UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

LRU 42.8 Northeastern Chihuahuan Desert Hills

ECOLOGICAL SITE DESCRIPTION

ECOLOGICAL SITE CHARACTERISTICS

Site Type: Rangeland

Site ID: R042XH001NM

Site Name: Very Shallow

Original Site Description Approval:

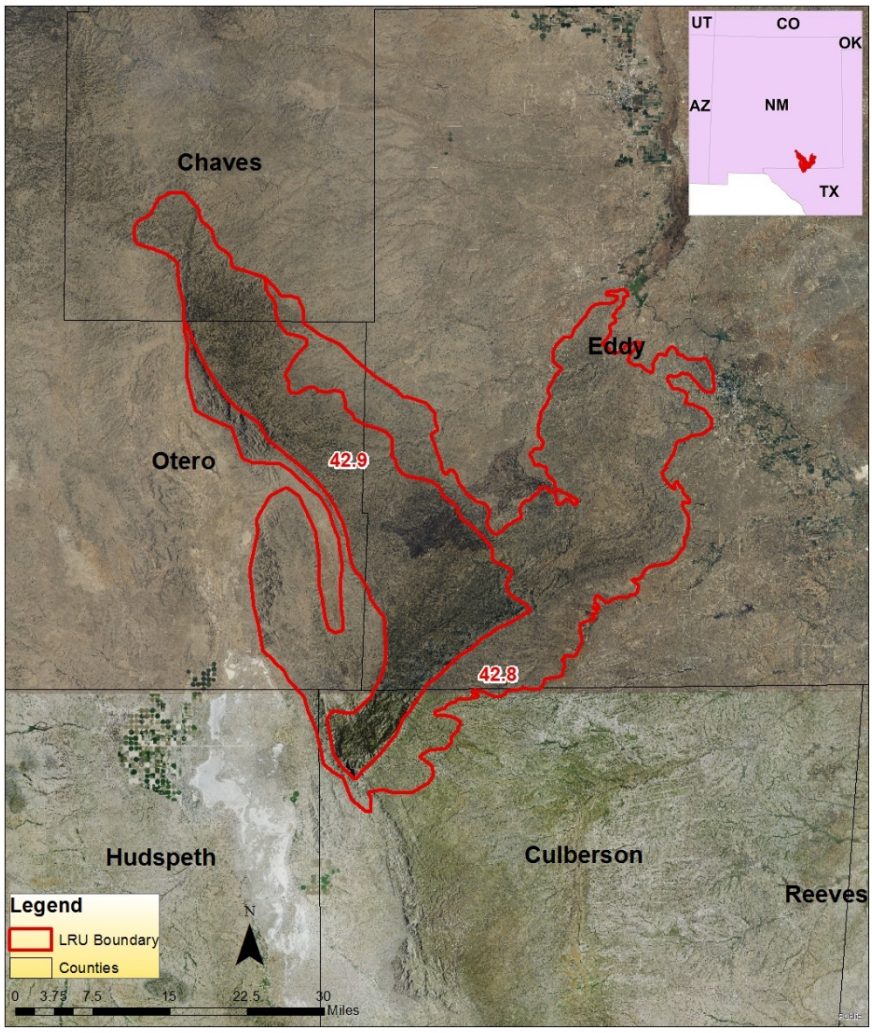
Site Date: 3/31/13

Site Author: Scott Woodall

Site Approval: John Tunberg

Approval Date: 10/22/13

The Very Shallow Ecological Site predominantly occurs in LRU 42.8, which is a subunit of MLRA 42 (*Southern Desertic Basins, Plains, and Mountains)*



MLRA Notes: LRU 42.8 was carved out of the Guadalupe Mountains portion of what used to be MLRA 70D. This Very Shallow Ecological Site has mostly taken the place of the Very Shallow Ecological Site that was traditionally used in MLRA 70D.

- It is possible, though very rare, that the Very Shallow Ecological Site may occur outside of this LRU boundary.
- To identify locations where this ESD has been mapped, refer to the most current natural resource soil survey data on *Web Soil Survey*, *Soil Data Mart*, or contact your local NRCS Conservation District field office.

Hierarchical Classification Relationships

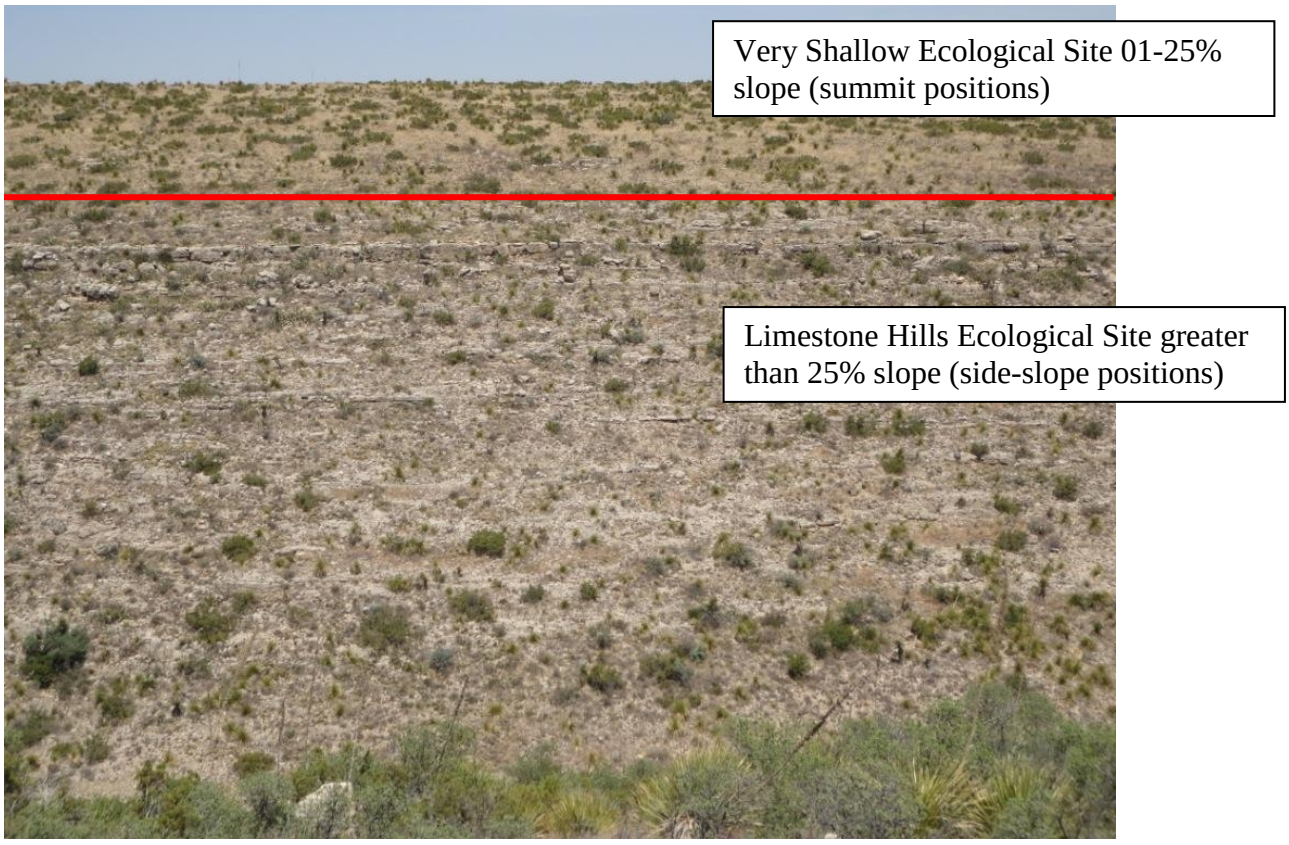
NRCS & BLM: Very Shallow Ecological Site < LRU 42.8 *Northeastern Chihuahuan Desert Hills*< Major Land Resource Area 42, *Southern Desertic Basins, Plains, and Mountains* < Land Resource Region D, *Western Range and Irrigated Region* (United States Department of Agriculture, Natural Resources Conservation Service, 2006)**.**

USFS: Very Shallow Ecological Site < *Artesia Plains Desert Grass-Shrubland Subsection < Pecos Valley Section < Southwest Plateau and Plains Dry Steppe and Shrub Province* (Cleland, et al., 2007).

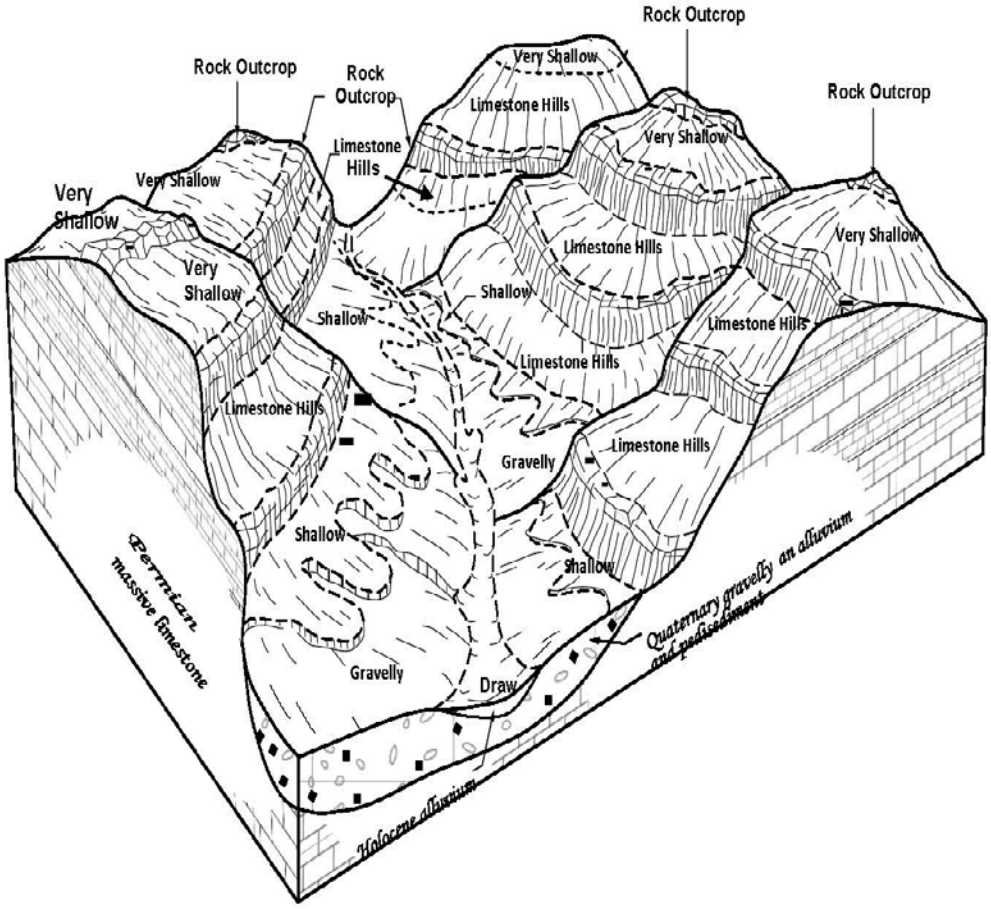
EPA: Very Shallow Ecological Site*<24b Chihuahuan Desert Grasslands<24 Chihuahuan Deserts* (Griffith, 2006).

