Ecological site R042CY995NM
Deep Sand Savanna 13-16 P.Z.

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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): 042C–Central New Mexico Highlands

This MLRA lies within the Sacramento Section of the Basin and Range Province of the Intermontane Plateaus. It is characterized by block-faulted ranges separated by intermountain basins. Tablelands and mesas are capped by sedimentary rocks. Many local terraces are near small streams. Steep escarpments and breaks are common. Elevation generally ranges from 5,000 to 7,400 feet (1,525 to 2,255 meters). In some mountainous areas, however, it is more than 8,500 feet (2,590 meters).

Ecological site concept

Sand sheets on relatively low relief areas, plateaus, plains, even some foothills areas. Sand sheets can cover a variety of landforms but when deep enough, provide the overriding interpretation for the ecological site. Well drained to excessively drained soils with a variety of plant communities adapted to sandy environments. Susceptibility to wind erosion is a major resource concern, especially since that is how these sites originated, via wind erosion of materials from a source nearby.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia filifolia*
Herbaceous	(1) *Andropogon hallii* (2) *Schizachyrium scoparium*

Physiographic features

This site occurs as coarse-textured eolian and alluvial sediments on upland plains. Slopes are nearly level to gently undulating, generally less than 5 percent. Low stabilized hummocks or dunes may occur. Exposure varies but is not significant. Elevations range from 4,500 to 7,200 feet above sea level.

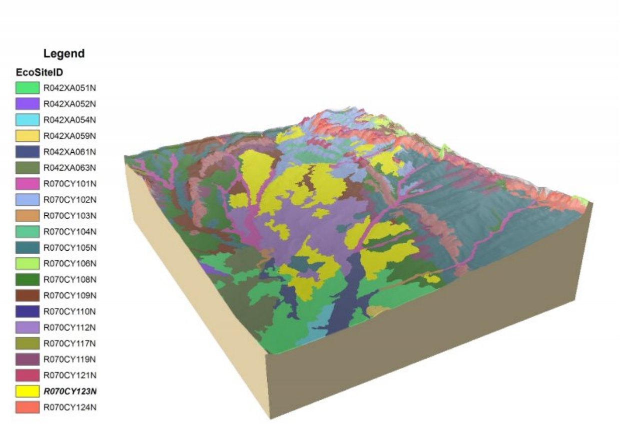


Figure 1.

Table 2. Representative physiographic features

Landforms	(1) Plain (2) Sand sheet
Elevation	1,372–2,195 m
Slope	0–5%
Aspect	Aspect is not a significant factor

Climatic features

The climate of the area is “semi-arid continental.”

The average annual precipitation ranges from 13 to 16 inches. Variations of 5 inches, more or less, are common. Seventy-five percent of the precipitation falls from April to October. Most of the summer precipitation falls in the form of high-intensity, short-duration thunderstorms.

Distinct seasonal changes and large annual and diurnal temperature changes characterize temperatures. The average annual temperature is about 50 degrees F with extremes of –29 degrees F in the winter and 103 degrees F in the summer.

The average frost-free season is 130 to 160 days. The last killing frost falls in early May and the first killing frost in early October.

Both temperature and precipitation favor warm-season, perennial plant species. However, about 40 percent of the precipitation falls at a time favorable for cool-season plant growth. This allows the cool-season species to occupy an important component in this site. Because of the coarse texture of the soil, the plant community can respond rapidly to any precipitation during the frost-free season. Strong winds blow from February to June, drying the soil during a critical stage for plant growth and causing the soil to blow, which can damage plants.

Climate data was obtained from http://www.wrcc.sage.dri.edu/summary/climsmnm.html web site using 50% probability for freeze-free and frost-free seasons using 28.5 degrees F and 32.5 degrees F respectively.

Table 3. Representative climatic features

Frost-free period (average)	171 days
Freeze-free period (average)	152 days
Precipitation total (average)	381 mm

