USDA Natural Resources
Conservation Service

# Ecological site R058BY146WY
# Sands (Sa) 10-14" PZ

Last updated: 10/05/2023
Accessed: 05/17/2024

## 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.

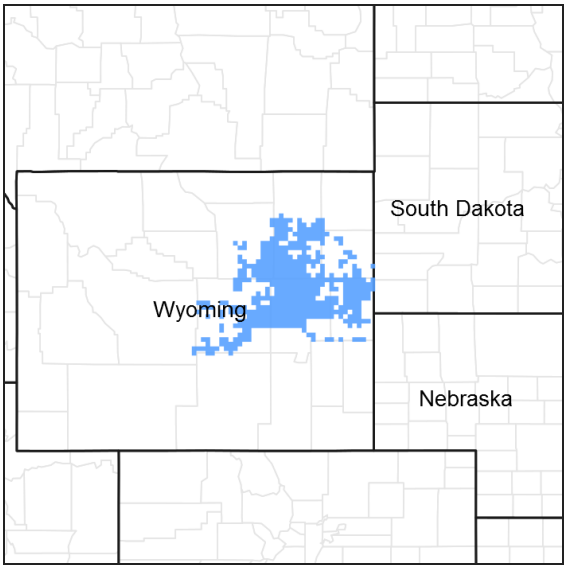



**Figure 1. Mapped extent**

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): 058B–Northern Rolling High Plains, Southern Part

MLRA 58B is located in northeastern Wyoming (95 percent) and extreme southeastern Montana (5 percent). It is comprised of sedimentary plains, scoria hills, and river valleys. The major rivers include the Powder, Tongue, Belle Fourche, Cheyenne, and North Platte. Tributaries include the Little Powder River, Little Missouri River, Clear Creek, Crazy Woman Creek, and others. This MLRA is traversed by Interstates 25 and 90, and U.S. Highways 14 and 16. The extent of MLRA 58B covers approximately 12.3 million acres. Major land uses include rangeland (approximately 93 percent), cropland, pasture, and hayland (approximately 2 percent), and forest, urban, and miscellaneous uses (approximately 5 percent). Cities include Buffalo, Casper, Sheridan, and Gillette, WY. Land ownership is mostly private. Federal lands include the Thunder Basin National Grassland (U.S. Forest Service) and lands administered by the Bureau of Land Management. Areas of interest in MLRA 58B in Wyoming include Fort Phil Kearny State Historic Site, Glendo State Park, and Lake DeSmet. The elevations in MLRA 58B increase gradually from north to south and range from approximately 2,900 to 5,900 feet. A few buttes are higher than 6,800 feet. The average annual precipitation in this area ranges from 10 to 17 inches per year. Precipitation occurs mostly during the growing season, often during rapidly developing thunderstorms. Mean annual air temperature is 46 degrees Fahrenheit. Summer temperatures may exceed 100 degrees Fahrenheit. Winter temperatures may drop to below zero. Snowfall averages 45 inches per year, but varies from 25 to over 70 inches in some locales.

## Classification relationships

USDA Natural Resources Conservation Service (NRCS):
Land Resource Region–G Western Great Plains Range and Irrigation; Major Land Resource Area (MLRA)–58B Northern Rolling High Plains, Southern Part (USDA, 2006)

Relationship to Other Classifications:

USDA Forest Service (FS) Classification Hierarchy:

Province–331 Great Plains-Palouse Dry Steppe; Section–331G-Powder River Basin; Subsections–331Gb Montana Shale Plains, 331Ge Powder River Basin, 331Gf South Powder River Basin-Scoria Hills (Cleland et al, 1997)

Environmental Protection Agency (EPA) Classification Hierarchy:

Level III Ecoregion–43 Northwestern Great Plains; Level IV Ecoregion–43p Scoria Hills, 43q Mesic-Dissected Plains, 43w Powder River Basin (EPA, 2013)
https://www.epa.gov/eco-research/ecoregions

## Ecological site concept

The Sands 10-14” PZ ecological site occurs on level to moderately sloping hills, ridges, and dunes, on sedimentary plains or uplands. It is predominantly a warm-season mixed grass prairie (tall- and midgrasses) with secondary cool-season midgrasses; and a lesser component of forbs and shrubs. The soils are sands to loamy fine sand.

## Associated sites

| | |
|---|---|
| R058BY122WY | **Loamy (Ly) 10-14” PZ**<br>Loamy will be in complex with the Sands and Sandy site along interbedded sandstone and shale outcroppings. |
| R058BY150WY | **Sandy (Sy) 10-14” PZ**<br>Sandy soils are generally on more sloping portions of the landform further from the bedrock parent material. |
| R058BY166WY | **Shallow Sandy (SwSy) 10-14” PZ**<br>Shallow Sandy will occur in a complex with Sandy and Sands sights along sandstone outcroppings. |

## Similar sites

| | |
|---|---|
| R058BY150WY | **Sandy (Sy) 10-14” PZ**<br>Sandy 10-14 occur on slightly more sloping and rolling landscapes and are more developed soils with a stable plant community. |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | Not specified |
| Shrub | Not specified |
| Herbaceous | (1) *Calamovilfa longifolia*<br>(2) *Andropogon hallii* |

## Physiographic features

This site occurs on nearly level to moderately sloping hills, ridges, and dunes, on sedimentary plains or uplands.

**Table 2. Representative physiographic features**

| | |
|---|---|
| Landforms | (1) Hill<br>(2) Ridge<br>(3) Dune |
| Runoff class | Negligible to low |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 1,067–1,981 m |
| Slope | 0–30% |
| Water table depth | 203 cm |
| Aspect | Aspect is not a significant factor |

## Climatic features

The average annual precipitation ranges from 10 to 17 inches per year across MLRA 58B. There are two precipitation zones (PZ). The 10 to 14 inch precipitation zone is predominant across the MLRA, including portions of Sheridan, Johnson, and Natrona Counties; portions of Campbell and Converse Counties; and smaller portions of Weston and Niobrara Counties. The 15 to 17 inch precipitation zone occurs in northern and eastern portions of the MLRA, including portions of Sheridan, Campbell, and western Crook Counties. Wide fluctuations in precipitation may occur from year to year, and occasional periods of extended drought (longer than one year in duration) can be expected. Two-thirds of the annual precipitation occurs during the growing season from May through September. Mean Annual Air Temperature (MAAT) is 46 degrees Fahrenheit. Cold air outbreaks from Canada in winter move rapidly from northwest to southeast and account for extreme minimum temperatures. Chinook winds may also occur in winter and bring rapid rises in temperature. Extreme storms may occur during the winter, but most severely affect ranching operations during late winter and spring. High-intensity afternoon thunderstorms may occur during the summer. Annual wind speeds average about 5 mph. Daytime winds are generally stronger than nighttime winds. Occasional strong storms may bring brief periods of high winds with gusts of more than 75 mph. The average length of the freeze-free period (28 degrees Fahrenheit) is 125 days and generally occurs from May 16 to September 19. The average frost-free period (32 degrees Fahrenheit) is 101 days and generally occurs from June 1 to September 9.

