USDA Natural Resources Conservation Service

Ecological site R067AY176WY
Very Shallow (VS)

Last updated: 9/07/2023
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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.

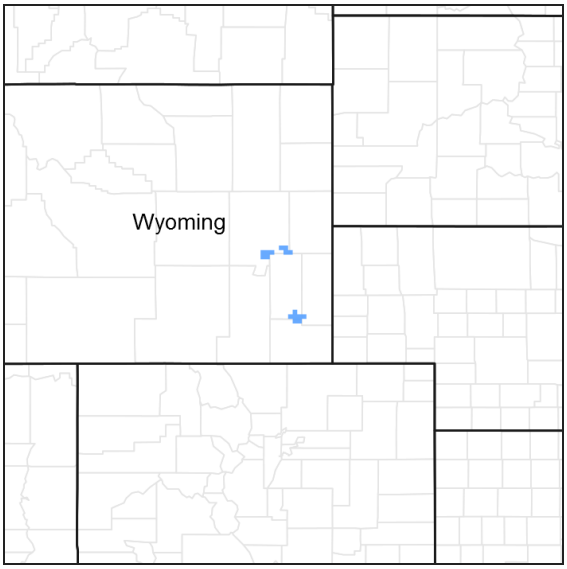


Figure 1. Mapped extent

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): 067A–Central High Plains, Northern Part

MLRA Notes:

MLRA 67A-Central High Plains, Northern Part is located in southeastern Wyoming (58 percent), the southwestern portion of the Nebraska panhandle (38 percent), and extreme northeastern Colorado (4 percent). It is comprised of rolling plains, upland breaks, and river valleys. The major rivers are the North Platte and Laramie. The headwaters of these systems are in the Rocky Mountains. Other tributaries include Crow, Horse, and Lodgepole Creeks. This MLRA is traversed by Interstate 25 and Interstate 80, and by U.S. Highways 26, 30 and 85. Major land uses include rangeland (71 percent), cropland (21 percent), pasture and hayland (1 percent), urban (3 percent), and miscellaneous (4 percent). Cities in this area include Cheyenne, Torrington, and Wheatland, WY; and Kimball, Oshkosh, and Scottsbluff, NE. Land ownership is mostly private. Areas of interest include Scotts Bluff National Monument, Chimney Rock and Fort Laramie National Historic Sites; Hawk Springs, Lake Minatare, and Wildcat Hills State Recreation Areas; Ash Hollow and Guernsey State Parks.

The elevations in MLRA 67A range from approximately 3,300 to 6,200 feet. The average annual precipitation in this area ranges from 13 to17 inches per year, but may increase up to 18 inches per year, in localized areas. Precipitation occurs mostly during the growing season from rapidly developing thunderstorms. Mean annual air temperature ranges from 47 degrees Fahrenheit in the western part to 52 degrees Fahrenheit in the eastern part.

Summer temperatures may exceed 100 degrees Fahrenheit. Winter temperatures may drop to sub-zero, and snowfall varies from 20 to 50 inches per year.

Classification relationships

MLRA 67A is in the Western Great Plains Range and Irrigation Land Resource Region. It is in the High Plains Section, of the Great Plains Province, of the Interior Plains (USDA, 2006). MLRA's can be defined by climate, landscapes, geology, and annual precipitation zones (PZ). Other features such as landforms, soil properties, and key vegetation further refine these concepts, and are described at the Ecological Site Description (ESD) level.

Revision Notes:

The Very Shallow Ecological Site was developed by an earlier version of the Very Shallow ESD (2005, updated 2008). The earlier version of the Very Shallow ESD was based on input from NRCS (formerly Soil Conservation Service) and historical information obtained from the Very Shallow Range Site Description (1988). This ESD meets the Provisional requirements of the National Ecological Site Handbook (NESH). This ESD will continue refinement towards an Approved status according to the NESH.

Ecological site concept

The Very Shallow site is a run-off site with bedrock within 10 inches of the soil surface. There are often areas of exposed bedrock.

Associated sites

R067AY162WY	**Shallow (Sw)** This ecological site is commonly adjacent.

Similar sites

R067AY162WY	**Shallow (Sw)** The Shallow Ecological Site has bedrock deeper than 10 inches from the soil surface, and rarely has exposed bedrock.
R067AY112WY	**Gravelly (Gr)** The Gravelly Ecological Site has bedrock deeper than 20 inches from the soil surface, and rarely has exposed bedrock.

Table 1. Dominant plant species

Tree	(1) *Juniperus scopulorum* (2) *Pinus ponderosa var. scopulorum*
Shrub	(1) *Cercocarpus montanus* (2) *Rhus trilobata*
Herbaceous	(1) *Schizachyrium scoparium* (2) *Pascopyrum smithii*

Physiographic features

This site occurs on shoulders or summits of hills, crests, or side slopes of ridges, and escarpments on upland breaks. The slopes on these landforms range from 6 to 45 percent, and some areas can range as high as 60 percent.

Table 2. Representative physiographic features

Landforms	(1) Hill (2) Ridge (3) Escarpment

Runoff class	Medium to very high
Flooding frequency	None
Ponding frequency	None
Elevation	1,372–1,981 m
Slope	6–45%
Water table depth	203–508 cm
Aspect	Aspect is not a significant factor

Climatic features

Wide fluctuations in precipitation may occur from year to year, as well as occasional periods of drought (longer than one year in duration). Two-thirds of the annual precipitation occurs during the growing season from April to September. The mean annual air temperature (MAAT) ranges from 47 degrees Fahrenheit in the western part to 52 degrees Fahrenheit in the eastern part. 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 ranch operations during the late winter and spring months. High-intensity afternoon thunderstorms may arise in summer. Wind speed averages about 8 miles per hour, ranging from 10 during the spring to 7 during late summer. Daytime winds are generally stronger than nighttime and occasional strong storms may bring brief periods of high winds with gusts to more than 75 mph. The average length of the freeze-free period (28 degrees Fahrenheit) is 150 days from May 4 to October 1. The average frost-free period (32 degrees Fahrenheit) is 128 days from May 16 to September 21. Growing season increases from west to east (Wyoming to Nebraska). Growth of native cool-season plants begins about April 1 and continues to mid-June. Native warm-season plants begin growth about May 15 and continue to about August 15. Regrowth of cool-season plants occur in September in most years, depending upon moisture.