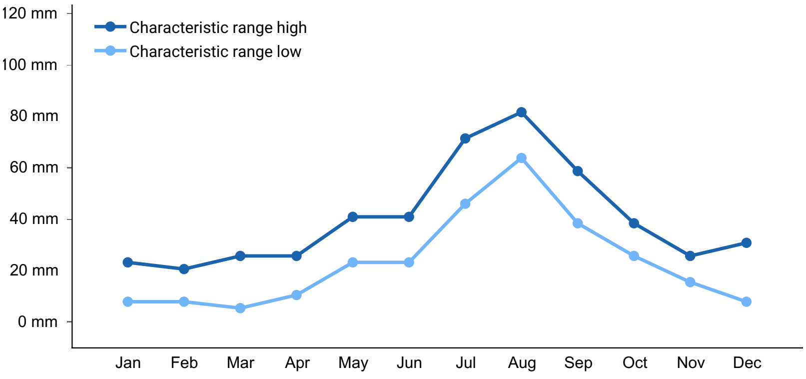


Figure 2. Monthly precipitation range

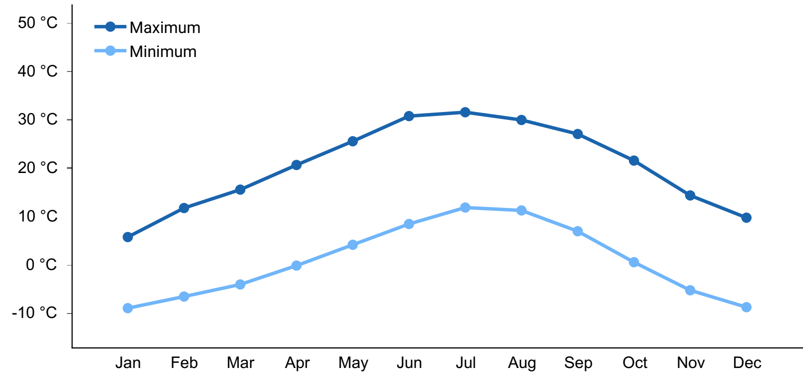


Figure 3. Monthly average minimum and maximum temperature

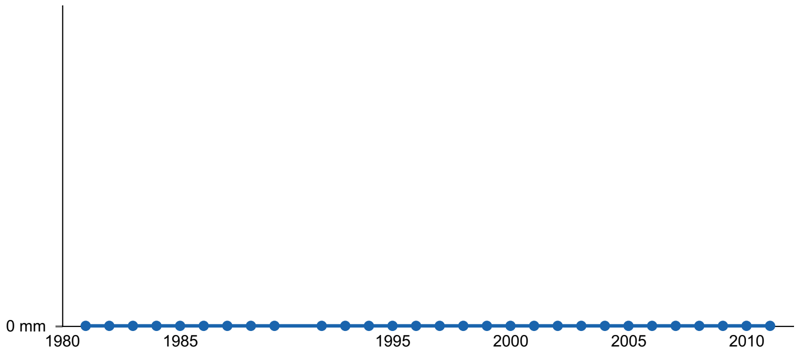


Figure 4. Annual precipitation pattern

Influencing water features

This site is not influenced by water from a wetland or stream.

Soil features

The soils on this site are deep and excessively drained. The surface textures are of loamy fine sand or fine sandy loams that extend to a depth of 60 inches or more. The soils are rapidly permeable and have a low water-holding capacity. Surface runoff is very slow. Drying of the surface is fast and soil-blowing hazard is high.

The following are a few soil series from which components may be correlated to this site.
Flugle
Mespun
Otero
Palma
Trail

Table 4. Representative soil features

Parent material	(1) Eolian sands–sandstone (2) Eolian deposits
Surface texture	(1) Loamy fine sand (2) Fine sandy loam (3) Loamy sand
Family particle size	(1) Loamy
Drainage class	Well drained to excessively drained
Permeability class	Moderately slow to rapid
Soil depth	183 cm
Available water capacity (0-101.6cm)	7.62–15.24 cm
Electrical conductivity (0-101.6cm)	0–4 mmhos/cm
Soil reaction (1:1 water) (0-101.6cm)	6.1–8.4
Subsurface fragment volume <=3" (Depth not specified)	15–35%
Subsurface fragment volume >3" (Depth not specified)	15–35%

Ecological dynamics

A state-and-transition model was developed using archeological and historical data, professional experience, expert and scientific knowledge. A brief summary of the information used is included here. The model was refined using professional experience and expert knowledge gained over the last 22 years of working on this ecological site. Scientific knowledge gained from the long term and expanded studies (Shaver 2010b) and the scientific and historical literature was also used.

In the early 1600's Gran Quivira (Jumano Pueblo) may have had as many as 1000 inhabitants. These people traded with the Pueblo peoples in the Rio Grande valley to the west, the Comanche in the east and the Apache in the south. Vivian (1961) quotes Spanish documents in which Nicolas de Aguilar, a Spanish "Encomendero", in 1663 states:
"It has never been possible to keep livestock in said Pueblo because there is not water, for what there is comes only from wells which are a quarter of a league (~850 – 900 m) from the place, forty or fifty estados (~70 - 85 m) in depth. And therefore it costs a great deal to get water and it makes a lot of work for the Indians in obtaining it, and the wells are exhausted and there is an insufficient water supply for the people, for their lack of water is so great they are accustomed to save their urine to water the land and to build walls."

Excavations of the ruin of Gran Quivira show that over half of the animal bones found were blacktailed jackrabbit (Lepus californicus) and pronghorn antelope (Antilocapra americana). Cottontail rabbits (Sylvilagus auduboni), domestic and wild sheep (Ovis spp), mule deer (Odocoileus hemionus), domestic horse (Equus caballus) and bison (Bison bison) were also present in much smaller amounts. Trace amounts of bones were found from various birds, cougar (Felis concolor), Gray fox (Urocyon cinereoargenteus) and black-tailed prairie dog (Cynomys ludovicianus) (Vivian 1961). The indication is that native herbivory prior to European influence, and even after Spanish reconquest and colonization in 1692, was mainly by lagomorphs and pronghorn antelope.

