The mosaic of grassland and wetlands provide excellent habitat for wading and shorebird species as well.

This landscape serves as a backdrop for a disturbance-driven ecosystem, which developed under the influences of herbivory, fire, and periodic long-term drought. Historically, these processes created a heterogeneous mosaic of plant communities and vegetative structure across the region. Any given site in this landscape experienced fire every six to ten years. Fires were caused by lightning strikes and also were set by Native Americans, who used fire for warfare, signaling, and to refresh the native grasses. Indigenous peoples 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 animals such as bison, elk, and pronghorn.

The natural fire regime has been disrupted by aggressive fire suppression policies which have facilitated woody species encroachment by both native and introduced shrubs and trees into the native prairie. The most common encroacher is eastern redcedar. While eastern redcedar is native to the landscape, it was present only in trace amounts due to the periodic fires. Widespread plantings of windbreaks with eastern redcedar as a primary component have provided a seed source for this aggressive woody plant causing encroachment into native grasslands, especially in the eastern and central Sand Hills. This encroachment causes significant forage loss for domestic livestock and degrades the native wildlife habit. Since it is not a root-sprouter, eastern redcedar is very susceptible to fire when under six feet tall making management with prescribed fire very effective when applied before trees reach this stage.

Classification relationships

►USDA-NRCS (2022)◄
Land Resource Region – G, Central Feed Grains and Livestock Region
Major Land Resource Area (MLRA) –65, Nebraska Sand Hills

►Fenneman (1916) Physiographic Regions ◄
Division – Interior Plains
Province – Great Plains
Section – High Plains

►USDA-USFS (2007) Ecoregions◄
Domain – Dry
Division – Temperate Steppe
Province – Great Plains Steppe (332)
Section – Mixed Grass Steppe

►EPA Ecoregions (Omernik 1997)◄
I – Great Plains (9)
II – West-Central Semi-Arid Prairies (9.3)
III – Nebraska Sandhills (44)
IV – Sandhills (44a), Alkaline Lakes Area (44b), Wet Meadow and Marsh Plain (44c), Lakes Area (44d)

Ecological site concept

The Subirrigated ecological site is a run-on site found on interdunes and stream valleys. Slopes range from 0 to 3 percent. The soils are very deep and primarily formed in eolian sand or sandy alluvium. The surface layer textures are typically fine sand, loamy fine sand or fine sandy loam. The surface layer ranges from 3 to 10 inches thick. Subsoil textures also range from fine sand to fine sandy loam. Soils are somewhat poorly drained. Permeability is moderately slow to rapid. Subirrigated sites have a seasonally high water table at 18 to 36 inches during a portion of the growing season.

The historic native vegetation of the Subirrigated ecological site is tallgrass prairie. Vegetation in the Reference Community (1.1) is dominated by warm- season tall- and midgrasses with a cool-season grass and grass-like understory. Dominant grasses include big bluestem, Indiangrass, little bluestem, and prairie cordgrass. This site is susceptible to invasion by non-native cool-season grasses.

Associated sites

R065XY011NE	**Sandy 14-17" PZ** The Sandy 14-17 PZ is often found adjacent to the Subirrigated ecological site but on a higher landscape position.
R065XY012NE	**Sands 14-17" PZ** The Sands 14-17 PZ may be found adjacent to the Subirrigated ecological site but on a higher landscape position.
R065XY022NE	**Wet Land** The Wet Land ecological site is often found interspersed with Subirrigated ecological sites in interdunes and stream valleys but on a lower landscape position.
R065XY023NE	**Wet Subirrigated** The Wet Subirrigated ecological site is often found interspersed with Subirrigated ecological site and occurs on a slightly lower landscape.
R065XY032NE	**Sandy 17-22" PZ** The Sandy 17-22 PZ is often found adjacent to the Subirrigated ecological site but on a higher landscape position.
R065XY054NE	**Sandy 22-25" PZ** The Sandy 22-25 PZ is often found adjacent to the Subirrigated ecological site but on a higher landscape position.
R065XY055NE	**Sands 22-25" PZ** The Sands 22-25 PZ may be found adjacent to the Subirrigated ecological site but on a higher landscape position.
R065XY033NE	**Sands 17-22" PZ** The Sands 17-22 PZ may be found adjacent to the Subirrigated ecological site but on a higher landscape position.

Similar sites

R065XY023NE	**Wet Subirrigated** The Wet Subirrigated and Subirrigated ecological sites occur on similar landscape positions and have similar soil textures. The seasonal high water table is higher on Wet Subirrigated sites and is typically present at 6 to 18 inches while the water table of Subirrigated sites is typically at 18 to 36 inches.
R065XY029NE	**Sandy Lowland** The Sandy Lowland and Subirrigated ecological sites occur on similar landscape positions and have similar soil textures. Subirrigated sites have a seasonal high water table above 36 inches while the water table is below 36 inches on Sandy Lowland sites.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Andropogon gerardii* (2) *Sorghastrum nutans*

Physiographic features

The Subirrigated ecological site occurs on level to nearly level areas on interdunes, floodplains, and drainageways. Soil water is moderately close to the soil surface and the site has a seasonal high water table at 18 to 36 inches during a portion of the growing season. This site receives run-off from areas higher on the landscape. Sites located on interdunes do not experience flooding while sites on floodplains experience flooding rarely to occasionally.

