USDA Natural Resources Conservation Service

Ecological site R067BY008CO
Loamy Slopes

Last updated: 12/05/2024
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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.

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 Loamy Slopes Ecological Site developed from an earlier version of the site. This earlier version was based on input from NRCS (formerly Soil Conservation service) and historical information obtained from the Loamy Slopes Range Site descriptions (1975, revised 1983). 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 Loamy Slopes Ecological Site is a run-off site on slopes greater than 6 percent. There is no bedrock within 40 inches of the surface, and there is less than 15 percent rock fragments on the surface or in the subsoil. There are no visible salts present on the surface or in the subsoil.

Associated sites

R067BY036CO	**Overflow** This ecological site is commonly adjacent.
R067BY042CO	**Clayey Plains** This ecological site is commonly adjacent.
R067BY002CO	**Loamy Plains** This ecological site is commonly adjacent.

Similar sites

R067BY063CO	**Gravel Breaks** Gravel Breaks Ecological Site has greater than 15 percent rock fragment on the surface or in the subsoil.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Krascheninnikovia lanata* (2) *Atriplex canescens*
Herbaceous	(1) *Bouteloua gracilis* (2) *Pascopyrum smithii*

Physiographic features

This site occurs on shoulders and backslopes of hills. It also occurs side slopes, nose slopes, and head slopes of interfluves on dissected plains.

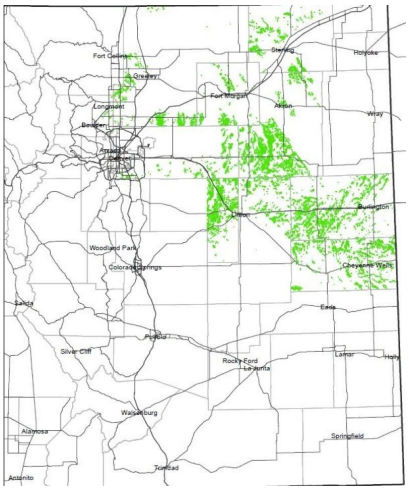


Figure 1. Distribution of the Loamy Slopes site in MLRA 67B.

Table 2. Representative physiographic features

Landforms	(1) Hill (2) Ridge
Runoff class	Medium to very high
Flooding frequency	None
Ponding frequency	None
Elevation	3,800–6,000 ft
Slope	6–15%
Ponding depth	0 in
Water table depth	80 in
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)	14-17 in

Frost-free period (actual range)	102-132 days
Freeze-free period (actual range)	126-156 days
Precipitation total (actual range)	14-17 in
Frost-free period (average)	121 days
Freeze-free period (average)	142 days
Precipitation total (average)	15 in