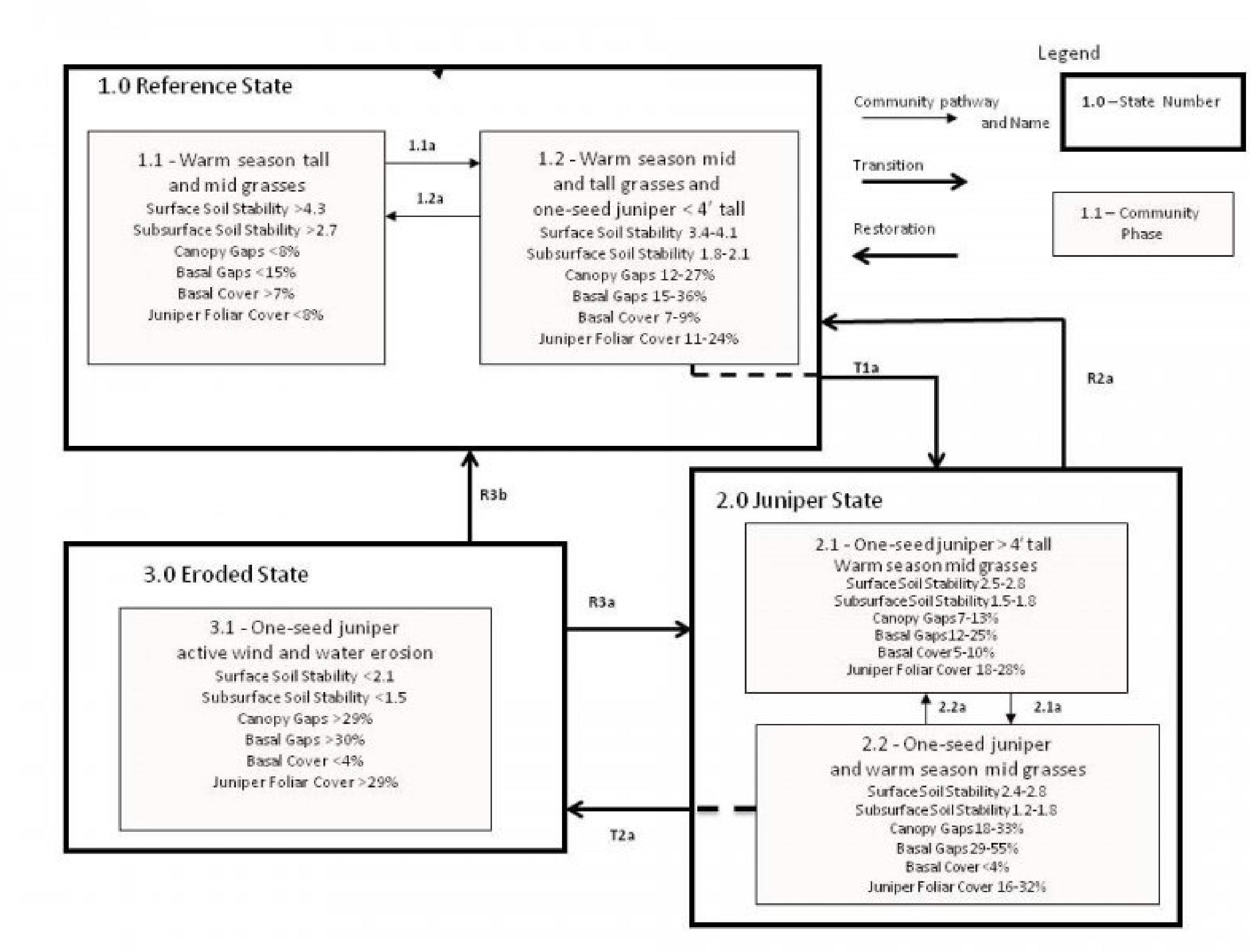
This area has historically been described as grassland with few junipers dotting the landscape. One-seed juniper (*Juniperus monosperma* (Engelm.) Sarg) was confined to ridge tops and the foot slopes of adjoining mountains (Bandelier 1884, Horgan 1954, McLeullough 1982). While not specific to the peoples of the Jumano Pueblo, Stewart (2002) states that the Apache, Navajo and Pueblo inhabitants of this area used fire as a management tool for hunting, to draw game into the area, for clearing crop fields and to increase the yield of grass seeds used for grain. Other authors support this contention with fire frequencies for the area ranging from 4 – 20 years (Allen 1989, Baisan and Swetnam 1997, and Frost 1998). This fire regime would be frequent enough to create and maintain a grassland aspect and herbaceous dominated plant community. Wright (1990) indicated that fires every 10 – 30 years kept juniper on shallow, rocky, rough places. He also indicated that non-sprouting junipers less than four feet tall are readily killed by ground fires of herbaceous fuel. Dwyer and Pieper (1967) show that one-seed juniper less than four feet tall were killed with a ground fire.

