USDA Natural Resources
Conservation Service

Ecological site GX070A01X019
Gravelly Terraces

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

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

Ecological site concept

The Gravelly Terraces ecological site occurs on treads of elevated stream terraces 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 LRU ranges from 5,000 to 7,500 feet.

The concept for this ecological site is a soil with a depth over 20 inches (50 centimeters) to root-restrictive layers. Surface textures are variable, but are typically high in both sand and coarse fragments and moderate in clay. There are at least 35 percent coarse fragments in a layer greater than or equal to 20 inches thick within the upper 100 40 inches of soil. An increase in clay with depth is common, causing a subsurface horizon to behave as an aquitard (a layer that impedes the percolation of water). This concentration of clay in the profile affects the rooting zone of plants by creating a zone by which water is temporarily “perched” and, thus, more accessible to shallow roots. Such soil properties have only been observed on older, elevated stream terraces formed by high-velocity waters than are typically observed today, carrying sediment from the Sangre De Cristo Mountains into the Great Plains.

Associated sites

GX070A01X015	**Clayey Flats** This site occurs on alluvial flats with slopes ≤ 1% and soils a that contain ≥ 35% in a layer beginning within 15 cm of the surface.
GX070A01X002	**Clayey Uplands** This site occurs in soils that contain layers in the upper 50 cm with ≥ 35% clay.
GX070A01X008	**Ephemeral Drainageways** This site occurs on the channels and floodplains of ephemeral streams where salts have not accumulated. Adjacent Gravelly Terraces sites may contribute water to this site via run-on and through-flow.

GX070A01X012	**Low Terraces** This site occurs on terraces above perennial streams where the flooding frequency interval is ≥ 10 years. This site is often used for hay and small grain production. Adjacent Gravelly Terraces sites may contribute water to this site via run-on and through-flow.
GX070A01X006	**Slopes** This site occurs on slopes ≥ 10%. Its soils lack a layer within the upper 100 cm that is ≥ 50 cm thick and contains ≥ 35% rounded rock fragments. This is the most common site to directly subtend Gravelly Terraces.
GX070A01X003	**Loamy Uplands** This site occurs in soils that lack layers in the upper 50 cm with ≥ 35% clay.
GX070A01X005	**Limy** This site occurs on slopes < 10% where soils surfaces have strong or violent effervescence and ≥ 5% calcareous rock fragments.
GX070A01X010	**Riparian** Occurs in perennial stream systems and related floodplains. These sites are situated below Gravelly Terraces and receive run-on moisture from these sites in some cases.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Legacy ID

R070AA019NM

Physiographic features

The Canadian Plateaus LRU (CP) 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 Gravelly Terraces ecological site occurs at the interface between treads and risers of elevated stream terraces in the Canadian Plateaus LRU—in other words, it occurs on shoulders of strath terrace escarpments. These terraces occur as small-acreage remnants of landforms that were once connected to larger stream systems draining from the Sangre de Cristo Mountains. On some terraces that are more dissected, the site may extend onto riser portion of the landform and therefore have slope upwards of 25 percent.

These terraces were formed by ancestral stream deposits from the early Sangre de Cristo Mountains, in a much wetter climate. The streams cut down through the plateau surfaces as high energy fluvial systems, then deposited a bedload of mixed sands, gravels, and cobbles. More recently they have been covered by younger deposits or an eolian cap. These remnant alluvial fans are now mostly preserved on islands of elevated, resilient terraces and where they have been cut by the historic stream channel, the shoulder positions have exposed the volume of gravels and cobbles. Often, the fragments migrate down the terrace risers and cover a portion of this landform as well.

The Gravelly Terraces site is not extensive, nor is it the only ecological site that occurs on stream terraces in the Canadian Plateaus LRU. Unlike the Gravelly Terraces site, the Low Terraces site occurs on younger terraces that receive additional moisture from upland landforms.

Associated ecological sites that may occur on plateau surfaces adjacent to the Gravelly Terraces site are the Clayey Uplands, Loamy Uplands, and Slopes. Fluvial sites that may occur below the Gravelly Terraces site in catenas are the Ephemeral Drainageways, Riparian, and Low Terraces.

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

Geology:
The geology of the CP consists primarily of Cretaceous rocks: shale, limestone, and sandstone of the Dakota, Graneros, Greenhorn, Pierre, and Niobrara Formations. However, the alluvial parent material for the soils of the Gravelly Terraces site is derived mostly from sources within the Sangre de Cristo Mountains. Much of this alluvial material comes from Precambrian metamorphic and igneous rocks. Thus, among the coarse fragments in a soil profile are granite, gneiss, schists, quartzite, sandstone, and limestone from a variety of geologic sources. This alluvial packet overlies the older Cretaceous formations, so there are often layers of shale-derived soil and even soft bedrock in lower horizons of these soils, especially on the riser positions.

Since the Gravelly Terraces site occupies ancient strath terraces, its alluvial package resembles that of the High Plains (HP) LRU of MLRA 70A. In most cases, the treads of these terraces fit the concept of the HP rather than the Canadian Plateaus, with the upper terminus of the Gravelly Terraces site constituting an LRU boundary.