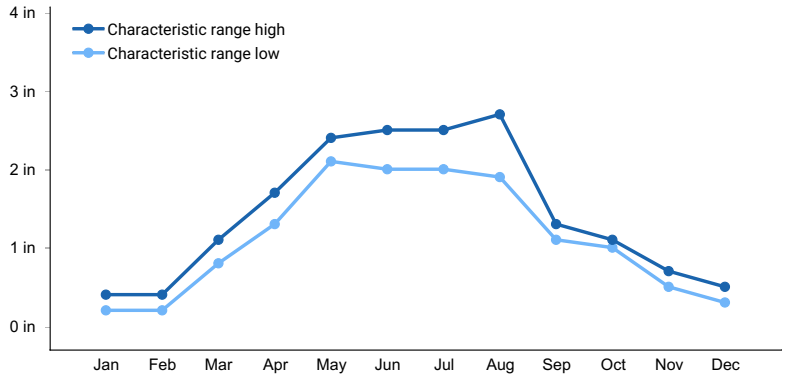


Figure 2. Monthly precipitation range

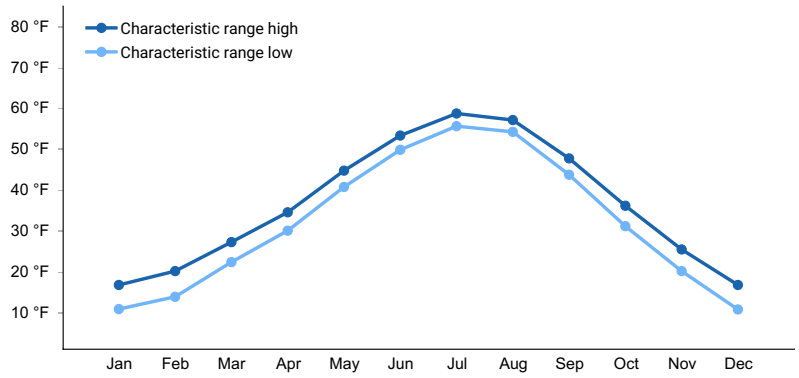


Figure 3. Monthly minimum temperature range

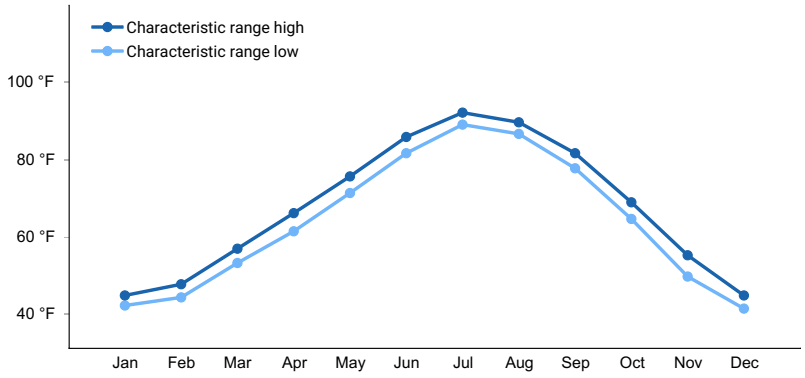


Figure 4. Monthly maximum temperature range

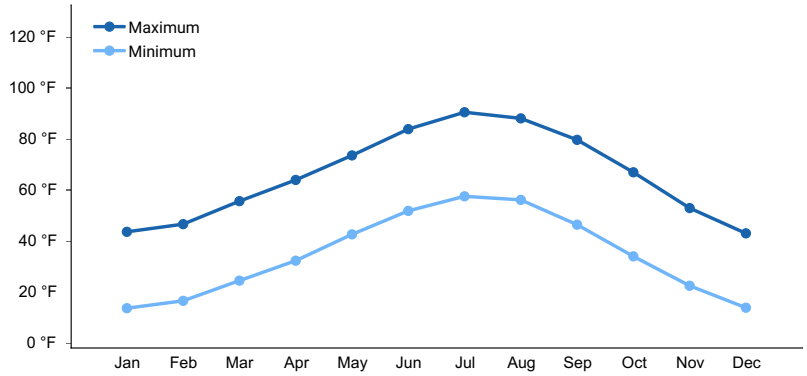


Figure 5. Monthly average minimum and maximum temperature

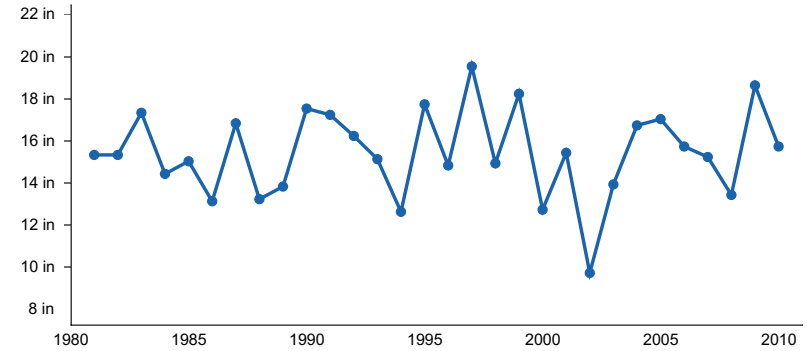


Figure 6. Annual precipitation pattern

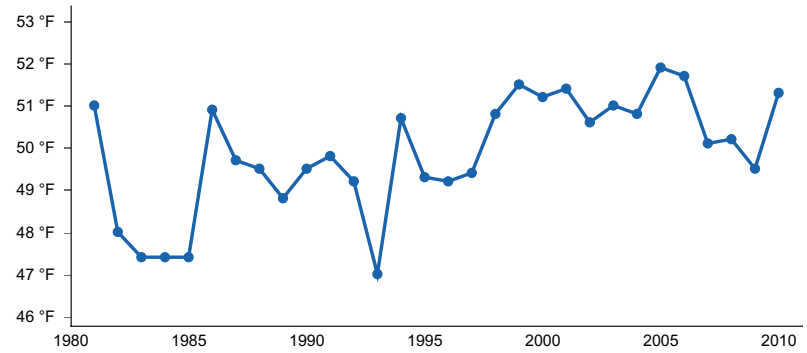


Figure 7. Annual average temperature pattern

Climate stations used

- (1) CHEYENNE WELLS [USC00051564], Cheyenne Wells, CO
- (2) FLAGLER 1S [USC00052932], Flagler, CO
- (3) KIT CARSON [USC00054603], Kit Carson, CO
- (4) BRIGGSDALE [USC00050945], Briggsdale, CO
- (5) FT MORGAN [USC00053038], Fort Morgan, CO
- (6) NUNN [USC00056023], Nunn, CO
- (7) GREELEY UNC [USC00053553], Greeley, CO
- (8) SPRINGFIELD 7 WSW [USC00057866], Springfield, CO
- (9) LIMON WSMO [USW00093010], Limon, CO
- (10) BYERS 5 ENE [USC00051179], Byers, CO
- (11) BRIGHTON 3 SE [USC00050950], Brighton, 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 drained soils that formed from loess or eolian deposits. They typically have a moderate 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 loam or silt loam. The surface layer ranges from 3 to 8 inches thick. The subsoil is typically clay loam or loam, but may include silt loam or silty clay loam. Soils in this site typically have free carbonates at the surface, but some soils may be leached to 13 inches. These soils are susceptible to erosion by water and wind. The potential for water erosion accelerates with increasing slope.

Major soil series correlated to this ecological site include: Adena, Baca, Buick, Colby (6-15 percent slope), Kimst, Norka, Stoneham, Ulmet, and Wiley.

Other soil series that have been correlated to this site, but may eventually be re-correlated include: Kim, Ulm, and Ulysses. In some areas this ecological site is associated with slopes greater than 15 percent (formerly known as Loess Breaks). Soils in these areas may have a much thinner surface horizon due to increased erosion. These areas may also contain a higher number of gullies or bare ground. Cat-steps may be present on the steeper slopes. 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.

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

Table 4. Representative soil features

Parent material	(1) Eolian deposits (2) Loess
Surface texture	(1) Loam (2) Silt loam
Drainage class	Well drained
Permeability class	Slow to moderate
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-40in)	3–9 in
