USDA Natural Resources Conservation Service

Ecological site R067BY024CO
Sandy Plains

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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.

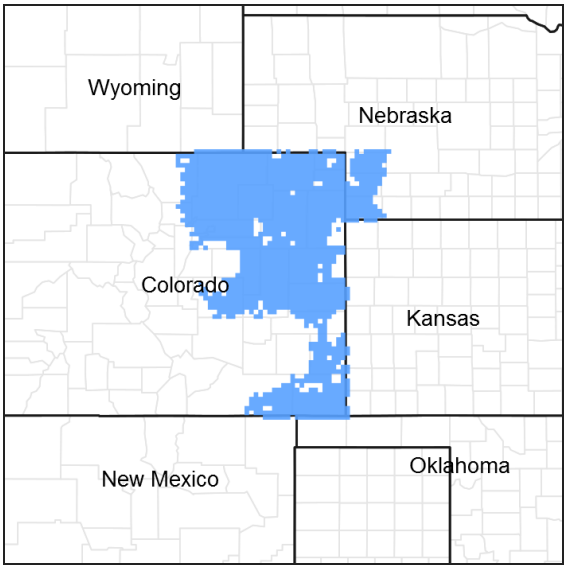


Figure 1. Mapped extent

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): 067B–Central High Plains, Southern Part

MLRA 67B occurs in eastern Colorado and consists of rolling plains and river valleys. Some canyonlands occur in the southeast portion. The major rivers are the South Platte and Arkansas which flow from the Rocky Mountains to Nebraska and Kansas. Other rivers in the MLRA include the Cache la Poudre and Republican and associated tributaries. This MLRA is traversed by Interstate 25, 70 and 76; and U.S. Highways 50 and 287. Major land uses include 54 percent rangeland, 35 percent cropland, and 2 percent pasture and hayland. Urban, developed open space, and miscellaneous land occupy approximately 9 percent. Major Cities in this area include Fort Collins, Greeley, Sterling, and Denver. Other cities include Limon, Cheyenne Wells, and Springfield. Land ownership is mostly private. Federal lands include Pawnee and Comanche National Grasslands (U.S. Forest Service), Sand Creek Massacre National Historic Site (National Park Service), and Rocky Mountain Arsenal National Wildlife Refuge (U.S. Fish & Wildlife Service). State Parks include Cherry Creek and Chatfield Reservoirs, and Barr and Jackson Lakes.

This region is periodically affected by severe drought, including the historic “Dust Bowl” of the 1930s. Dust storms may form during drought years in windy periods. Elevations range from 3,400 to 6,000 feet. The Average annual precipitation ranges from 14 to17 inches per year and ranges from 13 inches to over 18 inches, depending upon location. Precipitation occurs mostly during the growing season, often during rapidly developing thunderstorms. Mean annual air temperature (MAAT) is 48 to 52 degrees Fahrenheit. Summer temperatures may exceed 100

degrees Fahrenheit. Winter temperatures may be sub-zero, and snowfall varies from 20 to 40 inches per year. Snow cover frequently melts between snow events.

LRU notes

Land Resource Unit (LRU) A is the northeast portion of MLRA 67B, to an extent of approximately 9 million acres. Most of the LRU is rangeland, and includes the Pawnee National Grassland. Dryland winter wheat/fallow rotations (that may include dryland corn, sunflowers, and sorghum) are grown in most counties. Irrigated cropland is utilized in the South Platte Valley. Small acreage and urban ownership are more concentrated on the Front Range. This LRU is found in portions of Adams, Arapahoe, Elbert, Kit Carson, Larimer, Lincoln, Logan, Washington, and Weld counties. Other counties include Boulder, Cheyenne, Denver, Jefferson, and Yuma. The soil moisture regime is aridic ustic. The mean annual air temperature (MAAT) is 50 degrees Fahrenheit.

LRU B is in the southeast portion of MLRA 67B (2.6 million acres) and includes portions of Baca, Bent, Cheyenne, Kiowa, Las Animas, and Prowers counties. Most of the LRU remains in rangeland and includes the Comanche National Grassland. On the farmed land, a system of dryland winter wheat/fallow rotations (that may include dryland corn, sunflowers, and sorghum) is implemented. Irrigated cropland is found in the Arkansas Valley. The soil moisture regime is aridic ustic and the MAAT is 52 degrees Fahrenheit.

LRU C occurs in portions of Morgan and Weld counties (approximately 1.2 million acres). Most of LRU C is in rangeland. On the farmed land, a system of dryland winter wheat/fallow rotations (that may include dryland corn, sunflowers, and sorghum) is implemented. The soil moisture regime is ustic aridic and the MAAT is 48 degrees Fahrenheit.

Classification relationships

MLRA 67B is in the Colorado Piedmont and Raton Sections of the Great Plains Province (USDA, 2006). The MLRA is further defined by Land Resource Units (LRUs) A, B, and C. Features such as climate, geology, landforms, and key vegetation further refine these concepts and are described in other sections of the Ecological Site Description (ESD). NOTE: To date, these LRUs are DRAFT.

Relationship to Other Hierarchical Classifications:
NRCS Classification Hierarchy: Physiographic Division, Physiographic Province, Physiographic Section, Land Resource Region, Major Land Resource Area, Land Resource Unit (Fenneman, 1946).
USFS Classification Hierarchy: Domain, Division, Province, Section, Subsection,
Land Type Association: Land Type, Land Type Phase (Cleland et al, 1997).

REVISION NOTES:
The Sandy Plains Ecological Site was developed by an earlier version of the Sandy Ecological Site (2004, re-named Sandy Plains in 2007). This earlier version was based on input from NRCS (formerly Soil Conservation service) and historical information obtained from the Sandy Plains Range Site descriptions (1975, revised 1980). 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 Sandy Plains Ecological Site is a run-on site on slopes of less than five percent. Bedrock is deeper than 40 inches, and there is less than 15 percent rock fragments on the surface and in the subsoil. The site is dominated by sandy surface and subsoil textures.

Associated sites

R067BY002CO	**Loamy Plains** This ecological site is commonly adjacent.
R067BY015CO	**Deep Sand** This ecological site is commonly adjacent.