Table 2. Representative physiographic features

Landforms	(1) Sandhills > Interdune (2) Valley > Flood plain
Runoff class	Negligible to low
Flooding duration	Brief (2 to 7 days)
Flooding frequency	None to occasional
Ponding frequency	None
Elevation	305–1,219 m
Slope	0–3%
Water table depth	46–91 cm
Aspect	Aspect is not a significant factor

Climatic features

The mean average annual precipitation typically ranges from 14 to 25 inches but has varied from 12 to 34 inches in the driest to wettest seasons. Approximately 65 percent of the annual precipitation occurs during the growing season of mid-April to late September. The average annual snowfall varies from about 30 inches to about 55 inches. The wind velocity is high throughout the year, averaging 10 to 12 miles per hour. Maximum wind velocities generally occur in the spring.

The average length of the growing season is 138 days, but the growing season has varied from 114 to 168 days. The average date of first frost in the fall is September 25, and the last frost in the spring is about May 10. July is the hottest month and January is the coldest. It is not uncommon for the temperature to reach 100 ºF during the summer. Summer humidity is low, and evaporation is high. The winters are characterized with frequent northerly winds, producing severe cold with temperatures dropping to as low as -30 ºF.

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)	109-126 days
Freeze-free period (characteristic range)	131-143 days
Precipitation total (characteristic range)	483-660 mm
Frost-free period (actual range)	103-129 days
Freeze-free period (actual range)	129-146 days
Precipitation total (actual range)	457-686 mm
Frost-free period (average)	118 days
Freeze-free period (average)	137 days
Precipitation total (average)	559 mm

Climate stations used

- (1) ALLIANCE MUNI AP [USW00024044], Alliance, NE
- (2) ARTHUR [USC00250365], Arthur, NE
- (3) ATKINSON 3SW [USC00250420], Atkinson, NE
- (4) BARTLETT 1S [USC00250525], Bartlett, NE
- (5) BREWSTER [USC00251130], Brewster, NE
- (6) CHAMBERS [USC00251590], Chambers, NE
- (7) CRESCENT LAKE NWR [USC00252000], Oshkosh, NE
- (8) ELLSWORTH 15 NNE [USC00252647], Ellsworth, NE
- (9) ELSMERE 9 ENE [USC00252680], Johnstown, NE
- (10) ERICSON 8 WNW [USC00252770], Burwell, NE
- (11) GREELEY [USC00253425], Greeley, NE
- (12) HYANNIS [USC00254100], Hyannis, NE
- (13) KILGORE 1NE [USC00254432], Kilgore, NE
- (14) KINGSLEY DAM [USC00254455], Keystone, NE
- (15) MERRIMAN [USC00255470], Merriman, NE
- (16) MULLEN [USC00255700], Mullen, NE
- (17) MULLEN 21 NW [USC00255702], Whitman, NE
- (18) NEWPORT [USC00255925], Newport, NE
- (19) NORTH PLATTE RGNL AP [USW00024023], Maxwell, NE
- (20) PURDUM [USC00256970], Purdum, NE
- (21) ROSE 10 WNW [USC00257318], Long Pine, NE
- (22) SWAN LAKE [USC00258360], Amelia, NE
- (23) VALENTINE NWR [USC00258755], Valentine, NE
- (24) WHITMAN 5 ENE [USW00094079], Whitman, NE

Influencing water features

The Subirrigated ecological site has a combination of physical and hydrological features that: 1) normally has groundwater within the root zone (1.5 ft. to 3 ft.), 2) during a portion of the growing season, allowing relatively free movement of water and air (aerobic conditions) throughout the upper half of the root zone, and 3) is not normally ponded or flooded during the growing season.

Soil features

The soils associated with the Subirrigated ecological site are typically very deep soils. These soils formed primarily in eolian sand or sandy alluvium, but some soils formed in loamy eolian materials or loamy alluvium. Slopes range from 0 to 3 percent. Soil surface and subsurface textures range from fine sand to fine sandy loam. The thickness of the A horizon is typically 4 to 18 inches but may be thicker. Soil structures are primarily single grain to weak fine granular to weak fine granular parting to single grain.

Runoff as evidenced by rills, waterflow patterns, pedestalled plants, or gullies is negligible due to the low slope gradient and high intake rate of these soils. Litter should fall in place and signs of litter movement are rare.

The major soil series correlated to this ecological site are Els, Elsmere, Ord, Boel, and Bolent. Other soils correlated to this site include Gibbon, Lex, and Ovina. Additional information can be found in the various soil survey reports. Contact the local USDA Service Center for soil survey reports that include more details specific to your location or visit Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov).

Table 4. Representative soil features

Parent material	(1) Eolian sands (2) Alluvium
Surface texture	(1) Fine sand (2) Loamy fine sand (3) Fine sandy loam
Family particle size	(1) Sandy
Drainage class	Somewhat poorly drained
Permeability class	Moderately slow to rapid
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	7.62–15.24 cm
Calcium carbonate equivalent (0-101.6cm)	0–10%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–6
Soil reaction (1:1 water) (0-101.6cm)	5.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–6%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

Subirrigated ecological sites developed under Northern Great Plains climatic conditions, light to severe grazing by bison and other large herbivores, sporadic natural or man-caused fire, 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 in the plant communities occur due to short-term weather variations, impacts of native and exotic plant and animal species, and management actions. The plant diversity allows for high resistance to drought. The site is extremely resilient, and well adapted to Northern Great Plains climatic conditions.