The growth of native cool-season plants begins in late April to early May with peak growth occurring in mid to late June. Native warm-season plants begin growth in late May to early June and continue into August. Regrowth of cool-season plants occurs in September in most years, depending upon moisture.

Note: The climate described here is based on historic climate station data and is averaged to provide an overview of the annual precipitation, temperatures, and growing season. Future climate is beyond the scope of this document. However, research to determine the effects of elevated CO2 and heating on mixed-grass prairie ecosystems, and how it may relate to future plant communities, is ongoing.

For detailed information, or to find a specific climate station, visit the Western Regional Climate Center (WRCC) website: Western Regional Climate Center, Historical Data, Western U.S. Climate summaries, NOAA Coop Stations, Wyoming (Note: Montana climate stations are also listed under the Wyoming link). https://wrcc.dri.edu/summary/Climsmwy.html

Wind speed averages can be found at the WRCC home page, under the Specialty Climate tab: https://wrcc.dri.edu/

The following tables represent area-wide climate data for the 10 to 14 inch precipitation zone:

**Table 3. Representative climatic features**

| | |
|---|---|
| Frost-free period (characteristic range) | 92-103 days |
| Freeze-free period (characteristic range) | 121-128 days |
| Precipitation total (characteristic range) | 305-330 mm |
| Frost-free period (actual range) | 86-107 days |

| | |
|---|---|
| Freeze-free period (actual range) | 116-129 days |
| Precipitation total (actual range) | 254-356 mm |
| Frost-free period (average) | 101 days |
| Freeze-free period (average) | 125 days |
| Precipitation total (average) | 330 mm |

## Climate stations used

- (1) BUFFALO [USC00481165], Buffalo, WY
- (2) CASPER NATRONA CO AP [USW00024089], Casper, WY
- (3) WRIGHT 12W [USC00489805], Gillette, WY
- (4) DULL CTR 1SE [USC00482725], Douglas, WY
- (5) GLENROCK 5 ESE [USC00483950], Glenrock, WY
- (6) KAYCEE [USC00485055], Kaycee, WY
- (7) MIDWEST [USC00486195], Midwest, WY
- (8) SHERIDAN CO AP [USW00024029], Sheridan, WY
- (9) WESTON 1 E [USC00489580], Weston, WY

## Influencing water features

This upland ecological site is not influenced by a water table or run in from adjacent sites. Due to the semi-arid climate in which it occurs, the water budget is normally contained within the soil pedon. Soil moisture is recharged by spring rains, but it rarely exceeds field capacity in the upper 40 inches before being depleted by evapotranspiration. During intense precipitation events, precipitation rates frequently exceed infiltration rates and the site delivers moisture to downslope sites through surface runoff. Moisture loss through evapotranspiration exceeds precipitation for a majority of the growing season. Soil moisture is the primary limiting factor for vegetative production on this ecological site.

## Soil features

The soils on this site are typically deep to very deep, but includes moderately deep, excessively drained soils that formed from eolian deposits or alluvium; moderately deep soils formed from residuum derived from sandstone. They typically have a rapid to very rapid permeability class. The available water capacity is low to very low. The surface layer of the soils in this site are typically loamy sand, but may include fine sand, loamy fine sand, or sand. The surface layer ranges from a depth of 2 to 6 inches thick. The subsoil is typically loamy sand, but may include fine sand, loamy fine sand, or sand. Rock fragments typically are less than 5 percent in the subsoil but may range up to 14 percent in some soils. Soils in this site are typically leached of carbonates 2 to 40 inches or more; some soils may have carbonates at the surface. These soils are susceptible to erosion by wind if not covered. The potential hazard for water erosion accelerates with increasing slope. The soil moisture regime is typically ustic aridic. The soil temperature regime is mesic.

Major soil series correlated to this ecological site include: Dwyer, Orpha, Valent, and Tullock.

The attributes listed below represent 0-40 inches in depth or to the first restrictive layer.

**Table 4. Representative soil features**

| | |
|---|---|
| Parent material | (1) Alluvium<br>(2) Eolian deposits<br>(3) Residuum–sandstone |
| Surface texture | (1) Loamy sand<br>(2) Fine sand<br>(3) Loamy fine sand<br>(4) Sand |
| Drainage class | Well drained to excessively drained |

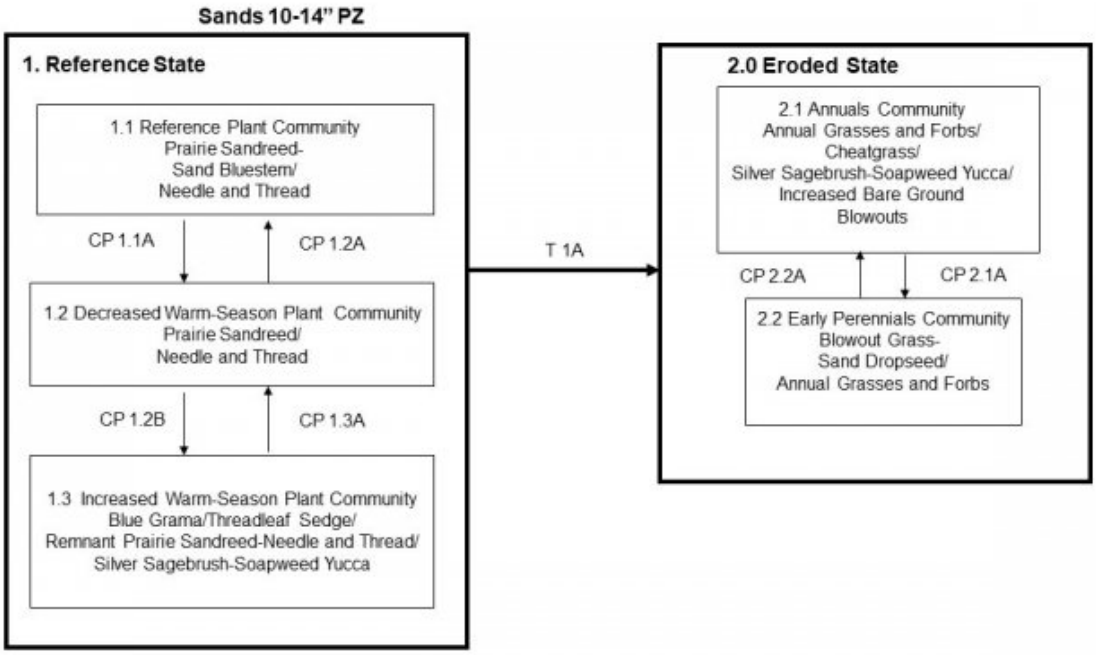
| | |
|---|---|
| Permeability class | Rapid to very rapid |
| Soil depth | 102–152 cm |
| Surface fragment cover <=3" | 0–5% |
| Available water capacity (Depth not specified) | 3.05–13.21 cm |
| Calcium carbonate equivalent (Depth not specified) | 0–5% |
| Electrical conductivity (Depth not specified) | 0–2 mmhos/cm |
| Sodium adsorption ratio (Depth not specified) | 0–3 |
| Soil reaction (1:1 water) (Depth not specified) | 6.6–8.4 |
| Subsurface fragment volume <=3" (Depth not specified) | 0–14% |

