Ecological site GX070A01X014
Lithic Limestone

Last updated: 10/01/2021
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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): 070A–High Plateaus of the Southwestern Great Plains

This site is only applicable to the Canadian Plateaus LRU of MLRA 70A (LRU 70A.1).

LRU notes

This site is only applicable to the Canadian Plateaus LRU of MLRA 70A (LRU 70A.1). Please refer to the following key:

Land Resource Unit (LRU) Key for MLRA 70A
– High Plateaus of the Southwestern Great Plains
1a. The site exists on a landform of volcanic origin, such as a basalt plateau, or is part of an escarpment system that rises directly to a volcanic structure. These escarpments are included if they have volcanic alluvium or colluvium (i.e. basalt, rhyolite, tuff, cinders) overlying non-volcanic residuum or bedrock (i.e. sandstone, shale). → VOLCANIC PLATEAUS LRU (VP)
User tip: Other alluvial or colluvial landform features extending below the escarpments are not included unless they have a predominance of volcanic fragments at the surface. Also, note that playas atop volcanic plateaus are included within the VP-LRU.
1b. All other sites. → 2
2a. The site exists in the annulus or floor of a playa. → CANADIAN PLATEAUS LRU (CP)
User tip: Small islands of playas occur within large areas of HP-LRU. These sites may be far from the nearest CP landform but will still key-out to the CP-LRU. The playa rim components, however, may key out to either LRU, so it is important to properly identify their soil properties.
2b All other sites. → 3
3a. The site is part of an escarpment landscape complex (defined below) or is within a canyon, valley, or small basin confined by such escarpments. At the upper boundary of the LRU, the soil surface meets at least 4 of the following 5 criteria:
I. Shallow or very shallow soils are present in at least 50% of the landform area;
II. Soils are underlain by sandstone bedrock of the Cretaceous Dakota Formation or older;
III. Presence or historical evidence of a conifer stand (≥ 2% canopy cover);
IV. The ground surface has a slope of at least 10%;
V. The landforms drain towards steep-walled escarpments or canyons below the Dakota sandstone (older Jurassic and Triassic Formations underlie this sandstone mesa cap).
→ MESOZOIC CANYONS AND BREAKS LRU (MCB)
User tip: The MCB sites also occur on any colluvial or alluvial bottomlands confined within escarpments or canyons. Some valleys transition from CP to MCB, or back to CP, and the turning point can be difficult to determine. Generally, the landforms are part of the MCB when confined between Dakota sandstone breaks or escarpments on both sides. Much of the acreage in the MCB is aproned by colluvial debris fans—composed of sandy materials with large sandstone fragments visible on the soil surface, including large stones or boulders. The soils in the bottoms of these confined valleys will also be in the MCB. When the valley opens, or there is only a single escarpment opening

to the plains, the landforms below the steeper, rockier escarpments will be members of the CP-LRU.
3b. Fewer than 4 of the above criteria are met. → 4
4a. The soil is on a plateau summit position (tread) and is within 50 cm to contact with either plateau bedrock (non-soil bedrock of cemented sandstone, limestone, or shale) or strath terrace cobbles, but not a petrocalcic contact (caprock or caliche of cemented calcium carbonate). → CANADIAN PLATEAUS LRU (CP)
4b. No plateau bedrock or strath terrace cobbles within 50 cm. → 5
5a. Fragments (>2 mm) are visible within the soil profile and/or on the surface. If fragments cannot be found in the profile, it is acceptable to look nearby on ant mounds or around burrows. If site is in a drainageway, one can look for fragments on landforms immediately upslope.→ 6
5b. Fragments are entirely absent. → 7
6a. Fragments are mostly petronodes or High Plains gravels. → HIGH PLAINS LRU (HP)
6b. Fragments are mostly plateau bedrock fragments. → CANADIAN PLATEAUS LRU
7a. All horizons in the upper 100 cm of soil have textures of sandy clay loam or sandier.
→ CANADIAN PLATEAUS LRU (CP)
7b. At least one horizon in the upper 100 cm of soil has a texture that is less sandy than sandy clay loam. → HIGH PLAINS LRU (HP)

Classification relationships

NRCS and BLM: Lithic Limestone Canadian Plateaus LRU Major Land Resource Area 70A, High Plateaus of the Southwestern Great Plains Land Resource Region G, Western Great Plains Range and Irrigated Region (United States Department of Agriculture, Natural Resources Conservation Service, 2006).

USFS: Lithic Limestone Sandy Smooth High Plains Subsection Southern High Plains Section Great Plains-Palouse Dry Steppe Province (Cleland, et al., 2007).

EPA: Lithic Limestone <26l Upper Canadian Plateau<26 Southwestern Tablelands (Griffith, et al., 2006).

Ecological site concept

The Lithic Limestone ecological site occurs on plateau summits in the Canadian Plateaus LRU. This LRU occupies the western portion of MLRA 70A and extends from Las Vegas, NM at the southern end to beyond Raton, NM at its northern end. Elevation for the Canadian Plateaus LRU ranges from 5,000 to 7,500 feet.

The site concept for Lithic Limestone is soils that are up to 20 inches (50 centimeters) deep to lithic contact with limestone bedrock which occur on plateau summits with slopes of less than 10 percent. The soils of this site are distinguished from the soils of the Lithic Sandstone ecological site in that they are underlain by, and formed from materials weathered from limestone rather than sandstone bedrock. While the Limy Escarpments ecological site also contains soils with shallow limestone bedrock, it occurs on escarpments with slopes greater than 10 percent.