Table 3. Representative climatic features

Frost-free period (characteristic range)	85-117 days
Freeze-free period (characteristic range)	119-135 days
Precipitation total (characteristic range)	406-432 mm
Frost-free period (actual range)	84-123 days
Freeze-free period (actual range)	116-137 days
Precipitation total (actual range)	356-457 mm
Frost-free period (average)	103 days
Freeze-free period (average)	128 days
Precipitation total (average)	406 mm

Climate stations used

- (1) SCOTTSBLUFF HEILIG AP [USW00024028], Scottsbluff, NE
- (2) CHUGWATER [USC00481730], Chugwater, WY
- (3) HARRISBURG 12WNW [USC00253605], Harrisburg, NE
- (4) OSHKOSH [USC00256385], Oshkosh, NE
- (5) OLD FT LARAMIE [USC00486852], Yoder, WY
- (6) PHILLIPS [USC00487200], LaGrange, WY
- (7) WHEATLAND 4 N [USC00489615], Wheatland, WY
- (8) BRIDGEPORT [USC00251145], Bridgeport, NE
- (9) KIMBALL 2NE [USC00254440], Kimball, NE
- (10) CHEYENNE [USW00024018], Cheyenne, WY

Influencing water features

There are no water features associated with the ecological site that influence the vegetation or management of the Very Shallow Ecological Site.

Soil features

The soils on this site are very shallow, well drained soils that formed from residuum derived from sandstone. They typically are in moderate to moderately rapid permeability class. The available water capacity is very low. Available water is the portion of water in a soil that can be readily absorbed by plant roots. The soil moisture regime is typically aridic ustic. The soil temperature regime is mesic.

The surface layer of the soils in this site are typically fine sandy loam, very fine sandy loam, or gravelly fine sandy loam, but may include sandy loam or cobbly fine sandy loam. The surface layer ranges from a depth of 2 to 6 inches thick. The subsoil is typically fine sandy loam, gravelly fine sandy loam, or gravelly sandy loam, but may include sandy loam. Soils in this site typically have carbonates throughout and to the soil surface, but some soils may be leached 3 to 4 inches. These soils are susceptible to erosion by water and wind. The potential for water erosion accelerates with increasing slope. Exposed areas of sandstone bedrock are inherent to this site.

Surface and subsoil structure in the Very Shallow 14-17 inch PZ ecological site are fine to medium granular but may also include massive structure in the subsoil. Soil structure describes the manner in which soil particles are aggregated and defines the nature of the system of pores and channels in a soil.

Major soil series correlated to this ecological site include: Taluce (thin solum), Tassel (thin solum), and Treon (thin solum).

Other soil series that have been correlated to this site: none.

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

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.

Representative soil profile of Treon fine sandy loam. Sandstone bedrock is at a depth of 26 centimeters (10 inches).

Figure 8. Laramie Co., WY (Western Part)

Table 4. Representative soil features

Parent material	(1) Residuum–sandstone
Surface texture	(1) Fine sandy loam (2) Very fine sandy loam (3) Gravelly fine sandy loam
Drainage class	Well drained
Permeability class	Moderate to moderately rapid
Soil depth	0–25 cm

Surface fragment cover <=3"	0–25%
Surface fragment cover >3"	0–20%
Available water capacity (0-101.6cm)	2.54–5.08 cm
Calcium carbonate equivalent (0-101.6cm)	1–15%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	7.4–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–25%
Subsurface fragment volume >3" (Depth not specified)	0–20%

Ecological dynamics

The information in this ESD, including the State-and-Transition Model (STM) diagram, was developed using archeological and historical data, professional experience, and scientific studies. The information is representative of a dynamic set of plant communities that represent the complex interaction of several ecological processes. The plant composition has been determined by study of rangeland relic areas, areas protected from excessive disturbance, seasonal use pastures, short duration/time controlled grazing strategies, and historical accounts.

The Very Shallow Ecological Site is characterized by three states: Reference, Sod-bound, and Increased *Bare Ground*. The Reference State is characterized by cool-season mid rhizomatous grasses (western wheatgrass), warm-season and cool-season mid bunchgrasses (little bluestem, sideoats grama, needle and thread, and Indian ricegrass), and secondary cool-season grasses (prairie Junegrass, plains muhly, and alkali bluegrass), warm-season shortgrass (blue grama), forbs (prairie clover species, dotted gayfeather, scarlet globemallow, buckwheat species, and hairy goldenaster), and shrubs (mountain mahogany and skunkbush sumac). A minor component of grass-likes (threadleaf sedge), is also present. The Sod-bound State is characterized by warm-season shortgrass (blue grama) and grass-likes (threadleaf sedge). The Increased *Bare Ground* State is characterized by annual grasses (sixweeks fescue), forbs (curlycup gumweed, hairy false goldenaster, and annuals), and shrubs (fringed sagewort, snakeweed, yucca, and pricklypear). Invasives include cheatgrass, especially on south-facing slopes.

As the Very Shallow ecological site begins to deteriorate from a combination of frequent and severe grazing during the growing season, grasses such as little bluestem, sideoats grama, and needle and thread decrease in both frequency and production. Grasses such as blue grama and threadleaf sedge increase. Under continued frequent and severe defoliation with no rest periods, western wheatgrass also begins to decrease. Forbs and shrubs such as fringed sagewort, hairy goldenaster, and broom snakeweed increase. If continued, the plant community becomes sod-bound, and all mid- to tall grasses can eventually be removed from the plant community. Over the long-term, this continuous use, in combination with high stock densities, results in broken sod, increased bare ground, and species such as broom snakeweed and cheatgrass increasing or invading.

The degree of grazing has a significant impact on the ecological dynamics of the site. This region was historically occupied by large grazing animals, such as bison, elk, pronghorn, and mule deer. Grazing by these large herbivores, along with climatic and seasonal weather fluctuations, had a major influence on the ecological dynamics of the site. Deer and pronghorn are widely distributed throughout the MLRA. Secondary influences of herbivory by species such as prairie dogs and other small rodents, insects, and root-feeding organisms continues to impact the vegetation.

Historically, grazing patterns by herds of large ungulates were driven by water distribution, precipitation events, drought events, and fire. It is believed that grazing periods would have been shorter, followed by longer recovery periods. These large migrating herds impacted the ecological processes of nutrient and hydrologic cycles, by

urination, trampling (incorporation of litter into the soil surface), and breaking of surface crust, (which increases water infiltration).