Calcium carbonate equivalent (0-40in)	0–15%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	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.

Mechanical treatment consisting of contour pitting, furrowing, terracing, chiseling, and disking has been practiced in the past. It was theorized that the use of this high-input technology would improve production and plant composition on rangeland. These high-cost practices have shown to have no significant long-term benefits on production or plant composition and have only resulted in a permanently rough ground surface. Prescribed grazing that mimics the historic grazing of herds of migratory herbivores, as described earlier, has been shown to result in desired improvements based on management goals for this ecological site.

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.

The Loamy Slopes Ecological Site is characterized by four states: Reference, Warm-Season Shortgrass, Severely Eroded, and Tilled. The Reference State is characterized primarily by warm-season shortgrass (blue grama), cool-season midgrass (western wheatgrass, green needlegrass), and a minor amount of warm-season midgrass (side oats grama, little bluestem). The Little Bluestem/Low Plant Density State has a plant community similar to the Reference State with reduced density and increased little bluestem. The Warm-Season Shortgrass State is characterized by a warm-season short bunchgrass (blue grama) and stoloniferous grass (buffalograss). The Severely Eroded State is characterized by remnant buffalograss, with increased 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 (seeded community) or early successional plants as well as annual grasses and forbs (go-back community).

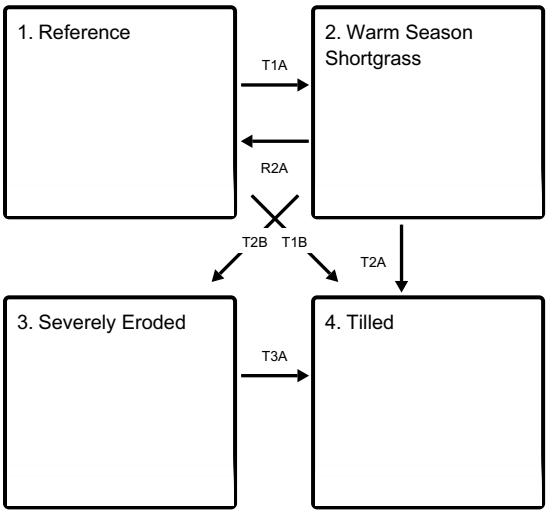
The Loamy Slopes Ecological Site can occur on slopes greater than 15 percent. On steeper slopes, the very deep

loam or silt loam soils can severely erode and display a rough and broken landscape appearance. The former Loess Breaks Ecological Site (less than 1,400 acres in MLRA 67B) was developed to describe this condition. The plant communities associated with the steep, broken condition will resemble those found in Loamy Slopes. The reference plant community plant composition on the steep broken condition has more warm-season mid bunchgrass (little bluestem and side oats grama) and a corresponding decrease in the amount of cool-season mid rhizomatous grass (western wheatgrass). Total annual production decreases slightly as a result of the steep slopes and broken landscape condition.