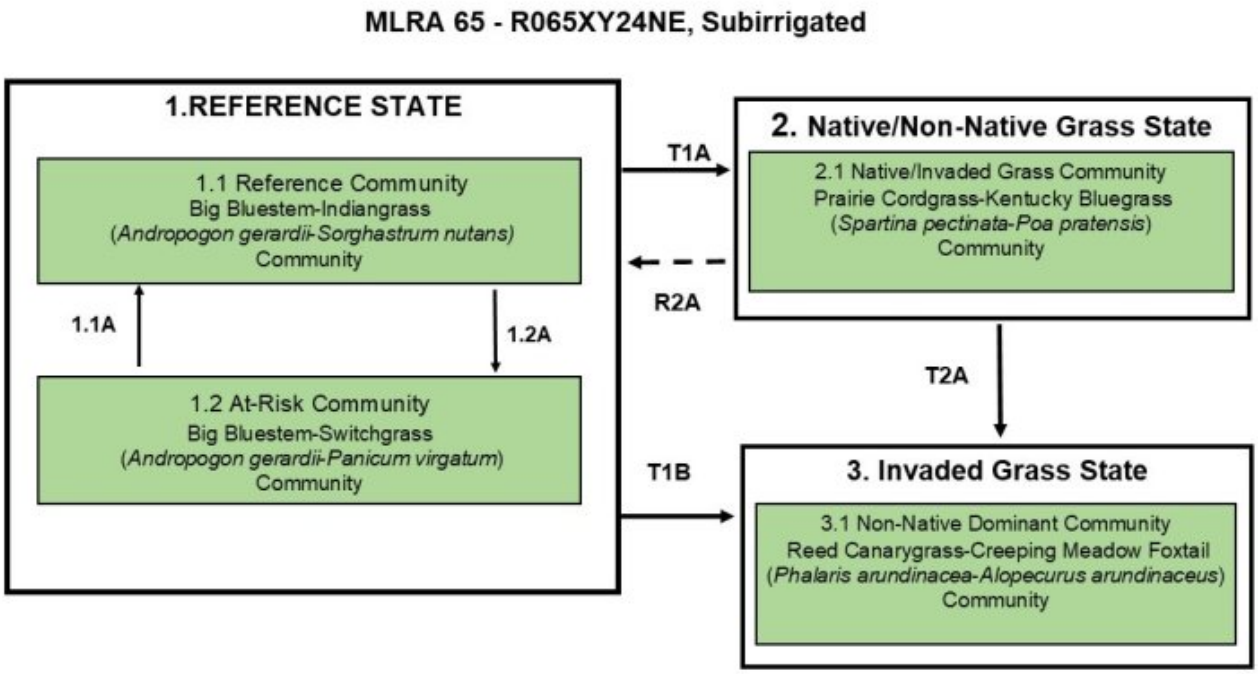
The introduction of domestic livestock by European settlers along with season-long, continuous grazing and annual late summer haying had a profound impact on the vegetation of the Subirrigated ecological site. Season-long, continuous grazing causes a repeated removal of the growing point and excessive defoliation of the leaf area of the more palatable warm-season tallgrasses, reducing the ability of the plants to harvest sunlight thereby depleting root reserves and 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, big bluestem, prairie cordgrass,

switchgrass, and Indiangrass decrease in frequency and production while cool-season grasses increase. As this management continues, the site becomes dominated by native cool-season grasses and the site is susceptible to invasion by non-native cool-season grasses.

The State and Transition Model (STM) is depicted below and includes a Reference State (1), a Native/Non-Native Grass State (2) and an Invaded Grass 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, hydrologic function, and functional/structural group composition. 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 local climatic fluctuations especially 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 description following the model diagram.

Interpretations are primarily based on the Reference Community (1.1) which has been determined by study of rangeland relic areas, areas protected from excessive disturbance, and areas under long-term rotational grazing regimes. Trends in plant community dynamics ranging from heavily grazed to lightly grazed areas, seasonal use pastures, and historical accounts have been used as well. Plant communities, states, transitional pathways, and thresholds have been determined through similar studies and experience.

State and transition model



Transitions and Restorations:

T1A: Long-term annual haying in mid-summer. Continuous, seasonal grazing in summer.

T1B: Seeding of introduced grass species.

T2A: Encroachment facilitated by long-term, annual mid-summer haying. Seeding.

R2A: Long-term early haying or long-term, early grazing with adequate growing season recovery periods. This restoration will take an extended amount of time and may not be feasible.

Community Pathways:

1.1A: Annual haying at same time each year or moderate seasonal grazing in the summer.

1.2A: Appropriately timed haying. Rotational grazing with adequate growing season recovery periods.

Figure 8. State and Transition Model Diagram, Subirrigated ecological site, MLRA 65.

State 1
Reference State

The Reference State (1) describes the range of vegetative communities that occur on the Subirrigated 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 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 occurs on the site when the natural disturbance regimes are intact or closely mimicked by management practices. The At-Risk Community results from management actions that are unfavorable for a healthy Reference Community.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- switchgrass (*Panicum virgatum*), grass
- prairie cordgrass (*Spartina pectinata*), grass
- slender wheatgrass (*Elymus trachycaulus*), grass