Given this description, it is very unlikely that large numbers of domesticated or wild animals were grazing in this region until the Anglo expansion into New Mexico occurred in the mid 1800's. It is estimated that there were several hundred thousand head of sheep in New Mexico from 1788 onward to about 1870 (Denevan 1967). Domestic livestock grazing increased rapidly following Anglo expansion. From 1870 to 1890 sheep numbers increased to around 5 million state wide (Denevan 1967). Cattle numbers were approximately 137,000 in 1880 and reached 1.3 million by 1889. Numbers of sheep and cattle increased from the 1880?s to the end of World War I and have been decreasing since 1920 (Schickedanz 1980). In 1906 there were approximately 1 million cattle and 6 million sheep in New Mexico. By 1979, cattle had increased to 1.5 million, while sheep had decreased to 600,000. This increase in livestock numbers undoubtedly impacted the natural disturbance regime of frequent fires and low levels of herbivory. Many studies have linked juniper expansion to increased livestock and decreased fire frequency (Jameson 1962, Johnsen 1962, Arnold 1964, Arnold et al. 1964, White 1965, Jameson 1967, Jameson 1970, Clary and Jameson 1981, and Pieper 1983, Miller and Wigand 1994, Allen and Breshears 1998, Lanner and Van Devender 1998).
The historical information, the Deep Sand Savannah ecological site description, 070CY123NM (UDSA 2004), and existing data (Shaver 2010a, 2010b) indicate these physical and environmental conditions have led to ecological dynamics that have produced an ecological site characterized by tall and mid warm season grasses. Warm and cool season mid and short grasses were the sub-dominant plant functional groups on this ecological site. Observation indicates the forb component was variable depending on timing and amount of precipitation and with the season. The woody plant component was both spatially and temporally variable depending on time since the last fire, but was always a minor component of the plant community (Allen 1989, Baisan and Swetnam 1997, Frost 1998, Stewart 2002). The production of a continuous fine fuel load and resulting fires were important negative feedbacks that limited the abundance of the woody components and maintained an herbaceous dominance on the site. One-seed juniper trees less than four feet tall were readily killed by ground fire fueled by herbaceous fuels (Dwyer and Pieper 1967, Wright 1990). The resilience of the ecological site was maintained by the continued input of organic matter primarily from root turnover of the herbaceous species (Gill and Jackson 2000) and herbaceous litter. Development and maintenance of stable soil aggregates is a function of the interactions of soil microbes and organic inputs, and the continuation of herbaceous litter production and root turnover. The resulting soil aggregate stability is integral to the negative feedback mechanisms responsible for ecological resilience. High soil aggregate stability provides optimal rates of infiltration, water holding capacity, aeration and mineral cycling, which maintains herbaceous production. Herbaceous production provides for a uniform distribution of soil nutrients and water throughout the soil profile (Schlesinger et al. 1990). This uniform distribution maintains uniform organic matter inputs (Kemper and Koch 1966, Tisdall and Oades 1982, Goldberg et al. 1988, Topp et al. 1996, Bird et al. 2007) and strengthens the resilience of the site to the periodic fires that were necessary to control the establishment and increase of one-seed juniper.

As European settlement progressed, domestic livestock numbers increased rapidly and the resulting grazing pressure decreased fine fuel for fires (Savage and Swetnam 1990, Swetnam et al. In Press). One-seed juniper increased in density and cover with an increase in the time since the last fire, also causing a decrease in herbaceous production (Jameson 1962, Johnsen 1962, Arnold 1964, Arnold et al. 1964, White 1965, Jameson 1967, Jameson 1970, Clary and Jameson 1981, and Pieper 1983, Miller and Wigand 1994, Allen and Breshears 1998, Lanner and Van Devender 1998). Decreased herbaceous production caused a decline in organic matter inputs, resulting in lowered soil aggregate stability (Tisdall and Oades 1982). As herbaceous production and cover were reduced and bare ground and erosion increased, fine fuels for fire became inadequate and resilience was weakened. Soil moisture, nutrients and organic matter decreased in the interspaces and increased under the trees and shrubs (Padien and Lajtha 1992, Davenport et al. 1996, Weltzin and McPherson 1997, Breshears and Barnes 1999, Reid et al. 1999, Bird et al. 2002, McIntyre and Tongway 2005, Bestelmeyer et al. 2006 and Bird et al. 2007). The decreased herbaceous production and organic matter in the interspaces likely decreased soil aggregate stability, infiltration, water holding capacity and mineral cycling. As the redistribution of resources continued the strength of the feedback mechanisms began to shift and site resilience decreased.

Plant interspaces continued to lose resources resulting in a lower proportion of root biomass available for annual turnover (Gill and Jackson 2000) further concentrating resources under the one-seed juniper. Gill and Jackson (2000) discussed the difference in root turnover from grasses and shrubs and state that the turnover from woody plants is much less proportionately than that of grasses. When juniper increases, the resulting reallocation of underground resources is well documented (Padien and Lajtha 1992, Davenport et al. 1996, Weltzin and McPherson 1997, Breshears and Barnes 1999, Reid et al. 1999, Bird et al. 2002, McIntyre and Tongway 2005, Bestelmeyer et al. 2006 and Bird et al. 2007). This change develops abiotic feedback mechanisms controlled by wind and water erosion, leading to desertification that builds very strong resilience feedback mechanisms and resistance to change (Schlesinger et al. 1996, Whisenant 1999, Bestelmeyer et al. 2006).

State and transition model



State 1
Reference State

The reference state consist of two community phases, 1.1 and 1.2, each being maintained by frequent fire (6 - 20 years) and weather fluctuations (drought and wet years). Indicators: High perennial grass cover and production. Litter accumulation. Feedbacks: Organic matter inputs allow for increased soil moisture, production, root turnover and litter increasing soil surface stability. At-risk Community Phase: Either community phase is at risk when bare ground increases and organic matter inputs decline.