Grazing by large herbivores without adequate recovery periods causes species such as blue grama and buffalograss to increase and eventually form a sod. Green needlegrass, western wheatgrass, big bluestem, and switchgrass decrease in frequency and production, as do key shrubs such as four wing saltbush and winter fat. American vetch, purple prairie clover, 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. This is an important site for livestock grazing, especially beef cattle. Today the management of livestock grazing has been a major influence on the ecological dynamics of the site. This management, coupled with the effects of annual climatic variations, largely dictates the plant communities for the site.

State and transition model

Ecosystem states



T1A - Excessive grazing. Lack of fire.

T1B - Mechanical tillage.

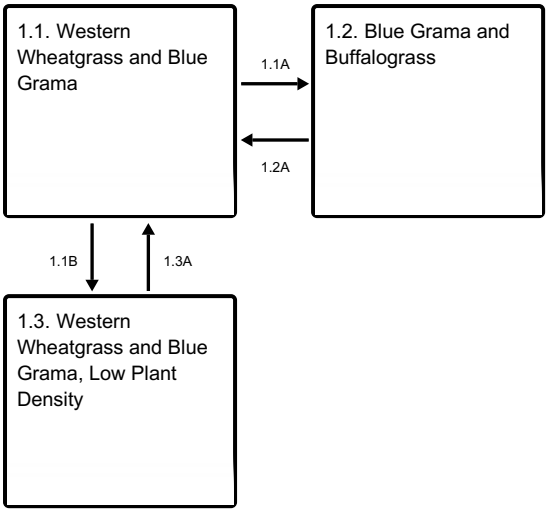
R2A - Prescribed grazing. Prescribed fire.

T2B - Excessive grazing.

T2A - Mechanical tillage.

T3A - Mechanical tillage.

State 1 submodel, plant communities



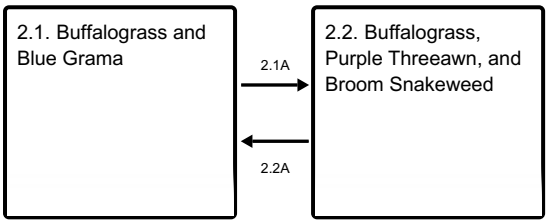
1.1A - Excessive grazing. Lack of fire.

1.1B - non-use. Lack of fire.

1.2A - Prescribed grazing. Prescribed fire.

1.3A - Prescribed grazing. Prescribed fire.

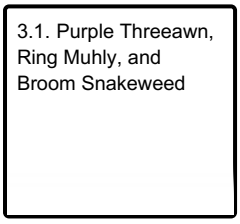
State 2 submodel, plant communities



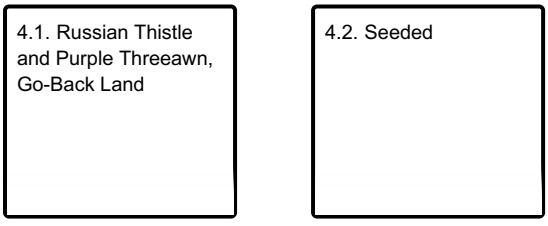
2.1A - Excessive grazing. Lack of fire.

2.2A - Prescribed grazing. Prescribed fire.

State 3 submodel, plant communities



State 4 submodel, plant communities



2 Sandstone bedrock

3 Limestone bedrock

4 Siltstone bedrock

B. Bedrock deeper than 40 inches from the soil surface

1 >15% rock fragments on the surface and/or in the subsoil

2 <15% rock fragments on the surface and/or in the subsoil

i. Sandy surface and subsoil textures (sand, loamy sand, sandy loam)

a. Rough, steep, dune-type appearance (cat-steps or terracettes are typically apparent)

b. No rough, steep, dune-type appearance

1) >5% slope with undulating/rolling topography

2) <5% slope with nearly level topography

ii. Surface and subsoil textures other than sandy

a. Visible salts present in the soil profile or on the soil surface

b. No visible salts present in the soil profile or on the soil surface

1) >6% slope

2) <6% slope

a) Surface texture of clay loam, clay, or silty clay

b) Other surface texture

(1) Calcium carbonates at the surface

(2) No calcium carbonates at the surface

i. <6% slope

State 1
Reference

The Reference state is diverse and productive. It is characterized by two distinct plant communities. 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, wildlife and livestock use, and is aesthetically pleasing. Community dynamics, nutrient cycle, water cycle, and energy flow are functioning properly. This state is resistant to many disturbances except excessive grazing, plowing, or development into urban or other uses. It can be maintained with proper stocking and prescribed grazing. The plant communities and various successional stages between them represent the natural range of variability.