## Ecological dynamics

The Reference State is the plant community in which interpretations are primarily based and is used as a reference in order to understand the original potential of the site. The Reference State evolved under the combined influences of climatic conditions, periodic fire activity, grazing by large herbivores, and impacts from small mammals and insects. Changes may occur to the Reference State due to management actions such as continuous season-long or year-long grazing, increased stocking rates, climatic conditions such as drought, and natural events such as multiple fires in close succession. The Reference State is characterized by warm-season bunch mid- and tallgrasses (prairie sandreed and sand bluestem), and cool-season bunch midgrass (needle and thread). A lesser component of forbs and shrubs are also present. The Reference Plant Community is not necessarily the management goal, as other vegetative states may be considered desired plant communities as long as critical resource concerns are met.

n addition to the Reference State, other plant communities can occur on this site and are usually the result of historic management practices. Grazing practices such as continuous season-long or year-long grazing, heavier stocking rates, or a combination of these factors on this ecological site results in bunchgrasses such as sand bluestem, prairie sandreed, switchgrass, and needle and thread decreasing in both frequency and production. Prairie sandreed may persist in remnant amounts. Key shrubs such as Woods' rose will decrease in frequency and production. Purple prairie clover and other highly palatable forbs will decrease. Silver sagebrush and soapweed yucca will continue to increase with an understory of grasses such as blue grama, hairy grama, and sand dropseed. Midgrasses will eventually be removed from the plant community. Cheatgrass will invade. Over the long-term, continuous seasonal use, in combination with high stocking rates, will result in bare ground and active blowouts. There are various transitional stages which may occur on this ecological site. The information presented is representative of a dynamic set of plant communities that illustrate the complex interaction of several ecological processes.

## State and transition model




**CP**- Community Pathway
**T**-Transition
**CP1.1A-** Continuous Seasonal-use grazing, frequent and severe defoliation, extended drought
**CP1.2A-** Prescribed grazing with adequate recovery and proper stocking, normal precipitation
**CP 1.2B-** Continuous Seasonal-use grazing, Continuous grazing without adequate recovery, frequent and severe defoliation, extended drought, fire
**CP 1.3A-** Prescribed grazing with adequate recovery, no fire
**CP 2.1A-** Prescribed grazing with adequate recovery, no fire
**CP 2.2A-** Continuous grazing without adequate recovery, heavy continuous grazing, frequent and severe defoliation
**T1A-** Long-term continuous grazing, heavy continuous grazing, frequent and severe defoliation

## State 1
## Reference State

The Reference State is characterized by three distinct plant community phases: Reference, Decreased Tall Warm-Season, and Increased Shortgrass Plant Communities. The plant communities and various successional stages between them represent the natural range of variability within the Reference State.

### Community 1.1
### Calamovilfa longifolia-Andropogon hallii (prairie sandreed-sand bluestem)

The Reference Plant Community is the interpretive plant community for an ecological site. This community developed with grazing by large herbivores and is suited to grazing by domestic livestock. Historically, fires likely occurred infrequently, and were randomly distributed. This plant community can be found on areas where grazed plants receive adequate periods of recovery during the growing season. The potential vegetation is about 80 to 85 percent grasses and grass-likes, 5 to 15 percent forbs and 5 to 10 percent woody plants (total pounds per acre air-dry). The Reference Plant Community consists predominantly of prairie sandreed, sand bluestem, and needle and thread. Secondary grasses are Indian ricegrass and western wheatgrass. Minor grasses and grass-likes that may occur include thickspike wheatgrass, prairie Junegrass, sand dropseed, and threadleaf sedge. Blue grama, hairy grama, and Sandberg bluegrass may also be found. A variety of forbs grow here such as scarlet globemallow, painted milkvetch, lemon scurfpea, prairie spiderwort, and purple prairie clover; also, veiny dock, prairie coneflower, senecio, and penstemon species. Half-shrubs and shrubs such as silver sagebrush, prairie rose, and occasionally yellow rabbitbrush (also known as Douglas rabbitbrush) also occur. Plant diversity is high. In the Sands 10 to 14 inch Precipitation Zone (PZ) ecological site, the total annual production (air-dry weight) is about 1,400 pounds per acre during an average year, but it can range from about 900 pounds per acre in unfavorable years to about 1,700 pounds per acre in above-average years. NOTE: A minor extent of the Sands site (about 200 acres), also occurs in

the 15 to 17 inch Precipitation Zone. Production will be higher. A site visit is needed to verify production. Defoliation levels should be determined as part of a grazing management plan based on objectives. Nutrient and water cycles and energy flow are functioning properly. Infiltration rates are moderate, and soil erosion is low. Litter is properly distributed where vegetative cover is continuous. Plant decadence and natural plant mortality is low. This community is resistant to many disturbances except excessive grazing, tillage, or development into other land uses.

**Table 5. Annual production by plant type**

| Plant Type | Low (Kg/Hectare) | Representative Value (Kg/Hectare) | High (Kg/Hectare) |
|---|---|---|---|
| Grass/Grasslike | 1211 | 1749 | 2287 |
| Shrub/Vine | 202 | 291 | 381 |
| Forb | 101 | 146 | 191 |
| **Total** | **1514** | **2186** | **2859** |

**Figure 9. Plant community growth curve (percent production by month). WY5803, Northern Rolling High Plains, Southern Part, cool-season/warm-season co-dominant. Cool-season/warm-season co-dominant.**

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

## Community 1.2
## Calamovilfa longifolia-Bouteloua gracilis (prairie sandreed-blue grama)

This plant community developed with excessive seasonal-use grazing, or frequent and severe defoliation without adequate recovery during the growing season, and/or with extended drought. Dominant grasses include prairie sandreed and needle and thread, with increasing blue grama. A cool-season/warm-season shift may occur depending on the pre-dominant season of use. Recurrent excessive grazing in the spring, over time, will eventually reduce the cool-season grasses such as needle and thread and the rhizomatous wheatgrasses. Likewise, recurrent excessive grazing in the summer will reduce the warm-season tall- and midgrasses such as sand bluestem and little bluestem. The significant forbs include dotted blazing star (also known as dotted gayfeather), scarlet globemallow, cudweed sagewort, spiderworts, and upright prairie coneflower. Shrubs in this community include Woods' rose, fringed sagewort, and silver sagebrush. All the midgrass species are present but in lesser amounts, especially the bunchgrasses. Plant diversity is moderate. Prescribed grazing with adequate recovery periods between grazing events will maintain the vegetation or move it toward the Reference Plant Community. Natural disturbances such as fire and drought can contribute to this shift. In the Sands 10 to 14 inch Precipitation Zone ecological site, the total annual production (air-dry weight) is about 1,200 pounds per acre during an average year, but it can range from about 700 pounds per acre in unfavorable years to about 1,500 pounds per acre in above-average years. Total aboveground biomass has been reduced. Reduction of rhizomatous wheatgrasses, nitrogen-fixing forbs, and increased warm-season shortgrasses have begun to alter the biotic integrity of this community. Water and nutrient cycles may be impaired. Nearly all plant species typically found in the Reference Plant Community are present and will respond to changes in grazing management.