Community 1.1
Warm season tall and mid grasses

Figure 6. 1.1 Community Phase

This site has an open stand of pinyon and/or juniper with grass understory. Both warm/cool-season mid and tall grasses characterize the understory grasses with scattered shrubs throughout the site. Half-shrubs and forbs are a minor part of the plant community. The open stand of pinyon and juniper at one time may have been maintained by natural fire. The overstory tree canopy ranges from 10 to 25 percent. Other grasses that could appear on this site include: switchgrass, mesa dropseed, alkali sacaton, threeawns, sandhill muhly, purple lovegrass, ring muhly, bottlebrush squirreltail, western wheatgrass, plains bristlegrass, green sprangletop, littleseed ricegrass, and prairie junegrass. Other woody plants include: feather dalea, cholla spp., ephedra spp., winterfat, rubber rabbitbrush, broom snakeweed, fourwing saltbush, yucca, and algerita. Other forbs include: tansymustard, locoweed, redstem milkvetch, scarlet globemallow, mariola, sand verbena, goldenrod, and threadleaf groundsel.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	532	785	1260
Forb	90	163	269
Shrub/Vine	6	22	39
Total	**628**	**970**	**1568**

Table 6. Ground cover

Tree foliar cover	10-25%
Shrub/vine/liana foliar cover	2-5%
Grass/grasslike foliar cover	0%
Forb foliar cover	0%
Non-vascular plants	0%
Biological crusts	0%
Litter	5-10%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	50-60%

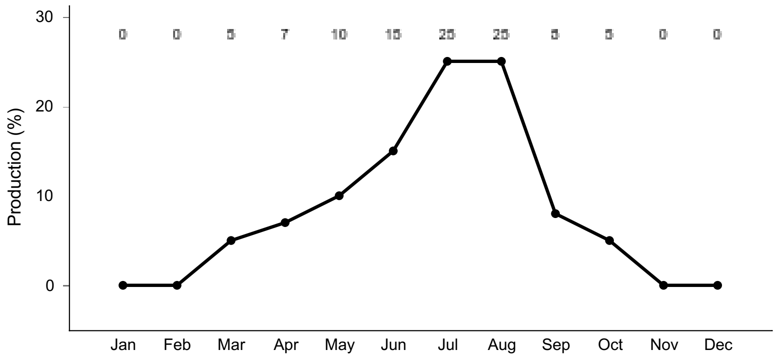


Figure 8. Plant community growth curve (percent production by month). NM4323, R070CY123NM Deep Sand Savanna Reference State. R070CY123NM Deep Sand Savanna Reference State Open stand of pinyon/uuniper w/mixed warm/cool-season mid and tall grass understory w/scattered shrubs. .

Community 1.2
Warm season mid and tall grasses/one-seed juniper < 4'

Community phases, 1.1 and 1.2, are both maintained by frequent fire (6 - 20 years) and weather fluctuations (drought and wet years). Indicators: High perennial grass cover and production. Litter accumulation. Feedbacks: Organic matter inputs allow for increased soil moisture, production, root turnover and litter increasing soil surface stability.

Pathway 1.1a
Community 1.1 to 1.2

Community Pathways: Characterized by time since last fire and fluctuations in weather. Community pathway 1.1a is driven by time since last fire or by a series of dry years followed by wet years. As time since the last fire increases the opportunity for juniper seedling establishment increases. A series of dry years that decreases herbaceous production, crown cover and organic matter input into the soil, when followed by a wet cycle allow opportunity for juniper seed germination and establishment. Juniper seedlings may increase in response to disturbances such as a series of dry years followed by wet years, or an interuption or delayed period from the normal fire frequency. A normal fire frequency allows ground fires to remove juniper seedlings and other established woody plants less than 1.5 metere in height. The site shifts back to community phase 1.1. As time since the last fire increased, the one-seed juniper increases size and number and the site moves towards community phases 1.2. The negative feedback mechanisms associated with site resilience weakened. Positive feedbacks associated with degradation increased, making this the at-risk community phase in the Reference State.

Pathway 1.2a
Community 1.2 to 1.1

This community pathway is driven by fire. Fire frequency allows for ground fires that remove juniper seedlings and established plants less than 1.5 meters tall. Community pathway 1.2a represent the feedback mechanisms that maintain the resilience of the Reference State. As time since the last fire increased, the one-seed juniper in community phase 1.2 increased in sizes and number and the negative feedback mechanisms associated with site resilience weakened. Positive feedbacks associated with degradation increased, making this the at-risk community phase in the Reference State. The average surface stability ratings in community phase 1.2 was 3.7, well within the range for the Reference State, but the average subsurface stability rating was 1.9, at the lowest end of the Reference State range. Canopy gaps >200 cm and basal gaps >200 cm were 20% and 25% respectively, both within the range for the Reference State. Juniper foliar cover for nine transects averaged 21%, outside the range of the Reference State and within the range of the Juniper State indicating these transects are at risk of crossing an ecological threshold. As the one-seed juniper increased in size and density, soil and water resources began to concentrate under and around the juniper plants, reducing herbaceous production. This reduction in herbaceous production increased gap size, reduced fine fuel for fires and reduced organic matter inputs for soil aggregate stability. This agrees with Archer (1989) who suggested that changes to natural disturbance regimes might cause increases in woody plants. Bestelmeyer et al. (2006) showed that as the size of bare patches increased, aggregate stability decreased. Shaver (2010b) showed the results of herbicide treatment on these treated plots, although long lasting, were beginning to decline. This suggests that without the reintroduction of fire, the feedback mechanisms of increased organic matter inputs were not able to limit the increase or encroachment of one-seed juniper onto the site. The resilience of the Reference State was weakened and the processes of infiltration, nutrient cycle, aggregate stability and annual production were nearing a threshold into the Juniper State. Threshold values from the Reference State to the Juniper State for surface soil stability were between 3.4 and 2.8 and for subsurface soil stability at 1.8. Once the threshold was crossed, along the transition (T1a) the positive feedbacks for change become negative feedbacks strengthening the resilience of the Juniper State.