Dominant plant species

- fourwing saltbush (*Atriplex canescens*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- western wheatgrass (*Pascopyrum smithii*), grass
- blue grama (*Bouteloua gracilis*), grass

Community 1.1
Western Wheatgrass and Blue Grama

This is the interpretive plant community. This plant community and associated soils developed with large herbivores (bison, elk, deer, and pronghorn). It is well suited for domestic livestock and wildlife use. The potential vegetation is a mixed grass prairie consisting of approximately 85 percent grasses and grass-like plants, 10 percent forbs, and 5 percent shrubs. Blue grama, western wheatgrass, and sideoats grama are the primary grasses in this community. Secondary species include green needlegrass, needle and thread, big bluestem, buffalograss, switchgrass, and threadleaf and sun sedge. Big bluestem and switchgrass are most likely to be located in a lower position on the

landform which receives more water. Little bluestem occurs in minor amounts. This community has a diverse forb population, most of which occur in small amounts. A minor component of shrubs include winterfat, fourwing saltbush, Arkansas rose, fringed sagebrush, pricklypear, and yucca. Western wheatgrass is considered a primary cool-season midgrass in this plant community. It is a valuable forage plant in late spring and early summer, and heavily relied upon for early season grazing. Western wheatgrass can provide late season (early fall) grazing in years when soil moisture is adequate. This 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, wildlife and livestock use, and is aesthetically pleasing. Community dynamics, nutrient cycle, water cycle, and energy flow are functioning properly. This plant community is resistant to many disturbances except excessive grazing, plowing, and development into urban or other uses. The community can be maintained with proper stocking and prescribed grazing. Total annual production during an average year ranges from 500 to1,500 pounds of air dry vegetation per acre per year and averages 1,000 pounds. 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 the annual production representing the variability by species throughout the extent of the community phase (i.e. variation of soil characteristics and topography).

Dominant plant species

- fourwing saltbush (*Atriplex canescens*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- western wheatgrass (*Pascopyrum smithii*), grass
- blue grama (*Bouteloua gracilis*), grass

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	410	825	1240
Shrub/Vine	45	100	155
Forb	45	75	105
Total	**500**	**1000**	**1500**

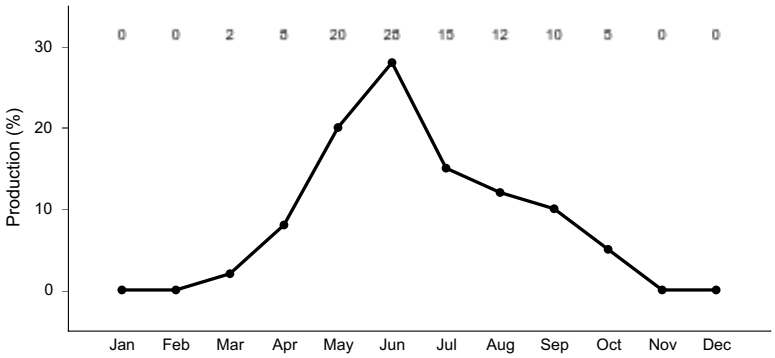


Figure 9. Plant community growth curve (percent production by month). CO6701, Cool-season/warm-season codominant; MLRA-67B; upland fine-textured soils..

Community 1.2
Blue Grama and Buffalograss

In this community, blue grama and buffalograss have increased in abundance. Threadleaf and sun sedge commonly increase. Small soapweed may also increase. Western wheatgrass, little bluestem, big bluestem, switchgrass, sideoats grama, American vetch, winterfat, and fourwing saltbush have been reduced in abundance, but are still present and are at risk of being further reduced. Reduction of rhizomatous wheatgrass, nitrogen fixing forbs, the shrub component, and increased warm-season short grasses has begun to shift the plant composition dominance between warm and cool-season grasses. Litter levels are reduced when compared to the reference plant community. Nutrient cycles are at risk of becoming impaired. As buffalograss and blue grama become more dominant, water infiltration reduces and runoff increases, causing erosion of steeper slopes and off-site

sedimentation. Total annual production during an average year range from 400 to 900 pounds of air-dry vegetation per acre per year and averages 700 pounds.