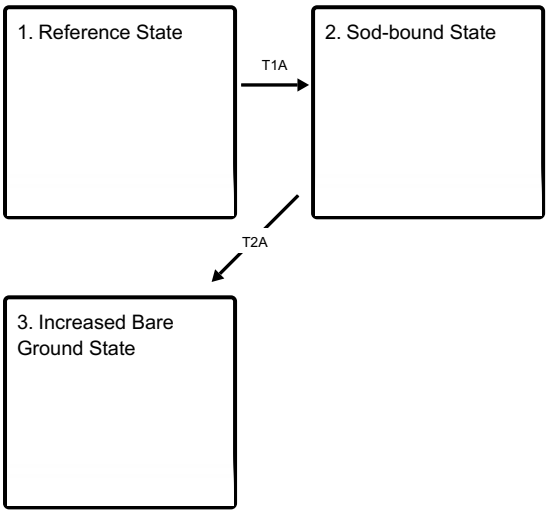
Today, livestock grazing, especially beef cattle has been a major influence on the ecological dynamics of the site. Grazing management, coupled with the effects of annual climatic variations, largely dictates the plant communities for the site.

Recurrent drought has historically impacted the vegetation of this region. Changes in species composition vary depending upon the duration and severity of the drought cycle and prior grazing management. Drought events since 2002 have significantly increased mortality of blue grama and buffalograss in some locales.

This site developed with occasional fire as part of the ecological processes. Historic fire frequency (pre-industrial) is estimated at 10 to14 years (Guyette, 2012), randomly distributed, and started by lightning at various times throughout the growing season. Early human inhabitants also were likely to start fires for various reasons (deliberate or accidental). It is believed that fires were set as a management tool for attracting herds of large migratory herbivores (Stewart, 2002). The impact of fire over the past 100 years has been relatively insignificant due to the human control of wildfires and the lack of acceptance of prescribed fire as a management tool.

State and transition model

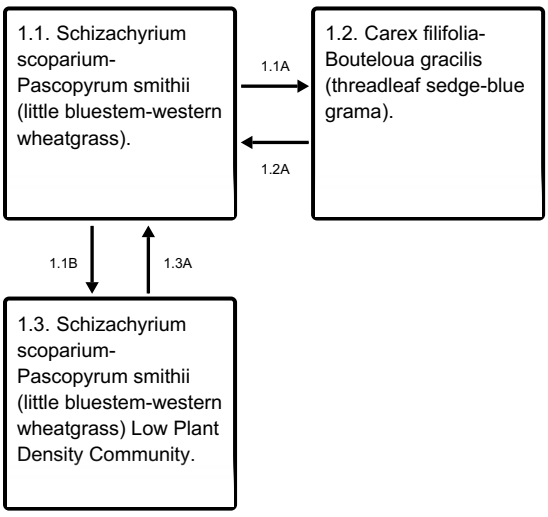
Ecosystem states



T1A - Excessive grazing. Lack of fire.

T2A - Excessive grazing. Lack of fire.

State 1 submodel, plant communities



1.1A - Excessive grazing. Lack of fire.

1.1B - Non-use. Lack of fire.

1.2A - Prescribed grazing. Prescribed fire.

1.3A - Prescribed grazing. Prescribed fire.

State 2 submodel, plant communities

2.1. Bouteloua gracilis-Carex filifolia (blue grama-threadleaf sedge).

State 3 submodel, plant communities

3.1. Bassia scoparia-Salsola/Aristida purpurea-Carex filifolia (burningbush-Russian thistle/Fendler threeawn-threadleaf sedge)

State 1
Reference State

The Reference State is characterized by three distinct plant community phases. The plant communities, and various successional stages between them, represent the natural range of variability within the Reference State.

Dominant plant species

- Rocky Mountain juniper (*Juniperus scopulorum*), tree
- ponderosa pine (*Pinus ponderosa var. scopulorum*), tree
- alderleaf mountain mahogany (*Cercocarpus montanus*), shrub
- skunkbush sumac (*Rhus trilobata*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- western wheatgrass (*Pascopyrum smithii*), grass

Community 1.1
Schizachyrium scoparium-Pascopyrum smithii (little bluestem-western wheatgrass).

Figure 9. Very Shallow ecological site, Platte Co., WY

This is the interpretive plant community for the Very Shallow Ecological Site. It is well-adapted to the Northern Great Plains climate. 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. The Reference plant community can be found on areas where grazed plants receive adequate periods of recovery during the growing season. The potential vegetation consists of about 70 to 90 percent grasses and grass-likes, 5 to15 percent forbs, and 5 to 5 percent woody plants. In the western portion of the MLRA, the plant community consists predominately of cool-season midgrasses, with a significant component of warm-season midgrasses. In the eastern portion of the MLRA, the plant community consists predominantly of warm-season with a significant cool-season component. The major grasses and grass-likes include little bluestem, western wheatgrass, needle and thread, sideoats grama, and Indian ricegrass. Secondary grasses include prairie Junegrass, alkali bluegrass, Fendler threeawn, plains muhly, and blue grama. Forbs include prairie clover species, dotted gayfeather, scarlet globemallow, buckwheat species, hairy goldenaster, pussytoes, phlox, and sandworts. Shrubs include alderleaf mountain mahogany, antelope bitterbrush, small soapweed (yucca), and pricklypear. Skunkbush sumac is found in outcrop areas. Trees such as Rocky Mountain juniper and ponderosa pine may occasionally occur. Mountain mahogany may increase in local areas, such as the Goshen Hole Rim. In the 12-14 inch Precipitation Zone (PZ), the total annual production (air-dry weight) is about 550 pounds per acre during an average year, but ranges from about 450 pounds per acre in unfavorable years to about 650 pounds per acre in above-average years. In the 15-17 inch PZ, the total annual production (air-dry weight) is about 600 pounds per acre during an average year; but ranges from about 475 pounds per acre in unfavorable years to about 725 pounds per acre in above-average years. Community dynamics (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. Some litter movement may occur on steeper, wind-swept slopes. Decadence and natural plant mortality are low. This community is resistant to many disturbances except heavy, continuous grazing, tillage, or development into urban or other uses. Areas that have lost all vegetation, such as livestock and vehicle trails, are subject to wind and water erosion.

Dominant plant species

- Rocky Mountain juniper (*Juniperus scopulorum*), tree
- ponderosa pine (*Pinus ponderosa var. scopulorum*), tree

- alderleaf mountain mahogany (*Cercocarpus montanus*), shrub
- skunkbush sumac (*Rhus trilobata*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- western wheatgrass (*Pascopyrum smithii*), grass

Figure 11. Plant community growth curve (percent production by month). WY1104, 12-14SP upland sites w/ warm. 12-14" Precipitation Zone, Southern Plains (SP) with warm-season (grass) species.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	20	35	30	5	5	0	0	0

Community 1.2
Carex filifolia-Bouteloua gracilis (threadleaf sedge-blue grama).