PHYSIOGRAPHIC FEATURES

Narrative: The Very Shallow Ecological Site is positioned across hill summits, ridge summits, and mesa tops, within LRU 42.8. Elevation ranges from 3500 to 5500 feet. Soil depth can range from very shallow to shallow to limestone and dolomite bedrock. Slopes vary from 1 to 25 percent, but are generally less than 15 percent. Aspect has very little effect on site dynamics. The Very Shallow is most closely associated with the Limestone Hills Ecological Site, which occurs on adjacent hill sides with slopes greater than 25 percent. On average, about 12 percent rock outcrop is associated with this site.



Loop Road; Carlsbad Caverns National Park (CCNP); 4-16-11



42.8 **Northeastern Chihuahuan Desert Hills**

Eddy County, New Mexico

Ecological Site Key for LRU 42.8 and 42.9, Northeastern Chihuahuan Hills and Mountains

1. Site is within LRU 42.8, which is the ustic-aridic soil moisture regime, and the thermic soil temperature regime. (Often contains red berry juniper)

2. Soils are loamy and not skeletal, and reside in low areas that are stream terraces and fan remnants. -**Loamy Terrace ESD**

2. Soils are skeletal (Greater than 35% by volume rock fragments greater than 2mm)

3. Soils are deep to very deep. (Greater than 100cm to root restrictive layer)

4. Site exists in an active floodplain.-**Draw ESD**

4. Site exists on a stream terrace or alluvial fan-**Gravelly ESD**

4. Site exists on steep slopes on limestone colluvium over gypsum. residuum-**Limy Gyp Escarpment**

3. Soils are very shallow to moderately deep (5-100cm).

5. Root restrictive layer is a petrocalcic horizon.-**Shallow ESD**

5. Root restrictive layer is bedrock.

6. Slopes are less than 25%-**Very Shallow ESD**

6. Slopes are greater than 25%- **Limestone Hills ESD**

1. Site is located within LRU 42.9, and is represented by the aridic-ustic soil moisture regime, and the mesic soil temperature regime. (It often contains alligator juniper and pinon pine.)

7. Slopes are less than 25%- **Shallow Limestone ESD**

7. Slopes are greater than 25%- **Limestone Mountains ESD**

Glossary:

Colluvium: "Unconsolidated, unsorted earth material being transported or deposited on side slopes and/or at the base of slopes by mass movement (e.g. direct gravitational action) and by local, concentrated runoff" (Schoenberger, et al., 2012).

Petrocalcic Horizon: The petrocalcic horizon is an illuvial horizon in which secondary calcium carbonate or other carbonates have accumulated to the extent that the horizon is cemented or indurated (Keys to Soil Taxonomy, 2010).

Residuum: "Unconsolidated, weathered, or partly weathered mineral material that accumulates by disintegration of bedrock in place" (Schoenberger, et al., 2012).

Soil moisture regime: Refers to the presence or absence either of ground water or of water held at a tension of less than 1500 kPa in the soil or in specific horizons during periods of the year. Water held at a tension of 1500 kPa or more is not available to keep most mesophytic plants alive. Major differences in soil moisture are often reflected in different vegetative communities. The two major soil moisture regimes for the Guadalupe Mountains are Aridic and Ustic (Keys to Soil Taxonomy, 2010).

Soil Temperature Regime: This is the range of temperatures experienced by a soil at a depth of 50 cm. When the average temperature of a soil falls between 46 degrees F and 59 degrees, it falls into the mesic soil temperature regime. The thermic soil temperature regime falls between 59 degrees F and 72 degrees (Keys to Soil Taxonomy, 2010).

Geology: The primary geologic formations that make up the parent material for the Very Shallow Ecological Site include the Seven Rivers, Tansil, Yates, and to a lesser extent the Capitan Limestone. During Guadalupian time of the Permian Period, dynamic sedimentation of carbonate and evaproite rocks occurred around the rim of the Delaware basin creating an ideal environment for the development of a large coral reef. The rim was topographically high; the waters were shallow, well-ventilated, agitated, and warm. In this excellent marine-life environment the great Capitan Reef began to form. The Capitan Reef grew rapidly and flourished throughout Guadalupian time, surrounding the Delaware basin, controlling environments and influencing sedimentation. (Kelley, 1971)

On the landward side of the reef (the backreef), the Seven Rivers, Yates, and Tansil formations developed. The first was the Seven Rivers Formation. The sediments of the Seven Rivers deposited at a time when conditions became drier, and the basin tended toward hypersalinity. The Seven Rivers contains gray to white dolomitic limestone, white to red gypsum, orange-red siltstone, and shale. Within the LRU, the Seven Rivers Formation is considered the surface layer on Azotea Mesa, Seven Rivers Hills, and West Hess Hills. The Seven Rivers Formation tends to contain more erodible sediments than the Tansil and Yates. Therefore, less bedrock is exposed where the Very Shallow ESD occurs on the Seven Rivers Formation.

Deposited above the Seven Rivers during a quiet period within an unrestricted lagoon is the Yates Formation. The Yates is characterized by layers of very pale orange to yellowish-gray fine-grained, laminated dolomite, alternating with grayish-orange to pale yellowish-orange, calcareous quartz siltstone or very fine-grained sandstone. The Yates is the surface formation over much of Carlsbad Caverns National Park, starting at Walnut Canyon and extending North through the Cueva Escarpment and up to Living Desert State Park.

Landward of the unrestricted lagoon was a restricted lagoon, (the Tansil Formation). Here freshwater mixed with seawater. Large amounts of sediments were carried in by streams causing a hostile environment for marine organisms. Like the Yates, the Tansill is characterized by clastic sediments such as siltstone and sandstone as well as layers of dolomite. Unlike the Yates, however, the Tansill contains many thin clay layers. (Burger, 2007) The Tansil Formation is the surface layer at the Carlsbad Caverns Visitor Center.

About 15 million years ago, the ancient reef rock that had been buried by younger layers of rock began to rise, creating the Guadalupe Ridge and Mountains while exposing the Seven Rivers, Tansill, and Yates Formations. Over the years, at the mountain summit positions, much of the more clastic layers of the Tansil, Yates, and Seven Rivers have eroded away, leaving the very shallow soils and exposed dolomitic limestone rock outcrop which makes up the Very Shallow Ecological Site.

Dolomitic Limestone Rock Outcrop on the Very Shallow Ecological Site; Ridge Trail; CCNP.

Landscape: Hills, Mesas

Landform: Hill Summit; Ridge Summit; Mesa Summit

Aspect: Aspect does not exert much influence on this ecological site.

	Minimum	**Maximum**
Elevation (feet):	3500	5500
Slope (percent):	1	25
Water Table Depth (inches):	n/a	n/a
Flooding:	None	None
Frequency:		
Duration:		
Ponding:	None	None
Depth (inches):	n/a	n/a
Frequency:		
Duration:		
Runoff Class	Medium	Very High
Depth Class:	Very Shallow	Shallow

CLIMATIC FEATURES

The mean annual precipitation is 10.4 inches to 18.3 inches, occurring mostly as high intensity, short-duration afternoon thunderstorms from July through September. Mean annual air temperature is 55to 70 degrees F, and the frost-free season is 207 to 243 days.

Annual weather patterns, influenced by global climate events, such as El Nino and La Nina, affect and alter production and composition across the Very Shallow Ecological Site. In general, because precipitation is minimal through the winter but increases during the summer, warm-season (C4) plants dominate the landscape. However, from year to year the production and composition can greatly shift due to variable weather patterns. The years that produce the most species richness and production are those that get slow, steady moisture through the months of May, June, and July. Late summer thunderstorms may induce heavy runoff on this site, creating flash-flooding in the draws, drainages, and canyons below.

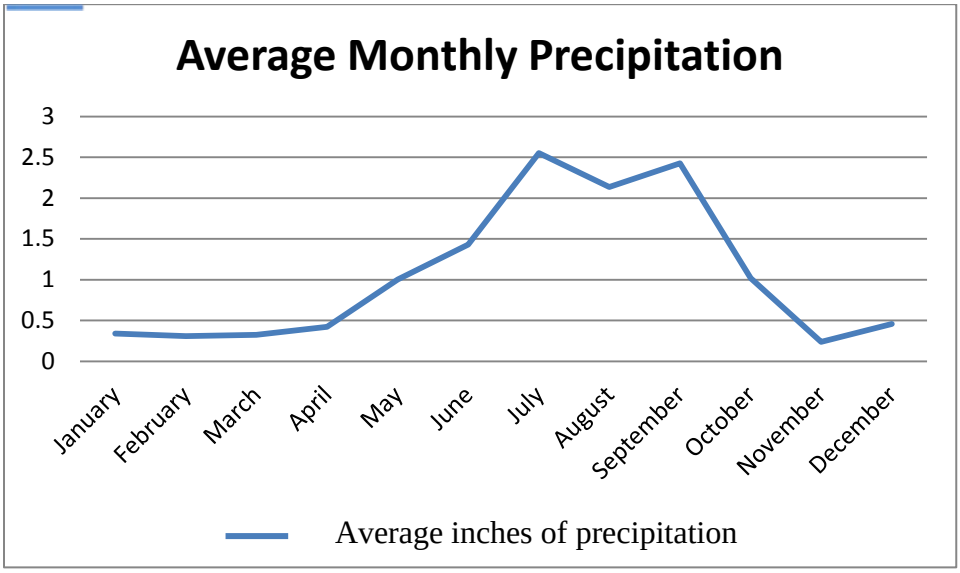
The climate trend of the area is one toward warmer temperatures and lower precipitation. According to the Carlsbad Caverns Climate Station, during the years 2001-2011, five years received less than 10 inches of rain. Three of those years, (2003, 2005, and 2011) were below 5 inches of rain. And 2011 was both the lowest rainfall and hottest year on record. Similarly, in 1947-1957, 6 out of 11 years were below the mean low of 10.4 inches. But in that stretch, only one year, 1951, was below 5 inches. To put this in perspective, in the dry 1930's only 2 years were below the mean low of 10.4 and none were below 5 inches. The 2001-2011 decade has been much warmer and drier than any in recorded history. In addition, during the two years of 2010 and 2011, Carlsbad Caverns National Park experienced extreme events of drought, wildfire, and flash flooding which have led to shifts in plant communities.

	Minimum	**Maximum**
Frost-free period (days):	207	243
Freeze-free period (days):	229	263
Mean annual precipitation (inches):	10.4	18.3

Monthly moisture (inches) and temperature (^{0}F) distribution:

	Precip. Min.	Precip. Max.	Temp. Min.	Temp. Max.
January	.04	.64	29.6	57.6
February	.09	.53	32.8	62
March	.09	.56	39.4	69.9
April	.04	.81	47.3	78.5
May	.29	1.72	56.3	85.7
June	.84	2.02	64.3	94
July	1.24	3.86	67.1	92.3
August	1.12	3.15	65.8	91.5
September	.79	4.06	59.1	85
October	.27	1.77	48.6	77.2

November	.02	.46	37.4	66.8
December	.05	.87	31.1	57.6



			Period	
	Station ID	**Location**	**From:**	**To:**
Climate Stations:				
Carlsbad Caverns N.P.	291480	Lat: 32.276, Long: 104.443	1935	2012
Dark Canyon Rd.	292365	Lat: 32.276, Long: 104.515	2005	2012
Carlsbad Airport	291475	Lat: 32.333, Long 104.258	1930	2012

Note: Local climate station data was obtained from ***http://www.wrcc.dri.edu****. Data was interpreted utilizing New Mexico NRCS Climate Summarizer.*

INFLUENCING WATER FEATURES

Narrative: The Very Shallow Ecological Site is not associated with a wetland or riparian system; it is an upland ecological site.