Community 1.1
Reference Community

Interpretations are primarily based on the Reference or Big Bluestem-Indiangrass (*Andropogon gerardii-Sorghastrum nutans*) Community. This plant community serves as a description of the native plant community that occurs on the site when the historic disturbance regimes are intact or are closely mimicked by management practices. This community phase is dynamic, with fluid relative abundance and spatial boundaries between the dominant structural and functional vegetative groups. These fluctuations are primarily driven by different responses of the plant species to fire and grazing events and to changes in precipitation timing and abundance. This site developed with grazing by large herbivores and is well suited for grazing by domestic livestock. The Reference Community is dominated by warm-season tallgrasses. Big bluestem, switchgrass, prairie cordgrass, and Indiangrass are the dominant grass species. Little bluestem is also an important component of the site. Native cool-season grasses and grass-likes occur in the understory. Forbs typically include American licorice, scouringrush horsetail, blackeyed Susan, Maximilian sunflower, and giant goldenrod. The potential vegetative composition is 75 to 85 percent grasses, 5 to 15 percent grass-likes, 5 to 10 percent forbs, and 0 to 5 percent shrubs by weight. Natural fire played a significant role in the succession of this site. Wildfires have been actively controlled in recent times, reducing forb diversity. This plant community can be found on areas that are managed with prescribed grazing, prescribed burning, or rotational haying. Haying or grazing during the same portion of the growing season can reduce plant diversity and reduce vigor of desirable plants. This resilient community is well adapted to the Northern Great Plains climatic conditions. Plant diversity promotes drought tolerance, site and soil stability, a functional hydrologic cycle, and a high degree of biotic integrity. These factors create a suitable environment for a healthy and sustainable plant community.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- prairie cordgrass (*Spartina pectinata*), grass
- switchgrass (*Panicum virgatum*), grass

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	4461	4741	4977
Forb	247	392	560
Shrub/Vine	–	22	67
Total	**4708**	**5155**	**5604**

Figure 10. Plant community growth curve (percent production by month). NE6543, NE/SD Sandhills, Native Grass, Wet. Warm-season dominant, cool-season subdominant, mid & tall grasses.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	20	35	25	10	5	0	0	0

Community 1.2
At-Risk Community

The At-Risk or Big Bluestem-Switchgrass (*Andropogon gerardii-Panicum virgatum*) Community (1.2) historically developed with annual haying or moderate seasonal grazing in the summer followed by heavy grazing in the fall. This plant community closely resembles the Reference Community (1.1) but lacks the plant diversity of that community. Warm-season tallgrasses are suppressed while cool-season grasses and grass-likes have increased slightly. The proportion of forbs and shrubs remains the same as in the Reference Community, but shifts in species composition have occurred. The dominant grasses include big bluestem, switchgrass, and prairie cordgrass. Grasses of secondary importance include little bluestem. Sedges are also important on the site. Non-native, cool-season grasses may have begun to encroach into the plant community. The potential vegetative composition is 70 to 80 percent grasses, 10 to 15 percent grasslikes, 5 to 10 percent forbs, and 0 to 5 percent shrubs. The At-Risk Community is not resistant to change but is resilient. Haying or grazing prior to the onset of active growth of the warm-season grasses will improve their vigor. Early haying will reduce cool-season grass competition and provide good quality hay. Grazing in the fall after a killing frost will also reduce cool-season grass competition. This community is stable in terms of hydrologic function and soil and site stability, but biotic integrity is reduced as compared to the Reference Community.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- switchgrass (*Panicum virgatum*), grass
- prairie cordgrass (*Spartina pectinata*), grass

Table 6. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	3923	4349	4775
Forb	–	112	224
Shrub/Vine	–	22	45
Total	**3923**	**4483**	**5044**

Figure 12. Plant community growth curve (percent production by month). NE6544, NE/SD Sandhills, Hayed and Grazed Subirrigated Meadows. Warm-season dominant, cool-season subdominant, mid and tall grasses.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	10	20	25	20	15	10	0	0	0

Pathway 1.1A
Community 1.1 to 1.2

Annual haying during the same time period each year or moderate summer grazing will move the Reference Community (1.1) to the At-Risk Community (1.2). This process is accelerated when heavy fall grazing follows summer haying or grazing.

Pathway 1.2A
Community 1.2 to 1.1

Haying or grazing prior to the onset of the rapid growth period of warm-season grasses will improve warm-season

grass vigor and move the At-Risk Community (1.2) to the Reference Community (1.1). Early haying or grazing reduces cool-season grass competition and provides high quality hay. Grazing after a killing frost in the fall will also reduce the amount of cool-season grasses. Rotational grazing with adequate, growing season recovery time will also facilitate the return to the Reference Community.

State 2
Native/Non-Native Grass State

The Native/Non-Native Grass State (2) transitioned from the Reference State (1) and a significant portion of the native grasses has been replaced by non-native cool-season grasses. The management that resulted in the Native/Invaded Grass State is typically long-term annual haying in mid-summer. Under this management strategy, introduced grasses encroach from adjacent seeded areas. In the past, many Sandhills meadows were interseeded with non-native introduced grasses in an attempt to improve forage production. This interseeding often produced to a mixture of native and non-native grasses. The loss of warm-season tall- and midgrasses negatively impacts energy flow and nutrient cycling and alters hydrologic function. The Native/Invaded Grass State is very resistant to change; Return to the Reference State will take a significant amount of time. If inadequate amounts of warm-season tall- and midgrasses are present, restoration to the Reference State will not be feasible. The Native/Non-Native Grass State includes one community, the Native/Invaded Grass Community (2.1).