Landscape: Plateaus
Landforms: Plateau Summits
Slope: 0 to 10 percent, but mostly under 5 percent
Aspect: Aspect does not exert much influence on this ecological site.

Associated sites

GX070A01X017	**Playas** This site occurs in playas. Adjacent Lithic Limestone sites contribute water to this site via run-on and through-flow.
GX070A01X002	**Clayey Uplands** This site occurs in soils that have high amounts of clay in subsurface horizons. Typically, these soils are on more stable landforms that have resisted erosion, or else they have subsurface horizons derived from shale residuum.

GX070A01X005	**Limy** This site occurs where soils surfaces have strong or violent effervescence and ≥ 5% calcareous rock fragments. The Limy site frequently occurs on deep soils adjacent to Lithic Limestone. Limy also exists on alluvial landforms below the Lithic Limestone site.
GX070A01X007	**Limy Escarpments** This site occurs on escarpments that contain visible rock outcrop, and that have both of the following properties at the soil surface: 1) strong or violent effervescence (HCl, 1N); 2) ≥ 5% calcareous surface fragments. Adjacent Lithic Limestone sites contribute water to this site via run-on and through-flow.
GX070A01X008	**Ephemeral Drainageways** This site occurs on the channels and floodplains of ephemeral streams where salts have not accumulated. Adjacent Lithic Limestone sites contribute water to this site via run-on and through-flow.
GX070A01X021	**Sandy** This site occurs in soils that are > 50 cm to a root restrictive layer and have surface textures of sandy loam or coarser with subsurface horizon textures of sandy clay loam or sandier. Such sites typically occur on sand sheets and dunes adjacent to playas or leeward from stream channels.
GX070A01X003	**Loamy Uplands** This site occurs in soils that are deeper than 50 cm.
GX070A01X004	**Shallow Loamy** This site occurs where soils have a paralithic contact to softer bedrock within 50 cm.
GX070A01X013	**Lithic Sandstone** This site occurs where soils are ≤ 50 cm to lithic contact with sandstone bedrock, and often supports oneseed juniper savannahs.

Similar sites

R070AY003NM	**Shallow Upland** The Penrose components of the Lithic Limestone are currently correlated to the Shallow Upland (R070AY003NM) site. Penrose series is an MLRA 69 concept. As noted above, the plant community described in this ESD seems to have been developed using data from hotter, drier areas than the CP, such as MLRAs 70B and 70C.
R070AY001NM	**Loamy Upland** The Escabosa component of this site is correlated to the Loamy Upland (R070AY001NM) site. This may fit deeper subsets of the Escabosa components, but is a poor fit for soils less than 75 cm deep. Also note that the Loamy Upland site doesn't reflect a site with limestone parent material. Refer to the Future Work section below for more information on this issue.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Legacy ID

R070AA014NM

Physiographic features

The Canadian Plateaus LRU exists on a plateau unit of the Great Plains Province landscape. The landforms that occur on this landscape include both erosional and depositional surfaces of plateaus and consist of alluvial fans, ridges, benches, playas, breaks, terraces, and floodplains. The Canadian River Valley, primarily to the east, is the base level towards which the entire LRU is eroding and draining. As plateaus grade towards the Canadian River, the elevation drops from above 7,500 feet to below 5,000 feet over a distance of 30 to 40 miles. Because of this erosional gradient, the exposed strata are generally older as you move from west to east across this LRU. In the west, the younger rocks, such as the late Cretaceous shales and limestones, remain intact, a testament to their distance from the Canadian River Valley. To the east, the early Cretaceous Dakota sandstone provides a caprock

that serves as the plateau rim.

The Lithic Limestone site is not very extensive. It occurs where limestone is the bedrock strata at the plateau surface and where eolian deposits are thin or absent. Other sites also occurring on plateau summits in the Canadian Plateaus (CP) LRU include: Clayey Uplands, Loamy Uplands, Limy, Lithic Sandstone, Sandy, and Shallow Loamy.

Associated sites that occur on landforms and landform positions adjacent to the Lithic Limestone site are the Limy Escarpments, Ephemeral Drainageways, and Playas.

For more detail on how the Lithic Limestone site contrasts with and relates to other sites in the Canadian Plateaus, see the Provisional Ecological Site Key and Associated Sites section.

Geology:
The geology of the Canadian Plateaus consists primarily of Cretaceous rocks: shale, limestone, and sandstone of the Dakota, Graneros, Greenhorn, Pierre, and Niobrara Formations. The Lithic Limestone site generally occurs on the limestone members of the Greenhorn and Niobrara Formations. Soils form in limestone residuum and may have thin eolian caps. Most of the limestone in Cretaceous bedrock is highly fractured and interbedded with shale, a smaller portion has the lithic character of this site.

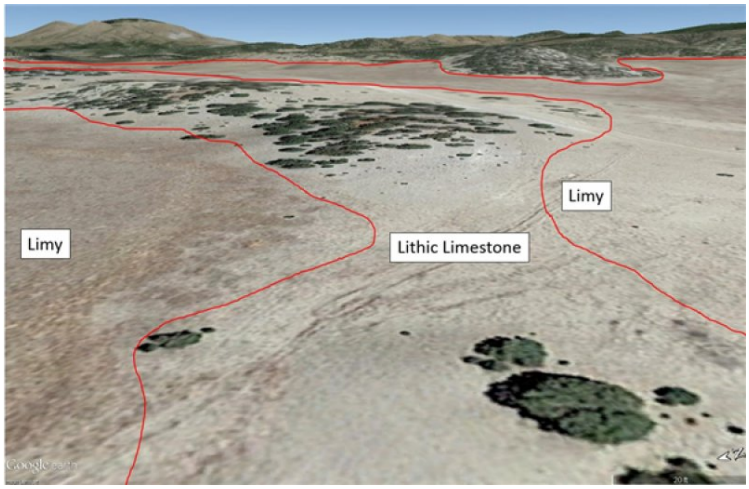


Figure 1. A physiographic diagram of the Lithic Limestone site occurring above the Limy site in a catena. Landforms of the Volcanic Plateaus LRU of MLRA 70A can be seen in the background.