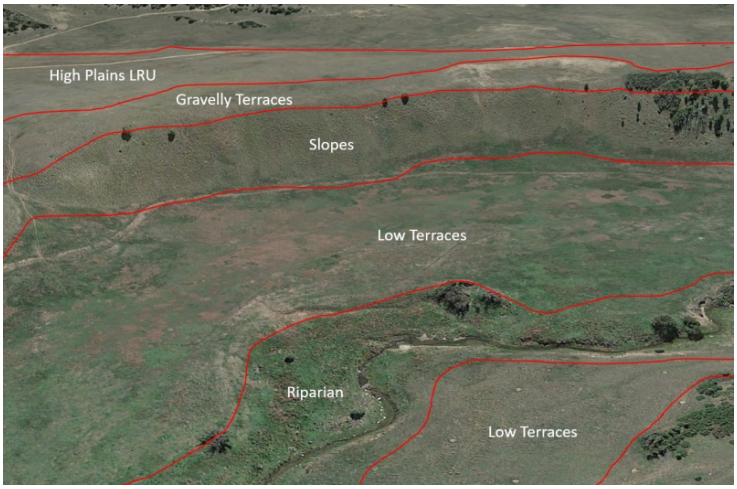


Figure 1. A physiographic diagram of the Gravelly Terraces ecological site as it relates to other sites. Note that this site is confined to the shoulder position of the strath terrace escarpment.

Table 2. Representative physiographic features

Landforms	(1) Plateau
Flooding frequency	None
Ponding frequency	None
Elevation	1,829–2,286 m
Slope	0–10%
Water table depth	203–251 cm
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 (average)	127 days
Freeze-free period (average)	148 days
Precipitation total (average)	457 mm

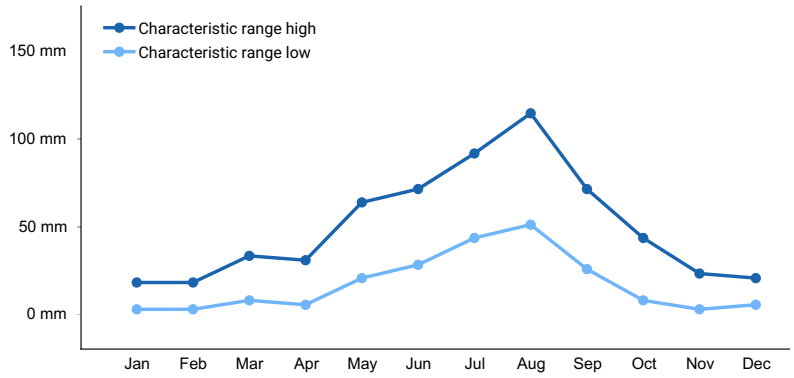


Figure 2. Monthly precipitation range

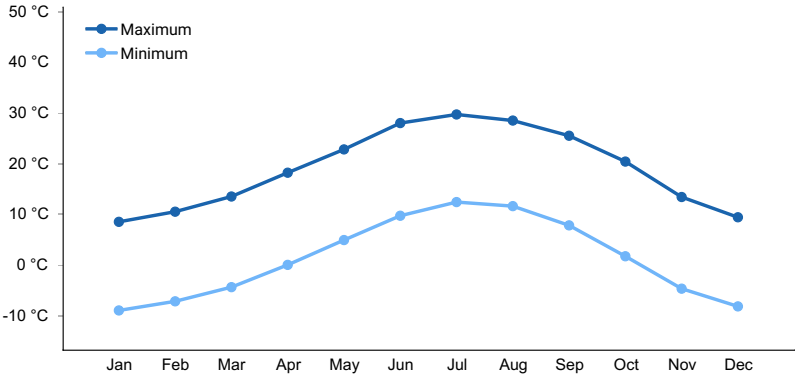


Figure 3. Monthly average minimum and maximum temperature

Climate stations used

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

Influencing water features

Soil Hydrology

The Gravelly Terraces 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 elevated terraces, it tends to contribute water (via through-flow or run-off) to sites lower in the catena. In most cases, the Slopes site directly subtends the Gravelly Terraces site—the former receiving extra moisture from the latter. In some cases, the Gravelly Terraces site immediately overlies fan remnants. In this scenario, the Limy and Clayey Flats sites are the most common recipients of the extra moisture. The Low Terraces, Ephemeral Drainageways, and Riparian sites commonly receive additional moisture from the Gravelly Terraces site, albeit indirectly, as other upland sites invariably occur between Gravelly Terraces and water-collecting landforms.

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 Gravelly Terraces ecological site. To learn about the dynamic properties of the soil components tied to this site, refer to the "plant communities" section of this ESD.

The Gravelly Terraces ecological site correlates to the Tinaja series of some mapunits. It appears that the elevated terraces were often missed during initial soil survey work because of their small acreage, but a few locations were identified that have similar characteristics. Basic pedon information validated by recent field observations is provided below.

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 soil temperature regime.