State 2
One-seed Juniper State

Juniper canopy cover controls the soil moisture, herbaceous production and organic matter inputs. Management practices applied to maintain current canopy cover and herbaceous production. Manipulation of brush species and prescribed fire and grazing management planned to maintain or improve warm season mid grass production. Indicators: Juniper canopy cover>15%, bare ground > 35% <50%. Feedbacks: Juniper use of moisture, decreasing herbaceous production, decreasing organic matter inputs. At-risk Community Phase: Either community phase is at risk if juniper seedling increase and canopy cover increases.

Community 2.1
One-seed juniper > 4' tall/warm season mid grasses

Figure 10. 2.1 Community Phase

On this ecological site, the data suggest that the herbicide treatment was necessary to restore the ecological function of the site and enable the feedback mechanisms to develop resilience within the restored state. The data also suggest that although the feedback mechanisms have persisted for 18 years, without the re-establishment of one or more properties or processes that limit the re-establishment of junipers, (such as frequent ground fires), site resilience is not strong enough to maintain the system in the Reference State. Surface soil stability proved to be a reliable indicator and predictor of state membership and provided indication of value ranges within states for itself and when combined with the other data elements, for those elements as well. The clear relationship between soil aggregate stability and gap size distribution is critical to understanding the feedback mechanisms responsible for site resilience. These relationships suggest that soil aggregate stability and gap size distribution can be incorporated into management systems and monitoring activities to ensure ecological function and vegetation structure in a state that provides the optimum in ecosystem services. This can provide decision makers the opportunity to manage the rangeland in a productive and sustainable manner. The understanding of resilience and the identification of feedback mechanisms and the change in dominance from negative to positive feedbacks is a powerful tool allowing managers to make decisions to maintain the desirable plant community function and structure before a threshold is crossed.

Table 7. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	370	476	657
Forb	112	336	448
Shrub/Vine	84	174	322
Total	**566**	**986**	**1427**

Community 2.2
One-seed juniper > 4' tall/at risk

Figure 12. Community Phase 2.2

Pathway 2.1a
Community 2.1 to 2.2

One-seed juniper > 4' tall/warm season mid grasses

One-seed juniper > 4' tall/at risk

Community Pathway 2.1a is characterized by prescribed burning, mechanical or chemical treatment of juniper, grazing and weather fluctuations. Juniper canopy increases with time since last fire or other management action to reduce juniper canopy. This increase in juniper canopy cover decreases shrub and herbaceous production and cover. Shrubs and tall grasses decrease or are eliminated. Drought years followed by wet years will allow for increase in juniper establishment.

Pathway 2.2a
Community 2.2 to 2.1

One-seed juniper > 4' tall/at risk

One-seed juniper > 4' tall/warm season mid grasses

Management actions that decrease juniper canopy and increase herbaceous and shrub production. These can include prescribed burning, chemical or mechanical brush management, while grazing management is aimed at increasing production.

State 3
Eroded State

Active wind and water erosion taking place. Indicators: Juniper canopy closed, soil surface stability indicators <3.0, active wind and water erosion prevalent. Feedbacks: Juniper use of all available moisture, eliminates organic matter inputs, decreases soil surface stability.

Community 3.1
One-seed juniper with active wind and water erosion

Figure 14. 3.1 Community Phase

One-seed juniper with active wind and water erosion.

Transition T1A
State 1 to 2

The trigger for this transition is the elimination of fire and overgrazing causing increase juniper canopy. The threshold values are as follows: Increasing bare ground > ??% and increase in juniper canopy cover to 15%. Slow variables and triggers for this transition are the elimination of fire due to decrease in fine fuels. The increasing canopies of juniper restrict or limit sunlight and moisturecritical for herbaceous cover. The threshold values are: surface stability < 3.4, basal cover < 7%, jniper foliar cover > 24%, and juniper > than 4' tall.

Restoration pathway R2A
State 2 to 1

Removal of juniper canopy cover to < 5% with minimal soil surface disturbance. Grazing management that increases herbaceous production and favors the establishment and growth of warm season tall and mid grasses is essential for success of this pathway.

Transition T2A
State 2 to 3

The trigger for this transition is the increase in juniper seedling establishment and/or juniper canopy cover. This is caused by management actions that lead to decreased herbaceous production and decreased organic matter inputs into the soil. This can also be caused by lack of management actions that actively reduce juniper canopy cover. Threshold values for this transaction are: Bare ground > 50% and soil surface stability <3.0.

Transition T2A
State 2 to 3

Slow variables and trigger for this transition are increase in juniper seedling establishment and juniper cover… caused by management actions that lead to decreased herbaceous production and decreased organic matter inputs…by lack of management actions that actively reduce juniper canopy cover…threshold values...surface soil stability <2.4, bare ground >40%, canopy gaps >30%, basal cover <4%.

Restoration pathway R3B
State 3 to 1

Management and restoration planned must decrease juniper canopy to <5%...little or no surface disturbance, management actions must increase herbaceous production…allow for litter accumulation…improve organic matter inputs to stabilize soil surface.

Restoration pathway R3A
State 3 to 2

Management and restoration practices planned must decrease juniper canopy to <5% with little or no surface disturbance, grazing must plan for increasing herbaceous production and allow for litter accumulation to improve organic matter inputs to stabilize soil surface.