Grazing-tolerant species such as blue grama and threadleaf sedge have noticeably increased. Little bluestem and sideoats grama are usually present as secondary grasses, especially on steeper slopes. Prairie clover species and other palatable forbs are present in reduced amounts. Needle and thread may initially increase or decrease, depending upon the season of grazing use. A cool-season/warm-season shift may occur depending upon the pre-dominant season of use. Recurrent heavy, continuous grazing in the spring over time eventually reduces the cool-season grasses, such as needle and thread and western wheatgrass. Likewise, recurrent heavy, continuous grazing in the summer reduces the warm-season bunchgrasses, such as little bluestem and sideoats grama. Prairie clover species and other palatable forbs are present in reduced amounts. Cuman ragweed (western ragweed), hairy false goldenaster, and fringed sagewort have increased. Small soapweed may also increase. In the 12 to 14 inch PZ, the total annual production (air-dry weight) is about 400 pounds per acre during an average year, but ranges from about 300 pounds per acre in unfavorable years to about 500 pounds per acre in above-average years. In the 15 to 17 inch PZ, the total annual production (air-dry weight) is about 450 pounds per acre during an average year, but ranges from about 350 pounds per acre in unfavorable years to about 550 pounds per acre in above-average years. Nearly all the plant species typically found in the Reference Plant Community are present and will respond to changes in grazing management. This plant community can become somewhat resistant to change, depending upon how sod-bound the plant community has become.

Dominant plant species

- Rocky Mountain juniper (*Juniperus scopulorum*), tree
- ponderosa pine (*Pinus ponderosa var. scopulorum*), tree
- alderleaf mountain mahogany (*Cercocarpus montanus*), shrub
- skunkbush sumac (*Rhus trilobata*), shrub
- threadleaf sedge (*Carex filifolia*), grass
- blue grama (*Bouteloua gracilis*), grass

Figure 12. Plant community growth curve (percent production by month). WY1101, 12-14SP Upland sites w/o warm seasons. 12-14" Precipitation Zone, Southern Plains (SP) without warm season (grass) species.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	25	40	15	5	10	0	0	0

Community 1.3
Schizachyrium scoparium-Pascopyrum smithii (little bluestem-western wheatgrass) Low Plant Density Community.

This plant community developed under many years of non-use and lack of fire. Plant species resemble the Reference Plant Community; however, frequency and production will be reduced. Eventually, litter levels can become high enough to cause decadence and mortality of the stand. Bunchgrasses such as little bluestem typically develop dead centers, and rhizomatous grasses can form small decadent communities due to a lack of impact by grazing animals. Noxious weeds may invade, if a seed source is readily available. Invasive grasses such as cheatgrass tend to encroach under these conditions. In advanced stages of non-use or lack of fire, plants will begin to die off. Water flow patterns and pedestalling can become apparent. Infiltration is reduced and runoff is increased.

Eventually, the interspaces between the plants increase in size, leaving more soil surface exposed and causing an erosion concern. In the 12 to 14 inch PZ, the total annual production (air-dry weight) is about 500 pounds per acre during an average year, but ranges from about 400 pounds per acre in unfavorable years to about 600 pounds per acre in above-average years. In the 15 to 17 inch PZ, the total annual production (air-dry weight) is about 550 pounds per acre during an average year, but ranges from about 450 pounds per acre in unfavorable years to about 650 pounds per acre in above-average years.

Dominant plant species

- Rocky Mountain juniper (*Juniperus scopulorum*), tree
- ponderosa pine (*Pinus ponderosa var. scopulorum*), tree
- alderleaf mountain mahogany (*Cercocarpus montanus*), shrub
- skunkbush sumac (*Rhus trilobata*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- western wheatgrass (*Pascopyrum smithii*), grass

Figure 13. Plant community growth curve (percent production by month). WY1101, 12-14SP Upland sites w/o warm seasons. 12-14" Precipitation Zone, Southern Plains (SP) without warm season (grass) species.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	25	40	15	5	10	0	0	0

Pathway 1.1A
Community 1.1 to 1.2

Frequent and severe defoliation without adequate recovery between grazing events and lack of fire shifts this plant community to the 1.2 Community. Drought accelerates this process. Biotic integrity and water and nutrient cycles may become impaired as a result of this community pathway.

Pathway 1.1B
Community 1.1 to 1.3

Non-use and lack of fire cause the Reference Plant Community to shift to the 1.3 Low Plant Density Community. Plant decadence and standing dead plant material impede energy flow. Initially, excess litter increases. Eventually, native plant density begins to decrease and annuals and introduced species may begin to invade. Water and nutrient cycles are impaired as a result of this community pathway.

Pathway 1.2A
Community 1.2 to 1.1

Grazing that allows for adequate recovery opportunity between grazing events, proper stocking rates, and prescribed fire shift this Community back toward the Reference Plant Community.

Conservation practices

Prescribed Burning
Prescribed Grazing

Pathway 1.3A
Community 1.3 to 1.1

The return of grazing with adequate recovery and normal fire frequency shifts this plant community to the Reference Plant Community. This change can occur in a relatively short timeframe with the return of these disturbances.

Conservation practices

Prescribed Burning

Prescribed Grazing

State 2
Sod-bound State

An ecological threshold has been crossed and a significant amount of production and diversity has been lost when compared to the Reference State. Significant biotic and soil changes have negatively impacted energy flow and nutrient and hydrologic cycles. The loss of functional/structural groups such as warm-season tallgrass reduces the biodiversity and productivity of this site.

Dominant plant species

- Rocky Mountain juniper (*Juniperus scopulorum*), tree
- ponderosa pine (*Pinus ponderosa var. scopulorum*), tree
- skunkbush sumac (*Rhus trilobata*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- blue grama (*Bouteloua gracilis*), grass
- threadleaf sedge (*Carex filifolia*), grass

Community 2.1
Bouteloua gracilis-Carex filifolia (blue grama-threadleaf sedge).