These soils contain at least 35 percent coarse fragments in a layer at least 50 cm thick within the upper 100 cm. They typically demonstrate a clay increase of at least 6 percent between the surface and a subsurface horizon, and have low EC values throughout. In cases where the topsoil has been removed, the clay increase described above may no longer be evident—thus a clay increase is not criteria within the ESD key.

TYPICAL PEDON: Observed on an elevated terrace above the Rio Mora, 1.46 miles east of Golondrinas, NM on Highway 161, north side of road.

A—0 to 14 cm; dark brown (7.5YR 4/2) gravelly loam, dark brown (7.5YR 3/2) moist; slightly sticky and slightly plastic.

Bt—14 to 33 cm; dark brown (7.5YR 4/2) very gravelly clay loam, dark brown (7.5YR 3/2) moist; moderately sticky and moderately plastic; slight effervescence in response to 1N HCl.

Btk1—33 to 60 cm; brown (7.5YR 5/3) very gravelly sandy clay loam, dark brown (7.5YR 3/3) moist; moderately sticky and slightly plastic; violent effervescence in response to 1N HCl.

Btk2—60 to 152 cm; light brown (7.5YR 6/4) very gravelly sandy clay loam, brown (7.5YR 4/4) moist; moderately sticky and slightly plastic; violent effervescence in response to 1N HCl.

Parent Material Kind: granitic gneiss, schist, sandstone, and limestone
Parent Material Origin: alluvial
Surface Texture Group: gravelly loam
Subsurface Texture Group: very gravelly clay loam and very gravelly sandy clay loam

Figure 4. A road-cut exposing a soil profile that fits the Gravelly Terraces site concept. Note that this soil includes shale-derived materials (tan/gray in

color) toward the bottom of the profile.

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Residuum–shale
Surface texture	(1) Gravelly loam
Family particle size	(1) Loamy-skeletal
Drainage class	Well drained
Permeability class	Slow
Soil depth	152–508 cm
Surface fragment cover <=3"	50–80%
Surface fragment cover >3"	10–40%
Available water capacity (0-152.4cm)	11.43–19.05 cm
Calcium carbonate equivalent (0-152.4cm)	0–20%
Electrical conductivity (0-152.4cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-152.4cm)	0–2
Soil reaction (1:1 water) (0-152.4cm)	6.6–8.4
Subsurface fragment volume <=3" (0-152.4cm)	20–50%
Subsurface fragment volume >3" (0-152.4cm)	15–30%

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 correlations to legacy ecological sites section below). With respect to the imperfect alignment of such correlations, be aware of these shortcomings in their applicability to conservation planning.

The Gravelly Terraces ecological site is usually dominated by short grasses, but also contains a mix of shrubs, forbs, and often trees. As is typical of plant communities, pronounced annual variations in precipitation translate to considerable short-term fluctuations in annual production within a given plant community phase.

There are numerous variables which affect the range of characteristics for this ecological site. Variables such as elevation, latitude, and orographic effects create a climatic gradient which influence the distribution of C3 and C4 plants. Soil properties such as surface texture, depth to clay layer, parent material, and accumulated salts affect species diversity and composition. Natural disturbances such as drought and wildfire affect species density and cover. The climate gradient across the CP LRU shows a greater distribution of C3 plants such as western wheatgrass and bottlebrush squirreltail where temperatures are cooler, and moisture is more abundant.

Fire is a disturbance regime that reduces succulents and shrubs while stimulating grasses and forbs. Not all fires are equal. According to Gebow (2001), fire effects in the same location will vary, especially with fire timing, both seasonally and within the scheme of year-to-year moisture variation. Precipitation during seasons before and after fire has a major effect on 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.

Grazing pressure will tend to favor grasses such as blue grama and purple threeawn as well as shrubs such as broom snakeweed and fringed sagebrush.

Correlation to Current Ecological Sites:
The Gravelly Terraces is currently correlated to the MLRA 70A Gravelly Upland ecological site (R070AY016NM) in San Miguel and Mora Counties, and to the MLRA 77B Gravelly ecological site (R077BY009NM) in Colfax County. Of the two, R077BY009NM seems to be the most applicable—even though it was apparently developed in another MLRA. Oddly, R070AY016NM appears to have been developed based on plant community data from warmer (thermic) areas. For example, the reference state for R070AY016NM lists sand bluestem as a dominant plant. While neither legacy ESD is perfectly applicable to the current site, these two legacy documents include useful information.