**Figure 10. Plant community growth curve (percent production by month). WY5803, Northern Rolling High Plains, Southern Part, cool-season/warm-season co-dominant. Cool-season/warm-season co-dominant.**

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

## Community 1.3
## Calamovilfa longifolia-Andropogon hallii/Psoralidium lanceolatum (prairie sandreed-sand bluestem/lemon scurfpea)

This plant community developed with excessive seasonal-use grazing, or frequent and severe defoliation without adequate recovery during the growing season, and/or with extended drought, or with fire. The plant community has a reduced component of tall- and midgrasses with an understory of short sod-forming grasses. Prairie sandreed and

needle and thread are limited to areas protected from grazing, with increasing blue grama, hairy grama, and threadleaf sedge. Fire may increase silver sage, a fire-adapted species, on the site. The significant forbs include scarlet globemallow, cudweed sagewort, lemon scurfpea, western ragweed, annual sunflower, annual buckwheat, and bractless blazingstar. Shrubs in this community include silver sagebrush, yucca, and pricklypear cactus. Compared to the Reference Plant Community, blue grama, sand dropseed, and threadleaf sedge have increased. All the midgrass species are present but in lesser amounts, especially the bunchgrasses. The midgrasses and palatable forbs have been reduced or eliminated. Plant diversity is moderate. The risk of losing key midgrasses and important forbs and shrubs is a major concern. Prescribed grazing with adequate recovery periods between grazing events will maintain the vegetation or move it toward the Reference Plant Community. Natural disturbances such as fire and drought can contribute to this shift. In the Sands 10 to 14 inch Precipitation Zone ecological site, the total annual production (air-dry weight) is about 800 pounds per acre during an average year, but it can range from about 600 pounds per acre in unfavorable years to about 1,000 pounds per acre in above-average years. Total aboveground biomass has been reduced. Reduction of rhizomatous wheatgrasses, nitrogen-fixing forbs, and increased warm-season shortgrasses have begun to alter the biotic integrity of this community. Water and nutrient cycles may be impaired. Nearly all plant species typically found in the Reference Plant Community are present and will respond to changes in grazing management.

**Figure 11. Plant community growth curve (percent production by month). WY5803, Northern Rolling High Plains, Southern Part, cool-season/warm-season co-dominant. Cool-season/warm-season co-dominant.**

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

### Pathway 1.1A
### Community 1.1 to 1.2

Excessive seasonal-use grazing without adequate recovery between grazing events, or frequent and severe defoliation, and extended drought, can shift this plant community toward the Decreased Tall Warm-Season Plant Community. Over a period of years, plant species less tolerant to frequent and severe defoliation will begin to decrease, and those more tolerant will begin to increase. Biotic integrity and water and nutrient cycles may become impaired because of this community pathway.

### Pathway 1.2A
### Community 1.2 to 1.1

Grazing that allows for adequate recovery between grazing events, along with proper stocking rates, will shift the Decreased Tall Warm-Season Plant Community back toward the Reference Plant Community. Natural disturbances such as return to normal precipitation patterns will contribute to this shift.

### Pathway 1.2B
### Community 1.2 to 1.3

Excessive grazing without adequate recovery between grazing events, or frequent and severe defoliation, extended drought, or fire can shift this plant community toward the Increased Shortgrass Plant Community. Over a period of years, plant species less tolerant to frequent and severe defoliation will begin to decrease, and those more tolerant will begin to increase. Biotic integrity, and water and nutrient cycles may become impaired because of this community pathway.

### Pathway 1.3A
### Community 1.3 to 1.2

Grazing that allows for adequate recovery between grazing events, along with proper stocking rates, will shift the Increased Shortgrass Plant Community back toward the Reference Plant Community. Natural disturbances such as return to normal precipitation patterns or no fire will contribute to this shift.

## State 2

## Eroded State

The Eroded State develops with heavy, excessive grazing with overstocking, or frequent and severe defoliation. An ecological threshold has been crossed. Erosion and loss of organic matter and carbon reserves are resource concerns.

## Community 2.1
## Annuals Plant Community

This early successional plant community occurs where the rangeland is grazed year-round, at high stock densities. Physical impacts such as trampling, soil compaction, and trailing typically contribute to this transition. Blowouts develop because of long-term heavy, excessive grazing, disturbance (such as tillage), and wildfire. Further excessive grazing will increase the size of the blowouts. This condition is not stable. It consists of bare areas that are continually eroded by wind. Desertification is well advanced. Production from this plant community phase can vary greatly, depending upon the plant density and weather conditions in any year. Shrubs such as silver sagebrush and soapweed yucca have increased. Annual grasses and forbs including cheatgrass, field brome (also known as Japanese brome), kochia, Russian thistle, sunflower, Cuman ragweed (also known as western ragweed), pigweed, and annual buckwheat are increasing or invading. Total annual production can vary from 0 to 200 pounds per acre (air-dry weight) per year. The hazard of soil erosion hazard has increased due to the increase of bare ground. Runoff is typically high and infiltration is low. All ecological functions are impaired. Desertification is advanced. Species diversity has substantially decreased. Production varies with density and vigor of silver sagebrush.

**Figure 12. Plant community growth curve (percent production by month). WY5804, Northern Rolling High Plains, Southern Part upland w/warm-season. 10-14" PZ, with warm-season dominant grasses and forbs.**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5 | 20 | 35 | 30 | 8 | 2 | | | |

## Community 2.2
## Early Perennials Plant Community

This plant community occurs as the Annual (Blowout) Plant Community becomes vegetated. Plant composition consists of annuals with a few species of perennial forbs and grasses that are very drought-tolerant. The dominant grasses include blowout grass and sand dropseed. Annual grasses such as stinkgrass have increased. The dominant forbs include lemon scurfpea, Rocky Mountain beeplant, and annual sunflower. Prairie sandreed, hairy grama, and Woods' rose will eventually become more evident. This plant community evolves from the Annuals Plant Community, with prescribed grazing that allows adequate recovery opportunity. The hazard of wind erosion continues to be a resource concern. In the Sands 10 to 14 inch Precipitation Zone ecological site, the total annual production (air-dry weight) is about 200 pounds per acre during an average year, but it can range from about 100 pounds per acre in unfavorable years to about 300 pounds per acre in above average years. Planned rest periods during the growing season will increase the number of perennial species and improve the vigor of the plant species present and eventually reduce the amount of bare ground. Soil erosion is still high compared to other potential plant communities because of the amount of bare ground.

**Figure 13. Plant community growth curve (percent production by month). WY5803, Northern Rolling High Plains, Southern Part, cool-season/warm-season co-dominant. Cool-season/warm-season co-dominant.**

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

## Pathway 2.1A
## Community 2.1 to 2.2

Prescribed grazing with adequate recovery between grazing events will shift this plant community toward the Early Perennials Plant Community. Controlled animal impact together with an appropriate grazing prescription will begin to heal blowouts and stabilize dunes.