REPRESENTATIVE SOIL FEATURES

Narrative: 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 Very Shallow Ecological Site. To learn about the dynamic processes of the lechuguilla soil component, refer to the "plant communities" section of the ESD.

The Very Shallow Ecological Site is tied to the **Lechuguilla** component of map units CC1 and LR1 within LRU 42.8, *Northeastern Chihuahuan Desert Hills*. The CC1 and LR1 map units are very similar, and consists of complexes of soil components which are dominated by about 80% Lechuguilla and 12% rock outcrop. These soils are formed from mostly residuum and some eolian deposits on mostly convex surfaces in limestone and dolomite and range from very shallow to shallow in depth.

In normal years this soil is driest during the winter. It is moist in the upper part for over 90 cumulative days, but fewer than 90 consecutive days during the growing season. The soil moisture regime is aridic bordering on ustic. The mean annual soil temperature: is 59 to 66 degrees F, which is classified as the thermic temperature regime.

This soil is well drained with high runoff at the surface and a saturated hydraulic conductivity ranging from 1.0 to 10 µm/second over impermeable bedrock. The Lechuguilla taxonomic class is: *Loamy-skeletal mixed, superactive, calcareous, thermic Lithic Ustic Torriorthents*. The soil is dark in color due to the accumulation of organic matter in the fine-earth fraction.

TYPICAL PEDON: Lechuguilla very gravelly loam, Carlsbad Caverns National Park and Wilderness Area. (Colors are for dry soil unless otherwise noted.) The soil surface is covered by approximately 35 percent gravel, 5 percent channers, 15 percent cobbles, 10 percent flagstones and 5 percent stones.

TYPE LOCATION: Eddy County, New Mexico; located on the north-facing side-slope of a ridge, exactly 2 miles west along the Loop Road of Carlsbad Caverns National Park, 50 yards past a turnout for an aerial tower walk about 100 yards due north. Approximately 6 miles west of Whites City; USGS Carlsbad Caverns, New Mexico 7.5 minute quadrangle; UTM zone 13, 541021 3553843, NAD83.

A1--0 to 4 inches (0 to 10 cm); dark brown (10YR 3/3) very cobbly loam, very dark brown (10YR 2/2), moist; 21 percent clay; weak medium subangular blocky parts to moderate medium granular structure; common very fine roots and common fine roots; many medium interstitial and common very fine interstitial and common fine interstitial pores; 10 percent gravel and 30 percent cobble and 10 percent stone; 1 percent calcium carbonate equivalent; neutral, pH 6.6; clear smooth boundary.

A2--4 to 8.5 inches (10 to 21 cm); brown (10YR 4/3) extremely cobbly loam, very dark brown (10YR 2/2), moist; 22 percent clay; moderate medium subangular blocky structure; common fine and medium roots and many very fine roots; common very fine, fine and medium interstitial pores; 5 percent gravel and 50 percent cobble and 5 percent stone; 0.8 percent calcium carbonate equivalent; neutral, pH 7.1; clear smooth boundary.

Bk--8.5 to 12.5 inches (21 to 32 cm); dark brown (7.5YR 3/3) extremely flaggy loam, very dark brown (7.5YR 2.5/3), moist; 20 percent clay; moderate medium subangular blocky structure; common very fine, fine and medium roots and few coarse roots; common very fine, fine and medium interstitial pores; common medium prominent irregular weakly cemented carbonate nodules on bottom of rock fragments; 5 percent gravel and 30 percent cobble and 30 percent flagstone; very slightly effervescent, 4.3 percent calcium carbonate equivalent; slightly alkaline, pH 7.4; abrupt wavy boundary.

R--12.5 to 78.5 inches (32 to 200 cm).

Photo from the Very Shallow diagnostic reference community on Azotea Mesa.

Parent Material Kind:
1. Dolomite
2. Limestone
3. Sandstone

Parent Material Origin:
Residuum and eolian
Surface Texture:
(1) Loam
(2) Silt Loam
(3) Silty Clay Loam
Surface Texture Modifier
(1) Gravelly
(2) Very Gravelly
(3) Cobbly
(4) Very Cobbly
(5) Stony
(6) Very Stony

(7) Channery
Subsurface Texture Group:
(1) Loam
(2) Silt Loam
(3) Silty Clay Loam
Surface Fragments <=3" (% Cover):
10-45%
Surface Fragments >3" (% Cover):
5-35%
Subsurface Fragments <=3" (%Volume):
5-50%
Subsurface Fragments >3" (%Volume)
10-70%
Drainage Class:
Well Drained
Depth (inches):
5 to 50cm
Electrical Conductivity (mmhos/cm):
0.1-1
Saturated Hydrologic Conductivity (KSAT)
1.0-10 µm/second over impermeable bedrock.
Sodium Absorption Ratio:
SAR 0 to 1
Soil Reaction (1:1 Water):
7.0-7.8 Neutral to slightly alkaline
Available Water Capacity (cm H20/cm soil):
A1 .07cm to .09cm
A2 .05 cm to .07 cm
Bk .04 cm to .06 cm
Total avg: 2.01cm
Calcium Carbonate Equivalent (percent):
A & A2 0 to 5
Bk 10 to 25

PLANT COMMUNITIES

Ecological Dynamics of the Site: The Very Shallow Ecological Site contains a mix of grass, shrubs, forbs, and succulents. It is often dry due to its very shallow depth and exposure to many dry, windy days. Because of its dryness, and very shallow depth, succulents such as lechuguilla, yucca, prickly pear, and sotol are very abundant on this site, sometimes causing difficulty with walking. Also, as typical with desert communities, wet springs and summers can cause swings in species richness causing an abundance of forbs to express themselves in a show of color.

There are numerous variables such as elevation, soil depth, fracturing of bedrock, fire frequency, and anthropogenic effects that influence plant communities. The first basic variable is elevation. At the lower end

of the range, (about 3500 feet) the climate is warmest and driest, and tends to promote more succulents and Chihuahuan desert species, such as ocotillo, mariola, and various cacti. As elevation increases to the upper extreme, (at about 5500 feet), grass communities slightly change: black grama phases into curly leaf muhly, and shrub species change from mariola dominant to redberry juniper dominant and, at the upper end, sandpaper oak dominant. Between 5300 and 5500 feet, this site transitions into the LRU 42.9 Shallow Limestone site.

Soil depth plays a role in determining species production and diversity. The underlying bedrock undulates in depth from being exposed at the surface to a depth of 50 cm in a few places. The deeper the soil, the greater the ability for different plant species to access water and utilize other resources. Species such as blue grama and wrights' beebrush prefer somewhat deeper soils, while curly leaf muhly and lechuguilla prefer the very shallow soils. According to Duniway, "Cracks and fissures in the bedrock also trap water and facilitate access to water contained within the matrix of the bedrock" (Duniway, et al., 2010). Sotol can dominate where higher levels of fracturing occur.

Fire is a consistent disturbance regime that reduces succulents and a few shrubs while stimulating grasses and forbs. Not all fires are equal. According to Gebow, "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 researchers in the area and region suggest a 10-to-15-year fire regime is common" (Gebow, 2001).

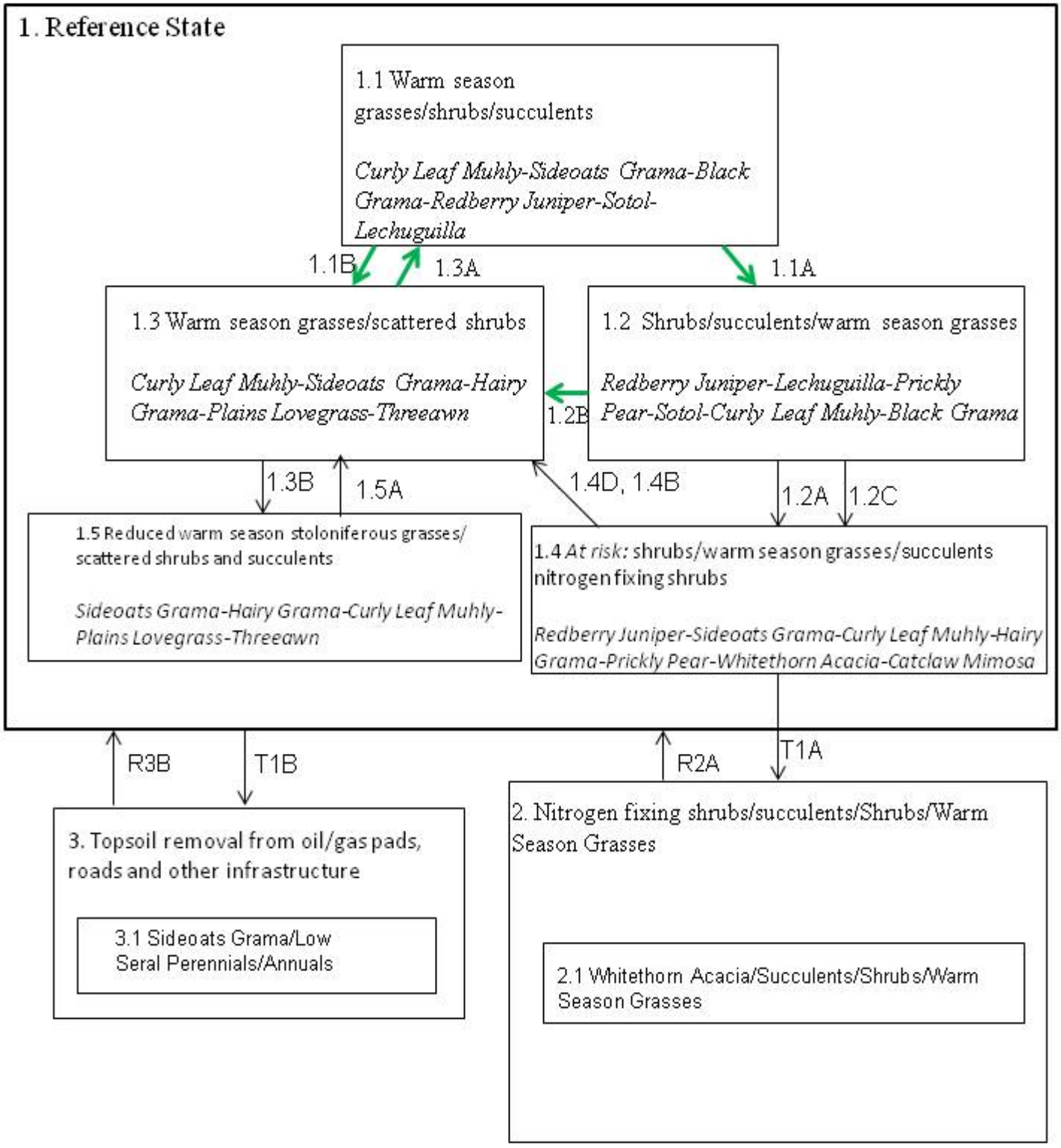
Small and more frequent fires were more common before the mid-1800's, with the Apache likely responsible for many small burns. Following colonization by Europeans, intervals between fires have lengthened and the average fire size has increased (Ahlstrand, 1981). Small fires are important for creating a patchy mosaic across the landscape, which provides beneficial habitats for many species.