The midgrasses and palatable forbs have been eliminated. The dominant species are blue grama and threadleaf sedge. These species have developed into a sod-bound condition, occurring in localized colonies exhibiting a mosaic appearance. Needle and thread may persist, if seasonal grazing use occurs after awn development. Sideoats grama and little bluestem may still be present in small amounts on steeper slopes. There may also be remnants of rhizomatous wheatgrasses. Fendler threeawn has increased. Forbs and shrubs that continue to increase are Cuman ragweed (western ragweed), hairy goldenaster, prairie sagewort (fringed sagebrush), and small soapweed. Plant diversity is very low. Species diversity and production have been significantly decreased due to the major reduction of mid- and tallgrass species and key shrubs. Energy flow and the water and mineral cycles have been negatively affected. Litter levels are very low and unevenly distributed. Water flow patterns and plant pedestals have increased. Soil erosion may be a concern on steeper slopes and exposed areas. Greatly reduced infiltration and increased runoff typically cause off-site gully erosion. In the 12-14 inch PZ, the total annual production (air-dry weight) is about 300 pounds per acre during an average year, but ranges from about 200 pounds per acre in unfavorable years to about 350 pounds per acre in above-average years. In the 15-17 inch PZ, the total annual production (air-dry weight) is about 350 pounds per acre during an average year, but ranges from about 250 pounds per acre in unfavorable years to about 400 pounds per acre in above-average years. This plant community is extremely resistant to change. Many plant species are missing and a seed source is not readily available. Also, sod-forming grasses tend to maintain themselves due to their resistance to any further overgrazing.

Dominant plant species

- Rocky Mountain juniper (*Juniperus scopulorum*), tree
- ponderosa pine (*Pinus ponderosa var. scopulorum*), tree
- skunkbush sumac (*Rhus trilobata*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- blue grama (*Bouteloua gracilis*), grass
- threadleaf sedge (*Carex filifolia*), grass

Figure 14. Plant community growth curve (percent production by month). WY1104, 12-14SP upland sites w/ warm. 12-14" Precipitation Zone, Southern Plains (SP) with warm-season (grass) species.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	20	35	30	5	5	0	0	0

State 3
Increased Bare Ground State

The hazard of soil erosion has increased due to the increase of bare ground and may be severe on steeper slopes. Typically, runoff is high and infiltration is low. All ecological functions are impaired. An ecological threshold has been crossed. Erosion and loss of organic matter and carbon reserves are concerns.

Dominant plant species

- Rocky Mountain juniper (*Juniperus scopulorum*), tree
- ponderosa pine (*Pinus ponderosa var. scopulorum*), tree
- skunkbush sumac (*Rhus trilobata*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- Fendler threeawn (*Aristida purpurea var. longiseta*), grass
- threadleaf sedge (*Carex filifolia*), grass
- blue grama (*Bouteloua gracilis*), grass
- burningbush (*Bassia scoparia*), other herbaceous
- Russian thistle (*Salsola*), other herbaceous

Community 3.1
Bassia scoparia-Salsola/Aristida purpurea-Carex filifolia (burningbush-Russian thistle/Fendler threeawn-threadleaf sedge).

The plant composition is made of annuals with a few species of perennial forbs and grasses that are very tolerant to frequent and severe defoliation. The dominant grasses include blue grama, threadleaf sedge, and Fendler threeawn. Annuals such as sixweeks fescue, Russian thistle, burningbush, and cheatgrass have increased or invaded. The dominant forbs include Cuman ragweed (western ragweed), phlox, sandwort, and hairy goldenaster. Fringed sagewort, pricklypear, broom snakeweed, and small soapweed have increased. In the 12-14 inch PZ, the total annual production (air-dry weight) is about 275 pounds per acre during an average year, but ranges from about 225 pounds per acre in unfavorable years to about 325 pounds per acre in above-average years. In the 15-17 inch PZ, the total annual production (air-dry weight) is about 300 pounds per acre during an average year, but ranges from about 250 pounds per acre in unfavorable years to about 350 pounds per acre in above-average years.

Dominant plant species

- Rocky Mountain juniper (*Juniperus scopulorum*), tree
- ponderosa pine (*Pinus ponderosa var. scopulorum*), tree
- skunkbush sumac (*Rhus trilobata*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- Fendler threeawn (*Aristida purpurea var. longiseta*), grass
- threadleaf sedge (*Carex filifolia*), grass
- blue grama (*Bouteloua gracilis*), grass
- burningbush (*Bassia scoparia*), other herbaceous
- Russian thistle (*Salsola*), other herbaceous

Figure 15. Plant community growth curve (percent production by month). WY1104, 12-14SP upland sites w/ warm. 12-14" Precipitation Zone, Southern Plains (SP) with warm-season (grass) species.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	20	35	30	5	5	0	0	0

Transition T1A
State 1 to 2

Frequent and severe defoliation without adequate recovery periods and lack of fire shifts this state across an ecological threshold to the Sod-bound State. Biotic integrity and hydrologic function are impaired as a result of this transition.

Transition T2A
State 2 to 3

Long-term, frequent, and severe defoliation and lack of fire cause a shift across an ecological threshold to the Increased *Bare Ground* State. Erosion and loss of organic matter and carbon reserves are land management concerns. Annual plants are likely to increase or invade as a result of this transition.

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**12"-14"**			155–308	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–185	–
	needle and thread	HECO26	*Hesperostipa comata*	31–93	–
	western wheatgrass	PASM	*Pascopyrum smithii*	62–93	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	31–62	–
2	**12"-14"**			93–185	
	little bluestem	SCSC	*Schizachyrium scoparium*	62–123	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	31–62	–
3	**12"-14"**			31–62	
	blue grama	BOGR2	*Bouteloua gracilis*	31–62	–
4	**12"-14"**			31–62	
	Grass, perennial	2GP	*Grass, perennial*	0–31	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–31	–
	plains muhly	MUCU3	*Muhlenbergia cuspidata*	0–31	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–31	–
	threeawn	ARIST	*Aristida*	0–12	–
5	**12"-14"**			31–62	
	threadleaf sedge	CAFI	*Carex filifolia*	0–31	–
	sedge	CAREX	*Carex*	0–31	–
9	**15"-17"**			168–336	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–202	–
	needle and thread	HECO26	*Hesperostipa comata*	34–101	–
	western wheatgrass	PASM	*Pascopyrum smithii*	67–101	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	34–67	–
10	**15"-17"**			101–202	
	little bluestem	SCSC	*Schizachyrium scoparium*	67–135	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	34–67	–
11	**15"-17"**			34–67	
	blue grama	BOGR2	*Bouteloua gracilis*	34–67	–
12	**15"-17"**			34–67	
	Grass, perennial	2GP	*Grass, perennial*	0–34	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–34	–
	plains muhly	MUCU3	*Muhlenbergia cuspidata*	0–34	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–34	–
	threeawn	ARIST	*Aristida*	0–12	–
13	**15"-17"**			34–67	