Gravelly Upland (R070AY016NM) tables
Annual production by plant type
Plant Type----------Low(Lb/Acre)-------Representative Value(Lb/Acre) -------High(Lb/Acre)
Grass/Grasslike----------456----------700----------988
Shrub/Vine----------48----------150----------208
Forb----------48----------87----------104
Total----------552----------937----------1300

Community 1.1 plant community composition
Common Name-------Symbol-------Scientific Name-------Annual Production (Lb/Acre)
GRASS/GRASSLIKE
1 blue grama----------BOGR2-------*Bouteloua gracilis*----------55–105
vine mesquite----------PAOB---------*Panicum obtusum*----------30–77
plains muhly----------MUCU3-------*Muhlenbergia cuspidata*----18–65
ring muhly----------MUTO2-------*Muhlenbergia torreyi*--------18–65
spike muhly----------MUWR--------*Muhlenbergia wrightii*-------18–65
buffalograss----------BODA2--------*Bouteloua dactyloides*-------18–65
2-------Tall Warm Season-------90–260
alkali sacaton----------SPAI----------*Sporobolus airoides*----------55–105
3-------Tall Cool Season Stolon-------200–600
western wheatgrass----PASM---------*Pascopyrum smithii*----------115–154
4-------Mid warm season stolon-------30–130
galleta grass----------PLEUR12-----Pleuraphis----------30–77
5-------Tall warm season-------30–130
sideoats grama----------BOCU---------*Bouteloua curtipendula*------30–130
6-------Short Coarse warm season-------10–2
threeawn----------ARIST---------Aristida----------18–35
eastern bottlebrush grass-ELHYH-----*Elymus hystrix* var. hystrix---10–23
SHRUB/VINE
7-------Mid palatable drought tolerant-------30–130
fourwing saltbush-------ATCA2-------*Atriplex canescens*----------30–77
8-------short high protein-------18–35
winterfat----------KRLA2-------*Krascheninnikovia lanata*-------18–35
9-------Low durable deciduous-------18–35
Gambel oak----------QUGA-------*Quercus gambelii*----------18–35
11-------Cactus 12–52
tree cholla----------CYIM2------*Cylindropuntia imbricata*--------6–32
cactus apple----------OPEN3------*Opuntia engelmannii*----------6–32
13-------Wolf Berry-------6–26
Berlandier's wolfberry----LYBE--------*Lycium berlandieri*----------6–26
14-------Yucca-------6–26
soapweed yucca----------YUGL-------*Yucca glauca*----------3–26
15-------Sagewort-------3–26
field sagewort----------ARCA12-----*Artemisia campestris*----------3–26
FORB
10-------perennial forbs 6–13
hairy ragweed----------AMCA7------*Ambrosia canescens*----------10–30
globemallow----------SPHAE-------Sphaeralcea----------10–30

buckwheat----------ERIOG-------Eriogonum----------3–26
Wright's spiderwort-------TRWR-------*Tradescantia wrightii*----------6–13
TREE
12------- Juniper 6–32
Rocky Mountain juniper--JUSC2-------*Juniperus scopulorum*----------6–32

Gravelly (R077BY009NM) tables
Annual production by plant type
Plant Type----------Low(Lb/Acre) --------Representative Value(Lb/Acre) --------High(Lb/Acre)
Grass/Grasslike--------183----------383----------584
Shrub/Vine----------33----------68----------104
Forb----------33----------68----------104
Total----------249----------519----------792

Community 1.1 plant community composition
Common Name--------Symbol--------Scientific Name--------Annual Production (Lb/Acre)
GRASS/GRASSLIKE
1--------Hairy Grama, Blue Grama, Ltle Blstm, Sideoats Gram--------79–105
sideoats grama----------BOCU--------*Bouteloua curtipendula*----------79–105
blue grama----------BOGR2-------*Bouteloua gracilis*----------79–105
copper fern----------BOHI---------*Bommeria hispida*----------79–105
little bluestem----------SCSC---------*Schizachyrium scoparium*-------79–105
2--------Wolftail--------16–26
common wolfstail--------LYPH--------*Lycurus phleoides*----------16–26
3--------New Mexico Feathergrass, Needleandthread----------53–79
needle and thread-------HECO2-----*Hesperostipa comata*----------53–79
New Mexico feathergrass-HENE5--*Hesperostipa neomexicana*-------53–79
4--------Threeawn spp. --------16–26
threeawn----------ARIST-------Aristida----------16–26
5--------Other Grasses--------16–26
Graminoid (grass or grass-like)-2GRAM-*Graminoid (grass or grass-like)*-16–26
FORB
6--------Prairie Coneflwr, Buckwht sp., Per Forbs, An For--------16–26
Forb, annual----------2FA---------- *Forb, annual*----------16–26
Forb, perennial----------2FP---------- *Forb, perennial*----------16–26
buckwheat----------ERIOG------Eriogonum----------16–26
upright prairie coneflower-RACO3----*Ratibida columnifera*----------16–26
SHRUB/VINE
7--------Yucca spp. --------16–26
yucca----------YUCCA------Yucca----------16–26
8--------Gambel Oak--------16–26
Gambel oak----------QUGA-------*Quercus gambelii*----------16–26
9--------Bigelow Sagebrush, Fringed Sagewort, Other Shrubs----------16–26
Shrub, deciduous----------2SD---------- *Shrub, deciduous*----------16–26
Bigelow sage----------ARBI3--------*Artemisia bigelovii*----------16–26
prairie sagewort----------ARFR4-------*Artemisia frigida*----------16–26

The following are excerpts from soil survey manuscripts:

From San Miguel County (NM630): Tinaja gravelly loam, hilly map unit
The potential plant community on this unit is mainly sideoats grama, blue grama, little bluestem, and New Mexico feathergrass. As the range deteriorates, the proportion of the desirable forage plants decreases and the proportion of threeawn, wolftail, blue grama, and Gambel oak increases. Oneseed juniper invades. Grazing management should be designed to increase the productivity and reproduction of sideoats grama, little bluestem, and New Mexico feathergrass.