There are numerous human influences that affect the variability of this site. In some places, like along the Guadalupe Ridge, this site has been used as a travel corridor for centuries. During the Apache era (1550-1880 A.D.) this site was prized for its provision of numerous plant species to sustain all aspects of life. Ancient mezcal pits still exist where plants, such as sotol were cooked in the ground as an important food source. When Europeans arrived they created change by introducing livestock and building infrastructure.

Recently, many acres have been converted to roads and gravel pads, needed for oil and gas production. Azotea Mesa is an important oil and gas producing area.

Very Shallow Ecological Site; Guadalupe Ridge; manipulated for travel; CCNP

Aerial photo of oil and gas infrastructure; Azotea Mesa. Scale: 1:70,000



The green arrow represents the historic range of variability.

STATE AND TRANSITION MODEL LEGEND:

1.0 Reference State

1.1 Warm season grasses/shrubs/succulents (diagnostic plant community)
A mix of grasses, shrubs and succulents is present. Total foliar cover is > 65%, depending on the amount of rock outcrop.

1.1A Community Pathway: This pathway represents intervals between fires, during which natural processes increase shrub and succulent vigor and decrease grass production and percent composition.

1.1B Community Pathway: This pathway represents fire. Fire suppresses succulents and many shrubs, giving grasses a competitive advantage.

1.2 Shrubs/succulents/warm season grasses: Over time, foliar cover of shrubs and succulents increases and that of warm season grasses decreases.

1.2A Community Pathway: This pathway represents an interval between fires which is longer than the historic range of variability. Fire suppression, whether through loss of fuel load due to herbivory or from fighting natural wildfires, has increased shrub and succulent vigor and decreased grass production and percent composition.

1.2B Community Pathway: This pathway represents fire. Fire suppresses succulents and many shrubs, giving grasses a competitive advantage.

1.2C Community Pathway: This pathway represents a growing competitive advantage from nitrogen fixing shrubs due to slow changes in soil chemistry and hydrology.

1.3 Warm season grasses/scattered shrubs: This plant phase exists after fire. Grasses respond well to fire, while many shrubs and succulents decrease.

1.3A Community Pathway: This pathway represents intervals between fires, during which natural processes increase shrub and succulent vigor and decrease grass production and percent composition. Over time, plant community 1.3 shifts to 1.1.

1.3B Community Pathway: This pathway represents prescribed burning at a more frequent rate than what is considered to be within the historic range of variability.

1.4 *At risk:* shrubs/warm season grasses/succulents/nitrogen fixing shrubs: Due to gradual changes in hydrologic function and soil chemistry, succulents and shrubs increase over time. The increased abundance of native nitrogen fixing shrubs such as whitethorn and catclaw mimosa is a key indicator that this community phase is “at risk.”

1.4B Community Pathway: This pathway represents fire. Fire sets back succulents and many shrubs, giving grasses a competitive advantage.

1.4D Community Pathway: A change in livestock grazing management promotes grass vigor and decreases shrub competition. This accelerates the turnover of fine roots, causing an increase in labile carbon, acceleration in decomposition, and a resulting increase in plant available water.

T1A Transition one: *Slow variables:* Continued encroachment by whitethorn acacia, coupled with the loss of herbaceous plant species, causes a decrease in soil organic matter, leading to a decrease in plant available water. *Trigger event:* A severe drought causes loss of soil organic carbon. *Threshold:* A hydrologic function/soil chemistry threshold is crossed.

1.5 Reduced warm season stoloniferous grasses/ scattered shrubs and succulents: This plant phase is the result of consistent fire every five to seven years. It is characterized by the loss of fire-sensitive species such as black grama and lechuguilla.

1.5A Community Pathway: This pathway represents time between fires, during which natural processes increase shrub and succulent vigor and decreases grass production and composition.

T1B Transition two: This transition is the mechanical removal of the topsoil to build infrastructure such as roads and drilling pads.

2.0 Nitrogen fixing shrubs/succulents/shrubs/warm season grasses State

2.1 Whitethorn Acacia/succulents/shrubs/warm season grasses: Whitethorn acacia has become a prominent plant on the site. Foliar cover has decreased to < 40%. A higher Nitrogen turnover rate increases the invasiveness and stability of Whitethorn. This community has a mix of shrubs, succulents, and warm season grasses.

R2A Restoration Process: An increase in the competitive advantage of non-nitrogen fixing species through physical, chemical, and biological management practices.

3.0 Topsoil removal from oil/gas pads, roads and other infrastructure State

3.1 Sideoats Grama/low seral perennials/annuals: This community occurs where the topsoil has been removed and the area (be it an old road or oil/gas pad) has been abandoned. Very little soil organic matter and native mycorhizal fungi occur on this State. After many years of abandonment, sideoats grama, which is not quite as dependent on native mycorhizal fungi, can dominate this site.

R3B Restoration Process: The replacement of mineral soil, range seeding, and incorporation of organic material.

1.0 REFERENCE STATE

1.1 Warm season grasses/shrubs/succulents (diagnostic plant community)

Community 1.1; Juniper Ridge; CCNP; 5-21-11

This community phase consists of a mix of warm season grasses, shrubs and succulents. Foliar cover is between 65 and 75 percent, basal cover is between 15 and 20 percent, and bare ground is minimal due to over 60 percent surface rock fragments. Warm season grasses make up about 40 percent foliar cover; shrubs, 15 percent; and succulents (including sotol and lechuguilla) around 13 percent. The average surface soil stability rating is 5 under canopy and 4.8 in the interspaces. Annual production averages around 800 lbs/ac, but can span between 500 and 1100 lbs/ac, depending on the percentage of rock outcrop, cracks and fissures in the bedrock, soil depth and annual weather patterns.

This community exists approximately five to seven years after low intensity fire. Curly leaf muhly is the dominant grass in mid to upper elevations, while “thermic” species, such as black grama, slim tridens and hairy tridens, are more dominant at lower elevations. Mariola tends to be a dominant shrub in lower to mid elevations, followed by redberry juniper in mid to upper elevations and sandpaper oak in upper elevations. Lechuguilla is the dominant succulent and is present at all elevations, especially around rock outcrop. Sotol can be a dominant shrub in this community, especially in areas where heavy fracturing of the bedrock occurs.

This plant community phase optimizes energy flow, hydrologic function and nutrient cycling. The diverse root systems take advantage of moisture from both close to the surface as well as deep in the rock strata. Decomposition is active, creating soil organic matter, which enhances plant available water needed for plant vigor.

Community Phase Pathways:

1.1A Community Pathway: This pathway is the slow movement from Community 1.1 to Community 1.2. This pathway represents time between fires within the historic range of variability, as it will take 10 to 14 years, after fire, for shrubs and succulents to achieve foliar cover > 20%.

Shrub and succulent vigor increase as grass vigor decreases due to various ecological processes. The first is through direct competition for resources. Shrubs have greater access to nutrients and moisture deep in cracks and fissures within the bedrock strata. The second is a slow decrease in labile carbon, thus decreasing soil organic matter. This, in turn, leads to a decrease in water-holding capacity and a resulting decrease in grass vigor.

1.1B Community Pathway: This pathway represents a single fire event, driving plant Community 1.1 to 1.3. Grasses respond fairly quickly after fire, while shrubs and succulents are suppressed. This pathway occurs within the range of historic variability.

Many shrubs and succulents take a while to respond after a fire event. They must re-grow from below ground root systems or come back from seed. Grasses can colonize quickly via tillering, especially when precipitation follows closely after fire.

Percent Foliar Cover by Material Type:

Vegetative Cover						Non-Vegetative Cover					
Grass/ Grasslike	Forb	Shrub	Succulents	Non-Vascular Plants	Biological Crust	Litter	Surface Fragments > 1/4 & <= 3"	Surface Fragments > 3"	Bedrock	Water	Bare Ground
40	3	15	13	T	2	50	36	9	12	0	1

Percent Canopy Cover by Height Class (Structure of Canopy Cover)

	Grasses/Grasslike	Forbs	Shrubs	Succulents/Cactus
<=15 cm	10	2	1	3
> 15 cm - < 30 cm	30	1	1	4
> 30 cm - < 70 cm			3	4
> 70 cm - < 100 cm			3	4
> 100 cm			3	3

Community Phase Annual Production by Plant Type:

Plant Type	Annual Production (lbs/ac)		
	Low	**RV**	**High**
Grass/Grass-like	390	630	858
Forbs/Ferns	15	25	33
Shrubs	75	110	165
Succulents	20	35	44
Annual Production Total	500	800	1100

Note: Data for production, height, cover, and composition were taken from multiple transects during the years 2011 and 2012.

Plant Community 1.1 Composition and Group Annual Production:

Note: This species list reflects the model concept of the diagnostic plant phase. Inventory data from multiple plots and sources were used to compile this list.

Note: Ranges reflect variability based on soils, temperature and moisture caused by factors such as elevation, and based on average moisture year conditions.

Note: Species annual production is given in pounds per acre.

Note: A zero in the species production column indicates that the species does not occur at the high or low elevation range of the ecological site. (I.e. sand muhly does not occur at 5500 feet)

Plant Type - Grass/Grass-like

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
1	**Warm SeasonTallgrasses**					4%		
	cane bluestem	BOBA3	Bothriochloa barbinodis	8	24		<1	3
	silver bluestem	BOLA2	Bothriochloa laguroides	8	24		<1	3
	little bluestem	SCSC	Schizachyrium scoparium	T	T		<1	<1
2	**Warm Season Midgrasses**					38%		
	curly leaf muhly	MUSE	Muhlenbergia setifolia	16	240		2	18
	sideoats grama	BOCU	Bouteloua curtipendula	48	80		4	6
	threeawn	ARPU9	Aristida pupurea	8	104		1	5
	slim tridens	TRMU	Tridens muticus	32	48		2	4
	plains lovegrass	ERIN	Eragrostis intermedia	8	40		1	3
	green sprangletop	LEDU	Leptochloa dubia	8	24		<1	2
	sand dropseed	SPCR	Sporobolus cryptandrus	4	12		<1	<1
3	**Warm Season Shortgrasses**					20%		
	hairy grama	BOHI2	Bouteloua hirsuta	40	72		3	5

	black grama	BOER4	Bouteloua eriopoda	16	64		2	6
	hairy tridens	ERPI5	Erioneuron pilosum	8	24		<1	2
	halls panicum	PAHA	Panicum hallii	4	12		<1	2
	blue grama	BOGR2	Bouteloua gracilis	4	12		<1	2
	wolftail	LYPH	Lycurus phleoides	6	10		<1	<1
	bristlegrass	SELE6	Setaria leucopila	6	10		<1	<1
	sand muhly	MUAR2	Muhlenbergia arenicola	0	16		0	<1
	red grama	BOTR2	Bouteloua trifida	0	16		0	<1
	fluff grass	DAPU7	Dasyochloa pulchella	0	T		0	<1
	nineawn	ENDE	Enneapogon desvauxii	0	T		0	<1
	fall witchgrass	DIPU9	Digitaria pubiflora	0	T		0	<1
	tobosa	PLMU3	Pleuraphis mutica	0	T		0	<1
4	**Cool Season Tallgrasses**					1%		
	New Mexico feathergrass	HENE5	Hesperostipa neomexicana	0	16		0	<1