R067BY022CO	**Choppy Sands** This ecological site is commonly adjacent.
R067BY031CO	**Sandy Bottomland** This ecological site is commonly adjacent.
R067BY056CO	**Sandstone Breaks** This ecological site is commonly adjacent.

Similar sites

R067BY022CO	**Choppy Sands** This ecological site has greater than 5 percent slopes and a rough, steep, dunelike appearance. Cat-steps are normally apparent.
R067BY015CO	**Deep Sand** This ecological site has greater than five percent slopes and rolling topography.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Eriogonum effusum* (2) *Amorpha canescens*
Herbaceous	(1) *Bouteloua gracilis* (2) *Calamovilfa longifolia*

Physiographic features

This site occurs on interdunes in dune fields and on terraces or narrow to broad, flat interfluves on dissected plains.

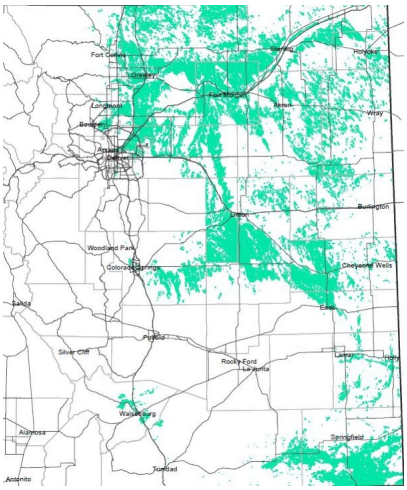


Figure 2. The distribution of the Sandy Plains site in MLRA 67B.

Table 2. Representative physiographic features

Landforms	(1) Interdune (2) Interfluve (3) Terrace
Runoff class	Very low to low
Flooding frequency	None
Ponding frequency	None
Elevation	1,036–1,829 m
Slope	0–6%
Ponding depth	0 cm

Water table depth	203 cm
Aspect	Aspect is not a significant factor

Climatic features

Average annual precipitation across the MLRA extent is 14 to 17 inches, and ranges from 13 to over 18 inches, depending on location. Precipitation increases from north to south. Mean Annual Air Temperature (MAAT) is 50 degrees Fahrenheit in the northern part and increases to 52 degrees Fahrenheit in the southern part. Portions of Morgan and Weld counties are cooler and drier, the MAAT is 48 degrees Fahrenheit, and average precipitation is 13 to14 inches per year.

Two-thirds of the annual precipitation occurs during the growing season from mid-April to late September. Snowfall averages 30 inches per year, area-wide, but varies by location from 20 to 40 inches per year. Winds are estimated to average 9 miles per hour annually. Daytime winds are generally stronger than at night, and occasional strong storms may bring periods of high winds with gusts to more than 90 mph. High-intensity afternoon thunderstorms may arise. The average length of the freeze-free period (28 degrees Fahrenheit) is 155 days from April 30th to October to 3rd. The average frost-free period (32 degrees Fahrenheit) is 136 days from May 11th to September 24th. July is the hottest month, and December and January are the coldest months. Summer temperatures average 90 degrees Fahrenheit and occasionally exceed 100 degrees Fahrenheit. Summer humidity is low and evaporation is high. Winters are characterized with frequent northerly winds, producing severe cold with temperatures occasionally dropping to -30 degrees Fahrenheit or lower. Blizzard conditions may form quickly. For detailed information, visit the Western Regional Climate Center website:
Western Regional Climate Center Historical Data Western U.S. Climate summaries, NOAA Coop Stations Colorado http://www.wrcc.dri.edu/summary/Climsmco.html.

Table 3. Representative climatic features

Frost-free period (characteristic range)	119-129 days
Freeze-free period (characteristic range)	134-151 days
Precipitation total (characteristic range)	356-432 mm
Frost-free period (actual range)	102-132 days
Freeze-free period (actual range)	126-156 days
Precipitation total (actual range)	356-432 mm
Frost-free period (average)	121 days
Freeze-free period (average)	142 days
Precipitation total (average)	381 mm

Climate stations used

- (1) SPRINGFIELD 7 WSW [USC00057866], Springfield, CO
- (2) LIMON WSMO [USW00093010], Limon, CO
- (3) FLAGLER 1S [USC00052932], Flagler, CO
- (4) FT MORGAN [USC00053038], Fort Morgan, CO
- (5) KIT CARSON [USC00054603], Kit Carson, CO
- (6) BRIGHTON 3 SE [USC00050950], Brighton, CO
- (7) BYERS 5 ENE [USC00051179], Byers, CO
- (8) CHEYENNE WELLS [USC00051564], Cheyenne Wells, CO
- (9) BRIGGSDALE [USC00050945], Briggsdale, CO
- (10) GREELEY UNC [USC00053553], Greeley, CO
- (11) NUNN [USC00056023], Nunn, CO

Influencing water features

There are no water features associated with this ecological site.

Soil features

The soils on this site are very deep, well to somewhat excessively drained soils that formed from eolian sand or alluvium. They typically have a moderately rapid to moderately slow permeability class, but range to slow in some soils. 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 sandy loam or fine sandy loam, but may include loamy sand. The surface layer ranges from a depth of 4 to 9 inches thick. The subsoil is typically sandy loam, fine sandy loam, or sandy clay loam, but may include loamy sand. Soils in this site can have free carbonates below 6 inches. These soils are susceptible to erosion by wind. The potential for wind erosion accelerates with a decrease in vegetative cover, clay percentage, and particle size.

Major soil series correlated to this ecological site include: Ascalon (loamy sand or sandy loam), Bijou, Blakeland, Bresser, Gilcrest, Haxtun, Julesburg, Manter, Olnest, Otero, Paoli, Truckton, and Vona.

Other soil series that have been correlated to this site, but may eventually be re-correlated include: Eastonville, Fort Collins (sandy loam), Haverson (sandy loam), Nunn (sandy loam), Olney, Platner (sandy loam and fine sandy loam), Stoneham (sandy loam), Sundance (sandy loam), and Weld (sandy loam).