### Pathway 2.2A
### Community 2.2 to 2.1

Excessive grazing, or frequent and severe defoliation without adequate recovery between grazing events, or heavy, excessive grazing with overstocking will shift this plant community back toward the Annuals Plant Community. Wind erosion is a resource concern and blowouts can form because of this community pathway.

## Transition T1A
## State 1 to 2

Long-term excessive grazing, or frequent and severe defoliation without adequate recovery between grazing events, or heavy, excessive grazing with overstocking, will shift the Reference State across an ecological threshold toward the Eroded State. Biotic integrity and hydrologic function will be impaired because of this transition. Severe soil erosion and loss of organic matter are resource concerns. Annual forbs and cheatgrass are likely to increase or invade because of this transition.

## Additional community tables

**Table 6. Community 1.1 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Kg/Hectare) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Grass/Grasslike** | | | | | |
| 1 | **Warm-Season Mid/Tall Bunch** | | | 252–476 | |
| | sand bluestem | ANHA | *Andropogon hallii* | 252–476 | 5–25 |
| 2 | **Warm-Season Mid/Tall Rhizomatous** | | | 504–953 | |
| | prairie sandreed | CALO | *Calamovilfa longifolia* | 504–953 | 10–50 |
| 3 | **Cool-Season Mid-Bunch** | | | 252–476 | |
| | needle and thread | HECO26 | *Hesperostipa comata* | 151–286 | 5–15 |
| | Indian ricegrass | ACHY | *Achnatherum hymenoides* | 101–191 | 5–10 |
| 4 | **Cool-Season Rhizomatous** | | | 101–191 | |
| | western wheatgrass | PASM | *Pascopyrum smithii* | 101–191 | 1–10 |
| | thickspike wheatgrass | ELLAL | *Elymus lanceolatus ssp. lanceolatus* | 101–191 | 1–10 |
| 5 | **Miscellaneous** | | | 101–191 | |
| | blue grama | BOGR2 | *Bouteloua gracilis* | 50–95 | 1–5 |
| | hairy grama | BOHI2 | *Bouteloua hirsuta* | 50–95 | 1–5 |
| | sand dropseed | SPCR | *Sporobolus cryptandrus* | 50–95 | 1–5 |
| | Sandberg bluegrass | POSE | *Poa secunda* | 50–95 | 1–5 |
| | threadleaf sedge | CAFI | *Carex filifolia* | 50–95 | 1–5 |
| | needleleaf sedge | CADU6 | *Carex duriuscula* | 50–95 | 1–5 |
| | Grass, perennial | 2GP | *Grass, perennial* | 50–95 | 1–5 |
| **Forb** | | | | | |
| 6 | **Forbs** | | | 101–191 | |
| | bluebells | MERTE | *Mertensia* | 50–95 | 1–5 |
| | Forb, perennial | 2FP | *Forb, perennial* | 50–95 | 1–5 |
| | lemon scurfpea | PSLA3 | *Psoralidium lanceolatum* | 50–95 | 1–5 |
| | common yarrow | ACMI2 | *Achillea millefolium* | 50–95 | 1–5 |
| | American vetch | VIAM | *Vicia americana* | 50–95 | 1–5 |
| | upright prairie coneflower | RACO3 | *Ratibida columnifera* | 50–95 | 1–5 |

| | | | | | |
|---|---|---|---|---|---|
| | aster | ASTER | *Aster* | 50–95 | 1–5 |
| | desertparsley | LOMAT | *Lomatium* | 50–95 | 1–5 |
| | large Indian breadroot | PEES | *Pediomelum esculentum* | 50–95 | 1–5 |
| | rosy pussytoes | ANRO2 | *Antennaria rosea* | 50–95 | 1–5 |
| | milkvetch | ASTRA | *Astragalus* | 50–95 | 1–5 |
| | stemless mock goldenweed | STAC | *Stenotus acaulis* | 50–95 | 1–5 |
| | sulphur-flower buckwheat | ERUM | *Eriogonum umbellatum* | 50–95 | 1–5 |
| | scarlet beeblossom | GACO5 | *Gaura coccinea* | 50–95 | 1–5 |
| | purple prairie clover | DAPU5 | *Dalea purpurea* | 50–95 | 1–5 |
| | white prairie clover | DACA7 | *Dalea candida* | 50–95 | 1–5 |
| | tapertip hawksbeard | CRAC2 | *Crepis acuminata* | 50–95 | 1–5 |
| **Shrub/Vine** | | | | | |
| 7 | **Shrubs** | | | 202–381 | |
| | prairie sagewort | ARFR4 | *Artemisia frigida* | 50–95 | 1–5 |
| | silver sagebrush | ARCA13 | *Artemisia cana* | 50–95 | 1–5 |
| | soapweed yucca | YUGL | *Yucca glauca* | 50–95 | 1–5 |
| | Shrub (>.5m) | 2SHRUB | *Shrub (>.5m)* | 50–95 | 1–5 |
| | Subshrub (<.5m) | 2SUBS | *Subshrub (<.5m)* | 50–95 | 1–5 |

## Animal community

Animal Community – Wildlife Interpretations (from 2001 legacy ESD, will be revised in future updates):

Needleandthread/ Prairie sandreed (Reference): The predominance of grasses in this plant community favors grazers and mixed-feeders, such as bison, elk, and antelope. Suitable thermal and escape cover for deer may be limited due to the low quantities of woody plants. However, topographical variations could provide some escape cover. When found adjacent to sagebrush-dominated states, this plant community may provide brood rearing and foraging areas for sage grouse, as well as lek sites. Other birds that would frequent this plant community include western meadowlarks, horned larks, and golden eagles. Many grassland-obligate small mammals would occur here.

Threadleaf sedge/Needle and thread/ Yucca: These communities provide limited foraging for antelope and other grazers. They may be used as a foraging site by sage grouse if proximal to woody cover. Generally, these are not target plant communities for wildlife habitat management.

Blowout: Yucca/Sandbur/ Western ragweed: These communities are unstable due to moving sand dunes. They provide a unique temporary habitat for some small mammals and birds.

Animal Community – Grazing Interpretations (updated in 2019 Provisional revision)

The following table is a guide to stocking rates for the plant communities described in the Sands 10 to 14 inch Precipitation Zone ecological site. These are conservative estimates for initial planning. On-site conditions will vary, and stocking rates should be adjusted based on range inventories, animal kind/class, forage availability (adjusted for slope and distance to water), and the type of grazing system (number of pastures, planned moves, etc.), all of which is determined in the conservation planning process.

The following stocking rates are based on the total annual forage production in a normal year multiplied by 25 percent harvest efficiency of preferred and desirable forage species, divided by 912 pounds of ingested air-dry vegetation for an animal unit per month (Natl. Range and Pasture Handbook, 1997). An animal unit month is defined as the amount of forage required by one livestock animal, with or without one calf, for one month, and is shortened to AUM.