Dominant plant species

- fourwing saltbush (*Atriplex canescens*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- blue grama (*Bouteloua gracilis*), grass
- buffalograss (*Bouteloua dactyloides*), grass

Community 1.3
Western Wheatgrass and Blue Grama, Low Plant Density

This plant community develops when grazing is removed for long periods of time in the absence of fire. Many nutrients are tied up in increased litter and above-ground dead canopy. The semiarid environment and the absence of animal traffic to break down litter impairs nutrient recycling. Standing dead canopy limits sunlight from reaching plant crowns. Many plants, especially bunchgrasses (blue grama) may die off. Increased litter and absence of grazing or fire reduce seed germination and establishment. In advanced stages, plant mortality can increase and erosion may eventually occur as bare ground increases. Once this happens it will require increased energy input in terms of practice cost and management to bring back. Total annual production can vary greatly. An average year may range from 50 to 600 pounds of air-dry vegetation per acre per year and averages 350 pounds.

Dominant plant species

- fourwing saltbush (*Atriplex canescens*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- western wheatgrass (*Pascopyrum smithii*), grass
- blue grama (*Bouteloua gracilis*), grass

Pathway 1.1A
Community 1.1 to 1.2

Excessive grazing without adequate recovery periods between grazing events and reduced fire frequency shifts this plant community to the 1.2 community. Biotic integrity is degraded and water and nutrient cycles are impaired.

Pathway 1.1B
Community 1.1 to 1.3

Non-use or lack of fire shifts the reference plant community to the 1.3 community. Plant decadence and standing dead plant material impede energy flow. Water and nutrient cycles become impaired.

Pathway 1.2A
Community 1.2 to 1.1

Grazing with adequate recovery opportunity, proper stocking, and prescribed fire return this community to the reference community. Drought followed by a return of normal precipitation may cause western wheatgrass to increase, closely resembling 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 periods, proper stocking, and fire cause a shift to the reference plant community. This change can occur in a relatively short time frame.

Conservation practices

Prescribed Burning
Prescribed Grazing

State 2
Warm Season Shortgrass

The Warm Season Shortgrass state is characterized by two plant communities. 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 and buffalograss to grazing, the development of a shallow root system (aka root pan), and subsequent changes in hydrology and nutrient cycling. The loss of other functional/structural groups such as cool-season rhizomatous grass, warm-season bunchgrasses, forbs, and shrubs reduces the biodiversity and productivity of this state.

Dominant plant species

- plains pricklypear (*Opuntia polyacantha*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- buffalograss (*Bouteloua dactyloides*), grass
- blue grama (*Bouteloua gracilis*), grass

Community 2.1
Buffalograss and Blue Grama

Buffalograss and blue grama dominate the community and have developed into a sodbound condition. Remnant amounts of sideoats grama remain, especially on steeper slopes. Threadleaf and sun sedge have increased. Small soapweed may continue to increase. Western wheatgrass, little bluestem, big bluestem, switchgrass, American vetch, winterfat, and fourwing saltbush have been removed. This is very stable, resistant to change due to the high tolerance of blue grama and buffalograss to grazing. The loss of other functional/structural groups such as cool season rhizomatous grass, warm-season bunchgrasses, forbs, and shrubs reduces the biodiversity and productivity of this site. Plant diversity, plant vigor, and litter levels are significantly reduced. The water cycle, nutrient cycle, and energy flow have been severely impaired due to the significant changes in root structure and overall production. Infiltration is reduced. Off-site flooding and erosion are concerns. Desertification is advancing. Total annual production during an average year ranges from 350 to 800 pounds of air-dry vegetation per acre per year and averages 500 pounds.

Dominant plant species

- plains pricklypear (*Opuntia polyacantha*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- buffalograss (*Bouteloua dactyloides*), grass
- blue grama (*Bouteloua gracilis*), grass

Community 2.2
Buffalograss, Purple Threeawn, and Broom Snakeweed

This plant community develops with long-term excessive grazing and lack of fire. Blue grama has decreased. Buffalograss, threeawn, ring muhly, and broom snakeweed are the dominant plants. Erosion has increased. Flow paths, rills, and small gullies are common. The nutrient cycle, water cycle, and overall energy flow have been severely impaired. Desertification is obvious. Total annual production during an average year ranges from 200 to 500 pounds of air dry vegetation per acre per year and averages 350 pounds.

Dominant plant species

- broom snakeweed (*Gutierrezia sarothrae*), shrub
- plains pricklypear (*Opuntia polyacantha*), shrub

- Fendler threeawn (*Aristida purpurea var. longiseta*), grass
- buffalograss (*Bouteloua dactyloides*), grass
- ring muhly (*Muhlenbergia torreyi*), grass

Pathway 2.1A
Community 2.1 to 2.2

Excessive grazing and lack of fire shift this plant community to the 2.2 community.