The attributes listed below represent 0 to 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

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Eolian sands
Surface texture	(1) Sandy loam (2) Loamy sand (3) Fine sandy loam
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderately slow to moderately rapid
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	7.62–15.24 cm
Calcium carbonate equivalent (0-101.6cm)	0–10%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–5
Soil reaction (1:1 water) (0-101.6cm)	6.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–5%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

The information in this ESD, including the state-and-transition model diagram (STM), 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 or time-controlled grazing strategies, and historical accounts.

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.

Eastern Colorado was strongly affected by extended drought conditions in the “Dust Bowl” period of the 1930’s, with recurrent drought cycles in the 1950s and 1970s. Extreme to exceptional drought conditions have re-visited the area from 2002 to 2012, with brief interludes of near normal to normal precipitation years. Long-term effects of these latest drought events have yet to be determined. Growth of native cool-season plants begins about April 1 and continues to mid-June. Native warm-season plants begin growth about May 1 and continue to about August 15. Regrowth of cool-season plants occurs in September in most years, depending on the availability of moisture.

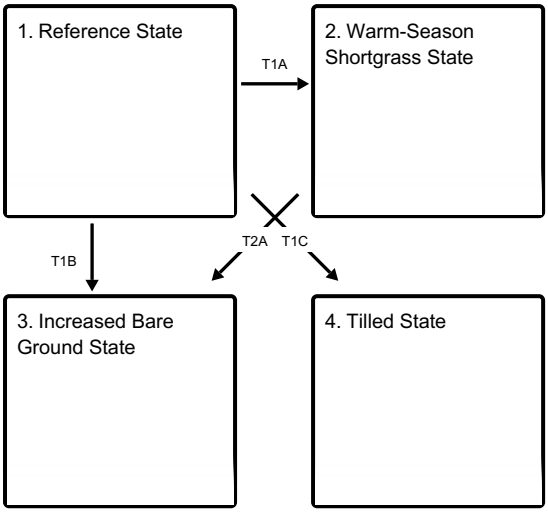
Grazing by large herbivores without adequate recovery periods causes blue grama to increase. Blue grama may eventually form a sod-like appearance. Prairie sandreed, sand bluestem, and switchgrass decrease. Prairie sandreed may persist in remnant amounts protected by remaining shrubs. Cool-season grasses such as needle and thread and western wheatgrass decrease in frequency and production. Key shrubs such as western sand cherry and fourwing saltbush decrease in frequency and production. American vetch and other highly palatable forbs also decrease. Fendler threeawn, annuals, and bare ground increases under heavy, continuous grazing, excessive defoliation, or long- term non-use. Much of this ecological site has been tilled and used for crop production. Other areas of this ecological site have been converted to suburban residence and small acreages, especially near the larger communities.

The Sandy Plains ecological site is characterized by four states: Reference, Warm-Season Shortgrass, Increased *Bare Ground*, and Tilled. The Reference State is characterized by a dominance of warm-season tallgrasses (prairie sandreed, sand bluestem, and switchgrass). Warm-season shortgrass (blue grama) is the primary understory species. The Warm-Season Shortgrass State is dominated by a warm-season short bunchgrass (blue grama). The Increased *Bare Ground* State is characterized by early successional warm-season (Fendler threeawn) and cool-

season short bunchgrasses (squirreltail), and annual grasses and forbs. The Tilled State has been mechanically disturbed by equipment and includes either a variety of reseeded warm and cool-season grasses or early successional plants as well as annual grasses and forbs.

State and transition model

Ecosystem states



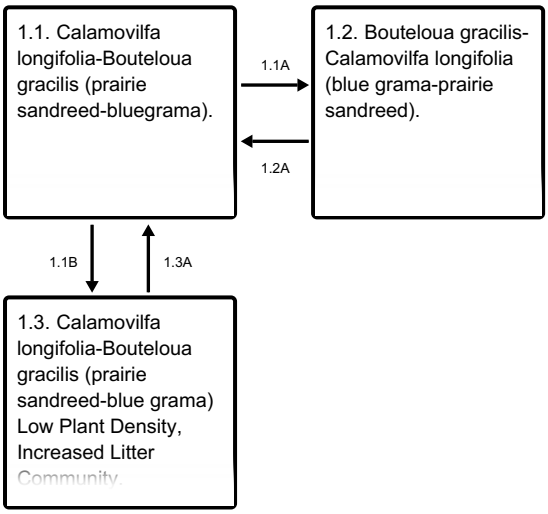
T1A - Excessive grazing. Lack of fire.

T1B - Excessive grazing. Lack of fire.

T1C - Mechanical soil disturbance.

T2A - Excessive grazing. Lack of fire.

State 1 submodel, plant communities



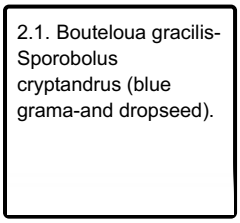
1.1A - Excessive grazing. Lack of fire.

1.1B - Non-use. Lack of fire.

1.2A - Prescribed grazing. Prescribed fire.

1.3A - Prescribed grazing. Prescribed fire.

State 2 submodel, plant communities



State 3 submodel, plant communities

3.1. Aristida purpurea-Sporobolus cryptandrus (Fendler threeawn-sand dropseed).

State 4 submodel, plant communities

4.1. Bromus tectorum - Aristida purpurea (cheatgrass - Fendler threeawn).	4.2. Seeded Plant Community

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 due to the disturbance regimes applicable to the site.

Dominant plant species

- spreading buckwheat (*Eriogonum effusum*), shrub
- (*Amaranthus acutilobus*), shrub
- blue grama (*Bouteloua gracilis*), grass
- prairie sandreed (*Calamovilfa longifolia*), grass

Community 1.1
Calamovilfa longifolia-Bouteloua gracilis (prairie sandreed-bluegrama).