Dominant plant species

- prairie cordgrass (*Spartina pectinata*), grass
- big bluestem (*Andropogon gerardii*), grass
- switchgrass (*Panicum virgatum*), grass
- slender wheatgrass (*Elymus trachycaulus*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

Community 2.1
Native/Invaded Grass Community

Historically, the Native/Invaded or Prairie Cordgrass/Kentucky Bluegrass (*Spartina pectinata*/*Poa pratensis*) Community developed with long-term annual haying in mid-summer. This community also occurs in over-utilized, winter feeding areas or with the interseeding of introduced forage grasses. As compared to the Reference Community (1.1), cool-season grasses have increased significantly, and the dominant cool-season grasses are often non-native species. Slender wheatgrass is typically the dominant native cool-season grass. Non-native grasses may also be present. Switchgrass and prairie cordgrass are reduced while big bluestem and Indiangrass are significantly reduced as compared to the Reference Community. Dominant native grasses include big bluestem, switchgrass, prairie cordgrass, and slender wheatgrass. Non-native grasses may include redtop, timothy, Kentucky bluegrass, quackgrass, reed canarygrass, creeping meadow foxtail, or smooth brome. White clover and red clover are common forbs. American licorice may be extensive in areas where cattle are hayed in the winter. The potential vegetative composition is 65 to 75 percent grasses, 5 to 20 percent grass-likes, 5 to 10 percent forbs, and 0 to 1 percent shrubs. Plant diversity is reduced as compared to the Reference Community and lower overall production of the site can be expected. This plant community is moderately resistant to change. With continuation of mid-summer haying, the warm-season grasses will continue to decline eventually causing the transition to the Invaded Grass State (3).

Dominant plant species

- prairie cordgrass (*Spartina pectinata*), grass
- slender wheatgrass (*Elymus trachycaulus*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

Table 7. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	2853	3228	3491
Forb	174	359	616
Total	**3027**	**3587**	**4107**

Figure 14. Plant community growth curve (percent production by month). NE6545, NE/SD Sandhills, Hayed and Grazed Cool-Season Meadows. Cool-season dominant, warm-season subdominant, mid & tall grasses.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	5	15	30	25	10	5	10	0	0	0

State 3
Invaded Grass State

The Invaded Grass State (3) transitioned from the Native/Invaded Grass State (2) and most of the native grasses, both warm- and cool-season, have been replaced by non-native cool-season grasses through encroachment from other areas. The management that causes this transition is typically long-term, repetitive haying during the same time during the growing season or a combination of heavy grazing and repetitive haying. The Invaded Grass State will also result when non-native, forage grasses such as reed canarygrass and creeping meadow foxtail are interseeded to improve forage production. In the past, many Sandhills meadows were interseeded with non-native grasses for this purpose. Due to the aggressive nature of these non-native grasses, restoration to either the Reference State or the Native/Invaded Grass State is unlikely. The Invaded Grass State includes one plant community, the Non-Native Dominant Community (3.1).

Community 3.1
Non-Native Dominant Community

The Non-Native Dominant or Reed Canarygrass-Creeping Meadow Foxtail (*Phalaris arundinacea-Alopecurus arundinaceus*) Community (3.1) occurs with encroachment or when introduced grasses are seeded. Non-native cultivars of reed canarygrass and creeping meadow foxtail are typical dominants but timothy, redtop, quackgrass, or other non-native grasses may dominate the site. The presence of this plant community has serious repercussions on plant diversity and is detrimental to numerous wildlife species. Once established, this plant community becomes difficult to alter due to the aggressive nature of the seeded species. While the production potential for this community is quite high, forage quality is significantly less than that of native grass especially when hayed.

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), grass
- creeping meadow foxtail (*Alopecurus arundinaceus*), grass

Figure 15. Plant community growth curve (percent production by month). NE6545, NE/SD Sandhills, Hayed and Grazed Cool-Season Meadows. Cool-season dominant, warm-season subdominant, mid & tall grasses.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	5	15	30	25	10	5	10	0	0	0

Transition T1A
State 1 to 2

The Reference State (1) most often transitions to the Native/Non-Native state with long-term annual haying during mid-summer. This transition can also occur with long-term, seasonal grazing during the summer months. This process is accelerated when mid-summer haying or grazing is accompanied by heavy grazing in the fall.

Transition T1B

State 1 to 3

Seeding non-native forage species will convert the Reference State (1) to the Invaded Grass State (3). Encroachment of non-native forage species from other areas will also cause this transition.

Restoration pathway R2A
State 2 to 1

Long-term haying or grazing prior to the onset of the rapid growth period of warm-season tallgrasses will improve the health and vigor of the warm-season grasses restoring the Native/Invaded Grass State (2) to the Reference State (1). Early haying or grazing reduces cool-season grass competition and provides high quality hay. Grazing after a killing frost in the fall will also help reduce cool-season grass abundance. Care must be used on areas where Subirrigated, Wet Subirrigated, and Wet Land sites are interspersed as concentrated grazing in the spring when water tables are highest can damage the wetter sites. This restoration will take a considerable amount of time and is only feasible if adequate warm-season tallgrasses remain in the plant community.

Transition T2A
State 2 to 3

When warm-season grasses are low in vigor due to long-term repeated haying at the same time each year, non-native grasses will encroach if a viable seed source is available transitioning the Native/Invaded Grass State (2) to the Non-Native State (3). This transition will also occur when the Native/Invaded Grass State is further stress by heavy grazing. The Non-Native State also occurs when reed canarygrass and/or creeping meadow foxtail have been seeded after deterioration of native grass production.