Table 2. Representative physiographic features

Landforms	(1) Plateau
Flooding frequency	None
Ponding frequency	None
Elevation	5,000–7,000 ft
Slope	0–10%
Water table depth	80–99 in
Aspect	Aspect is not a significant factor

Climatic features

The Canadian Plateaus are currently described as having an aridic-ustic and mesic soil climate regime. The estimated average annual soil temperature ranges from 49 to 58 F, supported by soil temperature measurements taken from May 2014 to July 2015. Rainfall occurs mostly during the summer months and ranges from 15 to 18 inches annually. An annual average range of 130 to 170 cumulative frost free days is common, with 150 days or fewer occurring above 7,000 feet.

Table 3. Representative climatic features

Frost-free period (characteristic range)	130-170 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	15-18 in
Frost-free period (average)	150 days
Freeze-free period (average)	
Precipitation total (average)	16 in

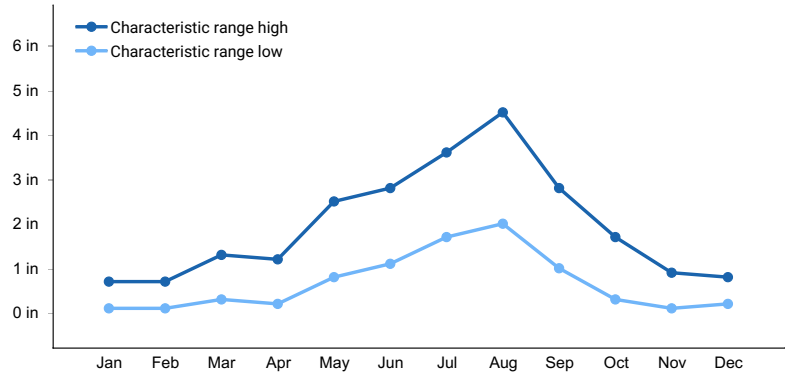


Figure 2. Monthly precipitation range

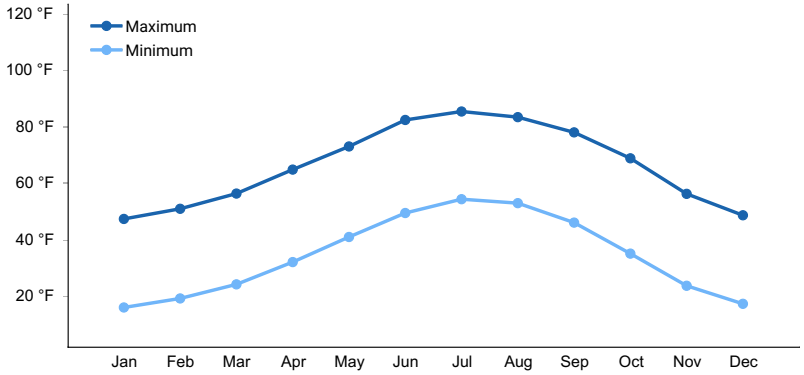


Figure 3. Monthly average minimum and maximum temperature

Climate stations used

- (1) MAXWELL 3 NW [USC00295490], Maxwell, NM
- (2) DES MOINES [USC00292453], Des Moines, NM
- (3) LAS VEGAS WWTP [USC00294862], Las Vegas, NM
- (4) ROY [USC00297638], Roy, NM
- (5) LAS VEGAS MUNI AP [USW00023054], Las Vegas, NM
- (6) CIMARRON 4 SW [USC00291813], Cimarron, NM
- (7) SPRINGER [USC00298501], Springer, NM
- (8) VALMORA [USC00299330], Valmora, NM

Influencing water features

The Lithic Limestone ecological site is not associated with a wetland or riparian system; it is an upland ecological site. Because this site occurs on linear or convex portions of plateau summits, it tends to shed water (via through-flow or run-off) to sites lower in the catena. The Limy, Limy Escarpments, Playas, and Ephemeral Drainageways are the sites that most commonly receive additional moisture from this site.

Soil features

Every ecological site and associated soil component has static soil properties that help define the physical, chemical, and biological characteristics that make the site unique. The following soil profile information is a description of those unique soil properties for the Lithic Limestone ecological site.

The Lithic Limestone ecological site currently correlates to major components of a number of map units in the Canadian Plateaus LRU of 70A. The soil series correlated to these components include Penrose, Laporte, and Escabosa. These soils form in limestone residuum, and may have some eolian materials mixed into the upper profile.

In normal years these soils are driest during the winter. They are dry in some or all parts for over 90 cumulative days, but are moist in some or all parts for either 180 cumulative days or 90 consecutive days, during the growing season. The soil moisture regime is ustic bordering on aridic. The mean annual soil temperature is 49 to 55 degrees F; this range falls in the mesic temperature regime.

Most components have base textures of loam or fine sandy loam at the surface, and often have textural modifiers of channery and very channery. Subsurface horizon textures include loam and clay loam, and gravelly, cobbly, and channery modifiers of these base textures.

A very important feature of the soils here is that they are armored by significant amounts of rock fragments (typically limestone channers) at the surface. Surface fragment cover ranges from 15 to 95 percent, and is usually over 50 percent. Also important is the amount of free carbonates throughout the soil profile—indicated by strong or violent effervescence when exposed to dilute hydrochloric acid.