Plant Type – Forbs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
5	**Perennial Forbs**					5%		
	croton	CROTO	Croton spp.	4	12		<1	2
	hawkweed buckwheat	ERHI3	Eriogonum hieraciifolium	4	12		<1	2
	james' nailwort	PAJA	Paronychia jamesii	4	12		<1	1
	havard's buckwheat	ERHA	Eriogonum havardii	4	12		<1	1
	spreading fleabane	ERDI4	Erigeron divergens	0	T		0	<1
	desert verbena	GLBIC	Glandularia bipinnatifida var. ciliata	0	T		0	<1
	fendler's bladderpod	LEFE	Lesquerella fendleri	0	T		0	<1
	Texas tansyaster	MABL2	Machaeranthera blephariphylla	0	T		0	<1
	polygala	POLYG	Polygala spp.	0	T		0	<1
	greenleaf five eyes	CHCO2	Chamaesaracha coronopus	0	T		0	<1
	douglas' ragwort	SEFLD	Senecio flaccidus var. douglasii	0	T		0	<1
	resurrection Plant	SEPI	Selaginella pilifera	0	T		0	<1
	whitemargin sandmat	CHAL11	Chamaesyce albomarginata	0	T		0	<1

	shaggy stenandrium	STBA	Stenandrium barbatum	0	T		0	<1
	Other perennial forbs			4	12		1	2
6	**Annual Forbs**					1%		
	lemmon scent	PEAN	Pectis angustifolia	0	T		0	<1
	Other annual forbs			2	14		<1	1

Plant Type - Shrubs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
7	**Shrubs**					14%		
	redberry juniper	JUPI	Juniperus pinchotii	16	32		2	6
	mariola	PAIN2	Parthenium incanum	16	32		1	5
	indigo bush	DAFO	Dalea Formosa	8	24		1	3
	sandpaper oak	QUPU	Quercus pungens	0	32		0	4
	javelina bush	COER5	Condalia ericoides	4	12		<1	2
	range ratany	KRER	Krameria erecta	4	12		<1	2
	algerita	MATR3	Mahonia trifoliolata	4	12		<1	2
	skeleton leaf goldeneye	VIST	Viguiera stenoloba	4	12		<1	2
	Wright's beebrush	ALWR	Aloysia wrightii	2	6		<1	1
	catclaw acacia	ACGR	Acacia greggii	0	T		0	<1
	roemer’s acacia	ACRO	Acacia roemeriana	0	T		0	<1
	mormon tea	EPTR	Ephedra trifurca	0	T		0	<1
	creosote bush	LATR2	Larrea tridentata	0	T		0	<1
	skunkbush sumac	RHTRT	Rhus trilobata var. trilobata	0	T		0	<1
	lotebush	ZIOB	Ziziphus obtusifolia	0	T		0	<1
8	**Half-Shrubs**					3%		
	dyssodia	DYSSO	Dyssodia spp.	4	12		<1	1
	broom snakeweed	GUSA2	Gutierrezia sarothrae	4	12		<1	1
	desert zinnia	ZIAC	Zinnia acerosa	4	12		<1	1
	rough menodora	MESC	Menodora scabra	0	T		0	<1
	five needle prickly leaf	THPEP	Thymophylla pentachaeta var. pentachaeta	0	T		0	<1
	hairy crinklemat	TIHI	Tiquilia hispidissima	0	T		0	<1

Plant Type – Succulents

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
9	**Cactus**					4%		
	purple pricklypear	OPMAM	Opuntia macrocentra	8	40		1	3
	tulip pricklypear	OPPH	Opuntia phaeacantha	2	14		<1	2
	tree cholla	CYIMI	Cylindropuntia imbricata var. imbricata	0	T		0	<1
	pitaya	ECEN2	Echinocereus enneacanthus	0	T		0	<1
	devilshead	ECHO	Echinocactus horizonthalonius	0	T		0	<1
	horse crippler	ECTE	Echinocactus texensis	0	T		0	<1
	kingcup cactus	ECTR	Echinocereus triglochidiatus	0	T		0	<1
	nylon hedgehog cactus	ECVI2	Echinocereus viridiflorus	0	T		0	<1
	Rainbow cactus	ECPE	Echinocereus pectinatus	0	T		0	<1
	ocotillo	FOSP2	Fouquieria splendens	0	T		0	<1
	cactus apple	OPEN3	Opuntia engelmannii	0	T		0	<1
	lee pincushion	ESSNL	Escobaria sneedii	0	T		0	<1
10	**Yucca**					2%		
	torrey's yucca	YUTO	Yucca torreyi	8	24		<1	2
	soaptree yucca	YUEL	Yucca elata	0	T		0	<1
11	**Yucca-like plants**					7%		
	lechuguilla	AGLE	Agave lechuguilla	24	40		2	6
	Sotol	DALE2	Dasylirion leiophyllum	8	24		2	4
	Texas sacahuista	NOTE	Nolina texana	6	10		1	3

12 Plant Type – Fern

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
	Cochise scaly cloakfern (jimmy fern)	ASCO42	Astrolepis cochisensis	6	10	1%	1	3

Growth Curve:
Growth Curve Number: NM4281
Growth Curve Name: Very Shallow Reference State
Growth Curve Description: R042XH001NM

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0	0	2	8	10	15	25	25	11	4	0	0

1.2 Shrubs/succulents/warm season grasses

Community 1.2; Loop Road; CCNP; 4-19-11

This community phase combines a mix of shrubs, succulents, and warm season grasses. Foliar cover is between 65 and 75 percent, basal cover is between 15 and 30 percent, and bare ground is around 3 to 8 percent. Warm season grasses make up about 30 percent foliar cover; shrubs, 23 percent; and succulents, 17 percent. The average surface soil stability rating is 5 under canopy and 4.8 in the interspaces. Annual production averages around 700 lbs/ac, but can span between 500 and 900 lbs/ac, depending on the percentage of rock outcrop, cracks and fissures in the bedrock, soil depth and annual weather patterns.

This community exists approximately 14-18 years after fire. Curly leaf muhly is the dominant grass in mid to upper elevations, while “thermic” species, such as black grama, slim tridens and hairy tridens, are more dominant at lower elevations. Mariola tends to be a dominant shrub in lower to mid elevations, followed by redberry juniper in mid to upper elevations and sandpaper oak in upper elevations. Lechuguilla is the

dominant succulent and is present at all elevations, especially around rock outcrop. Sotol can be a dominant shrub in this community, especially in areas where heavy fracturing of the bedrock occurs.

This plant community has developed due to an increase in shrub vigor and a decrease in grass vigor. As shrubs increase they gain a competitive advantage, primarily by out-competing grasses for water and nutrients. As shrubs increase, energy flow begins to lessen, and fine-root turnover decreases, causing a decrease in decomposition, labile carbon, and soil organic matter. Fire is the natural event that keeps mature shrub species from gaining a competitive advantage and stimulates colonization by grasses.

Community Phase Pathways:

1.2A Community Pathway: This pathway represents intervals between fires, which are longer than the historic range of variability. Fire suppression, whether through loss of fuel load due to herbivory or from fighting natural wildfires, has increased shrub and succulent vigor and decreased grass production and diversity.

Shrub and succulent vigor increases as grass vigor decreases due to various ecological processes. One such process is direct competition for resources. Shrubs have greater access to nutrients and moisture deep in cracks and fissures within the bedrock strata. Another process is a slow decrease in labile carbon, thus decreasing soil organic matter. This in turn, leads to a decrease in water-holding capacity and a consequential decrease in grass vigor.

1.2B Community Pathway: This pathway represents a single fire event driving plant Community 1.2 to 1.3. Grasses respond fairly quickly after fire, while shrubs and succulents are suppressed. This pathway occurs within the range of historic variability.

Many shrubs and succulents take a while to respond after a fire event. They must re-grow from below ground root systems or come back from seed. Grasses can colonize quickly, through tillering after a fire event, especially when precipitation follows closely after fire.

1.2C Community Pathway: This pathway represents a growing competitive advantage from nitrogen fixing shrubs due to slow changes in soil chemistry and hydrology. Nitrogen fixing shrubs such as whitethorn acacia, catclaw acacia, and catclaw mimosa will start to increase in vigor, creating immediate competition with grasses and eventually other shrubs.

Percent Foliar Cover by Material Type:

Vegetative Cover						Non-Vegetative Cover					
Grass/ Grasslike	Forb	Shrub	Succulents	Non-Vascular Plants	Biological Crust	Litter	Surface Fragments > 1/4 & <= 3"	Surface Fragments > 3"	Bedrock	Water	Bare Ground
30	3	23	17	T	2	50	36	9	12	0	5

Percent Canopy Cover by Height Class (Structure of Canopy Cover)

	Grasses/Grasslike	Forbs	Shrubs	Succulents/Cactus
<=15 cm	5	2	1	3
> 15 cm - < 30 cm	25	1	2	4
> 30 cm - < 70 cm			4	4
> 70 cm - < 100 cm			8	4
> 100 cm			8	2

Community Phase Annual Production by Plant Type:

Plant Type	Annual Production (lbs/ac)		
	Low	RV	High
Grass/Grass-like	300	420	540
Forbs/Ferns	15	21	27
Shrubs	125	175	225
Succulents	60	84	108
Annual Production Total	500	700	900

Plant Community 1.2 Composition and Group Annual Production:

Plant Type - Grass/Grass-like

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
1	**Warm SeasonTallgrasses**					4%		
	cane bluestem	BOBA3	Bothriochloa barbinodis	7	14		<1	3
	silver bluestem	BOLA2	Bothriochloa laguroides	7	14		<1	3
2	**Warm Season Midgrasses**					33%		
	curly leaf muhly	MUSE	Muhlenbergia setifolia	14	154		2	10
	sideoats grama	BOCU	Bouteloua curtipendula	42	56		3	5
	threeawn	ARPU9	Aristida pupurea	35	49		1	3
	slim tridens	TRMU	Tridens muticus	28	42		1	3
	plains lovegrass	ERIN	Eragrostis intermedia	7	35		1	3
	green sprangletop	LEDU	Leptochloa dubia	7	21		<1	<1
	sand dropseed	SPCR	Sporobolus cryptandrus	4	11		<1	<1
3	**Warm Season Shortgrasses**					20%		
	hairy grama	BOHI2	Bouteloua hirsuta	35	63		2	4
	black grama	BOER4	Bouteloua eriopoda	21	63		1	5
	hairy tridens	ERPI5	Erioneuron pilosum	7	35		<1	2
	halls panicum	PAHA	Panicum hallii	7	21		<1	2
	blue grama	BOGR2	Bouteloua gracilis	4	11		<1	2
	wolftail	LYPH	Lycurus phleoides	4	11		<1	2
	fluff grass	DAPU7	Dasyochloa pulchella	0	T		0	<1
	fall witchgrass	DIPU9	Digitaria pubiflora	0	T		0	<1

4	**Cool-season Tall grasses**					1%		
	New Mexico feathergrass	HENE5	Hesperostipa neomexicana	0	14		0	2

Plant Type – Forbs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
5	**Perennial Forbs**					4%		
	croton	CROTO	Croton spp.	4	11		<1	2
	hawkweed buckwheat	ERHI3	Eriogonum hieraciifolium	4	11		<1	2
	whitemargin sandmat	CHAL11	Chamaesyce albomarginata	4	11		<1	2
	james' nailwort	PAJA	Paronychia jamesii	0	T		0	<1
	spreading fleabane	ERDI4	Erigeron divergens	0	T		0	<1
	desert verbena	GLBIC	Glandularia bipinnatifida var. ciliata	0	T		0	<1
	fendler's bladderpod	LEFE	Lesquerella fendleri	0	T		0	<1
	polygala	POLYG	Polygala spp.	0	T		0	<1
	douglas' ragwort	SEFLD	Senecio flaccidus var. douglasii	0	T		0	<1
	resurrection Plant	SEPI	Selaginella pilifera	0	T		0	<1
	Other perennial forbs			4	11		1	2
6	**Annual Forbs**					T		
	Other annual forbs			0	T		0	<1