This is the interpretive plant community and is considered to be the Reference Plant Community. This plant community evolved with grazing by large herbivores, and is well suited for grazing by domestic livestock. It can be found on areas that are properly managed with prescribed grazing that allows for adequate recovery periods following each grazing event. The potential vegetation is about 70 to 85 percent grasses and grass-like plants, 10 to 15 percent forbs, and 5 to15 percent woody plants. This plant community is diverse, and productive. Litter is properly distributed with very little movement off-site, and natural plant mortality is very low. It is well-suited to carbon sequestration, effective water cycle, and wildlife use by many species, livestock use, and is aesthetically pleasing. Community dynamics, nutrient cycle, water cycle, and energy flow are functioning properly. This community is resistant to disturbances except moderate to heavy continuous grazing, tillage, or development into urban or other uses. The dominant tall warm-season grasses are prairie sandreed, sand bluestem, and switchgrass. Blue grama dominates the understory. Important cool-season grasses and grass-likes are needle and thread and sun sedge. Key forbs and shrubs are American vetch, pacific peavine (manystem pea), purple prairie clover, and spreading buckwheat. Total annual production ranges from 800 to 2,200 pounds of air-dry vegetation per acre and averages 1,650 pounds during an average year. These production figures are the fluctuations expected during favorable, normal, and unfavorable years due to the timing and amount of precipitation and temperature. Total annual production should not be confused with species productivity, which is annual production and variability by species throughout the extent of the community phase.

Dominant plant species

- spreading buckwheat (*Eriogonum effusum*), shrub
- (*Amaranthus acutilobus*), shrub
- prairie sandreed (*Calamovilfa longifolia*), grass
- blue grama (*Bouteloua gracilis*), grass

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	673	1457	1894
Forb	168	224	286
Shrub/Vine	56	168	286
Total	**897**	**1849**	**2466**

Figure 10. Plant community growth curve (percent production by month). CO6709, Warm-season dominant, cool-season subdominant; MLRA-67B; upland coarse textured soils..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	2	7	25	35	15	10	5	1	0	0

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

When compared to the Reference Plant Community, sand bluestem, prairie sandreed, switchgrass, leadplant, and western sandcherry have decreased in frequency and production. Blue grama has increased. Sand dropseed, Fendler threeawn, hairy goldaster, croton, slimflower scurfpea, Cuman ragweed, stickleaf, heath aster, lupine, loco, milkvetch, and plains pricklypear cactus have increased. Soils that have a sandy loam or coarser subsoil show an increase in sand sagebrush. Continuous spring grazing with summer deferment reduces the cool-season component (needle and thread, western wheatgrass, sun sedge) of this plant community and increase the warm-season component. Continuous summer grazing with spring deferment reduces the warm-season component (sand bluestem, prairie sandreed, and switchgrass) and increases the cool-season component. The risk of losing key warm-season tallgrasses, important forbs and shrubs is a major concern. Blue grama is increasing at the expense of the tallgrasses and deep-rooted shrubs. Water cycle, nutrient cycle, and energy flow may become impaired due to a shift in root structure and species composition. Less litter is being produced. Production in this community can vary from 400 to 1,200 pounds of air-dry vegetation per acre per year depending on weather conditions and averages 900 pounds.

Dominant plant species

- spreading buckwheat (*Eriogonum effusum*), shrub
- plains pricklypear (*Opuntia polyacantha*), shrub
- blue grama (*Bouteloua gracilis*), grass
- prairie sandreed (*Calamovilfa longifolia*), grass

Figure 11. Plant community growth curve (percent production by month). CO6710, Warm-season dominant; MLRA-67B; upland coarse-textured soils..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	20	40	20	10	5	0	0	0

Community 1.3
Calamovilfa longifolia-Bouteloua gracilis (prairie sandreed-blue grama) Low Plant Density, Increased Litter Community.

Most of the species occurring in the Reference Plant Community are present in this plant community but are reduced in abundance and production. Much of the nutrients are tied up in excessive litter and standing dead canopy. The semiarid environment and the absence of animal traffic to break down litter slow nutrient recycling. Aboveground litter also limits sunlight from reaching plant crowns. Many plants, especially bunchgrasses, die off. Accumulation of litter and absence of grazing or fire reduce seed germination and establishment. This plant community is at risk of losing many key species and if left ungrazed or ungrazed without fire can go to a vegetative state resembling the Increased *Bare Ground* State. This plant community changes rapidly if plant manipulation is allowed to occur (grazing by domestic livestock or fire). In advanced stages, plant mortality and erosion potential increase as bare areas increase. Production can vary from 300 to 1500 pounds of air-dry vegetation per acre per

year depending on weather conditions and the plants that are present.

Dominant plant species

- spreading buckwheat (*Eriogonum effusum*), shrub
- (*Amaranthus acutilobus*), shrub
- prairie sandreed (*Calamovilfa longifolia*), grass
- blue grama (*Bouteloua gracilis*), grass

Figure 12. Plant community growth curve (percent production by month). CO6711, Warm-season dominant, cool-season subdominant, excess litter; MLRA-67B; upland coarse texture soil..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	2	8	20	35	17	10	5	3	0	0

Pathway 1.1A
Community 1.1 to 1.2

Excessive grazing and reduced fire frequency shifts this plant community toward the 1.2 Community. Biotic integrity will be altered and water and nutrient cycles may be slightly impaired as a result of this community pathway.

Pathway 1.1B
Community 1.1 to 1.3

Non-use and lack of fire will move this plant community to the Low Plant Density, Increased Litter Plant Community. Plant decadence and standing dead plant material can impede energy flow. Water and nutrient cycles may be impaired as a result of this community pathway.

Pathway 1.2A
Community 1.2 to 1.1

Grazing with adequate recovery periods after each grazing occurrence with proper stocking rate and prescribed fire will return this plant community back to the Reference Community, relative to climatic conditions.

Conservation practices

Prescribed Burning
Prescribed Grazing

Pathway 1.3A
Community 1.3 to 1.1

The return of grazing with adequate recovery periods or normal fire frequency will cause a community pathway back toward the Reference Plant Community. This change can occur in a relatively short time frame with the return of these disturbances.

Conservation practices

Prescribed Burning
Prescribed Grazing

State 2
Warm-Season Shortgrass 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 edaphic (soil characteristics) changes have negatively impacted energy flow and nutrient and hydrologic cycles. This is a very stable state, resistant to change due to the

high tolerance of blue grama to grazing, the development of a shallow root system (aka root pan), and subsequent changes in hydrology (reduced infiltration) and nutrient cycling. The loss of other functional/structural groups such as warm-season bunchgrasses, forbs, and shrubs reduces the biodiversity and productivity of this state.