13	**15"-17"**			34–67	
	threadleaf sedge	CAFI	*Carex filifolia*	0–34	–
	sedge	CAREX	*Carex*	0–34	–
Forb					
6	**12"-14"**			62–93	
	Forb, perennial	2FP	*Forb, perennial*	0–31	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–12	–
	pussytoes	ANTEN	*Antennaria*	0–12	–
	sandwort	ARENA	*Arenaria*	0–12	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–12	–
	milkvetch	ASTRA	*Astragalus*	0–12	–
	prairie clover	DALEA	*Dalea*	0–12	–
	buckwheat	ERIOG	*Eriogonum*	0–12	–
	scarlet beeblossom	GACO5	*Gaura coccinea*	0–12	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–12	–
	dotted blazing star	LIPU	*Liatris punctata*	0–12	–
	beardtongue	PENST	*Penstemon*	0–12	–
	phlox	PHLOX	*Phlox*	0–12	–
	ragwort	SENEC	*Senecio*	0–12	–
	goldenrod	SOLID	*Solidago*	0–12	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–12	–
14	**15"-17"**			67–101	
	Forb, perennial	2FP	*Forb, perennial*	0–34	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–13	–
	pussytoes	ANTEN	*Antennaria*	0–13	–
	sandwort	ARENA	*Arenaria*	0–13	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–13	–
	milkvetch	ASTRA	*Astragalus*	0–13	–
	prairie clover	DALEA	*Dalea*	0–13	–
	buckwheat	ERIOG	*Eriogonum*	0–13	–
	scarlet beeblossom	GACO5	*Gaura coccinea*	0–13	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–13	–
	dotted blazing star	LIPU	*Liatris punctata*	0–13	–
	beardtongue	PENST	*Penstemon*	0–13	–
	phlox	PHLOX	*Phlox*	0–13	–
	ragwort	SENEC	*Senecio*	0–13	–
	goldenrod	SOLID	*Solidago*	0–13	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–13	–
Shrub/Vine					
7	**12"-14"**			0–93	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–31	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–31	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–12	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–12	

	winterfat	KRLA2	*Krascheninnikovia lanata*	0–12	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–12	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–12	–
	soapweed yucca	YUGL	*Yucca glauca*	0–12	–
15	**15"-17"**			0–34	
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–101	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–34	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–13	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–13	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–13	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–13	–
	soapweed yucca	YUGL	*Yucca glauca*	0–13	–
Tree					
8	**12"-14"**			0–31	
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	0–31	–
	ponderosa pine	PIPOS	*Pinus ponderosa var. scopulorum*	0–31	–
16	**15"-17"**			0–34	
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	0–34	–
	ponderosa pine	PIPOS	*Pinus ponderosa var. scopulorum*	0–34	–

Animal community

Wildlife Interpretations:

Reference Plant Community - Little Bluestem, Western Wheatgrass, Needle and Thread, Blue Grama:

The predominance of grasses plus high forb diversity in this community favors large grazers such as pronghorn and elk. Suitable thermal and escape cover for mule deer is limited due to low shrub cover. White-tailed and black- tailed jackrabbit, badger, and coyote commonly use this community. The Reference Plant Community also provides habitat for a wide array of smaller mammals, so diverse prey populations are available for raptors such as ferruginous and Swainson’s hawks. Birds such as western kingbird, western meadowlark, lark bunting, and grasshopper sparrow will utilize this community for nesting and foraging.

1.2 Community - Threadleaf Sedge, Blue Grama, with Remnant Mid-grasses:

The reduction in taller grasses in this community results in decreased use by lark buntings and western meadowlarks. Use by long-billed curlew increases, provided there is available water within one-quarter mile. Killdeer, horned larks, and McCown’s longspurs also make significant use of this community. Pronghorn may forage in this community.

2.1 Community - Blue Grama, Threadleaf Sedge:

This community provides limited foraging for antelope and other grazers. Ground-nesting birds favoring sparse vegetation may use this community. Long-billed curlews use the Sod-bound Plant Community if standing water is present nearby. Generally, this is not a target vegetative community for wildlife habitat management.

3.1 Community - Threadleaf Sedge, Annuals, Cheatgrass, Fringed Sagewort, Pricklypear, and *Bare Ground*:

Sparse vegetation and greater amounts of bare ground provide suitable habitat for horned larks and McCown’s longspurs. However, a lack of complex vegetation structure and residual cover makes this community poor habitat

in general for most ground-nesting birds and big game species.

1.3 Community - Low Plant Density, Increased Litter, Decadent Plants, and Standing Dead Canopy:

This community has low habitat value for most wildlife species. Horned larks may nest in this community.

Grazing Interpretations:

The following table is a guide to stocking rates for the plant communities described in the Very Shallow site. These are conservative estimates for initial planning. On-site conditions 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).

Plant Community (PC) Production (total lbs./acre in a normal year) and Stocking Rate (AUM/acre) are listed below:

Example:

Reference PC – (550) (.25)

550 lbs. per acre X 25% Harvest Efficiency = 138 lbs. forage demand for one month.
138 lbs. per acre/912 demand per AUM =0.15 AUM's/ac.

12-14" PZ
Reference PC - (550) (.15)
1.2 PC - (400) (.10)
2.1 PC - (300) (.08)

15-17" PZ
Reference PC – (600) (.16)
1.2 PC – (450) (0.12)
2.1 PC – (350) (.10)

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.

An on-site inventory is required prior to development of a grazing plan.

Hydrological functions

Water is the principal factor limiting forage production on this site. This site is highly variable and is dominated by soils in Hydrologic group B and C, with localized areas in hydrologic group D. Infiltration ranges from slow to very rapid. Runoff potential for this site varies from moderate to high depending on soil hydrologic group, slope and ground cover. In many cases, areas with greater than 75 percent ground cover have the greatest potential for high infiltration and lower runoff. An example of an exception would be where shortgrasses form a strong sod and dominate the site. Areas where ground cover is less than 50 percent have the greatest potential to have reduced infiltration and higher runoff (refer to NRCS Section 4, National Engineering Handbook (USDA–NRCS, 1972–2012) for runoff quantities and hydrologic curves.)

Exposed areas of bare ground between plants are inherent to this site. Where slopes are gentle, water flow paths should be broken, irregular in appearance or discontinuous with numerous debris dams or vegetative barriers and exhibit slight to no evidence of rills, wind scoured areas or pedestalled plants. As slopes become steep and bare areas increase, expect to find evidence of water flow patterns and pedestalled plants. Subsurface soil layers, where

not affected by bedrock, are non-restrictive to water movement and root penetration.

Recreational uses

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

Wood products

No appreciable wood products are present on the site.

Other products

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 (2008).

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

Livestock Interpretations: Stocking Rate table updated.

Wildlife Interpretations: Plant community names updated. Narrative is from “Previously Approved” ESD (2008). The Hydrology, Recreational Uses, Wood Products, Other Products, and Plant Preferences table, are carried over from previously “Approved” ESD (2008).