Plant Type - Shrubs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
7	**Shrubs**					20%		
	redberry juniper	JUPI	Juniperus pinchotii	21	63		4	12
	mariola	PAIN2	Parthenium incanum	14	42		2	6
	indigo bush	DAFO	Dalea Formosa	4	28		1	3
	javelina bush	COER5	Condalia ericoides	7	21		<1	2

	range ratany	KRER	Krameria erecta	4	11		<1	2
	algerita	MATR3	Mahonia trifoliolata	4	11		<1	2
	skeleton leaf goldeneye	VIST	Viguiera stenoloba	4	11		<1	2
	Wright's beebrush	ALWR	Aloysia wrightii	3	9		<1	1
	catclaw acacia	ACGR	Acacia greggii	0	T		0	<1
	roemer's acacia	ACRO	Acacia roemeriana	0	T		0	<1
	Catclaw mimosa	MIACB	Mimosa aculeaticarpa var. biuncifera	0	T		0	<1
	mormon tea	EPTR	Ephedra trifurca	0	T		0	<1
	whitethorn acacia	ACCO2	Acacia constricta	0	T		0	<1
	creosote bush	LATR2	Larrea tridentata	0	T		0	<1
8	**Half-Shrubs**					5%		
	broom snakeweed	GUSA2	Gutierrezia sarothrae	14	42		2	4
	desert zinnia	ZIAC	Zinnia acerosa	4	11		<1	1

Plant Type – Succulents

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
9	**Cactus**					4%		
	purple pricklypear	OPMAM	Opuntia macrocentra var. macrocentra	8	40		2	4
	tulip pricklypear	OPPH	Opuntia phaeacantha	2	14		1	3
	tree cholla	CYIMI	Cylindropuntia imbricata var. imbricata	0	T		0	2
	horse crippler	ECTE	Echinocactus texensis	0	T		0	<1
	nylon hedgehog cactus	ECVI2	Echinocereus viridiflorus	0	T		0	<1
	ocotillo	FOSP2	Fouquieria splendens	0	T		0	<1
	cactus apple	OPEN3	Opuntia engelmannii	0	T		0	<1
	lee pincushion	ESSNL	Escobaria sneedii	0	T		0	<1
10	**Yucca**					2%		
	torrey's yucca	YUTO	Yucca torreyi	8	24		1	3
	soaptree yucca	YUEL	Yucca elata	0	T		0	<1
11	**Yucca-like plants**					6%		
	lechuguilla	AGLE	Agave lechuguilla	24	40		4	8

	Sotol	DALE2	Dasylirion leiophyllum	8	24		2	4

12 Plant Type – Fern

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
	Cochise scaly cloakfern (jimmy fern)	ASCO42	Astrolepis cochisensis	6	10	1%	1	3

Growth Curve:
Growth Curve Number: NM42801
Growth Curve Name: Very Shallow Phase 1.2 shrubs/succulents/warm season grasses
Growth Curve Description: R042XH001NM

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0	0	1	8	10	16	25	25	11	4	0	0

1.3 Warm season grasses/scattered shrubs

This community phase consists of a mix of warm season grasses, succulents and shrubs. This plant phase exists shortly after fire has burned the site, suppressing succulents and shrubs and creating a competitive advantage for grasses. Foliar cover is between 60 and 80 percent, depending on how recent and how severe the fire had been. Also, precipitation following fire is needed for growth to resume. Basal cover is between 20 and 35 percent, depending on precipitation, and bare ground is around 2 to 4 percent. Warm season grasses make up about 55 percent foliar cover; shrubs, 10 percent; and succulents, 5 percent. The average surface soil stability rating is 5 under canopy and 4.8 in the interspaces. Annual production averages around 900 lbs/ac, but can span between 600 and 1200 lbs/ac, depending on the percentage of rock outcrop, cracks and fissures in the bedrock, soil depth and annual weather patterns.

This community exists approximately one to six years after fire. It is a grass dominated site, with basal sprouting shrubs scattered across the site. Curly leaf muhly is the dominant grass in mid to upper elevations, while “thermic” species, such as black grama, slim tridens and hairy tridens, are more dominant at lower elevations. Mariola tends to be a dominant shrub at lower to mid elevations, followed by redberry juniper at mid to upper elevations, and sandpaper oak at upper elevations. Lechuguilla and sacahuista are the dominant succulents and are present at all elevations.

This plant community is the ecological site’s response to fire within the reference state. Fire is the natural event that keeps shrub species from gaining a competitive advantage and stimulates colonization by grasses. As grasses respond with greater density following fire, decomposition speeds up, leading to greater soil organic matter, infiltration, and plant available water. Over time shrubs and succulents move back onto the site.

Community 1.3; Guadalupe Ridge Trail; CCNP; 3-16-11

Community Phase Pathways:

1.3A Community Pathway: This pathway represents intervals between fires, during which natural processes increase shrub and succulent vigor and decrease grass production and percent composition. Over time, plant community 1.3 shifts to 1.1.

Shrub and succulent vigor increases as grass vigor decreases due to various ecological processes. The first of these is direct competition for resources. Shrubs have greater access to nutrients and moisture deep in cracks and fissures within the bedrock strata. The second is a slow decrease in labile carbon, thus decreasing soil organic matter which leads to a decrease in grass vigor.

1.3B Community Pathway: This pathway represents a sustained short-interval prescribed fire regime driving plant Community 1.3 to 1.5. Succulents and black grama are greatly reduced and can be removed over time. If the fire regime is too frequent, there will be a net loss of carbon to the system, leading lower soil organic matter, lower infiltration, and greater topsoil loss.

Percent Foliar Cover by Material Type:

Vegetative Cover						Non-Vegetative Cover					
Grass/ Grasslike	Forb	Shrub	Succulents	Non-Vascular Plants	Biological Crust	Litter	Surface Fragments > 1/4 & <= 3"	Surface Fragments > 3"	Bedrock	Water	Bare Ground
55	5	10	5	T	2	65	36	9	12	0	3

Percent Canopy Cover by Height Class (Structure of Canopy Cover)

	Grasses/Grasslike	Forbs	Shrubs	Succulents/Cactus
<=15 cm	10	2	1	1
> 15 cm - < 30 cm	30	3	4	2
> 30 cm - < 70 cm	15		5	2
> 70 cm - < 100 cm				
> 100 cm				

Community Phase Annual Production by Plant Type:

Plant Type	Annual Production (lbs/ac)		
	Low	RV	High
Grass/Grass-like	450	675	900
Forbs/Ferns	42	63	84
Shrubs	90	135	180
Succulents	18	27	36
Annual Production Total	600	900	1200

Plant Community 1.3 Composition and Group Annual Production:

Plant Type - Grass/Grass-like

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
1	**Warm SeasonTallgrasses**					4%		
	cane bluestem	BOBA3	Bothriochloa barbinodis	9	27		1	3
	silver bluestem	BOLA2	Bothriochloa laguroides	9	27		1	3
	little bluestem	SCSC	Schizachyrium scoparium	T	T		<1	<1
2	**Warm Season Midgrasses**					45%		
	curly leaf muhly	MUSE	Muhlenbergia setifolia	45	261		4	24
	sideoats grama	BOCU	Bouteloua curtipendula	99	135		7	9
	threeawn	ARPU9	Aristida pupurea	45	63		1	5
	slim tridens	TRMU	Tridens muticus	32	48		2	4
	plains lovegrass	ERIN	Eragrostis intermedia	9	45		1	3
	green sprangletop	LEDU	Leptochloa dubia	8	24		<1	2
	sand dropseed	SPCR	Sporobolus Cryptandrus	5	14		<1	<1

3	**Warm Season Shortgrasses**					25%		
	hairy grama	BOHI2	Bouteloua hirsuta	54	108		5	9
	black grama	BOER4	Bouteloua eriopoda	27	81		2	10
	hairy tridens	ERPI5	Erioneuron pilosum	9	27		1	3
	halls panicum	PAHA	Panicum hallii	9	27		1	3
	blue grama	BOGR2	Bouteloua gracilis	9	27		1	3
	wolftail	LYPH	Lycurus phleoides	5	14		<1	2
	bristlegrass	SELE6	Setaria leucopila	5	14		<1	2
	sand muhly	MUAR2	Muhlenbergia arenicola	0	18		0	<1
	red grama	BOTR2	Bouteloua trifida	0	18		0	<1
	fluff grass	DAPU7	Dasyochloa pulchella	0	T		0	<1
	nineawn	ENDE	Enneapogon desvauxii	0	T		0	<1
	fall witchgrass	DIPU9	Digitaria pubiflora	0	T		0	<1
4	**Cool-season Tall grasses**					1%		
	New Mexico feathergrass	HENE5	Hesperostipa neomexicana	0	18		0	3

Plant Type – Forbs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
5	**Perennial Forbs**					4%		
	Desert verbena	GLBIC	Glandularia bipinnatifida var. ciliata	9	27		1	3
	spreading fleabane	ERDI4	Erigeron divergens	5	14		<1	2
	hawkweed buckwheat	ERHI3	Eriogonum hieraciifolium	5	14		<1	2
	croton	CROTO	Croton spp.	0	T		0	<1
	james' nailwort	PAJA	Paronychia jamesii	0	T		0	<1
	havard's buckwheat	ERHA	Eriogonum havardii	0	T		0	<1
	fendler's bladderpod	LEFE	Lesquerella fendleri	0	T		0	<1
	Texas tansyaster	MABL2	Machaeranthera blephariphylla	0	T		0	<1
	polygala	POLYG	Polygala spp.	0	T		0	<1
	douglas' ragwort	SEFLD	Senecio flaccidus var. douglasii	0	T		0	<1
	shaggy stenandrium	STBA	Stenandrium barbatum	0	T		0	<1

	Other perennial forbs			0	T		0	<1
6	**Annual Forbs**					1%		
	Annual Sunflower	HEAN3	Helianthus annuus	2	14		1	3
	Other annual forbs			0	T		0	<1

Plant Type - Shrubs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
7	**Shrubs**					12%		
	redberry juniper	JUPI	Juniperus pinchotii	9	45		1	3
	mariola	PAIN2	Parthenium incanum	9	45		1	3
	indigo bush	DAFO	Dalea Formosa	9	27		<1	2
	sandpaper oak	QUPU	Quercus pungens	0	27		0	3
	javelina bush	COER5	Condalia ericoides	5	14		<1	2
	skeleton leaf goldeneye	VIST	Viguiera stenoloba	5	14		<1	2
	range ratany	KRER	Krameria erecta	0	T		0	<1
	algerita	MATR3	Mahonia trifoliolata	0	T		0	<1
	catclaw acacia	ACGR	Acacia greggii	0	T		0	<1
	roemer's acacia	ACRO	Acacia roemeriana	0	T		0	<1
	mormon tea	EPTR	Ephedra trifurca	0	T		0	<1
	creosote bush	LATR2	Larrea tridentata	0	T		0	<1
	skunkbush sumac	RHTRT	Rhus trilobata var. trilobata	0	T		0	<1
	lotebush	ZIOB	Ziziphus obtusifolia	0	T		0	<1
8	**Half-Shrubs**					3%		
	broom snakeweed	GUSA2	Gutierrezia sarothrae	9	27		<1	3
	dyssodia	DYSSO	Dyssodia spp.	5	14		<1	2
	desert zinnia	ZIAC	Zinnia acerosa	0	T		0	<1
	rough menodora	MESC	Menodora scabra	0	T		0	<1
	five needle prickly leaf	THPEP	Thymophylla pentachaeta var. pentachaeta	0	T		0	<1
	hairy crinklemat	TIHI	Tiquilia hispidissima	0	T		0	<1