Plant Community (PC) Production (total lbs./acre in a normal year) and Stocking Rate (AUM/acre) are listed below:
Example:
1,400 lbs. per acre X 25% Harvest Efficiency = 350 lbs. forage demand for one month. 350 lbs. per acre/912 demand per AUM =0.38

Plant Community (PC) Production (lbs.ac), and Stocking Rate (AUM/Acre)

Reference Plant Community 900-1700 .4
Threadleaf sedge/Needleandthread/ Yucca 600-1000 .33
Blowout /Yucca /Western ragweed/Sand bur 500-900 .1

Annuals PC (*) (*)

Early Perennials PC (*) (*)

* Highly variable stocking rates must be determined on site.

Grazing by domestic livestock is one of the major income-producing industries in the area. Rangelands in this area provide year-long forage under prescribed grazing for cattle, sheep, horses, and other herbivores. During the dormant period, livestock may need supplementation based on reliable forage analysis.

## Hydrological functions

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic groups A and B. Infiltration potential for this site varies from moderately rapid to very rapid depending on soil hydrologic group and ground cover. Runoff is from low to moderate. Areas where ground cover is less than 50 percent have the greatest potential to have reduced infiltration and higher runoff (refer to Part 630, NRCS National Engineering Handbook for detailed hydrology information).

Rills and gullies should not typically be present. Water flow patterns should be barely distinguishable if at all present. Pedestals should not be present. Litter typically falls in place, and signs of movement are not common. Chemical and physical crusts are rare to non-existent. Cryptogamic crusts are present, but only cover 1-2 percent of the soil surface.

## 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

None noted.

## Other information

Site Development & Testing Plan

General Data (MLRA and Revision Notes, Hierarchical Classification, Ecological Site Concept, Physiographic, Climate, and Water Features, and Soils Data):

Updated. All “Required” items complete to Provisional level.

Community Phase Data (Ecological Dynamics, STM, Transition & Recovery Pathways, Reference Plant Community, Species Composition List, Annual Production Table):

Updated. All “Required” items complete to Provisional level.

Annual Production Table is from the “Previously Approved” ESD (2001).

The Annual Production Table and Species Composition List will be reviewed for future updates at the Approved level.

Each Alternative State/Community:

Complete to Provisional level.

Supporting Information (Site Interpretations, Assoc. & Similar Sites, Inventory Data References, Agency/State Correlation, References):

Updated. All “Required” items complete to Provisional level.

Wildlife Interpretations: Narrative is from “Previously Approved” ESD (2001). Wildlife species will need to be updated at the next Approved level.

Livestock Interpretations: Plant community names and stocking rates updated.

Hydrology, Recreational Uses, Wood Products, and Other Products carried over from previously “Approved” ESD (2001).

Existing NRI Inventory Data References updated. More field data collection is necessary to support this site concept.

Reference Sheet:

Rangeland Health Reference Sheet carried over from previously “Approved” ESD (2005).
It will be updated at the next “Approved” level.

“Future work, as described in a project plan, to validate the information in this provisional ecological site description is needed. This will include field activities to collect low and medium intensity sampling, soil correlations, and analysis of that data. Annual field reviews 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.” (NI 430_306 ESI and ESD, April 2015)

## Inventory data references

Inventory data has been collected on private and federal lands by the following methods:
• Double Sampling (Determining Vegetation Production and Stocking Rates, WY-ECS-1)
• Rangeland Health (Interpreting Indicators of Rangeland Health, Version 4, 2005)
• Soil Stability (Interpreting Indicators of Rangeland Health, Version 4, 2005)
• Line Point Intercept (Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems, Volume II, 2005)
• Soil Pedon Descriptions (Field Book for Describing and Sampling Soils, Version 3, 2012)
• SCS-RANGE-417 (Production & Composition Record for Native Grazing Lands)

National Resources Inventory (NRI)
Number of Records: 7
Sample Period: 2004-2010
Counties: Converse, Natrona

Additional data collection includes ESI data collection in conjunction with Soil Surveys conducted within MLRA 58B; ocular estimates; rangeland vegetative clipping for NRCS program support; field observations from experienced rangeland personnel

Data collection for this ecological site was done in conjunction with the progressive soil surveys within MLRA 58B Northern Rolling High Plains (Southern Part)

Note: Revisions to soil surveys are on-going. For the most recent updates, visit the Web Soil Survey, the official site for soils information: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

## Other references


Anderson, R.C. 2006. Evolution and origin of the central grassland of North America: Climate, fire, and mammalian grazers. Journal of the Torrey Botanical Society 133:626–647.

Bragg, T.B. 1995. The physical environment of the Great Plains grasslands. In: A. Joern and K.H. Keeler (eds) The changing prairie. Oxford University Press, Oxford, UK, pages 49–81.

Branson, D.H. and G.A. Sword. 2010. An experimental analysis of grasshopper community responses to fire and livestock grazing in a northern mixed-grass prairie. Environmental Entomology 39:1441–1446.

Brinson, M.M. 1993. A hydrogeomorphic classification for wetlands. Technical Report WRP–DE–4. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Cleland, D., P. Avers, W.H. McNab, M. Jensen, R. Bailey, T. King, and W. Russell. 1997. National hierarchical framework of ecological units. In: Ecosystem Management: Applications for Sustainable Forest and Wildlife Resources, Yale University Press.

Coupland, R.T. 1958. The effects of fluctuations in weather upon the grasslands of the Great Plains. Botanical Review 24:273–317.

Davis, S.K., R.J. Fisher, S.L. Skinner, T.L. Shaffer, and R.M. Brigham. 2013. Songbird abundance in native and planted grassland varies with type and amount of grassland in the surrounding landscape. Journal of Wildlife Management 77:908–919.

DeLuca, T.H. and P. Lesica. 1996. Long-term harmful effects of crested wheatgrass on Great Plains grassland ecosystems. Journal of Soil and Water Conservation 51:408–409.

Derner, J.D. and R.H. Hart. 2007. Grazing-induced modifications to peak standing crop in northern mixed-grass prairie. Rangeland Ecology and Management 60:270–276.

Derner, J.D. and A.J. Whitman. 2009. Plant interspaces resulting from contrasting grazing management in northern mixed-grass prairie: Implications for ecosystem function. Rangeland Ecology and Management 62:83–88.

Derner, J.D., W.K. Lauenroth, P. Stapp, and D.J. Augustine. 2009. Livestock as ecosystem engineers for grassland bird habitat in the western Great Plains of North America. Rangeland Ecology and Management 62:111–118.

Dillehay, T.D. 1974. Late Quaternary bison population changes on the southern Plains. Plains Anthropologist 19:180–196.

Dormaar, J.F. and S. Smoliak. 1985. Recovery of vegetative cover and soil organic matter during revegetation of abandoned farmland in a semiarid climate. Journal of Range Management 38:487–491.

Guyette, Richard P., M.C. Stambaugh, D.C. Dey, and R.M. Muzika. (2012). Predicting fire frequency with chemistry and climate. Ecosystems, 15: 322-335.

Harmoney, K.R. 2007. Grazing and burning Japanese brome (Bromus japonicus) on mixed grass rangelands. Rangeland Ecology and Management 60:479–486.