Dominant plant species

- plains pricklypear (*Opuntia polyacantha*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- blue grama (*Bouteloua gracilis*), grass
- sand dropseed (*Sporobolus cryptandrus*), grass

Community 2.1
Bouteloua gracilis-Sporobolus cryptandrus (blue grama-and dropseed).

Blue grama dominates this plant community and has taken on a sodbound appearance. Large amounts of sand dropseed and Fendler threeawn are common. White sage, lupine, stickleaf, croton, hairy goldaster, loco, wormwood, fringed sage, and soapweed have increased. Sand sagebrush may increase on sandy loam or coarser subsoils. Sand bluestem, switchgrass, western sandcherry, and fourwing saltbush have been removed. Prairie sandreed and needle and thread may persist in remnant amounts protected by remaining shrubs. Western wheatgrass may be found in small depressions. A significant amount of production and diversity has been lost when compared to the Reference Plant Community. The soil is stable at this stage however, the nutrient cycle, water cycle, community dynamics, and energy flow are all impaired do to the substantial increase of blue grama and loss of warm-season tallgrasses, nitrogen fixing legumes, and shrubs. Production varies from 200 to 900 pounds of air-dry vegetation per acre per year depending on weather and averages 700 pounds.

Dominant plant species

- plains pricklypear (*Opuntia polyacantha*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- blue grama (*Bouteloua gracilis*), grass
- sand dropseed (*Sporobolus cryptandrus*), grass

Figure 13. Plant community growth curve (percent production by month). CO6710, Warm-season dominant; MLRA-67B; upland coarse-textured soils..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	20	40	20	10	5	0	0	0

State 3
Increased Bare Ground State

Litter levels are extremely low. The nutrient cycle, water cycle, and energy flow are greatly reduced. Infiltration is greatly reduced and erosion is occurring. Pedestalling is evident. Organic matter/carbon reserves are greatly reduced. An ecological threshold has been crossed. Erosion and loss of organic matter and carbon reserves are concerns. Sand dropseed and threeawn are the dominant species. Blue grama may persist in localized areas. Introduced annuals such as burningbush and Russian thistle are present. Introduced species such as field bindweed and knapweed can also be present.

Dominant plant species

- plains pricklypear (*Opuntia polyacantha*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- Fendler threeawn (*Aristida purpurea var. longiseta*), grass
- sand dropseed (*Sporobolus cryptandrus*), grass
- Russian thistle (*Salsola*), other herbaceous
- burningbush (*Bassia scoparia*), other herbaceous

Community 3.1
Aristida purpurea-Sporobolus cryptandrus (Fendler threeawn-sand dropseed).

Fendler threeawn and sand dropseed are the dominant species. A number of annual plants such as Russian thistle, burningbush, knapweed, and cheatgrass will increase or invade. Field bindweed is often present on prairie dog towns. Production can vary from 50 to 400 pounds of air-dry vegetation per acre per year depending on weather conditions and the plants that are present.

Dominant plant species

- plains pricklypear (*Opuntia polyacantha*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- Fendler threeawn (*Aristida purpurea var. longiseta*), grass
- sand dropseed (*Sporobolus cryptandrus*), grass
- Russian thistle (*Salsola*), other herbaceous
- burningbush (*Bassia scoparia*), other herbaceous

Figure 14. Plant community growth curve (percent production by month). CO6710, Warm-season dominant; MLRA-67B; upland coarse-textured soils..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	20	40	20	10	5	0	0	0

State 4
Tilled State

The Tilled State is the result of mechanical farming operations. An ecological threshold has been crossed due to complete removal of vegetation and years of soil tillage. Physical, chemical, and biological soil properties have been dramatically altered.

Dominant plant species

- cheatgrass (*Bromus tectorum*), grass
- Fendler threeawn (*Aristida purpurea var. longiseta*), grass
- Russian thistle (*Salsola*), other herbaceous
- burningbush (*Bassia scoparia*), other herbaceous

Community 4.1
Bromus tectorum - Aristida purpurea (cheatgrass - Fendler threeawn).

Go-back land is created when the soil is tilled or farmed (sodbusted) and abandoned. All of the native plants are destroyed, soil organic matter is reduced, soil structure is changed, and a plowpan or compacted layer is formed. Residual synthetic chemicals often remain from past farming operations and erosion processes may be active. Go-back land evolves through several plant communities beginning with an early annual plant community, which initiates the revegetation process. Plants such as Russian thistle, burningbush, and other annuals begin to establish. These plants give some protection from erosion and start to build minor levels of soil organic matter. This early annual plant community lasts for two to several years. Fendler threeawn, sand dropseed, and several other early perennials can then dominate the plant community for several years. Eventually other native species become reestablished. In much of the MLRA go-back land has eroded where tillage or farming and severe erosion has occurred. If the parent material that the original soil developed from is lost, then another ecosite will evolve. If the same parent material is present, then re-seeding or the slow process of developing soil and vegetation will start by similar processes as mentioned above. This is a very slow process (100 years or more).

Dominant plant species

- cheatgrass (*Bromus tectorum*), grass
- Fendler threeawn (*Aristida purpurea var. longiseta*), grass
- Russian thistle (*Salsola*), other herbaceous
- burningbush (*Bassia scoparia*), other herbaceous

Community 4.2
Seeded Plant Community

This plant community can vary considerably depending on how eroded the soil was, the species seeded, the quality of the stand that was established and how long ago the stand was established. The management of the stand since establishment will significantly affect the species composition and annual production.

Transition T1A
State 1 to 2

Continuous, heavy grazing without adequate recovery periods between grazing events and lack of fire shifts this state across an ecological threshold to the Warm-Season Shortgrass State.

Transition T1B
State 1 to 3

Long-term excessive grazing and lack of fire causes a shift across an ecological threshold to the Increased *Bare Ground* State. Erosion and loss of organic matter and carbon reserves are concerns.

Transition T1C
State 1 to 4

Mechanical tillage of this ecological site will cause an immediate transition across an ecological threshold to the Tilled State. This transition can occur from any plant community and it is irreversible.

Transition T2A
State 2 to 3

Long-term excessive grazing and lack of fire shifts this state across an ecological threshold to the Increased *Bare Ground* State. Erosion and loss of organic matter and carbon reserves are concerns.