From the Mora (NM638) and San Miguel manuscript descriptions for Tinaja gravelly loam, moderately steep:
The potential natural plant community on this unit is mainly sideoats grama, blue grama, little bluestem, hairy

grama, and New Mexico feathergrass. As the potential natural plant community deteriorates, sideoats grama, little bluestem, and New Mexico feathergrass decrease and the blue grama forms a dense, low turf. Plants that occur in the potential natural plant community in smaller amounts such as ring muhly, wolfstail, threeawn, broom snakeweed, fringed sagebrush, and oneseed juniper increase. Grazing management should be designed to increase the vigor, productivity, and reproduction of sideoats grama, New Mexico feathergrass, and little bluestem. The average annual production of air-dry vegetation on this unit ranges from 1,150 pounds per acre in favorable years to 450 pounds in unfavorable years

State and transition model

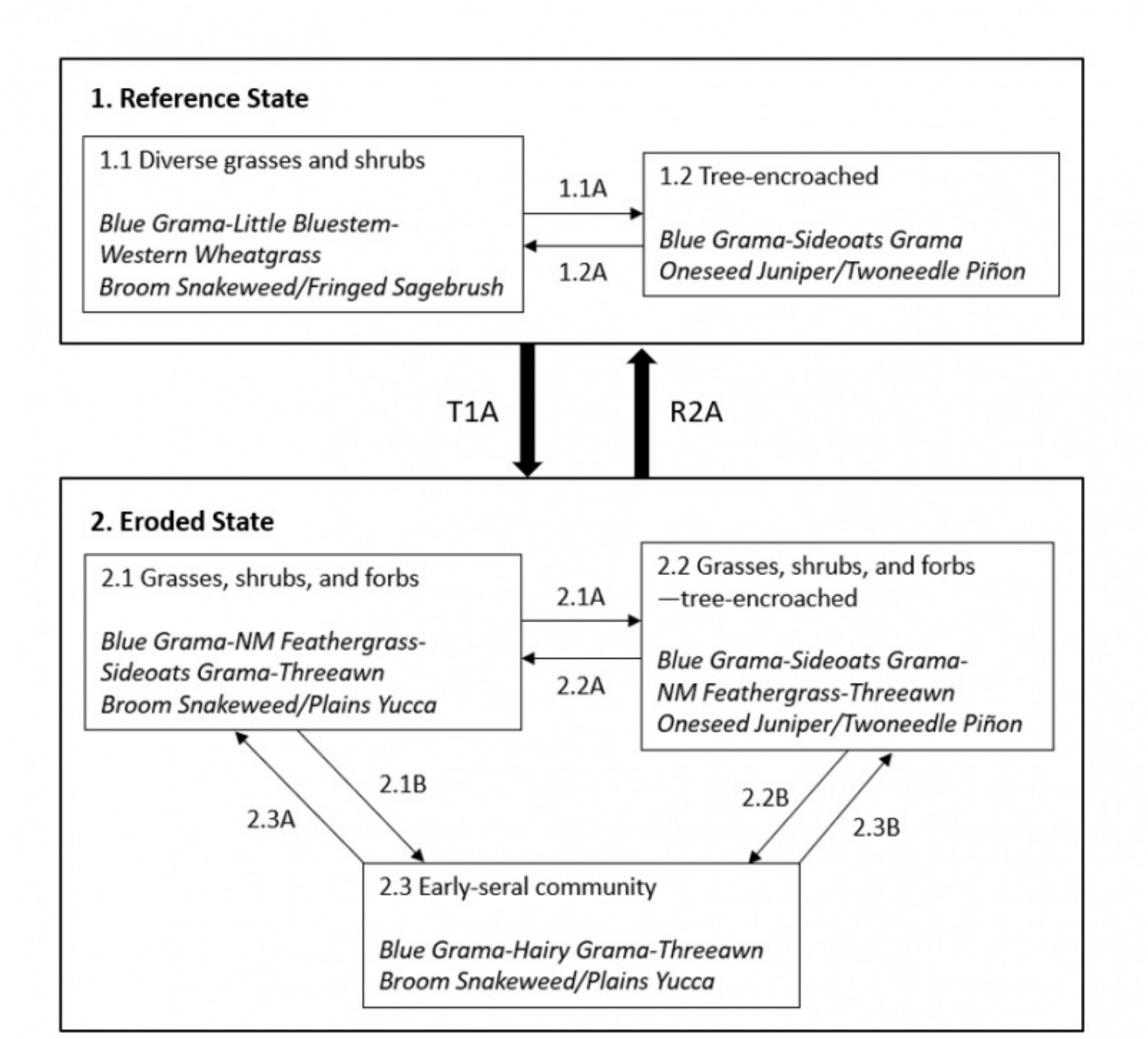


Figure 5. State and transition model diagram for the Gravelly Terraces ecological site.