Plant Type – Succulents

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
9	**Cactus**					1%		
	purple pricklypear	OPMAM	Opuntia macrocentra var. macrocentra	5	14		<1	3
	tulip pricklypear	OPPH	Opuntia phaeacantha	0	T		0	<1
	tree cholla	CYIMI	Cylindropuntia imbricata var. imbricata	0	T		0	<1
	pitaya	ECEN2	Echinocereus enneacanthus	0	T		0	<1
	devilshead	ECHO	Echinocactus horizonthalonius	0	T		0	<1
	horse crippler	ECTE	Echinocactus texensis	0	T		0	<1
	kingcup cactus	ECTR	Echinocereus triglochidiatus	0	T		0	<1
	nylon hedgehog cactus	ECVI2	Echinocereus viridiflorus	0	T		0	<1
	ocotillo	FOSP2	Fouquieria splendens	0	T		0	<1
	cactus apple	OPEN3	Opuntia engelmannii	0	T		0	<1
	lee pincushion	ESSNL	Escobaria sneedii	0	T		0	<1
10	**Yucca**					1%		
	torrey's yucca	YUTO	Yucca torreyi	5	14		<1	2
	soaptree yucca	YUEL	Yucca elata	0	T		0	<1
11	**Yucca-like plants**					2%		
	lechuguilla	AGLE	Agave lechuguilla	5	14		<1	2
	Texas sacahuista	NOTE	Nolina texana	5	14		<1	2
	Sotol	DALE2	Dasylirion leiophyllum	0	T		0	<1

12 Plant Type – Fern

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
	Cochise scaly cloakfern (jimmy fern)	ASCO42	Astrolepis cochisensis	0	T	T	0	<1

Growth Curve:
Growth Curve Number: NM4281
Growth Curve Name: Very Shallow Phase 1.3 warm season grasses/scattered shrubs
Growth Curve Description: R042XH001NM

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0	0	2	8	10	15	25	25	11	4	0	0

1.4 *At risk* shrubs/ warm season grasses/ succulents/nitrogen fixing shrubs

Community 1.4; McGruder Hill 7-11-11

This community phase consists of a mix of shrubs, succulents and warm season grasses along with an increase in nitrogen fixing shrubs. It is no longer within the "historic range of variability" as management has created an "at risk" community phase. However, it is still within the reference state, meaning it has not crossed a

threshold, and that intensive management (i.e., accelerating practices) is not yet required to push the system back into the historic range of variability (Bestelmeyer, et al., 2010).

Foliar cover is between 35 and 65 percent, basal cover is between 10 and 20 percent, and bare ground is around 2 to 10 percent. Warm season grasses make up about 20 percent foliar cover; shrubs, 23 percent; and succulents, 7 percent. The average surface soil stability rating is 5 under canopy and 4.0 in the interspaces. Annual production averages around 550 lbs/ac, but can span between 300 and 800 lbs/ac, depending on the percentage of rock outcrop, cracks and fissures in the bedrock, soil depth and annual weather patterns.

This community exists due to past management and disturbance, primarily fire suppression coupled with loosely managed livestock grazing over many years. Due to the site's relatively level slope and summit position, it was historically used as a corridor for livestock travel, as well as for bedding grounds for goats and sheep. As compared to the "historic range of variability," a greater percentage of short- warm season grasses and nitrogen fixing shrubs occur in this community.

This plant community phase has developed over time due to a number of slow ecological variables. One management practice that influences ecology is fire suppression. Shrubs gain a competitive advantage through fire suppression. Through deeper root systems, shrubs can take advantage of moisture stored in cracks and fissures in the bedrock, while grasses struggle with the slow decline of soil organic matter and the decrease of plant available water. Also, due to the decrease in soil organic matter, aggregate stability diminishes, causing a decrease in infiltration and an increase in runoff.

Another factor in creating this community is the loose management of livestock over many years. Livestock contribute to the distribution of seed and can lessen plant vigor and soil organic matter through continuous grazing and over-utilization. As the vigor of grasses and some shrubs decreases, nitrogen fixing plants start to increase and begin to change the chemistry and hydrology of the site. This site is "at risk" of crossing a threshold into state two.

Community Phase and Transitional Pathways:

1.4 B Community Pathway: This pathway represents a single fire event driving plant Community 1.4 to 1.3. Grasses respond fairly quickly after fire, while shrubs and succulents are suppressed. This pathway coupled with a change in livestock grazing will lead back to the historic range of variability.

1.4D Community Pathway: A change in livestock grazing management promotes grass vigor and decreases shrub competition. This accelerates the turnover of fine roots, causing an increase in labile carbon, acceleration in decomposition, and an increase in plant available water.

T1A Transition one: This transition moves the site across a threshold to state two. *Slow variables:* Continued encroachment by whitethorn acacia, coupled with the loss of the herbaceous plant community. Both a chemical and hydrological shift occurs as the C:N decreases creating an increase in the nitrogen turnover rate and creating an on-going competitive advantage for nitrogen fixing shrubs.

Trigger event: A severe drought, causing a loss of organic carbon. *Threshold:* A hydrologic function/soil chemistry threshold is crossed.

Percent Foliar Cover by Material Type:

Vegetative Cover						Non-Vegetative Cover					
Grass/ Grasslike	Forb	Shrub	succulents	Non-Vascular Plants	Biological Crust	Litter	Surface Fragments > 1/4 & <= 3"	Surface Fragments > 3"	Bedrock	Water	Bare Ground
20	5	23	7	T	4	40	36	9	12	0	6

Percent Canopy Cover by Height Class (Structure of Canopy Cover)

	Grasses/Grasslike	Forbs	Shrubs	Succulents/Cactus
<=15 cm	10	2	2	2
> 15 cm - < 30 cm	8	3	5	2
> 30 cm - < 70 cm	2		6	3
> 70 cm - < 100 cm			6	
> 100 cm			4	

Community Phase Annual Production by Plant Type:

Plant Type	Annual Production (lbs/ac)		
	Low	RV	High
Grass/Grass-like	165	300	440
Forbs/Ferns	15	30	40
Shrubs	90	165	240
Succulents	30	55	80
Annual Production Total	300	550	800

Plant Community 1.4 Composition and Group Annual Production:

Plant Type - Grass/Grass-like

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
1	**Warm SeasonTallgrasses**					2%		
	cane bluestem	BOBA3	Bothriochloa barbinodis	6	17		<1	2
2	**Warm Season Midgrasses**					26%		
	sideoats grama	BOCU	Bouteloua curtipendula	50	72		2	5
	curly leaf muhly	MUSE	Muhlenbergia setifolia	6	61		1	3
	slim tridens	TRMU	Tridens muticus	17	28		1	2
	threeawn	ARPU9	Aristida pupurea	11	22		1	2
	sand dropseed	SPCR	Sporobolus Cryptandrus	6	17		1	2
	plains lovegrass	ERIN	Eragrostis intermedia	3	8		1	2
3	**Warm Season Shortgrasses**					24%		
	hairy grama	BOHI2	Bouteloua hirsuta	33	66		2	5

	black grama	BOER4	Bouteloua eriopoda	6	50		1	3
	hairy tridens	ERPI5	Erioneuron pilosum	6	17		1	2
	halls panicum	PAHA	Panicum hallii	6	17		1	2
	blue grama	BOGR2	Bouteloua gracilis	6	17		1	2
	nineawn	ENDE	Enneapogon desvauxii	3	19		<1	2
	wolftail	LYPH	Lycurus phleoides	3	8		<1	2
	bristlegrass	SELE6	Setaria leucopila	3	8		<1	1
	fluff grass	DAPU7	Dasyochloa pulchella	3	8		<1	1
	fall witchgrass	DIPU9	Digitaria pubiflora	0	T		0	<1
4	**Cool-season Tall grasses**					1%		
	New Mexico feathergrass	HENE5	Hesperostipa neomexicana	3	8		<1	1

Plant Type – Forbs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
5	**Perennial Forbs**					5%		
	Desert verbena	GLBIC	Glandularia bipinnatifida var. ciliata	3	8		<1	2
	hawkweed buckwheat	ERHI3	Eriogonum hieraciifolium	3	8		<1	2
	croton	CROTO	Croton spp.	3	8		<1	2
	james' nailwort	PAJA	Paronychia jamesii	3	8		<1	2
	polygala	POLYG	Polygala spp.	3	8		<1	2
	resurrection plant	SEPI	Selaginella spp.	0	T		0	<1
	whitemargin sandmat	CHAL11	Chamaesyce albomarginata	0	T		0	<1
	Other perennial forbs			0	T		0	<1
6	**Annual Forbs**					1%		
	Annual Sunflower	HEAN3	Helianthus annuus L.	3	8		<1	1
	Other annual forbs			0	T		0	<1

Plant Type - Shrubs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
7	**Shrubs**					27%		
	redberry juniper	JUPI	Juniperus pinchotii	6	50		1	7
	mariola	PAIN2	Parthenium incanum	6	39		1	5

	indigo bush	DAFO	Dalea Formosa	11	22		1	3
	sandpaper oak	QUPU	Quercus pungens	0	33		0	4
	whitethorn acacia	ACCO2	Acacia constricta	6	28		1	3
	catclaw mimosa	MIACB	Mimosa aculeaticarpa var. biuncifera	6	17		1	3
	catclaw acacia	ACGR	Acacia greggii	6	17		1	3
	skeleton leaf goldeneye	VIST	Viguiera stenoloba	6	17		1	3
	javelina bush	COER5	Condalia ericoides	3	8		<1	2
	algerita	MATR3	Mahonia trifoliolata	3	8		<1	2
	roemer's acacia	ACRO	Acacia roemeriana	3	8		<1	2
	littleleaf sumac	RHMI3	Rhus microphylla	0	T		0	2
	mormon tea	EPTR	Ephedra trifurca	0	T		0	2
	creosote bush	LATR2	Larrea tridentata	0	T		0	1
8	**Half-Shrubs**					3%		
	dyssodia	DYSSO	Dyssodia spp.	6	17		<1	2
	rough menodora	MESC	Menodora scabra	3	8		<1	<1
	five needle prickly leaf	THPEP	Thymophylla pentachaeta var. pentachaeta	0	T		0	<1
	hairy crinklemat	TIHI	Tiquilia hispidissima	0	T		0	<1

Plant Type – Succulents

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
9	**Cactus**					4%		
	purple pricklypear	OPMAM	Opuntia macrocentra var. macrocentra	6	17		2	4
	tulip pricklypear	OPPH	Opuntia phaeacantha	3	8		1	3
	tree cholla	CYIMI	Cylindropuntia imbricata var. imbricata	3	8		<1	1
	horse crippler	ECTE	Echinocactus texensis	0	T		0	<1
	kingcup cactus	ECTR	Echinocereus triglochidiatus	0	T		0	<1
	nylon hedgehog cactus	ECVI2	Echinocereus viridiflorus	0	T		0	<1
	ocotillo	FOSP2	Fouquieria splendens	0	T		0	<1
	cactus apple	OPEN3	Opuntia engelmannii	0	T		0	<1
	lee pincushion	ESSNL	Escobaria sneedii	0	T		0	<1