Additional community tables

Table 8. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm-Season Tallgrass**			2836–3609	
	big bluestem	ANGE	*Andropogon gerardii*	1547–2578	–
	Indiangrass	SONU2	*Sorghastrum nutans*	773–1289	–
	prairie cordgrass	SPPE	*Spartina pectinata*	258–773	–
	switchgrass	PAVI2	*Panicum virgatum*	258–773	–
	marsh muhly	MURA	*Muhlenbergia racemosa*	0–258	–
	Grass, perennial	2GP	*Grass, perennial*	0–155	–
2	**Warm-Season Midgrass**			516–1289	
	little bluestem	SCSC	*Schizachyrium scoparium*	516–1289	–
	Grass, perennial	2GP	*Grass, perennial*	0–155	–
3	**Native Cool-Season Grass**			258–773	
	western wheatgrass	PASM	*Pascopyrum smithii*	0–516	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	103–516	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–258	–
	slender wheatgrass	ELTRT	*Elymus trachycaulus ssp. trachycaulus*	0–258	–
	plains bluegrass	POAR3	*Poa arida*	0–155	–
	foxtail barley	HOJU	*Hordeum jubatum*	0–105	–
	Grass, perennial	2GP	*Grass, perennial*	0–103	–
4	**Grass-like**			258–773	
	sedge	CAREX	*Carex*	258–516	–
	spikerush	ELEOC	*Eleocharis*	0–258	–
	rush	JUNCU	*Juncus*	0–258	–
	bulrush	SCIRP	*Scirpus*	0–258	–
Forb					
5	**Forb**			258–516	
	white heath aster	SYER	*Symphyotrichum ericoides*	0–155	–
	American licorice	GLLE3	*Glycyrrhiza lepidota*	0–155	–
	Forb, perennial	2FP	*Forb, perennial*	0–155	–
	scouringrush horsetail	EQHY	*Equisetum hyemale*	0–103	–
	Nebraska aster	SYPRN	*Symphyotrichum praealtum var. nebraskense*	0–103	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	0–103	–
	blazing star	LIATR	*Liatris*	0–103	–
	blackeyed Susan	RUHI2	*Rudbeckia hirta*	0–103	–
	giant goldenrod	SOGI	*Solidago gigantea*	0–103	–
Shrub/Vine					
7	**Shrub**			0–258	
	dwarf false indigo	AMNA	*Amorpha nana*	0–258	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–258	–

Table 9. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm-Season Tallgrass**			1345–2242	
	big bluestem	ANGE	*Andropogon gerardii*	448–1121	–
	switchgrass	PAVI2	*Panicum virgatum*	448–1121	–
	prairie cordgrass	SPPE	*Spartina pectinata*	224–673	–
	Indiangrass	SONU2	*Sorghastrum nutans*	90–448	–
	marsh muhly	MURA	*Muhlenbergia racemosa*	0–135	–
	Grass, perennial	2GP	*Grass, perennial*	0–90	–
2	**Warm-Season Midgrass**			224–448	
	little bluestem	SCSC	*Schizachyrium scoparium*	224–448	–
	Grass, perennial	2GP	*Grass, perennial*	0–45	–
3	**Native Cool-Season Grass**			224–897	
	slender wheatgrass	ELTRT	*Elymus trachycaulus ssp. trachycaulus*	0–224	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	103–224	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–224	–
	foxtail barley	HOJU	*Hordeum jubatum*	0–224	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–224	–
	plains bluegrass	POAR3	*Poa arida*	0–224	–
	Grass, perennial	2GP	*Grass, perennial*	0–90	–
4	**Grass-like**			448–673	
	sedge	CAREX	*Carex*	224–448	–
	spikerush	ELEOC	*Eleocharis*	0–224	–
	rush	JUNCU	*Juncus*	0–224	–
	bulrush	SCIRP	*Scirpus*	0–224	–
7	**Non-Native Cool-Season Grass**			0–448	
	Kentucky bluegrass	POPR	*Poa pratensis*	0–224	–
	smooth brome	BRIN2	*Bromus inermis*	0–224	–
	Grass, perennial	2GP	*Grass, perennial*	0–224	–
Forb					
5	**Forb**			224–448	
	giant goldenrod	SOGI	*Solidago gigantea*	0–224	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–135	–
	blackeyed Susan	RUHI2	*Rudbeckia hirta*	0–135	–
	American licorice	GLLE3	*Glycyrrhiza lepidota*	0–135	–
	blazing star	LIATR	*Liatris*	0–90	–
	scouringrush horsetail	EQHY	*Equisetum hyemale*	0–90	–
	Forb, perennial	2FP	*Forb, perennial*	0–90	–
	Nebraska aster	SYPRN	*Symphyotrichum praealtum var. nebraskense*	0–90	–
Shrub/Vine					
6	**Shrub**			0–224	

	dwarf false indigo	AMNA	*Amorpha nana*	0–224	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–90	–