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	**Grasses-Grasslikes**			1295–1573	
	blue grama	BOGR2	*Bouteloua gracilis*	370–555	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	370–555	–
	sand bluestem	ANHA	*Andropogon hallii*	93–278	–
	switchgrass	PAVI2	*Panicum virgatum*	93–185	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	93–185	–
	western wheatgrass	PASM	*Pascopyrum smithii*	19–130	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–93	–
	sun sedge	CAINH2	*Carex inops ssp. heliophila*	19–93	–
	little bluestem	SCSC	*Schizachyrium scoparium*	19–93	–
	Indiangrass	SONU2	*Sorghastrum nutans*	0–93	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	19–93	–
	Grass, perennial	2GP	*Grass, perennial*	0–93	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	19–56	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	19–56	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	19–37	–
	buffalograss	BODA2	*Bouteloua dactyloides*	0–19	–

	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	0–19	–
	thin paspalum	PASE5	*Paspalum setaceum*	0–19	–
Forb					
2	**Forbs**			185–278	
	Forb, perennial	2FP	*Forb, perennial*	37–93	–
	purple prairie clover	DAPUP	*Dalea purpurea var. purpurea*	19–37	–
	manystem pea	LAPO2	*Lathyrus polymorphus*	19–37	–
	dotted blazing star	LIPU	*Liatris punctata*	19–37	–
	broadbeard beardtongue	PEAN4	*Penstemon angustifolius*	19–37	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	19–37	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	19–37	–
	prairie spiderwort	TROC	*Tradescantia occidentalis*	19–37	–
	American vetch	VIAM	*Vicia americana*	19–37	–
	white heath aster	SYERE	*Symphyotrichum ericoides var. ericoides*	0–19	–
	silverleaf Indian breadroot	PEAR6	*Pediomelum argophyllum*	0–19	–
	slimflower scurfpea	PSTE5	*Psoralidium tenuiflorum*	0–19	–
	rush skeletonplant	LYJU	*Lygodesmia juncea*	0–19	–
	tenpetal blazingstar	MEDE2	*Mentzelia decapetala*	0–19	–
	crownleaf evening primrose	OECO2	*Oenothera coronopifolia*	0–19	–
	winged buckwheat	ERAL4	*Eriogonum alatum*	0–19	–
	shaggy dwarf morning-glory	EVNU	*Evolvulus nuttallianus*	0–19	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–19	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–19	–
	tarragon	ARDR4	*Artemisia dracunculus*	0–19	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–19	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–19	–
	Texas croton	CRTE4	*Croton texensis*	0–19	–
Shrub/Vine					
3	**Shrubs**			93–278	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	19–93	–
		AMAC6	*Amaranthus acutilobus*	0–56	–
	western sandcherry	PRPUB	*Prunus pumila var. besseyi*	0–56	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–37	–
	sand sagebrush	ARFI2	*Artemisia filifolia*	0–37	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–19	–
	spinystar	ESVIV	*Escobaria vivipara var. vivipara*	0–19	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–19	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–19	–
	soapweed yucca	YUGL	*Yucca glauca*	0–19	–
	spreading buckwheat	EREF	*Eriogonum effusum*	19–	–

Animal community

WILDLIFE INTERPRETATIONS:
The variety of grasses, forbs, and shrubs on this ecological site in the various plant communities provides habitat for a wide range of wildlife species. Historic large grazers that influenced these plant communities were bison, elk, and pronghorn. Changes over time have resulted in the loss of bison, the reduction in elk numbers, and pronghorn population swings. Domestic grazers now share these habitats with wildlife. The grassland communities of eastern Colorado are home to many bird species. Changes in the composition of the plant community when moving from the reference plant community to other communities on this ecological site may result in dramatic species shifts in the bird community. Because of a lack of permanent water, fish and many amphibians are not expected on this ecological site. Mule and white-tailed deer may use this ecological site, however the shrub cover is too low to expect more than occasional use. The gray wolf and wild bison used this ecological site in historic times. The wolf is thought to be extirpated from Eastern Colorado. Bison in the area are domesticated.

1.1 Reference Plant Community: Blue Grama, Prairie Sandreed, Sand Bluestem

The structural diversity found on the Reference Plant Community is attractive to a number of wildlife species. Common grassland bird species expected on the reference community include Cassin's and Brewer's sparrow, chestnut collared longspur, lark bunting, western meadowlark, ferruginous hawk, and Swainson's hawk. The combination of mid-tall grasses and shrubs provides habitat for lesser prairie chicken in the southeastern parts of this site. Greater prairie chicken and sharp-tailed grouse use this site in the northern portion of the MLRA. Scaled quail may also use this community in the southern half of the MLRA. White-tailed jackrabbit, badger, pronghorn, coyote, plains pocket gopher, long-tailed weasel, and several species of mice are mammals that commonly use this plant community. Reptiles using this community include western hognose snake, and ornate box turtle.

1.2 Community: Increased Blue Grama, Decreased Prairie Sandreed, Decreased Sand Bluestem

All Reference Plant Community species are expected to be found in this community. However, the loss of some of the vegetative structural diversity may make it less attractive to some of the reference species such as lesser prairie chicken, greater prairie chicken, and sharp-tailed grouse.

1.3 Community: Blue Grama, Warm-Season Tallgrasses, Low Plant Density, Increased Standing Dead Canopy, Increased Litter and Decadence

The same species found in the 1.2 Community are expected to be found in this community.

2.1 Community: Blue Grama

Many of the Reference Plant Community species are expected in the 1.2 community, however, the loss of some of the vegetative structural diversity in this community may make it less attractive to lesser prairie chicken, greater prairie chicken, as well as for scaled quail. Swift fox will increase in this community.

3.1 Community: Fendler Threeawn, Sand Dropseed, Herbaceous Invasives and Increased *Bare Ground*

Although not likely abundant, mountain plover, black-tailed prairie dog, and burrowing owl are expected on these communities where soils are loamier. Rodents will likely decrease because of less cover. Scaled quail may use these sites when adequate cover is available. Grasshoppers will be the common insect, although some pollinators searching out the nectar from the annual flowers may still be found. Prairie rattlesnake and other reptiles are still be found here. Swainson's hawks will continue to be found here because it is easy to spot prey.