Existing NRI or 417 Inventory Data References updated. More field data collection is needed to support this site concept.

Reference Sheet
Rangeland Health Reference Sheet carried over from previously “Approved” ESD (2008).
It will be updated at the next “Approved” level. I t will also need to be modified to include features found in the former "Rocky Hills" site.

“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

Date Source: NRI
Number of Records: 2
Sample Period: 2004-2013
States: WY
Platte

Date Source: 417s
Number of Records: 2
Sample Period: 1985-1986
States: WY
Counties: Platte

Information presented here has been derived from data collection on private and federal lands using:
• Double Sampling (clipped 2 of 5 plots)*
• Rangeland Health (Pellant et al., 2005)
• Soil Stability (Pellant et al., 2005)
• Line Point Intercept : Foliar canopy, basal cover (Forb, Graminoid, Shrub, subshrub, Lichen, Moss, Rock fragments, bare ground, % Litter) (Herrick et al., 2005)
• Soil pedon descriptions collected on site (Schoeneberger et al., 2012)

*NRCS double-sampling method, CO NRCS Similarity Index Worksheet 528(1).
Additional reconnaissance data collection using numerous ocular estimates and other inventory data; NRCS clipping data for USDA program support; Field observations from experienced range trained personnel. Specific data information is contained in individual landowner/user case files and other files located in county NRCS field offices.

References

Guyette, R.P., M.C. Stambaugh, D.C. Dey, and R. Muzika. 2012. Predicting Fire Frequency with Chemistry and Climate. Ecosystems 15:322–335.

Stewart, O.C., H.T. Lewis, and M.K. Anderson. 2002. Forgotten Fires: Native Americans and the Transient Wilderness. University of Oklahoma Press, Norman, OK. 351p.

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. pp. 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.

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.

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. p. 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. pp. 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. pp. 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. USDA 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. USDA 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 Science Division Staff. 2017. Soil survey manual. C. Ditzler, K. Scheffe, and H.C. Monger (eds.). USDA

Handbook 18. Government Printing Office, Washington, DC.

Soil Survey Staff. Official Soil Series Descriptions. USDA Natural Resources Conservation Service. 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. USDA Natural Resources Conservation Service.

Soil Survey Staff. 2014. Keys to Soil Taxonomy, 12th edition. USDA Natural Resources Conservation Service, Washington, DC.

Soil Survey Staff. 2018. Web Soil Survey. USDA 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.

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

U.S. 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.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2010a. Field indicators of hydric soils in the United States, version 7.0. L.M. Vasilas, G.W. Hurt, and C.V. Noble (eds). USDA-NRCS, in cooperation with the National Technical Committee for Hydric Soils.

U.S. 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.

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

U.S. 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.

U.S. Dept. of Agriculture, Natural Resources Conservation Service. 1997, revised 2003. National Range and Pasture Handbook. Available online. http://www.glti.nrcs.usda.gov/technical/publications/nrph.html. Accessed 26 February, 2018.

U.S. 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.

U.S. Department of the Interior, Geological Survey. 2008. LANDFIRE 1.1.0 Vegetation Dynamics Models. Available online. http://landfire.cr.usgs.gov/viewer/.

U.S. Department of the Interior, Geological Survey. 2011. LANDFIRE 1.1.0 Existing Vegetation Types. Available online. 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.

Additional References:

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. Journal of Vegetation Science, Doi:10.1111/jvs.12508, International Association of Vegetative Science

Butler, LD., J.B. Cropper, R.H. Johnson, A.J. Norman, G.L. Peacock, P.L. Shaver and K.E. Spaeth. 1997, revised 2003. National Range and Pasture Handbook. National Cartography and Geospatial Center's Technical Publishing Team: Fort Worth, TX. Available online. http://www.glti.nrcs.usda.gov/technical/publications/nrph.html. Accessed 26 February, 2018.

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), 595-601.

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

Cooperative climatological data summaries. NOAA. Western Regional Climate Center: Reno, NV. Available online. http://www.wrcc.dri.edu/climatedata/climsum. Accessed 16 November, 2017.

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

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

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

Pellant, M., P. Shaver, D.A. Pyke, J.E. Herrick. 2005. Interpreting Indicators of Rangeland Health, Version 4. BLM National Business Center Printed Materials Distribution Service: Denver, CO.

Mack, Richard N. and J.N. Thompson. 1982. Evolution in Steppe with Few Large, Hooved Mammals. The American Naturalist. 119, No. 6, 757-773

Reyes-Fox, M., Stelzer H., Trlica M.J., McMaster, G.S., Andales, A.A., LeCain, D.R., and Morgan J.A. 2014. Elevated CO2 further lengthens growing season under warming conditions. Nature, April 23, 2014 issue at 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. Natural Resources Conservation Service, National Soil Survey Center: Lincoln, NE.

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. Eos, 81(12), 121-125.

Zelikova, Tamara Jane, D.M. Blumenthal, D.G. Williams, L. Souza, D.R. LeCain, J.Morgan. 2014. Long-term exposure to elevated CO2 enhances plant community stability by suppressing dominant plant species in a mixed-grass prairie. Ecology, 2014 issue at www.pnas.org/cgi/doi/10.1073/pnas.1414659111

U.S. Dept. of Agriculture, Natural Resources Conservation Service. 2009. Part 630, Hydrology, National Engineering Handbook.

U.S. Dept. 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.

U.S. Dept. 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

U.S. Dept. of Agriculture, Natural Resources Conservation Service. Web Soil Survey.http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx (Accessed 15 November 2017).

Data collection for this ecological site was done in conjunction with the progressive soil surveys within the 67A Central High Plains (Northern Part) of Nebraska, Wyoming, and Colorado. It has been mapped and correlated with soils in the following soil surveys:

U.S. Dept. of Agriculture.1994. Soil Survey of Banner County, Nebraska.

U.S. Dept. of Agriculture. 1997. Soil Survey of Cheyenne County, Nebraska.

U.S. Dept. of Agriculture. 1999. Soil Survey of Garden County, Nebraska.

U.S. Dept. of Agriculture. 2005. Soil Survey of Kimball County, Nebraska.

U.S. Dept. of Agriculture. 1985. Soil Survey of Morrill County, Nebraska.

U.S. Dept. of Agriculture. 1968 Soil Survey of Scotts Bluff County, Nebraska.

U.S. Dept. of Agriculture.2013. Soil Survey of Scotts Bluff National Monument, Nebraska.

U.S. Dept. of Agriculture. 1998. Soil Survey of Sioux County, Nebraska.