From the San Miguel County (NM630) soil survey manuscript, with horizon designations modernized:
TYPICAL PEDON: Penrose channery silt loam, San Miguel County, New Mexico; about 10 miles north of Las Vegas, in the northeast corner of sec. 13, T. 17 N., R. 17 E. (projected). Approximate location in UTM: 13S 478697 E, 3956210 N; Elevation: 7,010 feet.

A—0 to 4 inches; grayish brown (2.5Y 5/2) channery silt loam, dark grayish brown (2.5Y 4/2) moist; moderate fine granular structure; soft, friable, sticky and plastic; many fine and very fine roots; many fine interstitial pores; weakly calcareous; moderately alkaline; clear smooth boundary.

Bt—4 to 14 inches; grayish brown (2.5Y 5/2) channery silt loam, dark grayish brown (2.5Y 4/2) moist; moderate subangular blocky structure; slightly hard, firm, slightly sticky and plastic; many fine and very fine roots; common fine tubular pores; 10 to 15 percent limestone fragments; weakly calcareous; moderately alkaline; abrupt smooth boundary.

R—14 inches; hard limestone that is fractured; calcium carbonate coatings are on the bottom of the fragments.

Parent Material Kind: Loess over residuum
Parent Material Origin: Eolian and limestone
Surface Texture Group: loam, channery silt loam, channery loam, channery sandy loam
Subsurface Texture Group: loam, clay loam, gravelly loam, channery clay loam, cobbly clay loam

Figure 4. A typical soil profile for the Lithic Limestone site. The point of the knife is resting on the same sheet of hard limestone that forms the outcrop in the foreground.

Table 4. Representative soil features

Parent material	(1) Residuum–limestone (2) Eolian deposits–limestone, sandstone, and shale
Surface texture	(1) Channery loam (2) Silt loam (3) Sandy loam
Family particle size	(1) Loamy (2) Loamy-skeletal
Drainage class	Well drained
Permeability class	Slow to moderate
Soil depth	2–20 in
Surface fragment cover <=3"	0–25%
Surface fragment cover >3"	0–15%
Available water capacity (0-20in)	0.5–4 in
Calcium carbonate equivalent (0-20in)	3–55%
Electrical conductivity (0-20in)	0–2 mmhos/cm
Sodium adsorption ratio (0-20in)	0–2
Soil reaction (1:1 water) (0-20in)	7.9–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–15%
Subsurface fragment volume >3" (Depth not specified)	0–15%

Ecological dynamics

Plant tables have not been developed for this site. Until such time as they can be updated, use the plant tables in the referenced literature that correlates to this concept (refer to plant tables from legacy ecological sites below). Since current ecological sites and legacy manuscript information was not correlated to the precise concept of the Lithic Limestone there are notable shortcomings in their applicability to conservation planning here.

The Lithic Limestone site is distinguished from other upland sites in the CP in that cool-season grasses (namely New Mexico feathergrass) are at least codominant in most of its community phases. Similar plant communities can be seen on the upper escarpments of the Limy Escarpments site, and also on many soils in the High Plains (HP) LRU of 70A. In the latter, abundant free carbonates and calcareous petronodes create the same basic soil properties that select for New Mexico feathergrass in the Lithic Limestone site. Another grass species that seems particularly well-suited to this site is sideoats grama.

Since this site is distributed across a relatively large area and covers a considerable range in elevation, and since its soil properties are variable, plant community composition is variable within any given state or community phase. At lower elevations toward the eastern end of the CP, hairy grama is quite common, and one frequently encounters sacahuista and hairy tridens. At higher elevations and toward the northern end of the CP, fringed sage is often found on this site. Similarly, twoneedle pinyon dominates the tree communities at the highest elevations, while oneseed juniper is the dominant tree across most of this site's extent. Older trees are more common in locations with a significant amount of rock outcrop.

Within this site, the dominant species of short grasses are inherently drought- and grazing-tolerant (Lauenroth, 1994). Across the western parts of the U.S., blue grama is one of the most extensively distributed grasses and occurs in a wide variety of different ecosites ranging from grasslands to shrubland and woodland sites. This grass evolved with grazing by large herbivores and, when grazed continuously, tends to form a short sod. When allowed to grow under lower grazing pressures, the plants develop the upright physiognomy of a bunchgrass. If blue grama is eliminated from an area by extended drought (3 to 4 years) or disturbance such as plowing, regeneration is slow because of very slow tillering rates (Samuel, 1985), low and variable seed production, minimal seed storage in the soil (Coffin, 1989) and limited seedling germination and establishment due to particular temperature and extended soil moisture requirements for successful seedling establishment (Briske, 1978). Buffalograss, which is more abundant at warmer, lower elevations of this site, is often found occupying swale or depression positions across the landscape. Buffalograss is less drought-tolerant than blue grama but re-establishes more quickly following disturbance due to higher seed abundance and viability and more effective above-ground tillering (Peters, 2008).

Large-scale processes such as climate, fire and grazing influence this site. During years with favorable growing seasons, the effects of grazing may be mitigated. During years of low precipitation, grazing can magnify degradation of the site (Milchunas D.G., 1989). Fire is a natural disturbance regime that suppresses succulents and shrubs while stimulating grasses and forbs, however, in contrast to mid and tall grass prairie sites, fire is less important (Wright, 1982). This is because the drier conditions produce less vegetation/fuel load, lowering the relative fire frequency. However, historically, fires that did occur were often very expansive, especially after a series of years where above average precipitation built enough litter/fine fuels. Currently, fire suppression and more extensive grazing in the region have decreased the fire frequency, and it is unlikely that these processes could occur at a natural scale (USNVC, 2017)-G144. According to (Gebow, 2001), fire effects in the same location will vary, especially with fire timing, where seasonality can either hinder or benefit plants depending on their growing stage. Precipitation events occurring before and after fire will also influence the recovery of plants. Fire promotes rhizomatous plant species, such as western wheatgrass, that can take advantage of below-ground rhizomes from which tillering is rapidly initiated.