4.1 Community: Fendler Threeawn, Sand Dropseed, and Annual Grasses and Forbs

The wildlife found here will be similar to the 3.1 Community.

4.2 Seeded Plant Community: Adapted Seed Mixes

Wildlife use of tilled and replanted fields is dependent on the plant species used in the planted seed mix. Many of these sites currently support plains sharp-tailed grouse, lesser prairie chicken, greater prairie chicken, ring-necked

pheasant, and grasshopper sparrow. Purpose of the seeding (i.e. reclamation, soil erosion control, livestock grazing, targeted wildlife species, etc.) would affect the usability for wildlife. If wildlife use is a primary concern, then formulate a seed mix accordingly.

GRAZING INTERPRETATIONS:
The following table lists suggested initial stocking rates for an animal unit (1000-pound beef cow) under continuous grazing (yearlong grazing or growing-season-long grazing) based on normal growing conditions. However, continuous grazing is not recommended. These estimates should only be used as preliminary guidelines in the initial stages of the conservation planning process. Often, the existing plant composition does not entirely match any particular plant community described in this ecological site description. Therefore, field inventories are always recommended to document plant composition, total production, and palatable forage production. Carrying capacity estimates that reflect on-site conditions should be calculated using field inventories.

If the following production estimates are used, they should be adjusted based on animal kind or class and on the specific palatability of the forage plants in the various plant community descriptions. Under a properly stocked, properly applied, prescribed grazing management system that provides adequate recovery periods following each grazing event, improved harvest efficiencies eventually result in increased carrying capacity. See USDA-NRCS Colorado Prescribed Grazing Standard and Specification Guide (528).

The stocking rate calculations are based on the total annual forage production in a normal year multiplied by 25 percent harvest efficiency divided by 912.5 pounds of ingested air-dry vegetation for an animal unit per month (AUM).

Plant Community (PC) Production (lbs./acre) and Stocking Rate (AUM/acre)

Reference PC - (1650) (0.45)

1.2 PC - (900) (0.25)

2.1 PC - (700) (0.19)

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

Grazing by domestic livestock is one of the major income-producing industries in the area. Rangeland in this area may provide yearlong forage under prescribed grazing for cattle, sheep, horses and other herbivores.

Hydrological functions

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group A. Infiltration and runoff potential for this site varies from high to moderate depending on soil hydrologic group and ground cover. 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).

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 and 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.
NOTE: Annual Production Table is from the “Previously Approved” ESD 2004. The Species Composition List is also from the 2004 version, with minor edits. These will need review 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 updated to reflect Total Annual Production revisions in each plant community.

Wildlife interpretations, general narrative, and individual plant communities updated to the Provisional level. Hydrology, Recreational Uses, Wood Products, Other Products, Plant Preferences table, and Rangeland Health Reference Sheet carried over from previously “Approved” ESD 2004.

Reference Sheet

The Reference Sheet was previously approved in 2007.
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).

Other information

Relationship to Other Hierarchical Classifications:

NRCS Classification Hierarchy:
Physiographic Divisions of the United States (Fenneman, 1946): Physiographic DivisionPhysiographic ProvincePhysiographic SectionLand Resource RegionMajor Land Resource Area (MLRA)Land Resource Unit (LRU).
USFS Classification Hierarchy:
National Hierarchical Framework of Ecological Units (Cleland et al, 181-200):
DomainDivisionProvinceSectionSubsectionLandtype Association LandtypeLandtype Phase.

Inventory data references

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.

Those involved in developing the 2004 site description include: Harvey Sprock, Rangeland Management Specialist, CO-NRCS; Ben Berlinger, Rangeland Management Specialist, CO-NRCS; Scott Woodall, Rangeland Management Specialist, CO-NRCS; James Borchert, Soil Scientist, CO-NRCS; Dave Sharman, Resource Conservationist, CO-NRCS; Terri Skadeland, Biologist, CO-NRCS; Dave Cook, Rangeland Management Specialist, NE-NRCS; Chuck Ring, Rangeland Management Specialist, WY-NRCS.

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

Data collection for this ecological site was done in conjunction with the progressive soil surveys within the 67B Central High Plains (Southern Part) of Colorado. It has been mapped and correlated with soils in the following soil surveys: Adams County, Arapahoe County, Baca County, Bent County, Boulder County, Cheyenne County, El Paso County Area, Elbert County, Eastern Part, Kiowa County, Kit Carson County, Larimer County Area, Las Animas County Area, Lincoln County, Logan County, Morgan County, Prowers County, Washington County, Weld County, Northern Part, and Weld County, Southern Part.

30 Year Climatic and Hydrologic Normals (1981-2010) Reports. National Water and climate Center: Portland, OR. August 2015

ACIS-USDA Field Office Climate Data (WETS), period of record 1971-2000 http://agacis.rcc-acis.org (powered by WRCC) Accessed March 2016

Andrews, R. and R. Righter. 1992. Colorado Birds. Denver Museum of Natural History, Denver, CO. 442

Armstrong, D.M. 1972. Distribution of mammals in Colorado. Univ. Kansas Museum Natural History Monograph #3. 415.

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. http://www.glti.nrcs.usda.gov/technical/publications/nrph.html Accessed August 2015

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.

Cleland, D., P. Avers, W.H. McNab, M. Jensen, R. Bailey, T. King, and W. Russell. 1997. National Hierarchical Framework of Ecological Units, published in Ecosystem Management: Applications for Sustainable Forest and Wildlife Resources, Yale University Press

Cooperative climatological data summaries. NOAA. Western Regional Climate Center: Reno, NV. Web. http://www.wrcc.dri.edu/climatedata/climsum Accessed August 2015

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

Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History, Denver, CO. 467. Hammerson, G.A. 1986. Amphibians and reptiles in Colorado. CO Div. Wild. Publication Code DOW-M-I-3-86. 131.

Herrick, Jeffrey E., J.W. Van Zee, K.M. Haystad, L.M. Burkett, and W.G. Witford. 2005. Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems, Volume II. U.S. Dept. of Agriculture, Agricultural Research Service. Jornada Experimental Range, Las Cruces, N.M.