Additional community tables

Table 8. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall Grasses, Dense**			280–448	
	little bluestem	SCSC	*Schizachyrium scoparium*	280–476	–
	sand bluestem	ANHA	*Andropogon hallii*	224–319	–
	big bluestem	ANGE	*Andropogon gerardii*	118–179	–
	Indiangrass	SONU2	*Sorghastrum nutans*	56–84	–
2	**Tall, Open**			56–280	
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	112–168	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	28–112	–
3	**Mid grasses**			45–112	
	sideoats grama	BOCU	*Bouteloua curtipendula*	45–112	–
4	**Midgrasses**			11–224	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	45–179	–
	spike dropseed	SPCO4	*Sporobolus contractus*	56–140	–
	giant dropseed	SPGI	*Sporobolus giganteus*	27–67	–
5				118–177	
	blue grama	BOGR2	*Bouteloua gracilis*	0–90	–
	needle and thread	HECO26	*Hesperostipa comata*	36–59	–
	James' galleta	PLJA	*Pleuraphis jamesii*	0–45	–
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	0–29	–
6				6–22	
	black grama	BOER4	*Bouteloua eriopoda*	59–118	–
7				6–22	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	6–22	–
Forb					
8				0–62	
	needle and thread	HECO26	*Hesperostipa comata*	36–59	–
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	36–59	–
Shrub/Vine					
9				56–112	
	sand sagebrush	ARFI2	*Artemisia filifolia*	39–84	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	36–59	–
	oak	QUERC	*Quercus*	25–45	–
	skunkbush sumac	RHTR	*Rhus trilobata*	11–39	–
	common sunflower	HEAN3	*Helianthus annuus*	0–22	–
	buckwheat	ERIOG	*Eriogonum*	0–17	–
	leatherweed	CRPOP	*Croton pottsii var. pottsii*	0–11	–

Table 9. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall Grasses, Dense**			280–448	
	little bluestem	SCSC	*Schizachyrium scoparium*	280–476	–
	sand bluestem	ANHA	*Andropogon hallii*	224–319	–
	big bluestem	ANGE	*Andropogon gerardii*	118–179	–
	Indiangrass	SONU2	*Sorghastrum nutans*	56–84	–
2	**Tall, Open**			56–280	
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	112–168	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	28–112	–
3	**Mid grasses**			45–112	
	sideoats grama	BOCU	*Bouteloua curtipendula*	45–112	–
4	**Midgrasses**			11–224	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	45–179	–
	spike dropseed	SPCO4	*Sporobolus contractus*	56–140	–
	giant dropseed	SPGI	*Sporobolus giganteus*	27–67	–
5				118–177	
	blue grama	BOGR2	*Bouteloua gracilis*	0–90	–
	needle and thread	HECO26	*Hesperostipa comata*	36–59	–
	James' galleta	PLJA	*Pleuraphis jamesii*	0–45	–
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	0–29	–
6				6–22	
	black grama	BOER4	*Bouteloua eriopoda*	59–118	–
7				6–22	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	6–22	–
Forb					
8				0–62	
Shrub/Vine					
9				56–112	
	sand sagebrush	ARFI2	*Artemisia filifolia*	39–84	–
	oak	QUERC	*Quercus*	25–45	–
	skunkbush sumac	RHTR	*Rhus trilobata*	11–39	–

Table 10. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall grasses**			112–247	
	little bluestem	SCSC	*Schizachyrium scoparium*	56–95	–
	sand bluestem	ANHA	*Andropogon hallii*	11–34	–
2	**Tall, Open**			0–34	
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–28	–
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	0–17	–
3	**Midgrass**			0–45	

	sideoats grama	BOCU	*Bouteloua curtipendula*	0–45	–
4	**Midgrasses**			11–224	
	sandhill muhly	MUPU2	*Muhlenbergia pungens*	11–56	–
	alligator juniper	JUDE2	*Juniperus deppeana*	–	5–15
	ponderosa pine	PIPOS	*Pinus ponderosa var. scopulorum*	–	5–15
	twoneedle pinyon	PIED	*Pinus edulis*	–	1–10
	oneseed juniper	JUMO	*Juniperus monosperma*	–	1–5
	Gambel oak	QUGA	*Quercus gambelii*	–	1–5
5				118–177	
	pungent oak	QUPU	*Quercus pungens*	224–560	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	112–224	–
	cliff fendlerbush	FERU	*Fendlera rupicola*	56–168	–
	desert ceanothus	CEGR	*Ceanothus greggii*	56–168	–
	eggleaf silktassel	GAOV	*Garrya ovata*	28–84	–
	blue grama	BOGR2	*Bouteloua gracilis*	22–45	–
6				6–22	
	Havard's century plant	AGHA	*Agave havardiana*	34–84	–
	tree cholla	CYIMI	*Cylindropuntia imbricata var. imbricata*	11–56	–
	Texas sacahuista	NOTE	*Nolina texana*	11–56	–
	pricklypear	OPUNT	*Opuntia*	11–56	–
	banana yucca	YUBA	*Yucca baccata*	11–56	–
	threeawn	ARIST	*Aristida*	17–50	–
	sixweeks grama	BOBA2	*Bouteloua barbata*	0–17	–
7				6–22	
	Forb, perennial	2FP	*Forb, perennial*	6–56	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–45	–
	spike dropseed	SPCO4	*Sporobolus contractus*	0–34	–
	white sagebrush	ARLUM2	*Artemisia ludoviciana ssp. mexicana*	6–17	–
	buckwheat	ERIOG	*Eriogonum*	6–17	–
	Drummond's false pennyroyal	HEDR	*Hedeoma drummondii*	6–17	–
	slimleaf plainsmustard	SCLI12	*Schoenocrambe linearifolia*	6–17	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–11	–
Forb					
8				0–62	
	needle and thread	HECO26	*Hesperostipa comata*	36–59	–
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	36–59	–
	Forb, annual	2FA	*Forb, annual*	0–11	–
Shrub/Vine					
9				56–112	
	oneseed juniper	JUMO	*Juniperus monosperma*	84–95	–
	sand sagebrush	ARFI2	*Artemisia filifolia*	39–84	–