Correlation to Current Ecological Sites:
The Penrose components of the Lithic Limestone are currently correlated to the Shallow Upland (R070AY003NM) site. Penrose series is an MLRA 69 concept. As noted above, the plant community described in this ESD seems to have been developed using data from hotter, drier areas than the CP, such as MLRAs 70B and 70C.

Shallow Upland legacy tables (R070AY003NM)
Annual production by plant type
Plant Type----------Low(Lb/Acre) ----------Representative Value(Lb/Acre) ----------High(Lb/Acre)
Grass/Grasslike----------312----------700----------858
Shrub/Vine----------32----------70----------88
Forb----------32----------70----------88
Total----------376----------840----------1034

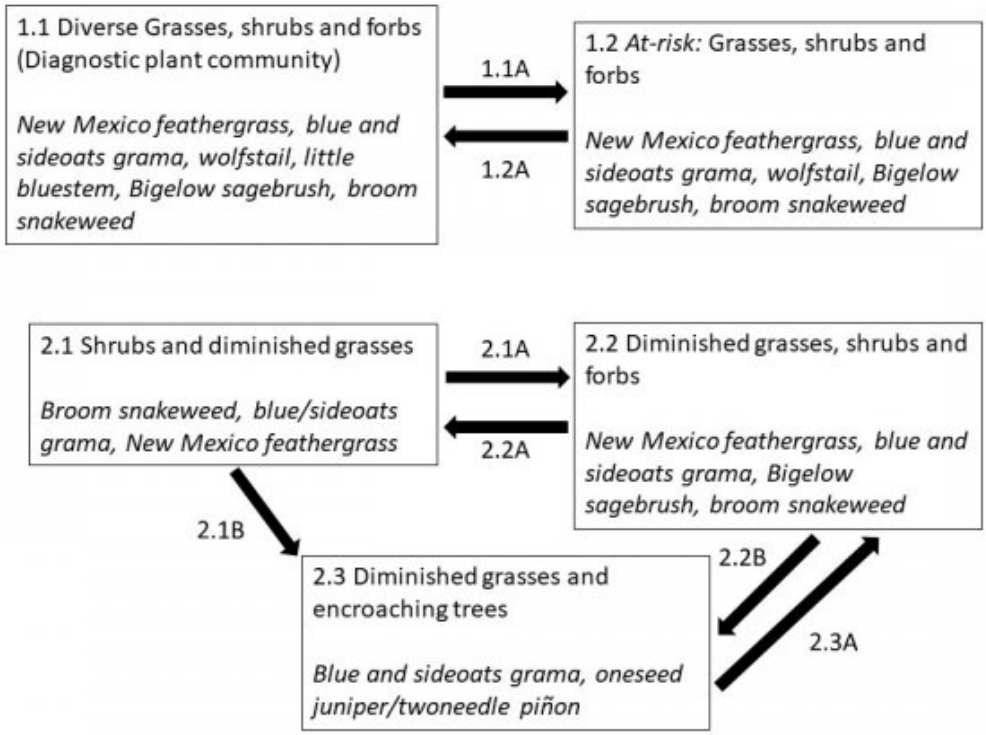
Community 1.1 plant community composition
Common Name----------Symbol----------Scientific Name----------Annual Production (Lb/Acre)
GRASS/GRASSLIKE

1 sideoats grama----------BOCU----------*Bouteloua curtipendula*----------63–150
2 blue grama----------BOGR2----------*Bouteloua gracilis*----------63–150
3 hairy grama----------BOHI2----------*Bouteloua hirsuta*----------63–150
4 little bluestem----------SCSC----------*Schizachyrium scoparium*---------63–150
5 needle and thread------HECO26--------*Hesperostipa comata*----------75–113
6 New Mexico feathergrass-HENE5------*Hesperostipa neomexicana*------75–113
7 threeawn----------ARIST----------Aristida----------8–38
8 common wolfstail---------LYPH----------*Lycurus phleoides*----------8–38
9 squirreltail----------ELEL5---------*Elymus elymoides*----------8–38
10 western wheatgrass-----PASM---------*Pascopyrum smithii*----------8–38
11 *Graminoid (grass or grass-like)*-2GRAM-*Graminoid (grass or grass-like)*-8–38
FORB
12 buckwheat----------ERIOG--------Eriogonum----------8–38
13 globemallow----------SPHAE--------Sphaeralcea----------8–38
14 *Forb, annual*----------2FA---------- *Forb, annual*----------15–38
15 *Forb, perennial*----------2FP---------- *Forb, perennial*----------15–38
SHRUB/VINE
16 prairie sagewort----------ARFR4---------*Artemisia frigida*----------8–38
17 Bigelow sage----------ARBI3----------*Artemisia bigelovii*----------15–23
18 winterfat----------KRLA2----------*Krascheninnikovia lanata*--------15–23
19 skunkbush sumac--------RHTR----------*Rhus trilobata*----------15–38
20 *Shrub, deciduous*---------2SD---------- *Shrub, deciduous*----------8–38