Table 10. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm-Season Tallgrass**			897–1435	
	big bluestem	ANGE	*Andropogon gerardii*	359–538	–
	switchgrass	PAVI2	*Panicum virgatum*	359–538	–
	prairie cordgrass	SPPE	*Spartina pectinata*	179–538	–
	Indiangrass	SONU2	*Sorghastrum nutans*	0–179	–
	marsh muhly	MURA	*Muhlenbergia racemosa*	0–72	–
	Grass, perennial	2GP	*Grass, perennial*	0–72	–
2	**Warm-Season Midgrass**			179–359	
	little bluestem	SCSC	*Schizachyrium scoparium*	179–359	–
	Grass, perennial	2GP	*Grass, perennial*	0–72	–
3	**Native Cool-Season Grass**			538–1255	
	western wheatgrass	PASM	*Pascopyrum smithii*	179–359	–
	plains bluegrass	POAR3	*Poa arida*	0–359	–
	slender wheatgrass	ELTRT	*Elymus trachycaulus ssp. trachycaulus*	179–359	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	179–359	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–179	–
	foxtail barley	HOJU	*Hordeum jubatum*	0–179	–
	Grass, perennial	2GP	*Grass, perennial*	0–72	–
4	**Grass-Like**			179–717	
	spikerush	ELEOC	*Eleocharis*	0–717	–
	sedge	CAREX	*Carex*	179–538	–
	rush	JUNCU	*Juncus*	0–179	–
	bulrush	SCIRP	*Scirpus*	0–179	–
7	**Non-Native Cool-Season Grass**			359–1255	
	Kentucky bluegrass	POPR	*Poa pratensis*	359–897	–
	smooth brome	BRIN2	*Bromus inermis*	0–717	–
	timothy	PHPR3	*Phleum pratense*	0–538	–
	redtop	AGGI2	*Agrostis gigantea*	0–359	–
	quackgrass	ELRE4	*Elymus repens*	0–179	–
	Grass, perennial	2GP	*Grass, perennial*	0–179	–
Forb					
5	**Forb**			139–359	
	white heath aster	SYER	*Symphyotrichum ericoides*	0–179	–
	Nebraska aster	SYPRN	*Symphyotrichum praealtum var. nebraskense*	0–108	–
	Forb, perennial	2FP	*Forb, perennial*	0–108	–
	American licorice	GLLE3	*Glycyrrhiza lepidota*	0–108	–
	blazing star	LIATR	*Liatris*	0–108	–

	blackeyed Susan	RUHI2	*Rudbeckia hirta*	0–108	–
	giant goldenrod	SOGI	*Solidago gigantea*	0–72	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	0–72	–
	scouringrush horsetail	EQHY	*Equisetum hyemale*	0–72	–
8	**Introduced Forb**			40–359	
	red clover	TRPR2	*Trifolium pratense*	0–359	–
	white clover	TRRE3	*Trifolium repens*	0–287	–
	Forb, introduced	2FI	*Forb, introduced*	0–179	–
Shrub/Vine					
6	**Shrub**			0–36	
	dwarf false indigo	AMNA	*Amorpha nana*	0–36	–

Animal community

LIVESTOCK - GRAZING INTERPRETATIONS:
Grazing by domestic livestock is the major income-producing industry 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*
►Reference Community (1.1)
Average Production (lb./acre, air-dry): 4,600
Stocking Rate (AUM/acre): 1.26
►At-Risk Community (1.2)
Average Production (lb./acre, air-dry): 4,000
Stocking Rate (AUM/acre): 1.1
►Native/Invaded Grass Community (2.1)
Average Production (lb./acre, air-dry): 3,200
Stocking Rate (AUM/acre): 0.88
*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:
The Sandhills Prairie ecosystem consists of diverse grassland habitats interspersed with varying densities of Sandhills lakes and limited woody riparian corridors. The majority of this ecosystem is intact. 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 Sandhills Prairie was a disturbance-driven ecosystem with fire, herbivory, and climate functioning as the primary disturbances. Following European settlement, elimination of fire and overgrazing altered the appearance and functionality of the 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 influenced the

character of the remaining native grasslands and the habitats that they provide. Fragmentation in MLRA 65 is limited and area sensitive grassland birds such as greater prairie chicken and sharp-tailed grouse continue to thrive here. The mosaic of sites continues to provide habitat for species requiring unfragmented grasslands, 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.

In the absence of fire and grazing, heavy litter buildup can occur on this site hindering the movement of young birds, especially quail and prairie chickens. Increased litter buildup results in decreased forb abundance and diversity and an accompanying decrease in insects, a critical food source for young birds. Introduced species such as cheatgrass, Kentucky bluegrass, and introduced forbs may be present but degradation of the biotic integrity from non-native species in this precipitation zone on ecological site is limited.

Disruption of the natural fire regime and accompanying woody encroachment is the greatest threat to ecosystem dynamics in this MLRA. Lack of fire facilitates tree and shrub encroachment degrades grassland habitats and creates habitats that favor generalist species such as American robin and mourning dove. Woody species provide perches for raptors, increasing the predation mortality on native bird populations. Woody encroachment is most severe in the eastern half of the MLRA but is a threat across the MLRA.

Hydrological functions

Moisture conditions are ideal for forage production the Subirrigated ecological site. Soils on this site are mostly in Hydrologic Soil Group A, but may include soils in Group B, and local areas in Group C. Although most of these soils are very permeable, water tables provide subirrigation of grasses and other vegetation. 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 flood.

For the interpretive plant community, rills and gullies should not be present. Water flow patterns should not be present. Pedestals should not be present. Litter falls in place, and signs of movement are rare. Chemical and physical crusts are rare to non-existent. Cryptogamic crusts may be present but are not significant for hydrologic considerations. Overall, this site has the appearance of being very stable and extremely 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 esthetic value that appeals to visitors.

Wood products

No appreciable wood products are present on the site.

Other products

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

Other information

Revision Notes: “This PROVISIONAL ecological site concept has been through the quality control and quality assurance processes to ensure that the site meets the NESH standards for a provisional ecological site that provides basic compiled information in one location. This site should not be considered an Approved ESD until further data entry and editing is completed.

Site Development and Testing Plan:
Future work is needed to validate the information in this Provisional Ecological Site Description. Additional data collection and evaluation may also be needed to develop this ESD to the Approved, then Correlated level. This could include field activities to collect low, medium and high intensity sampling, soil correlations, and analysis of that data. Field reviews of the project plan should be done by soil scientists and vegetation specialists. A final field review, peer review, quality control, and quality assurance reviews of the ESD will be needed to produce the final document. Annual reviews of the Project Plan are to be conducted by the Ecological Site Technical Team. The

project plan is ES-R065XY013NE - MLRA 65.