Pathway 2.2A
Community 2.2 to 2.1

Prescribed grazing that allows adequate recovery periods between grazing events, proper stocking, and prescribed fire move this plant community back to the 2.1 community. The time involved with this community pathway depends on the degree of soil degradation.

Conservation practices

Prescribed Burning
Prescribed Grazing

State 3
Severely Eroded

This state is characterized by significant impairment to the soil and site stability and the hydrologic function due to accelerated water and wind erosion. Biologic diversity has been reduced resulting in impairment of the biotic integrity of the plant community. Litter levels are extremely low. Erosion is evident where flow paths are continuous. Rills may occur on steeper slopes. Wind scoured areas may be apparent on knolls or unprotected areas. Plant pedestals caused by wind scouring are common. The nutrient cycle, water cycle, and overall energy flow are greatly impaired. Organic matter and carbon reserves are greatly reduced. This state is not stable and desertification is advanced.

Dominant plant species

- plains pricklypear (*Opuntia polyacantha*), shrub
- broom snakeweed (*Gutierrezia sarothrae*), shrub
- Fendler threeawn (*Aristida purpurea var. longiseta*), grass
- sand dropseed (*Sporobolus cryptandrus*), grass
- ring muhly (*Muhlenbergia torreyi*), grass

Community 3.1
Purple Threeawn, Ring Muhly, and Broom Snakeweed

Sideoats grama and blue grama have been removed. Buffalograss is reduced to remnants and purple threeawn, ring muhly, and broom snakeweed are the dominant species. Sustained excessive grazing will eventually lead to severe erosion. This community is not stable. Desertification is advanced.

Dominant plant species

- broom snakeweed (*Gutierrezia sarothrae*), shrub
- Fendler threeawn (*Aristida purpurea var. longiseta*), grass
- ring muhly (*Muhlenbergia torreyi*), grass
- Russian thistle (*Salsola*), other herbaceous
- burningbush (*Bassia scoparia*), other herbaceous

State 4
Tilled

This state is characterized by go-back land, created when the soil is tilled or farmed (sodbusted) and abandoned. All of the native plants are removed, soil organic matter is reduced, soil structure is degraded and a plowpan or compacted layer is formed. Residual synthetic chemicals often remain from past farming operations and erosion processes may be active.

Dominant plant species

- Fendler threeawn (*Aristida purpurea var. longiseta*), grass
- sand dropseed (*Sporobolus cryptandrus*), grass
- Russian thistle (*Salsola*), other herbaceous
- burningbush (*Bassia scoparia*), other herbaceous

Community 4.1
Russian Thistle and Purple Threeawn, Go-Back Land

An early annual plant community such as Russian thistle, burningbush, and other introduced annuals invade the area and initiate the revegetation process. These plants give some protection for erosion and start to rebuild some organic matter. This plant community may last for several years. Purple threeawn and sand dropseed eventually establish and dominate the site. In many instances, small soapweed begins to re-establish and can occur in significant amounts. If a seed source is available, little bluestem can become established. Little bluestem can dominate the community for many years. Eventually some native species will establish. Revegetation practices are very costly. Production varies from 0 to 500 pounds of air-dry vegetation per acre per year depending on the soil present, the state of secondary succession, and climatic conditions.

Dominant plant species

- Fendler threeawn (*Aristida purpurea var. longiseta*), grass
- sand dropseed (*Sporobolus cryptandrus*), grass
- Russian thistle (*Salsola*), other herbaceous
- burningbush (*Bassia scoparia*), other herbaceous

Community 4.2
Seeded

This community results from any plant community which was tilled or degraded over time by continuous grazing and is seeded to adapted native plant species. A seed mixture of grasses, forbs, and shrubs can be used to achieve management objectives. This plant community can vary considerably depending on the amount of soil erosion, the species seeded, and post-seeding management.

Transition T1A
State 1 to 2

Excessive grazing and lack of fire cause this state to transition to the Warm-season Shortgrass State.

Transition T1B
State 1 to 4

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

Restoration pathway R2A
State 2 to 1

Prescribed grazing and prescribed fire allow this state to recover to the Reference State.

Conservation practices

Prescribed Burning

Prescribed Grazing

Transition T2B
State 2 to 3

Long-term excessive grazing drives this plant community across an ecological threshold to the Severely Eroded State. A different ecological site may evolve if original parent material is lost.

Transition T2A
State 2 to 4

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

Transition T3A
State 3 to 4

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

Additional community tables

Table 6. Community 1.1 plant community composition

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

Animal community

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
Pronghorns are the most abundant ungulate on this site, followed by mule deer. This site also supports a high diversity of migratory grassland birds including grasshopper sparrow, McCown's longspur, chestnut-collared longspur, and loggerheaded shrike. Reptiles using this community include western rattlesnake. Swift fox use this community, especially for denning activities.