Loamy Upland legacy tables (R070AY001NM)
Annual production by plant type
Plant Type-------Low(Lb/Acre) -------RV(Lb/Acre)-------High(Lb/Acre)
Grass/Grasslike -------610----------860----------1100
Forb----------130----------130----------140
Shrub/Vine----------130----------130----------130
Total----------870----------1120----------1370

Community 1.1 plant community composition
Common Name----------Symbol-------Scientific Name-------Annual Production (Lb/Acre)
GRASS/GRASSLIKE
1-------blue grama----------BOGR2-------*Bouteloua gracilis*---------312–357
2-------western wheatgrass----PASM-------*Pascopyrum smithii*-------178–223
3-------squirreltail----------ELEL5-------*Elymus elymoides*---------89–133
4-------James' galleta----------PLJA-------*Pleuraphis jamesii*----------43–89
5-------sideoats grama----------BOCU-------*Bouteloua curtipendula*---43–89
6-------threeawn----------ARIST-------Aristida----------25–44
7-------ring muhly----------MUTO2------*Muhlenbergia torreyi*-----25–44
8-------buffalograss----------BODA2------*Bouteloua dactyloides*-----25–44
9-------common wolfstail--------LYPH---------*Lycurus phleoides*----------25–44
10-------sand dropseed----------SPCR---------*Sporobolus cryptandrus*----25–44
FORB
12-------*Forb, annual*----------2FA---------- *Forb, annual*----------10–48
13-------*Forb, perennial*----------2FP---------- *Forb, perennial*----------10–48
14-------Cuman ragweed----------AMPS---------*Ambrosia psilostachya*------10–25
15-------scurfpea----------CULLE---------Cullen----------5–25
16-------prairie clover----------DALEA-------Dalea----------5–25
17-------dotted blazing star---------LIPU----------*Liatris punctata*----------5–25
18-------locoweed----------OXYTR-------Oxytropis----------5–25
19-------upright prairie coneflower-RACO3------*Ratibida columnifera*-------5–25
20-------scarlet globemallow--------SPCO--------*Sphaeralcea coccinea*-------5–25
SHRUB/VINE
21-------winterfat----------KRLA2-------*Krascheninnikovia lanata*---29–48
22-------prairie sagewort----------ARFR4-------*Artemisia frigida*----------29–48
23-------*Shrub, deciduous*----------2SD--------- *Shrub, deciduous*----------29–48

State and transition model



State 1
Reference State

This state exists where the effects of grazing pressure are less pronounced. The two most obvious variables that distinguish States 1 and 2 are the annual production and species composition of grasses. While grass dominance is not confined to State 1, codominance or dominance of woody species is a reliable indicator that a particular community is not in State 1. Since the soils on this site are generally protected from erosion by surface fragments, thickness of topsoil is not a reliable indicator of state or community phase. Additionally, soil organic matter is typically quite high in all states and phases of this site—likely the result of carbonates' ability to bind to and stabilize soil organic matter.

Community 1.1
Diverse grasses, shrubs, and forbs (diagnostic plant community)

Figure 5. Community 1.1 in Colfax County, September 2018. New Mexico feathergrass is the abundant bunchgrass here. Little bluestem (reddish hue) is also quite prevalent.

This community is dominated by grasses, but contains a number of forb species, along with a considerable amount of shrubs (generally less than 10 percent cover). Foliar cover ranges from 60 to 80 percent. Total canopy cover of warm-season grasses is between 10 and 50 percent, and cool-season grass ranges between 10 and 50 percent. Forbs and shrubs can each account for up to 10 percent cover. Annual production averages around 850 pounds per acre, but can range between 600 and 1,000 pounds per acre, depending mostly on annual weather patterns. New Mexico feathergrass is either dominant or codominant. Little bluestem represents at least 2 percent cover, and wolfstail is typically well-represented. While forbs represent a small percentage of foliar cover, their species richness is often high—leading to colorful displays following major rain events. Shrubs are always present, and are often a considerable component. Broom snakeweed, Bigelow sagebrush, and plains yucca are the most common species. Tree species (particularly oneseed juniper) are often present in trace amounts. It is not clear whether periodic fire, the vigor of grasses, or some combination of these two suppresses tree encroachment. Since considerable understory biomass is needed to produce a stand-killing fire, it stands to reason that grass vigor and fire frequency are covariate.

Dominant plant species

- broom snakeweed (*Gutierrezia sarothrae*), shrub
- Bigelow sage (*Artemisia bigelovii*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- New Mexico feathergrass (*Hesperostipa neomexicana*), grass
- blue grama (*Bouteloua gracilis*), grass
- little bluestem (*Schizachyrium scoparium*), grass

Community 1.2
At-risk: Grasses, shrubs and forbs

Figure 6. Community 1.2 in Colfax County, September, 2017. Note the sod-bound habit of the blue grama. While the bare ground and rock outcrop visible here can be found on any community phase, they are more obvious where grass height is diminished.

This community is dominated by grasses, but contains a number of forb species, along with a considerable amount of shrubs (generally less than 10 percent cover). Foliar cover ranges from 60 to 85 percent. Total canopy cover of warm season grasses is between 10 and 50 percent, and cool-season grass ranges between 10 and 50 percent. Forbs and shrubs can each account for up to 10 percent cover. Annual production averages around 700 pounds per acre, but can range between 550 and 900 pounds per acre, depending mostly on annual weather patterns. New Mexico feathergrass is either dominant or codominant to blue grama. The latter is generally sod-bound. Little bluestem is present, but represents less than 2 percent cover, and wolfstail is typically well-represented. While forbs represent a small percentage of foliar cover, their species richness is often high—leading to colorful displays following major rain events. Shrubs are always present, and are often a considerable component. Broom snakeweed, Bigelow sagebrush, and plains yucca are the most common species. Tree species (particularly oneseed juniper) are often present in small amounts—typically representing less than 1 percent cover.