State 1
Reference State

This state occurs where topsoil has remained relatively stable for a very long period. These stable soils exhibit thick dark surface horizons (meeting mollic criteria) that lack free carbonates (no reaction to HCl). Conversely, State 2 is characterized by a truncated soil with free carbonates at the surface (frothy reaction to HCl). Where the Gravelly Terraces ecological site occurs on the shoulders of actively eroding escarpments, there is generally a strip of highly

eroded Tinaja soil somewhere on the escarpment. In this scenario, it is not uncommon for States 1 and 2 to occur on the same slope—with State 2 subtending State 1. The presence of intact topsoil is ecologically important here for several reasons. First, it is usually lower in clay and higher in organic matter than the subsoil. This translates to higher potential plant available water in the rooting zone of many plants—particularly of herbaceous species. Second, the argillic (higher clay) horizon below the topsoil serves as a temporary aquitard which perches water in the topsoil during/after precipitation events. Third, the original topsoil has been leached of carbonates—giving it a relatively neutral pH. This, coupled with higher organic matter translates to higher availability of many essential plant nutrients. Lastly, this topsoil serves as a seedbank.

Community 1.1
1.1 Diverse grasses and shrubs

Figure 6. Community 1.1 on the riser of a strath terrace in San Miguel County, March 2017. State 1 occurs on the vegetated terrain above the cut. Note the thick topsoil exposed in the cut, and the grass-dominated plant community above.

This community is dominated by grasses, but also contains shrubs, and forbs, and the occasional tree. Foliar cover is approximately 80 percent, and bare ground is typically less than 5 percent—due largely to a preponderance of surface fragments. Total canopy cover of grasses ranges from 35 to 60 percent. Shrub cover ranges from 5 to 10 percent. Annual production averages around 1,500 pounds per acre, but varies considerably in response to annual weather patterns. This community generally occurs where season-long grazing has not been practiced in a number of years. Blue grama is the dominant grass. Palatable species such as little bluestem and western wheatgrass are well-represented. The shrub community is usually dominated by broom snakeweed and/or fringed sagebrush. Oneseed juniper and twoneedle pinyon are the tree species that can inhabit this phase, albeit in small numbers. It should be noted that all of the plant communities observed on the Gravelly Terraces ecological site showed evidence of a history of continuous grazing, and Community Phase 1.1 probably does not reflect pre-Columbian conditions.

Dominant plant species

- broom snakeweed (*Gutierrezia sarothrae*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- blue grama (*Bouteloua gracilis*), grass

Community 1.2
Tree-encroached

Figure 7. Community 1.2 in Mora County, October 2017.

In this community, trees have gained a competitive advantage, and may even dominate the plant community. Foliar cover is approximately 60 percent, and bare ground is typically less than 5 percent—due largely to a preponderance of tree litter and surface fragments. Total canopy cover of trees ranges from 5 to 40 percent. Total canopy cover of grasses ranges from 10 to 40 percent. Shrub cover is typically around 5 percent. Annual production averages around 1,000 pounds per acre, but varies considerably in response to annual weather patterns and the degree of tree dominance. This community occurs where fire has been absent for a number of years. Oneseed juniper and twoneedle pinyon are the most common tree species. Blue grama typically dominates the grass community, but sideoats grama, silvery bluestem, and wolfstail are also common. The shrub community is often diverse, and includes Plains pricklypear, Gambel oak, fringed sagebrush, and skunkbush sumac.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- twoneedle pinyon (*Pinus edulis*), tree
- plains pricklypear (*Opuntia polyacantha*), shrub
- Gambel oak (*Quercus gambelii*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- broom snakeweed (*Gutierrezia sarothrae*), shrub
- blue grama (*Bouteloua gracilis*), grass

Pathway 1.1A
Community 1.1 to 1.2

1.1 Diverse grasses and shrubs

Tree-encroached

This pathway represents the encroachment of tree species. The most likely mechanisms are season-long grazing providing little rest and recovery for preferred grazed plants during critical growing periods, coupled with high utilization, along with fire suppression.

Pathway 1.2A
Community 1.2 to 1.1

Tree-encroached

1.1 Diverse grasses and shrubs

This pathway represents tree mortality caused by fire, mechanical treatment, or perhaps herbicide application.

State 2
Eroded State

This state occurs where topsoil has been removed—generally by water erosion. Here, a subsoil that is higher in clay and lower in organic matter now resides at or near the soil surface. This translates to reduced infiltration rates and to lower potential plant available water than in State 1. In most cases, the subsoil contains significant amounts of free carbonates—both as masses in the soil matrix and coatings on rock fragments. When exposed at the soil surface, this calcareous material selects for certain plant species that are generally absent in State 1. Most notably, New Mexico feathergrass is quite prominent in two of the three phases of State 2.

Community 2.1
Grasses, shrubs, and forbs

Figure 8. Community 2.1 in Mora County, September 2017. The prominent bunchgrass is New Mexico feathergrass, and the flowering sub-shrub is broom snakeweed. The fragments exposed at the surface here are coated with carbonates.