1.2 Community
This community is very similar to the reference community therefore, the value for wildlife is not significantly different.

1.3 Community
Due to the increased little bluestem and yucca, birds that favor taller structure, like grasshopper sparrow, use this plant community. The yucca blossoms are preferred forage for pronghorn and deer.

2.1 Community
The loss of tall structure grasses and reduced forb diversity affects the diversity of wildlife species using this plant community. Pronghorn use this community but it has reduced forage value. Swift fox continue to use these areas due to decreased visual obstruction. Grassland birds preferring shorter structure grasses occur here, and these

include horned lark, McCown’s and chestnut collared longspurs, and loggerheaded shrike.

2.2 Community
This community is similar to the 2.1 community. However, blue grama and buffalograss have been reduced, and bare ground and soil erosion have increased. The value for wildlife have been reduced.

3.1 Community
Due to reduced plant diversity, cover, and forage for many wildlife species is limited in this community.

4.1 Community
This community is very similar to the 3.1 community.

4.2 Community
Wildlife use of tilled and replanted fields is dependent on the plant species used in the planted seed mix. The purpose of the seeding(i.e. reclamation, soil erosion control, livestock grazing, targeted wildlife species, etc.) affects the usability for wildlife. If wildlife use is a primary concern, seed mixes must be designed to meet species specific habitat requirements.

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- (1000) (0.27)

1.2 PC - (700) (0.19)

2.1 PC - (500) (0.14)

3.1 PC - (350) (.10)

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

An on-site visit is required before developing grazing plans.

Hydrological functions

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group B and C, with localized areas in hydrologic group D. Infiltration and runoff potential for this site varies from moderate to high depending on soil hydrologic group 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 short grasses 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).

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:

Relationship to Other Classifications:
NRCS Classification Hierarchy:
Physiographic Divisions of the United States (Fenneman, 1946): Physiographic DivisionPhysiographic ProvincePhysiographicSectionLand Resource RegionMajor Land Resource Area(MLRA)Land Resource Unit (LRU).
USFS Classification Hierarchy:
National Hierarchical Framework of Ecological Units (Cleland et al,181-200):
DomainDivisionProvinceSectionSubsectionLandtypeAssociationLandtypeLandtype Phase.

Inventory data references

Information presented here has been derived from NRCS clipping data, numerous ocular estimates and other inventory data. Field observations from experienced range trained personnel were used extensively to develop this ecological site description. 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 descriptions include: Harvey Sprock, Rangeland Management Specialist, CO-NRCS; Ben Berlinger, Rangeland Management Specialist, CO-NRCS; James Borchert, Soil Scientist, CO-NRCS; Terri Skadeland, Biologist, CO-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.

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.

Author(s)/participant(s)	
Contact for lead author	
Date	11/01/2022
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, if present, water flow patterns are on steeper slopes following intense storms, short and not connected.

3. **Number and height of erosional pedestals or terracettes:** None. “Cat-steps” naturally occur on this site.

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 generally less than 2-3 inches in diameter. Extended drought can cause bare ground to increase upwards to 10-20 percent with bare patches reaching upwards to 6-12 inches in diameter. Cross sectional viewing of this site appears to have more bare ground than vertical viewing due to cat-steps.

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

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

7. **Amount of litter movement (describe size and distance expected to travel):** Minimal and short. Movement of 1-2 feet is possible following intense rain storms.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Stability class rating is anticipated to be 5-6 in interspace at soil surface.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soils are typically deep to very deep. Surface texture is typically silt loam. The A-horizon is 0-4 inches in depth. Soil is grayish brown, weak fine platy to 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

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: Cool-season mid rhizomatous >

    Sub-dominant: Cool-season bunchgrass and grasslikes > warm-season short bunchgrass > warm-season mid bunchgrass > shrubs > leguminous forbs >

    Other: Warm-season short stoloniferous > warm-season forbs > cool-season forbs

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Typically minimal. Expect slight mortality and decadence during and following drought, fire, and long-term lack of disturbance.

14. **Average percent litter cover (%) and depth (in):** Litter cover during and following extended drought ranges from 15-30 percent.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 500lbs./ac. low precip years; 1000 lbs./ac. average precip years; 1500 lbs./ac. above average precip years. After extended drought or the first growing season following wildfire, production may be significantly reduced by 350 – 600 lbs./ac. or more.

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. Cheatgrass, Russian thistle, burningbush, and other non-native annuals may invade following extended drought or fire assuming a seed source is available.

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