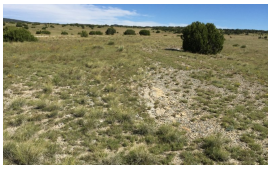
Dominant plant species

- broom snakeweed (*Gutierrezia sarothrae*), shrub

- Bigelow sage (*Artemisia bigelovii*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- New Mexico feathergrass (*Hesperostipa neomexicana*), grass
- blue grama (*Bouteloua gracilis*), grass

Pathway P1.1A
Community 1.1 to 1.2

Diverse grasses, shrubs, and forbs (diagnostic plant community)



At-risk: Grasses, shrubs and forbs

This pathway represents a period of season-long grazing, which advantages the growth and reproduction of shrubs and grazing-tolerant grasses, and suppresses herbaceous species that are more palatable and/or less resilient under grazing pressure. Under such a grazing regime, little bluestem diminishes markedly in abundance. Shrub and tree vigor increase. While the cover of blue grama may increase, it begins to assume a sod-bound habit, and its vigor diminishes.

Pathway P1.2A
Community 1.2 to 1.1

At-risk: Grasses, shrubs and forbs

Diverse grasses, shrubs, and forbs (diagnostic plant community)

This pathway represents a period of rest from season-long grazing. This advantages the growth and reproduction palatable grasses, particularly little bluestem, and allows blue grama to assume a cespitose (bunchgrass) habit. Shrub and tree vigor decrease.

State 2
Degraded State

This state occurs where a prolonged continuous grazing regime, coupled with fire suppression (intentional or incidental) have resulted in diminished diversity and vigor in the grass community. Total annual production is significantly lower than in State 1. Most or all of this difference in production results from reduced vigor of grasses. Little bluestem is absent or present in trace amounts; and early seral grasses such as purple threeawn and ring muhly are well-represented. With the exception of Community Phase 2.

Community 2.1
Shrubs and diminished grasses

Figure 7. Community phase 2.1 in Mora County, October 2018. This is a rather extreme example of broom snakeweed encroachment.

In this community, grasses are roughly codominant to shrubs. Trees are usually present, but their cover is less than 5 percent. Total foliar cover ranges from 50 to 75 percent. Total canopy cover of warm-season grasses is between 5 and 35 percent. Cool-season grasses, particularly New Mexico feathergrass, account for less than 25 percent. Forbs account for up to 5 percent cover. Annual production averages around 600 pounds per acre, but can range between 500 and 850 pounds per acre, depending mostly on annual weather patterns. Dominant grass species here are blue grama, sideoats grama, New Mexico feathergrass, and purple threeawn. Little bluestem is generally absent; wolfstail is often so, as well. Broom snakeweed and Bigelow sagebrush are the most common shrub species, and the former is often quite abundant. Increased competition from shrubs appears to be suppressing forbs as well as grasses here. Blue grama is typically sod-bound in this phase.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- twoneedle pinyon (*Pinus edulis*), tree
- broom snakeweed (*Gutierrezia sarothrae*), shrub
- Bigelow sage (*Artemisia bigelovii*), shrub
- blue grama (*Bouteloua gracilis*), grass
- sideoats grama (*Bouteloua curtipendula*), grass
- New Mexico feathergrass (*Hesperostipa neomexicana*), grass
- purple threeawn (*Aristida purpurea*), grass

Community 2.2
Diminished grasses, shrubs, and forbs

Figure 8. Community 2.2 in Mora County, 2018. Note the dominance of New Mexico feathergrass and the relative lack of woody species.

This community exists on degraded sites where woody species have been suppressed by some mechanism—fire, chemical treatments, or mechanical removal. In this community, grasses are dominant, although their total

production is usually lower than that found in State 1. Trees are often present, but their cover is less than 5 percent. Total foliar cover ranges from 50 to 75 percent. Total canopy cover of warm-season grasses is between 5 and 20 percent. Cool-season grasses, particularly New Mexico feathergrass, account for between 25 and 60 percent. Forbs account for up to 5 percent cover. Annual production averages around 600 pounds per acre, but can range between 400 and 800 pounds per acre, depending mostly on annual weather patterns. Dominant grass species here are New Mexico feathergrass, blue grama, sideoats grama, and purple threeawn. Little bluestem is generally absent; wolfstail is often so, as well. Broom snakeweed and Bigelow sagebrush are the most common shrub species.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- twoneedle pinyon (*Pinus edulis*), tree
- broom snakeweed (*Gutierrezia sarothrae*), shrub
- Bigelow sage (*Artemisia bigelovii*), shrub
- New Mexico feathergrass (*Hesperostipa neomexicana*), grass
- blue grama (*Bouteloua gracilis*), grass
- sideoats grama (*Bouteloua curtipendula*), grass
- purple threeawn (*Aristida purpurea*), grass

Community 2.3
Diminished grasses and encroaching trees

Figure 9. Community 2.3 in Mora County, October 2018.