This community is dominated by grasses, but also contains shrubs, and forbs, and the occasional tree. Foliar cover is approximately 70 percent, and bare ground is typically less than 15 percent—due largely to a preponderance of surface fragments. Total canopy cover of grasses ranges from 35 to 60 percent. Shrub cover ranges from 10 to 30 percent. Annual production averages around 1,300 pounds per acre, but varies considerably in response to annual weather patterns. Blue grama, New Mexico feathergrass, and sideoats grama are the dominant grasses. Purple threeawn and wolfstail are typically well-represented. Western wheatgrass is generally absent. The shrub community is usually dominated by broom snakeweed and/or fringed sagebrush. Oneseed juniper and twoneedle pinyon are the tree species that can inhabit this phase, albeit in small numbers.

Dominant plant species

- broom snakeweed (*Gutierrezia sarothrae*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- blue grama (*Bouteloua gracilis*), grass
- sideoats grama (*Bouteloua curtipendula*), grass
- New Mexico feathergrass (*Hesperostipa neomexicana*), grass

Community 2.2
Grasses, shrubs, and forbs—tree-encroached

Figure 9. Community 2.2 in Mora County, September 2017. Twoneedle piñon and oneseed juniper are codominant here. Blue grama, New Mexico feathergrass, and sideoats grama are the dominant grasses.

This community occurs on eroded sites where tree encroachment has not been countered by phenomena such as fire and chemical/mechanical treatments. Grasses are either dominant or codominant to trees. Foliar cover is approximately 70 percent, and bare ground is typically less than 15 percent—due largely to a preponderance of surface fragments. Total canopy cover of grasses ranges from 30 to 50 percent. Shrub cover ranges from 10 to 30 percent. Annual production averages around 1,000 pounds per acre, but varies considerably in response to annual weather patterns. Blue grama, New Mexico feathergrass, and sideoats grama are the dominant grasses. Early-seral grasses such as purple threeawn, sleepygrass, and silvery bluestem are typically well-represented. Western wheatgrass is generally absent. Oneseed juniper and twoneedle pinyon are the most common tree species. The shrub community is usually dominated by broom snakeweed and/or fringed sagebrush

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- twoneedle pinyon (*Pinus edulis*), tree
- broom snakeweed (*Gutierrezia sarothrae*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- blue grama (*Bouteloua gracilis*), grass
- New Mexico feathergrass (*Hesperostipa neomexicana*), grass
- sideoats grama (*Bouteloua curtipendula*), grass

Community 2.3
Early-seral community

Figure 10. Community 2.3 in Mora County, August 2017. Note the preponderance of broom snakeweed here.

Figure 11. Community 2.3 in Mora County, October 2018.

This community is dominated by grasses, but shrubs may achieve codominance in some cases. Foliar cover is approximately 65 percent, and bare ground is typically less than 15 percent—due largely to a preponderance of surface fragments. Total canopy cover of grasses ranges from 30 to 60 percent. Shrub cover ranges from 10 to 35 percent. Annual production averages around 1,100 pounds per acre, but varies considerably in response to annual weather patterns. Blue grama and sideoats grama are the dominant grasses. Early-seral grasses such as purple threeawn, sleepygrass, and silvery bluestem are typically well-represented. Western wheatgrass is generally absent. The shrub community is usually dominated by broom snakeweed and/or fringed sagebrush. Oneseed juniper and twoneedle pinyon are the tree species that can inhabit this phase, albeit in small numbers.

Dominant plant species

- broom snakeweed (*Gutierrezia sarothrae*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- blue grama (*Bouteloua gracilis*), grass
- sideoats grama (*Bouteloua curtipendula*), grass

Pathway 2.1A
Community 2.1 to 2.2

Grasses, shrubs, and forbs

Grasses, shrubs, and forbs—tree-encroached

This pathway represents the encroachment of tree species. The most likely mechanisms are season-long grazing providing little rest and recovery for preferred grazed plants during critical growing periods, coupled with high utilization, along with fire suppression.

Pathway 2.1B
Community 2.1 to 2.3

Grasses, shrubs, and forbs

Early-seral community

This pathway represents the drastic reduction or extirpation of New Mexico feathergrass. This could be expected where heavy, continuous grazing occurs in the late spring—during seed-set of New Mexico feathergrass.

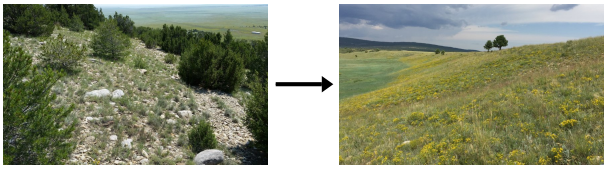
Pathway 2.2A
Community 2.2 to 2.1

Grasses, shrubs, and forbs—tree-encroached

Grasses, shrubs, and forbs

This pathway represents a drastic reduction in tree cover. Fire, herbicide application, and mechanical treatments are thought to be the most common mechanisms.