	Indian ricegrass	ACHY	*Achnatherum hymenoides*	36–59	–
	oak	QUERC	*Quercus*	25–45	–
	skunkbush sumac	RHTR	*Rhus trilobata*	11–39	–

Table 11. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall Grasses, Dense**			280–448	
	little bluestem	SCSC	*Schizachyrium scoparium*	280–476	–
	sand bluestem	ANHA	*Andropogon hallii*	224–319	–
	big bluestem	ANGE	*Andropogon gerardii*	118–179	–
	Indiangrass	SONU2	*Sorghastrum nutans*	56–84	–
2	**Tall, Open**			56–280	
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	112–168	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	28–112	–
3	**Mid grasses**			45–112	
	sideoats grama	BOCU	*Bouteloua curtipendula*	45–112	–
4	**Midgrasses**			11–224	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	45–179	–
	spike dropseed	SPCO4	*Sporobolus contractus*	56–140	–
	giant dropseed	SPGI	*Sporobolus giganteus*	27–67	–
5				118–177	
	blue grama	BOGR2	*Bouteloua gracilis*	0–90	–
	needle and thread	HECO26	*Hesperostipa comata*	36–59	–
	James' galleta	PLJA	*Pleuraphis jamesii*	0–45	–
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	0–29	–
6				6–22	
	black grama	BOER4	*Bouteloua eriopoda*	59–118	–
7				6–22	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	6–22	–
Forb					
8				0–62	
Shrub/Vine					
9				56–112	
	sand sagebrush	ARFI2	*Artemisia filifolia*	39–84	–
	oak	QUERC	*Quercus*	25–45	–
	skunkbush sumac	RHTR	*Rhus trilobata*	11–39	–

Animal community

Habitat for Wildlife:
This site provides habitat which supports a resident animal community that is characterized by mule deer, bobcat, coyote, blacktailed jackrabbit, desert cottontail, Stephen’s woodrat, rock squirrel, pinyon mouse, scrub jay, blacktailed rattlesnake, and red spotted toad. The woody vegetation provides nesting opportunities for many bird species.

Hydrological functions

The runoff curve numbers are determined by field investigations using hydrologic cover conditions and hydrologic soil groups.

Hydrologic Interpretations
Soil Series-------------Hydrologic Group
Flugle-----------------------B
Mespun-----------------------A
Otero------------------------B
Palma------------------------B
Trail------------------------A

Recreational uses

This site offers fair to good potential for hiking, horseback riding, nature observation, photography, camping and picnicking. Hunting for mule deer is fair. Hunting of hare and other rodents is good.

Wood products

This site has a potential for wood products that are limited to fuelwood and fencing material. Although this is a limited potential, it may well be very economical. If this site has deteriorated, as much as six to ten cords of fuelwood per acre may be harvested. Harvesting should be selective and done by hand cutting. Tree spacing should be at a D+15 spacing.

Other products

Grazing:
This site is suitable for grazing by all kinds and classes of livestock during all seasons of the year. Because of the site's potential to produce woody plants, it is very suited to browsing animals. Continuous grazing of this site during the growing season will cause the high producing desirable forage plants such as, big bluestem, little bluestem, Indiangrass, sideoats grama, black grama, and New Mexico feathergrass to decrease. As this occurs, there will be a corresponding increase in the dropseeds, threeawns, ring muhly, blue grama, pinyon and juniper. As the condition of this site deteriorates, a sharp increase of juniper will occur. As the tree canopy increases, the understory vegetation decreases rapidly. The increase in numbers of trees can be attributed in part to the control of fire. Brush management is needed to restore understory production once the canopy reaches 25 percent. Due to the sandy nature of the soil, mechanical control is not feasible on this site. A system of grazing that varies the season of use is most beneficial to maintaining or improving the plant community.

Other information

Guide to Suggested Initial Stocking Rate Acres per Animal Unit Month

Similarity---------------Index Ac/AUM
100 - 76--------------------3.2 – 4.4
75 – 51---------------------4.0 – 6.5
50 – 26---------------------6.0 – 10.0
25 – 0----------------------10.0+

Type locality

Location 1:	Lincoln County, NM
Location 2:	Socorro County, NM
Location 3:	Torrance County, NM

Other references

Data collection for this site was done in conjunction with the progressive soil surveys within the Pecos-Canadian Plains and Valleys 70 Major Land Resource Area of New Mexico. This site has been mapped and correlated with soils in the following soil surveys: Chaves, De Baca, Guadalupe, Lincoln, Sna Miguel, Santa Fe, Torrance.

Characteristic Soils Are:
Flugle, Mespun, Otero, Palma, Trail

Contributors

Don Sylvester

Approval

Kendra Moseley, 10/21/2024

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	07/28/2021
Approved by	Kendra Moseley
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):**

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:**

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:**