This community occurs where trees have increased in abundance and vigor. The mechanisms for such encroachment include continuous grazing and fire suppression—the latter occurring either by direct human actions, or via reductions in understory fuel loads caused by grazing. In this community, grasses and trees are typically codominant in terms of cover. Total foliar cover ranges from 35 to 55 percent. Total canopy cover of trees is at least 5 percent, and can exceed 25 percent. Total canopy cover of warm-season grasses is between 10 and 25 percent, and cool-season grass cover is generally below percent. Shrub cover ranges from 2 to 10 percent. Forbs typically account for less than 1 percent cover. Annual production averages around 400 pounds per acre, but can range between 300 and 600 pounds per acre, depending mostly on annual weather patterns. Dominant trees are oneseed juniper and twoneedle pinyon, the latter being more common at higher elevations. Dominant grasses are blue grama, hairy grama, and sideoats grama. New Mexico feathergrass is sparse, if even present, in this community. Forb diversity is quite low in this community, with low spurge and perkysue being the most common species. Broom snakeweed and plains yucca are the most shrub common species.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- twoneedle pinyon (*Pinus edulis*), tree
- broom snakeweed (*Gutierrezia sarothrae*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- blue grama (*Bouteloua gracilis*), grass
- hairy grama (*Bouteloua hirsuta var. hirsuta*), grass
- sideoats grama (*Bouteloua curtipendula*), grass

Pathway P2.1A
Community 2.1 to 2.2

Shrubs and diminished grasses

Diminished grasses, shrubs, and forbs

This pathway represents disturbance that either kills or suppresses the growth of woody species. Fire and herbicide application are two common examples. It is also possible that a late summer drought can kill enough broom snakeweed to affect this change. In response to the suppression of shrubs, the grass community increases in vigor. New Mexico feathergrass has a particularly strong positive response here.

Pathway P2.1B
Community 2.1 to 2.3

Shrubs and diminished grasses

Diminished grasses and encroaching trees

This pathway represents the encroachment of tree species in the absence of mitigating phenomena—fire, chemical treatments, or mechanical removal. Once established, encroaching trees outcompete grasses, shrubs, and forbs in particular.

Pathway P2.2A
Community 2.2 to 2.1

Diminished grasses, shrubs, and forbs

Shrubs and diminished grasses

This pathway represents season-long grazing providing little rest and recovery for preferred grazed plants during critical growing periods, coupled with high utilization and the absence of fire. This combination of mechanisms advantages shrub species. Both herbivory and competition from shrubs suppress the growth and reproduction of grasses.

Pathway P2.2B
Community 2.2 to 2.3

Diminished grasses, shrubs, and forbs

Diminished grasses and encroaching trees

This pathway represents the encroachment of tree species in the absence of mitigating phenomena—fire, chemical treatments, or mechanical removal. Once established, encroaching trees outcompete grasses, shrubs, and forbs in particular.

Pathway P2.3A
Community 2.3 to 2.2

Diminished grasses and encroaching trees

Diminished grasses, shrubs, and forbs

This pathway represents disturbance that either kills or suppresses the growth of woody species. Fire and herbicide application are two common examples. New Mexico feathergrass has a particularly strong positive response here.

Transition T1A
State 1 to 2

This pathway represents season-long grazing providing little rest and recovery for preferred grazed plants during critical growing periods, coupled with high utilization. This typically occurs with an absence of fire. Drought is thought to push the plant community over the threshold into the degraded State 2. During this transition, little bluestem is extirpated. Other highly palatable and grazing-sensitive grass species are diminished—both in vigor and abundance. Concurrently, early seral grasses, particularly threeawn and ring muhly, increase. Shrub and tree species enjoy a competitive advantage, and increase in abundance.

Restoration pathway R2A
State 2 to 1

This process results in the recovery of the vigor and diversity of herbaceous species, as well as a significant increase in total productivity. Late seral grass species such as little bluestem and New Mexico feathergrass may require re-introduction. Since an abundance of either trees or shrubs appears to suppress herbaceous plants here, it is thought that this recovery pathway necessarily proceeds from Community Phase 2.2.

Additional community tables

Animal community

From the Shallow Upland* (R070AY003NM) site: “Habitat for Wildlife: This site provides habitats which support a resident animal community that is characterized by pronghorn antelope, coyote, gray fox, black-tailed jackrabbit, northern grasshopper mouse, hispid pocket mouse, marsh hawk, horned lark, meadowlark, prairie rattlesnake, six-lined racerunner, and the Great Plains toad.”
*Note that this site was apparently developed based, in part, on data from MLRAs 70B and 70C. Some animals listed here may be restricted to these MLRAs.

Hydrological functions

Soil Hydrology
The Lithic Limestone ecological site is not associated with a wetland or riparian system; it is an upland ecological site. Because this site occurs on linear or convex portions of plateau summits, it tends to shed water (via through-flow or run-off) to sites lower in the catena. The Limy, Limy Escarpments, Playas, and Ephemeral Drainageways are the sites that most commonly receive additional moisture from this site.

Wood products

This site typically supports woodlands of oneseed juniper--often containing some piñon pine.

Other information

Future Work:
In order to develop plant tables that are directly correlated to this site, highly quantitative plant inventories will need

to be performed. Also, the Penrose series should be replaced with an MLRA 70 concept.

Discussion of grazing systems herein is admittedly general. In the future, we hope to address this deficiency by incorporating the experiences of range management professionals regarding the effects of specific practices.

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Contributors

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Approval

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Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	07/27/2024
Approved by	Curtis Talbot
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

   _____

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

   _____

3. **Number and height of erosional pedestals or terracettes:**

   _____

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

   _____

5. **Number of gullies and erosion associated with gullies:**

   _____

6. **Extent of wind scoured, blowouts and/or depositional areas:**

   _____

7. **Amount of litter movement (describe size and distance expected to travel):**

   _____

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

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

---

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

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

---

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:

    Sub-dominant:

    Other:

    Additional:

---

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

---

14. **Average percent litter cover (%) and depth (in):**

---

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

---

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:**

---

17. **Perennial plant reproductive capability:**