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; Sheila Luoma, Resource Conservationist, NRCS; Marla Shelbourn, Rangeland Management Specialist, NRCS; Dave Steffen, Rangeland Management Specialist, NRCS.

There are 27 SCS-RANGE-417 records available that were collected in Nebraska and South Dakota counties: Blaine, Cherry, Custer, Garden, Garfield, Grant, Morrill, Lincoln, Loup, Thomas, Todd, and Wheeler. These records are from 1968 to 1999.

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Approval

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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)	Original Author: Stan Boltz. Version V participants: Dave Cook, Emily Helms, Jeff Nichols, Myra Richardson, Nadine Bishop
Contact for lead author	Jeff Nichols: jeffrey.nichols@usda.gov
Date	11/30/2024
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 are not expected on this site.

2. **Presence of water flow patterns:** None. Water flow patterns are not expected on this site.

3. **Number and height of erosional pedestals or terracettes:** None. Pedestals and terracettes are not expected on this site.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is typically 5 percent or less.

   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).

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):** Litter should fall in place. Litter movement 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, 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 3 to 10 inches (7.5-25.5 cm) thick. Soil colors range from dark gray, very dark gray, brown, grayish brown, to dark grayish brown (values of 3-7) when dry and brown, very dark brown, very dark grayish brown, gray, to

black (values of 2-6) when moist. Soil structure is typically single grain, weak fine granular, or weak fine granular parting to single grain.

Els, Elsmere, Ord, Boel, and Bolent are the major soil series correlated to this ecological site. Other soil series that have been correlated to this site include Gibbon, Lex, and Ovina.

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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 (mid & tall rhizomatous and tufted perennial cool season grasses) with fine and coarse roots positively influences infiltration. Woody encroachment may adversely impact infiltration on this site.

    The expected composition of the plant community is 75 to 85 percent grasses, 5 to 15 percent grass-likes, 5-10 percent forbs, and 0 to 5 percent shrubs. The perennial grass component is made up of warm-season tallgrass (55-70%), warm-season midgrass (10-25%), and cool-season grass (5-15%).

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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. Compaction layers should not be present.

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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, warm-season tallgrass, 2530-3220 #/ac, 55-70%, 4 species minimum: big bluestem, Indiangrass, prairie cordgrass, switchgrass, marsh muhly.

    Phase 1.2
    1.Native, perennial, warm-season tallgrass, 1200-2000 #/ac, 30-50%, 4 species minimum: big bluestem, switchgrass, prairie cordgrass, Indiangrass, marsh muhly.

    Sub-dominant: Phase 1.1
    1. Native, perennial, warm-season midgrass, 460-1150 #/ac, 10-25% , 1 species minimum: little bluestem.
    2. Grass-like, 230-690 #/ac, 5-15%, 1 species minimum: sedge, spikerush, rush, bulrush.
    3. Native, perennial, cool-season grass, 230-690 #/ac, 5- 15%, 1 species minimum: slender wheatgrass, needle and thread, porcupinegrass, foxtail barley, western wheatgrass, plains bluegrass.

    Phase 1.2
    1. Native, perennial, cool-season grass, 200-800 #/ac, 5- 20%, 1 species minimum: slender wheatgrass, needle and thread, porcupinegrass, foxtail barley, western wheatgrass, plains bluegrass.
    2. Grass-like, 400-600 #/ac, 10-15%, 1 species minimum: sedge, rush, spikerush, bulrush.

    Other: Minor - Phase 1.1
    1. Native forb, 230-460 #/ac, 5-10%: forbs present vary from location to location.
    2 Shrub, 0-230 #/ac, 0-5%: dwarf false indigo, and other shrubs which vary from location to location.

    Minor - Phase 1.2
    1. Native, perennial, warm-season midgrass, 200-400 #/ac, 5-10%: little bluestem.
    2. Native forb, 200-400 #/ac, 5-10%: forbs present vary from location to location.
    3. Non-native, cool-season grass, 0-400 #/ac, 0-10%: Kentucky bluegrass, smooth brome.

4. Shrub, 0-200 #/ac , 0-5%: dwarf false indigo and other shrubs that vary from location to location.

Additional: The Reference Community (1.1) includes six F/S groups. These groups are, in order of relative abundance, native, perennial, C4 tallgrass; native, perennial, C4 midgrass; grass-like=native, perennial, C3 grass; native forb and shrub.

The At-Risk Community (1.2) includes seven F/S groups which are in order of relative abundance native, perennial C4 tallgrass; native, perennial, C3 grass; grass-likes; native, perennial, C4 midgrass=native forb; non-native, C3 grass; shrub.

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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 80 to 90 percent and at a depth of 0.50 to 1.0 inch (1.3-2.6 cm). Litter cover during and following drought can range from 70 to 80 percent.

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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 4,600 pounds per acre on an air dry weight basis. Low and high production years should yield 4,200 and 5,000 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. Canada thistle, reed canarygrass, creeping foxtail, common watercress, leafy spurge, quackgrass, redtop, smooth brome, eastern redcedar, tamarisk (salt cedar), and Russian olive that have the potential to be dominant or co-dominant on the site. Consult the state noxious weed and state watch lists for potential invasive species.

NOTE: Invasive plants (for the purposes of the IIRH protocol) are plant species that are typically not found on the ecological site or should only be in trace or minor categories under the natural disturbance regime and have the potential to become a dominant or codominant species on the site if their establishment and growth are not actively controlled by natural disturbances or management interventions. Species listed characterize degraded states AND have the potential to become a dominant or co-dominant species.

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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.