U.S. Dept. of Agriculture. 1981. Soil Survey of Goshen County, Northern Part, Wyoming.

U.S. Dept. of Agriculture. 1971. Soil Survey of Goshen County, Southern Part, Wyoming.

U.S. Dept. of Agriculture. 1983. Soil Survey of Laramie County, Eastern Part, Wyoming.

U.S. Dept. of Agriculture. 2001. Soil Survey of Laramie County, Western Part, Wyoming.

U.S. Dept. of Agriculture. 2003. Soil Survey of Platte County, Wyoming.

U.S. Dept. of Agriculture. 1982. Soil Survey of Weld County, Northern Part, Colorado.

For manuscripts of archived soil surveys, see: https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

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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)	Dave Cook, Kristin Dickinson, George Gamblin, John Hartung, Andy Steinert, Nadine Bishop
Contact for lead author	
Date	11/23/2020
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** None. Rills are not expected on the site.

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2. **Presence of water flow patterns:** None expected on more level terrain. Water flow patterns will be present on steeper slopes (greater than 30 percent) becoming more abundant as slopes increase. Debris dams will be present in association with the waterflow patterns.

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3. **Number and height of erosional pedestals or terracettes:** None expected on more level terrain. Pedestalled plants and terracettes may be present on steeper slopes (greater than 30 percent) becoming more common as slopes increase. Debris dams will be present in association with the waterflow patterns.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is 20 to 40 percent occurring in patches up to 12 to 24 inches (30.5- 61 cm) in diameter.

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

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

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7. **Amount of litter movement (describe size and distance expected to travel):** Small size litter classes will generally move short distances (less than 6 inches/15.25 cm), some medium size class litter will move very short distances. Litter debris dams are present. On the steepest slopes (greater than 30 percent), litter will travel greater distances.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil aggregate stability ratings should typically be 3 or greater. Surface organic matter adheres to the soil surface. Soil surface peds will typically retain structure for 1 minute or longer when dipped in distilled water.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** The surface layer ranges from 2 to 6 inches (5.1-15.25 cm) thick. Soil colors range from yellowish brown, light grayish brown, to brown (values of 5 to 6) when dry and light yellowish brown, dark grayish brown, or dark brown (values of 3 to 4) when moist. Soil surface structure is fine to medium granular.

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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. The expected composition of the plant community is 70 to 90 percent perennial grasses and grass-likes, 5 to 15 percent forbs, and 5 to 15 percent shrubs and trees.

    The grass and grass-like component is made up of cool-season, bunch grasses (10-50%); cool-season, rhizomatous

grasses (10-15%), warm-season short grasses (5-10%); warm-season mid-grasses (15-30%); and grass-likes (5-10%)

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None. A compaction layer should not 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: 12-14” PZ - Community 1.1:
1. Native, C3, bunch grasses – 55-275 #/ac (10-50%), 2 species minimum

15-17” PZ - Community 1.1:
Native, C3 bunch grasses – 60-300 #/ac (10-50%), 2 species minimum

Sub-dominant: 12-14” PZ - Community 1.1:
2. Native, C4, mid-grasses – 83-165 #/ac (15-30%), 2 species minimum
3. Native, C3, rhizomatous grasses – 55-83 #/ac (10-15%), 1 species minimum
4. Native, Perennial and Annual Forbs – 55-83 #/ac (10-15%), 5 species minimum
5. Shrubs, Vines, Cacti – 28-83 #/ac (5-15%), 1 species minimum

15-17” PZ - Community 1.1:
2. Native, C4, mid-grasses – 90-180 #/ac (15-30%), 2 species minimum
3. Native, C3, rhizomatous grasses – 60-90 #/ac (10-15%), 1 species minimum
4. Native, Perennial and Annual Forbs – 60-90 #/ac (10-15%), 5 species minimum

Other: Minor:
12-14” PZ - Community 1.1:
6. Native, C4, short grasses – 28-55 #/ac (5-10%)
7. Grass-likes – 28-55 #/ac (5-10%)
8. Trees – 0-28 #/ac (0-5%)

15-17” PZ - Community 1.1:
5. Native, C4, short grasses – 30-60 #/ac (5-10%)
6. Grass-likes – 30-60 #/ac (5-10%)
7. Shrubs, Vines, Cacti – 0-30 #/ac: (0-5%)
8. Trees – 0-30 #/ac (0-5%)

Additional: 12-14” PZ - Community 1.1:
12a. Relative Dominance: Native, C3 bunch grasses > Native, C4, mid-grasses > Native, C3, rhizomatous grasses = Native, Annual or Perennial Forbs > or = Shrubs, Cacti, Vines > C4, short grasses = Grass-likes > Trees

12b. F/S Groups not expected for the site: Introduced annual grasses, perennial introduced and naturalized grasses.

12c. Number of F/S Groups: 8

12d. Species number in Dominant and Sub-dominant F/S Groups: 11

15-17” PZ - Community 1.1:
12a. Relative Dominance: Native, C3 bunch grasses > Native, C4, mid-grasses > Native, C3, rhizomatous = Native, Annual or Perennial Forbs > Native, C4, short grasses = Grass-likes > Shrubs, Cacti, Vines = Trees

12b. F/S Groups not expected for the site: Introduced annual grasses, perennial introduced and naturalized grasses.

12c. Number of F/S Groups: 8

12d. Species number in Dominant and Sub-dominant F/S Groups: 10

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Very little evidence of decadence or mortality. Bunch grasses have strong, healthy centers with less than 3 percent mortality and shrubs have few dead stems. The exception is the potential of up to 20 percent mortality in mid and short, warm-season bunch grasses during multi-year drought cycles.

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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 30 to 50 percent. Litter depth is expected to be approximately 0.25 inch (0.65 cm).

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** In the 12-14" precipitation zone, annual production ranges from 450 to 650 pounds per acres (air dry basis). Average annual production is 550 pounds per acre under normal precipitation and weather conditions.

    In the 15-17" Precipitation Zone, annual production ranges from 475 to 725 pounds per acre (air dry basis). Average annual production is 600 pounds per acre under normal precipitation and weather conditions.

    No significant reduction is expected the growing season following wildfire.

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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:** Annual bromes, Russian thistle, kochia, broom snakeweed, fringed sagewort, pricklypear, and others as they become known.

    See:
    Colorado Department of Agriculture Invasive Species Website:
    https://www.colorado.gov/pacific/agconservation/noxious-weed-species
    Wyoming Weed and Pest Council Website: https://wyoweed.org/
    Nebraska Invasive Species website: https://neinvasives.com/plants.

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