Kingery, H., Ed. (1998) Colorado Breeding Birds Atlas. Dist. CO Wildlife Heritage Foundation: Denver, CO. 636.

National Water & Climate Center. USDA-NRCS. USDA Pacific Northwest Climate Hub: Portland, OR. http://www.wcc.nrcs.usda.gov/ Accessed March 2016

National Weather Service Co-op Program. 2010. Colorado Climate Center. Colorado State Univ. Web. http://climate.atmos.colostate.edu/dataaccess.php March 2016

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.

PLANTS Database. 2015. USDA-NRCS. Web. http://plants.usda.gov/java/ Accessed August 2015. February 2016

PRISM Climate Data. 2015. Prism Climate Group. Oregon State Univ. Corvallis, OR. http://www.prism.oregonstate.edu/ Accessed August 2015.

Rennicke, J. 1990. Colorado Wildlife. Falcon Press, Helena and Billings, MT and CO Div. Wildlife, Denver CO. 138.

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.

The Denver Posse of Westerners. 1999. The Cherokee Trail: Bent's Old Fort to Fort Bridger. The Denver Posse of Westerners, Inc. Johnson Printing: Boulder, CO

U.S. Dept. of Agriculture, Agricultural Research Service. September 1991. Changes in Vegetation and Land Use I eastern Colorado, A Photographic study, 1904-1986.

U.S. Dept. 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. US Department of Agriculture Handbook 296.

U.S. Dept. of Agriculture, Natural Resources Conservation Service. National Geospatial Center of Excellence. Colorado annual Precipitation Map from 1981-2010, Annual Average Precipitation by State

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. 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 Accessed July 2015

U.S. Dept. of Agriculture, Soil Survey Division Staff. 1993. Soil Survey Manual.

U.S. Dept. of Agriculture.1973. Soil Survey of Baca County, Colorado.

U.S. Dept. of Agriculture. 1970. Soil Survey of Bent County, Colorado.

U.S. Dept. of Agriculture. 1968. Soil Survey of Crowley County, Colorado.

U.S. Dept. of Agriculture. 1981 Soil Survey of El Paso County Area, Colorado.

U.S. Dept. of Agriculture. 1995. Soil Survey of Fremont County Area, Colorado.

U.S. Dept. of Agriculture. 1983. Soil Survey of Huerfano County Area, Colorado.

U.S. Dept. of Agriculture.1981. Soil Survey of Kiowa County, Colorado.

Western Regional Climate Center. 2022. Climate of Colorado, climate of the eastern plains. https://wrcc.dri.edu/Climate/narrative_co.php (accessed 9 August 2022).

Additional Literature:

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. Vegetation, 64, 87-94.

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.

Heitschmidt, Rodney K., J.W. Stuth, (edited by). 1991. Grazing Management, an Ecological Perspective. Timberland Press, Portland, OR.

Jackson, D. 1966. The Journals of Zebulon Montgomery Pike with letters & related documents. Univ. of Oklahoma Press, First edition: Norman, OK.

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.Available online. http://www.nature.com/nature/journal/v510/n7504/full/nature13207.html, accessed March 2017.

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.

The Denver Posse of Westerners. 1999. The Cherokee Trail: Bent’s Old Fort to Fort Bridger. The Denver Posse of Westerners, Inc. Johnson Printing: Boulder, CO.

U.S. Dept. of Agriculture. 2004. Vascular plant species of the Comanche National Grasslands in southeastern Colorado. US Forest Service. Rocky Mountain Research Station. Fort Collins, CO.

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. Available online. www.pnas.org/cgi/doi/10.1073/pnas.1414659111.

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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.

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Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** None

2. **Presence of water flow patterns:** Typically none to slight. If present, water patterns are broken, irregular in appearance or discontinuous with numerous debris dams or vegetative barriers.

3. **Number and height of erosional pedestals or terracettes:** Pedestalled plants caused by wind or water erosion would be minor.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 3 percent or less bare ground, with bare patches ranging from 3 to 5 inches in diameter. Prolonged drought or wildfire events will cause bare ground to increase upwards to 5 to10 percent with bare patches ranging from 8 to12 inches in diameter.

5. **Number of gullies and erosion associated with gullies:** None

6. **Extent of wind scoured, blowouts and/or depositional areas:** A minor amount of wind scouring may occur on naturally disturbed areas. Fire or extended drought can exacerbate the appearance. Typically, wind scouring should be insignificant.

7. **Amount of litter movement (describe size and distance expected to travel):** Litter should be uniformly distributed with little movement. On steep slopes or knolls, litter may move from a few inches to 1 to 2 feet depending on intensity of wind or rainfall event.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Stability class rating anticipated to be 3 to 5 in the interspaces at soil surface.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** SOM ranges from 2 to 4. A-horizon ranges from 0 to 6 inches. Soils are deep, dark brown, weak fine granular structure.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Raindrop impact is reduced by the diverse grass, forb, shrub functional/structural groups and root structure. This slows overland flow and provides increased time for infiltration to occur. Extended drought, wildfire or both may reduce basal density, canopy cover, and litter amounts (primarily from tall, warm-season bunch and rhizomatous grasses), resulting in decreased infiltration and increased runoff on steep slopes following intense rainfall events.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None

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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: Warm-season tall rhizomatous >

    Sub-dominant: Warm-season short bunchgrass = warm-season tall bunchgrass > cool-season grasses/grasslikes > shrubs > warm-season mid bunchgrass >

    Other: Leguminous forbs > warm-season forbs > cool-season forbs

    Additional:

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

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14. **Average percent litter cover (%) and depth (in):** Litter cover during and following drought can range from 20 to 30 percent and 5 to15 percent following wildfire.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 800 lbs./ac. low precip years; 1650 lbs./ac. average precip years; 2200 lbs./ac. high precip years. After extended drought or the first growing season following wildfire, production may be significantly reduced by 300 to 650 lbs./ac. or more.

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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:** Invasive plants should not occur in reference plant community. Following fire or extended drought, cheatgrass, Russian thistle, and burningbush may invade assuming a seed source is available.

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17. **Perennial plant reproductive capability:** The only limitations are weather-related, wildfire, natural disease, and insects that may temporarily reduce reproductive capability.