Pathway 2.2B
Community 2.2 to 2.3



Grasses, shrubs, and forbs—tree-encroached

Early-seral community

This pathway represents the drastic reduction or extirpation of New Mexico feathergrass, coupled with the reduction or elimination of tree species. This could be expected where heavy, continuous grazing occurs in the late spring—coupled with tree-killing processes such as those outlined in 2.2A.

Pathway 2.3A
Community 2.3 to 2.1

Early-seral community

Grasses, shrubs, and forbs

This pathway represents the re-emergence of New Mexico feathergrass as a dominant species. This seems most likely where grazing is curtailed during the late spring.

Pathway 2.3B
Community 2.3 to 2.2

Early-seral community

Grasses, shrubs, and forbs—tree-encroached

This pathway represents the encroachment of tree species. The most likely mechanisms are season-long grazing providing little rest and recovery for preferred grazed plants during critical growing periods, coupled with high utilization, along with fire suppression.

Transition T1A
State 1 to 2

Significant water erosion removes much of the original topsoil, exposing subsurface horizons that contain free carbonates. Mechanisms for this event are varied. Active erosion of shale-derived soils on escarpment positions

can lead to head-cutting into the Gravelly Terraces site. Excessive grazing on the Gravelly Terraces can also lead to erosion here. It is also possible that a high intensity fire could create a hydrophobic soil surface, which would promote runoff and attendant erosion.

Restoration pathway R2A
State 2 to 1

This pathway represents the genesis of a layer of thick, organic-rich topsoil. Theoretically, this pathway would proceed most rapidly from Community Phase 2.1—where relatively high herbaceous production would favor the accumulation of soil organic matter. Barring expensive and high-energy inputs such as trucking-in topsoil, this restoration pathway will be quite slow. It would involve the accumulation of large amounts of soil organic matter, the leaching and neutralization of carbonates from the upper soil, and the illuviation of significant amounts of clay from the upper soil. These pedogenic processes cannot be expected to produce State 1 conditions on the scale of a human lifespan.

Additional community tables

Animal community

From R070AY001NM
The Gravelly Terraces ecological site provides habitats which support a resident animal community that is characterized by pronghorn antelope, badger, black-tailed jackrabbit, black-tailed prairie dog, thirteen-lined ground squirrel, prairie pocket gopher, marsh hawk, burrowing owl, horned lark, meadowlark, scaled quail, prairie rattlesnake, Great Plains toad, and ornate box turtle. The prairie falcon hunts yearlong over these habitats. These short grass sites are breeding areas for the long-billed curlew, upland plover, and lark bunting.

Hydrological functions

Soil Hydrology
The Gravelly Terraces 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 elevated terraces, it tends to contribute water (via through-flow or run-off) to sites lower in the catena. In most cases, the Slopes ecological site directly subtends the Gravelly Terraces ecological site—the former receiving extra moisture from the latter. In some cases, the Gravelly Terraces ecological site immediately overlies fan remnants. In this scenario, the Limy and Clayey Flats ecological sites are the most common recipients of the extra moisture. The Low Terraces, Ephemeral Drainageways, and Riparian ecological sites commonly receive additional moisture from the Gravelly Terraces ecological site, albeit indirectly, as other upland sites invariably occur between Gravelly Terraces and water-collecting landforms.

Wood products

Tree-encroached phases support stands of oneseed juniper and twoneedle pinyon.

Other information

Future Work:
The Tinaja soil series, which correlates to the Gravelly Terraces ecological site is not mapped to its full extent in the existing soil survey data set. During soil survey update work, efforts should be made to identify and delineate Tinaja and similar soils. Such work would add to our dataset for the Gravelly Terraces site, and would surely strengthen this ESD.

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Other references

Cleland, D.T.; Freeouf, J.A.; Keys, J.E., Jr.; Nowacki, G.J.; Carpenter, C; McNab, W.H. 2007. Ecological

Subregions: Sections and Subsections of the Conterminous United States.[1:3,500,000], Sloan, A.M., cartog. Gen. Tech. Report WO-76. Washington, DC: U.S. Department of Agriculture, Forest Service.

Gebow, B. S., 2001. Search, Compile, and Analyze Fire Literature and Research Associated with Chihuahuan Desert Uplands, Tucson: The University of Arizona.

Griffith, G.E.; Omernik, J.M.; McGraw, M.M.; Jacobi, G.Z.; Canavan, C.M.; Schrader, T.S.; Mercer, D.; Hill, R.; and Moran, B.C., 2006. Ecoregions of New Mexico (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,400,000).

Kuchler, A.W. 1964. Potential Natural Vegetation of the Conterminous United States. American Geographical Society, Special Publication No. 36

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296.

United States Department of Agriculture, Natural Resources Conservation Service. 1977. Soil survey of San Miguel County, New Mexico.
https://www.nrcs.usda.gov/wps/portal/nrcs/soilsurvey/soils/survey/state/

United States Department of Agriculture, Natural Resources Conservation Service. 1981. Soil survey of Mora County, New Mexico.
https://www.nrcs.usda.gov/wps/portal/nrcs/soilsurvey/soils/survey/state/

Contributors

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Approval

Curtis Talbot, 10/01/2021

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	05/18/2024
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:**

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

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

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

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

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

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

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

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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:**