Heitschmidt, R.K. and L.T. Vermeire. 2005. An ecological and economic risk avoidance drought management decision support system. In: J.A. Milne (ed.) Pastoral systems in marginal environments, 20th International Grasslands Congress, July, 2005. Page 178.

Knopf, F.L. 1996. Prairie legacies—Birds. In: F.B. Samson and F.L. Knopf (eds.) Prairie conservation: Preserving North America's most endangered ecosystem. Island Press, Washington, DC. Pages 135–148.

Knopf, F.L. and F.B. Samson. 1997. Conservation of grassland vertebrates. In: F.B. Samson and F.L. Knopf (eds.) Ecology and conservation of Great Plains vertebrates: Ecological Studies 125. Springer-Verlag, New York, NY. Pages 273–289.

Lauenroth, W.K., O.E. Sala, D.P. Coffin, and T.B. Kirchner. 1994. The importance of soil water in recruitment of *Bouteloua gracilis* in the shortgrass steppe. Ecological Applications 4:741–749.

Laycock, W.A. 1988. History of grassland plowing and grass planting on the Great Plains. In: J.E. Mitchell (ed.) Impacts of the Conservation Reserve Program in the Great Plains—symposium proceedings, September 16–18, 1987. U.S. Dept. of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-158.

Malloch, D.W., K.A. Pirozynski, and P.H. Raven. 1980. Ecological and evolutionary significance of mycorrhizal symbioses in vascular plants (a review). Proceedings of the National Academy of Sciences 77:2113–2118.

Ogle, S.M., W.A. Reiners, and K.G. Gerow. 2003. Impacts of exotic annual brome grasses (Bromus spp.) on ecosystem properties of the northern mixed grass prairie. American Midland Naturalist 149:46–58.

Roath, L.R. 1988. Implications of land conversions and management for the future. In: J.E. Mitchell (ed.) Impacts of the Conservation Reserve Program in the Great Plains—symposium proceedings, September 16–18, 1987. U.S. Dept. of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-158.

Smoliak, S. and J.F. Dormaar. 1985. Productivity of Russian wildrye and crested wheatgrass and their effect on prairie soils. Journal of Range Management 38:403–405.

Smoliak, S. J.F. Dormaar, and A. Johnston. 1972. Long-term grazing effects on Stipa-Bouteloua prairie soils. Journal of Range Management 25:246–250.

Soil Survey Division Staff. 2017. Soil survey manual. U.S. Dept. of Agriculture Handbook 18.

Soil Survey Staff. Official Soil Series Descriptions. U.S. Dept. of Agriculture, Natural Resources Conservation Service. Available online. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053587. Accessed 15 November, 2017.

Soil Survey Staff. Soil Survey Geographic (SSURGO) database. U.S. Dept. of Agriculture, Natural Resources Conservation Service.

Soil Survey Staff. 2014. Keys to Soil Taxonomy, 12th edition. U.S. Dept. of Agriculture, Natural Resources Conservation Service.

Soil Survey Staff. 2018. Web Soil Survey. U.S. Dept. of Agriculture, Natural Resources Conservation Service. Available online. https://websoilsurvey.nrcs.usda.gov/app/. Accessed 15 February, 2018.

Soller, D.R. 2001. Map showing the thickness and character of Quaternary sediments in the glaciated United States east of the Rocky Mountains. U.S. Geological Survey Miscellaneous Investigations Series I-1970-E, scale 1:3,500,000.

Stewart, Omer C. 2002. Forgotten Fires. Univ. of Oklahoma Press, Norman, OK.

United States Department of Agriculture, Natural Resources Conservation Service. Glossary of landform and geologic terms. National Soil Survey Handbook, Title 430-VI, Part 629.02c. Available online. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054242. Accessed 16 January, 2018.

United States Army Corps of Engineers. 1987. Corps of Engineers wetlands delineation manual. Wetlands Research Program Technical Report Y-87-1 (http://www.lrh.usace.army.mil/Portals/38/docs/USACE%2087%20Wetland%20Delineation%20Manual.pdf). Waterways Experiment Station, Vicksburg, MS.

United States Environmental Protection Agency, National Health and Environmental Effects Research Laboratory. 2013. Level III ecoregions of the continental United States. Available online. https://www.epa.gov/eco-research/ecoregions. Accessed 30 January, 2019.

United States Department of Agriculture, Natural Resources Conservation Service. 2010a. Field indicators of hydric soils in the United States, version 7.0.

United States Department of Agriculture, Natural Resources Conservation Service. 2013a. Climate data. National Water and Climate Center. Available online. http://www.wcc.nrcs.usda.gov/climate. Accessed 13 October, 2017.

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. Agriculture Handbook 296.

United States Department of Agriculture, Natural Resources Conservation Service. 2013b. National Soil Information System. Available online. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?Cid=nrcs142p2_053552. Accessed 30 October, 2017.

United States Department of the Interior, Geological Survey. 2008. LANDFIRE 1.1.0 Vegetation Dynamics Models. http://landfire.cr.usgs.gov/viewer/.

United States Department of the Interior, Geological Survey. 2011. LANDFIRE 1.1.0 Existing Vegetation Types. http://landfire.cr.usgs.gov/viewer/.

Willeke, G.E. 1994. The national drought atlas [CD ROM]. U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources Report 94-NDS-4.

Wilson, S.D., and J.M. Shay. 1990. Competition, fire, and nutrients in a mixed-grass prairie. Ecology 71:1959–1967.

With, K.A. 2010. McCown's longspur (Rhynchophanes mccownii). In: A. Poole (ed.) The birds of North America [online]. Cornell Lab of Ornithology, Ithaca, NY. https://birdsna.org/Species-Account/bna/home.

Augustine, D.J., J. Derner, D. Milchunas, D. Blumenthal, and L. Porensky. 2017. Grazing moderates increases in C3 grass abundance over seven decades across a soil texture gradient in shortgrass steppe. In: Journal of Vegetation Science, DOI:10.1111/jvs.12508.

Clark, J., E. Grimm, J. Donovan, S. Fritz, D. Engrstom, and J. Almendinger. 2002. Drought cycles and landscape responses to past aridity on prairies of the Northern Great Plains, USA. Ecology, 83(3), Pages 595-601.

Connell, L. C., J. D. Scasta, and L. M. Porensky. 2018. Prairie dogs and wildfires shape vegetation structure in a sagebrush grassland more than does rest from ungulate grazing. Ecosphere 9(8):e02390. 10.1002/ecs2.2390.

Collins, S. and S. Barber. (1985). Effects of disturbance on diversity in mixed-grass prairie. In: Vegetation, 64, pages 87-94.

Egan, Timothy. 2006. The Worst Hard Time. Houghton Mifflin Harcourt Publishing Company, New York, NY.

Guyette, R.P., M.C. Stambaugh, D.C. Dey, and R.M. Muzika. 2012. Predicting fire frequency with chemistry and climate. In: Ecosystems, 15: pages 322-335.

Hart, R. and J. Hart. 1997. Rangelands of the Great Plains before European settlement. In: Rangelands, 19(1), pages 4-11.

Hart, R. 2001. Plant biodiversity on shortgrass steppe after 55 years of zero, light, moderate, or heavy cattle grazing. In: Plant Ecology, 155, pages 111-118.

Pellant, M., P. Shaver, D.A. Pyke, and J.E. Herrick. 2005. Interpreting indicators of rangeland health, Version 4. United States Department of the Interior, Bureau of Land Management.

Porensky, L.M. and D.M. Blumenthal. 2016. Historical wildfires do not promote cheatgrass invasion in a western Great Plains steppe. In: Biological Invasions 18:3333-3349: DOI 10.1007/s10530-16-1225-z

Porensky, L., J.D. Derner, and D.W. Pellatz. 2018. Plant community responses to historical wildfire in a shrubland-grassland ecotone reveal hybrid disturbance response. In: Ecosphere. DOI: 9(8):e02363. 10.1002/ecs2.2363.

Mack, Richard N., and J.N. Thompson. 1982. Evolution in steppe with few large, hooved mammals. In: The American Naturalist. 119, No. 6, pages 757-773

Reyes-Fox, M., H. Stelzer, M.J. Trlica, G.S. McMaster, A.A. Andales, D.R. LeCain, and J.A. Morgan. 2014. Elevated CO2 further lengthens growing season under warming conditions. In: Nature, April 23, 2014. Available online. http://www.nature.com/nature/journal/v510/n7504/full/nature13207.html. Accessed 1 March, 2017.

Schoeneberger, P.J., D.A. Wysockie, E.C. Benham, and Soil Survey Staff. 2012. Field book for describing and sampling soils, Version 3.0. U.S. Dept. of Agriculture, Natural Resources Conservation Service.

Stahl, David W., E.R. Cook, M.K. Cleaveland, M.D. Therrell, D.M. Meko, H.D. Grissino-Mayer, E. Watson, and B.H. Luckman. Tree-ring data document 16th century megadrought over North America. 2000. In: Eos, 81(12), pages 121-125.

Stubbendieck, James, S.L. Hatch, and L.M. Landholt. 2003. North American wildland plants. Univ. of Nebraska Press, Lincoln and London.

Zelikova, T.J., D.M. Blumenthal, D.G. Williams, L. Souza, D.R. LeCain, and J .Morgan. 2014. Long-term exposure to elevated CO2 enhances plant community stability by suppressing dominant plant species in a mixed-grass prairie. In: Ecology, 2014 https://www.pnas.org/content/111/43/15456.

United States Department of Agriculture, Natural Resources Conservation Service. National Ecological Site Handbook, Title 190, Part 630, 1st Edition. Available online. https://directives.sc.egov.usda.gov/. Accessed 15 September, 2017.

United States Department of Agriculture, Natural Resources Conservation Service. 2009. Part 630, Hydrology, National Engineering Handbook

United States Department of Agriculture, Natural Resources Conservation Service. 1972-2012. National Engineering Handbook Hydrology Chapters. Available online. http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/?&cid=stelprdb1043063. Accessed August, 2015.

United States Department of Agriculture, Natural Resources Conservation Service. 1997, revised 2003. National Range and Pasture Handbook. http://www.glti.nrcs.usda.gov/technical/publications/nrph.html (Accessed 26 February, 2018).

United States Department of Agriculture, Natural Resources Conservation Service. National Soil Survey Handbook title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. Web Soil Survey. Available online. http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx. Accessed 15 November, 2017.

United States Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). Cooperative climatological data summaries. NOAA Western Regional Climate Center, Reno, NV. Available online. http://www.wrcc.dri.edu/climatedata/climsum. Accessed 16 November, 2017.

## Contributors

Everett Bainter
Glenn Mitchell

## Approval

Kirt Walstad, 10/05/2023

## Acknowledgments

Project Staff:
Kimberly Diller, Ecological Site Inventory Specialist, NRCS MLRA SSO, Pueblo CO
Mike Leno, Project Leader, NRCS MLRA SSO, Buffalo, WY

Partners/Contributors:
Joe Dyer, Soil Scientist, NRCS MLRA SSO, Buffalo, WY
Arnie Irwin, Soil Scientist, BLM, Buffalo, WY
Blaine Horn, Rangeland Extension Educator, UW Extension, Buffalo, WY
Isabelle Giuliani, Resource Soil Scientist, NRCS, Douglas, WY
Mary Jo Kimble, Project Leader, NRCS MLRA SSO, Miles City, MT
Ryan Murray, Rangeland Management Specialist, NRCS, Buffalo, WY
Lauren Porensky, Ph.D., Ecologist, ARS, Fort Collins, CO
Chadley Prosser, Rangeland Program Manager, USFS, Bismarck, ND
Bryan Christensen, Ecological Site Inventory Specialist, NRCS-MLRA SSO, Pinedale, WY
Marji Patz, Ecological Site Inventory Specialist, NRCS-MLRA SSO, Powell, WY
Rick Peterson, Ecological Site Inventory Specialist, NRCS-MLRA SSO, Rapid City, SD

Program Support:
John Hartung, WY State Rangeland Management Specialist-QC, NRCS, Casper, WY
David Kraft, NRCS MLRA Ecological Site Inventory Specialist-QA, Emporia, KS
Carla Green Adams, Editor, NRCS-SSR5, Denver, CO
Chad Remley, Regional Director, Northern Great Plains Soil Survey, Salina, KS

## Rangeland health reference sheet

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

| | |
|---|---|
| Author(s)/participant(s) | |
| Contact for lead author | |
| Date | 04/01/2005 |
| Approved by | Kirt Walstad |
| Approval date | |
| Composition (Indicators 10 and 12) based on | Annual Production |

## Indicators

1. **Number and extent of rills:** Rills should not be present.

2. **Presence of water flow patterns:** Barely observable.

3. **Number and height of erosional pedestals or terracettes:** Essentially non-existent.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is 20-30% occurring in small areas throughout site.

5. **Number of gullies and erosion associated with gullies:** Active gullies should not be present.

6. **Extent of wind scoured, blowouts and/or depositional areas:** Active blowouts should not be present.

7. **Amount of litter movement (describe size and distance expected to travel):** Little to no plant litter movement. Plant litter
remains in place and is not moved by erosional forces.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Plant cover and litter is at 70% or greater of soil surface and maintains soil surface
integrity. Soil Stability class is anticipated to be 4 or greater.

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

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Grass canopy and basal cover should reduce raindrop impact and slow overland flow providing increased time for infiltration to occur. Healthy deep rooted native grasses enhance infiltration and reduce runoff. Infiltration is Moderately rapid to Very Rapid.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** No compaction layer or soil surface crusting should be present.

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

    Dominant: Tall and Mid stature Warm Season Grasses > Mid Stature
    Grasses/Grasslikes Forbs = Shrubs

    Sub-dominant:

    Other:

Additional:

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

14. **Average percent litter cover (%) and depth ( in):** Average litter cover is 25-35% with depths of 0.25 to 1.0 inches.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 1400 lbs./ac

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:** Sandhills Muhly, Threadleaf sedge, Brittle cactus, Sandbur, Western ragweed, Yucca, and Species
found on Noxious Weed List

17. **Perennial plant reproductive capability:** All species are capable of reproducing.