10	**Yucca**					1%		
	torrey's yucca	YUTO	Yucca torreyi	3	8		<1	<1
	soaptree yucca	YUEL	Yucca elata	0	T		0	<1
11	**Yucca-like plants**					5%		
	lechuguilla	AGLE	Agave lechuguilla	11	22		<1	2
	Sotol	DALE2	Dasylirion leiophyllum	11	22		<1	2

12 Plant Type – Fern

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low 1/	Species Annual Production High	Group Annual Production 2/	Foliar Cover (percent) low	Foliar Cover (percent) high
	Cochise scaly cloakfern (jimmy fern)	ASCO42	Astrolepis cochisensis	3	8	1%	<1	2

Growth Curve:
Growth Curve Number: NM4281
Growth Curve Name: Very Shallow Phase 1.4 *At Risk:* shrubs/ warm season grasses/succulents/nitrogen fixing shrubs
Growth Curve Description: R042XH001NM

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0	0	3	10	12	15	24	21	11	4	0	0

1.5 Reduced warm stoloniferous grasses/ scattered shrubs and succulents

This community consists of a mix of warm season grasses, shrubs, and a few succulents. This plant phase results from repeated prescribed burning that exceeds the historic range of frequency. Succulents, shrubs and black grama are reduced while bunch grasses such as curly leaf muhly and sideoats grama have a competitive advantage. Foliar cover is between 70 and 90 percent, basal cover is between 35 and 45 percent, and bare ground is around 1 to 2 percent. Warm season grasses make up about 60 percent foliar cover; shrubs, 15 percent; and succulents, 5 percent. The average surface soil stability rating is 5 under canopy and 4.8 in the interspaces. Annual production averages around 1100 lbs/ac, but can span between 600 and 1400 lbs/ac, depending on the percentage of rock outcrop, cracks and fissures in the bedrock, soil depth and annual weather patterns.

This community exists approximately one to six years after fire. It is a grass dominated site, with basal sprouting shrubs scattered across its extent. Curly leaf muhly is the dominant grass in mid to upper elevations, while “thermic” species, such as slim tridens and hairy tridens, are more dominant at lower elevations. Redberry juniper is the dominant shrub in this community. Succulents such as sotol and sacahuista are lightly scattered.

This plant community is the ecological site’s response to frequent fire (every six years) that exceeds the historic fire regime. Plants more sensitive to fire such as black grama and lechuguilla begin to phase out of the

system. Overall grass production is higher within this community phase as fire keeps shrub competition down. As grasses respond with greater density following fire, decomposition speeds up, creating greater soil organic matter, infiltration, and plant available water. However, there can be great variability in production between wet and dry years. Without the deep root systems of shrubs, overall nutrient cycling is decreased and deep water resources between cracks and fissures are unattainable.

If this site is allowed to rest from prescribed fire, shrubs will once again multiply and this plant phase will move again into the historic range of variability. If, on the other hand, fire frequency is increased (every two or three years), there would be a net depletion of carbon, creating lower infiltration, lower aggregate stability, lower plant vigor, and the eventual loss of topsoil.

Community 1.5; Loop Road; CCNP; 4-19-11

Community Phase Pathways:

1.5A Community Pathway: This pathway represents intervals between fires, during which natural processes increase shrub and succulent vigor and decrease grass production and percent composition. Over time the plant community moves back into the historic range of variability.

Shrub and succulent vigor increase as grass vigor decreases due to various ecological processes. The first is the direct competition for resources. Shrubs have greater access to nutrients and moisture deep in cracks and

fissures within the bedrock strata. The second is a slow decrease in labile carbon, thus decreasing soil organic matter which indirectly leads to a decrease in grass vigor. Eventually black grama begins to establish itself.

Percent Foliar Cover by Material Type:

Vegetative Cover						Non-Vegetative Cover					
Grass/ Grasslike	Forb	Shrub	succulents	Non-Vascular Plants	Biological Crust	Litter	Surface Fragments > 1/4 & <= 3"	Surface Fragments > 3"	Bedrock	Water	Bare Ground
60	5	15	5	T	2	90	36	9	12	0	1

Percent Canopy Cover by Height Class (Structure of Canopy Cover)

	Grasses/Grasslike	Forbs	Shrubs	Succulents/Cactus
<=15 cm	10	2	3	2
> 15 cm - < 30 cm	30	3	5	2
> 30 cm - < 70 cm	20		5	1
> 70 cm - < 100 cm			2	
> 100 cm				

Community Phase Annual Production by Plant Type:

Plant Type	Annual Production (lbs/ac)		
	Low	RV	High
Grass/Grass-like	480	880	1120
Forbs/Ferns	30	55	70
Shrubs	72	132	168
Succulents	18	33	42
Annual Production Total	600	1100	1400

Plant Community 1.5 Composition and Group Annual Production:

Plant Type - Grass/Grass-like

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
1	**Warm SeasonTallgrasses**					6%		
	cane bluestem	BOBA3	Bothriochloa barbinodis	55	77		1	3
2	**Warm Season Midgrasses**					50%		
	curly leaf muhly	MUSE	Muhlenbergia setifolia	110	286		4	24
	sideoats grama	BOCU	Bouteloua curtipendula	88	132		6	8
	slim tridens	TRMU	Tridens muticus	55	77		2	4
	sand dropseed	SPCR	Sporobolus Cryptandrus	44	66		<1	<1
	green sprangletop	LEDU	Leptochloa dubia	22	66		<1	2
	threeawn	ARPU9	Aristida pupurea	33	55		1	5
	plains lovegrass	ERIN	Eragrostis intermedia	11	55		1	3

3	**Warm Season Shortgrasses**					23%		
	hairy grama	BOHI2	Bouteloua hirsuta	132	198		5	9
	bristlegrass	SELE6	Setaria leucopila	33	55		<1	2
	mat muhly	MURI	Muhlenbergia richardsonis	22	44		1	2
	halls panicum	PAHA	Panicum hallii	11	33		1	3

Plant Type – Forbs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
4	**Perennial Forbs**					4%		
	Desert verbena	GLBIC	Glandularia bipinnatifida var. ciliata	6	17		1	3
	hawkweed buckwheat	ERHI3	Eriogonum hieraciifolium	6	17		<1	2
	shaggy stenandrium	STBA	Stenandrium barbatum	6	17		<1	<1
	james' nailwort	PAJA	Paronychia jamesii	0	T		<1	<1
	havard's buckwheat	ERHA	Eriogonum havardii	0	T		<1	<1
	Other perennial forbs			6	17		<1	<1
5	**Annual Forbs**					1%		
	Annual Sunflower	HEAN3	Helianthus annuus L.	6	17		1	3
	Other annual forbs			0	T		0	<1

Plant Type - Shrubs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
6	**Shrubs**					8%		
	redberry juniper	JUPI	Juniperus pinchotii	11	55		1	3
	indigo bush	DAFO	Dalea Formosa	11	33		<1	2
	sandpaper oak	QUPU	Quercus pungens	0	44		0	3
	javelina bush	COER5	Condalia ericoides	6	17		<1	2
	skeleton leaf goldeneye	VIST	Viguiera stenoloba	6	17		<1	2
	algerita	MATR3	Mahonia trifoliolata	0	T		0	<1
	catclaw acacia	ACGR	Acacia greggii	0	T		0	<1

	roemer's acacia	ACRO	Acacia roemeriana	0	T		0	<1
7	**Half-Shrubs**					3%		
	desert zinnia	ZIAC	Zinnia acerosa	11	33		<1	<1
	dyssodia	DYSSO	Dyssodia spp.	6	17		<1	2
	rough menodora	MESC	Menodora scabra	0	T		0	<1
	five needle prickly leaf	THPEP	Thymophylla pentachaeta var. pentachaeta	0	T		0	<1
	hairy crinklemat	TIHI	Tiquilia hispidissima	0	T		0	<1

Plant Type – Succulents

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
8	**Cactus**					1%		
	purple pricklypear	OPMAM	Opuntia macrocentra var. macrocentra	6	17		<1	3
	tree cholla	CYIMI	Cylindropuntia imbricata var. imbricata	0	T		0	<1
	devilshead	ECHO	Echinocactus horizonthalonius	0	T		0	<1
	horse crippler	ECTE	Echinocactus texensis	0	T		0	<1
	Rainbow cactus	ECPE	Echinocereus pectinatus	0	T		0	<1
	ocotillo	FOSP2	Fouquieria splendens	0	T		0	<1
9	**Yucca**					T		
	torrey's yucca	YUTO	Yucca torreyi	0	T		0	2
	soaptree yucca	YUEL	Yucca elata	0	T		0	<1
10	**Yucca-like plants**					3%		
	Sotol	DALE2	Dasylirion leiophyllum	11	33		<1	<1
	lechuguilla	AGLE	Agave lechuguilla	6	17		<1	2
	Texas sacahuista	NOTE	Nolina texana	0	T		0	2

11 Plant Type – Fern

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
	Cochise scaly cloakfern (jimmy fern)	ASCO42	Astrolepis cochisensis	6	17	1%	<1	<1

Growth Curve:
Growth Curve Number: NM4281
Growth Curve Name: Very Shallow Phase 1.5: Reduced warm season stoloniferous grasses/ scattered shrubs and succulents
Growth Curve Description: R042XH001NM

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0	0	2	8	10	15	25	25	11	4	0	0

2.0 NITROGEN FIXING SHRUBS/SUCCULENTS/SHRUBS/WARM SEASON GRASSES STATE

2.1 Whitethorn acacia/succulents/shrubs/warm season grasses

Community 2.1; Boyds canyon 7/10/11

This community consists of a mix of shrubs, succulents and warm season grasses along with an increase in nitrogen fixing shrubs, especially whitethorn acacia. It is no longer within the reference state as the site has crossed a threshold into a degraded state. Because the site has crossed a threshold, intensive management (i.e., accelerating practices) is required to restore the system.

Foliar cover is between 30 and 50 percent, basal cover is between 3 and 12 percent, and bare ground is around 5 to 20 percent. Warm season grasses make up about 10 percent foliar cover; shrubs, 20 percent; and succulents, 8 percent. The average surface soil stability rating is 3.5 under canopy and 3 in the interspaces. Annual production averages around 300 lbs/ac, but can span between 150 and 450 lbs/ac, depending on the percentage of rock outcrop, cracks and fissures in the bedrock, soil depth, and annual weather patterns.

This community exists due to past management and disturbance, primarily fire suppression coupled with grazing management that decreases grass competition. After many years of slow retrogression, a trigger event such as a severe drought could cause this site to cross a threshold where ecological processes and soil properties keep it in a degraded state.

With fire suppression, shrubs gain a competitive advantage due to deeper root systems, which take advantage of moisture stored in cracks and fissures in the bedrock, while grasses struggle with the slow decline of soil organic matter and the decrease of plant available water. Also, due to the decrease in soil organic matter, aggregate stability diminishes, causing a decrease in infiltration and an increase in runoff.

Livestock contribute to the distribution of seed and can lessen plant vigor and soil organic matter through continuous grazing and over-stocking. As grass vigor decreases, shrubs gain a competitive advantage. As nitrogen fixing shrubs, especially whitethorn, increase a change in the chemistry and hydrology of the system occurs. This site suffers from low labile carbon and high nitrogen turnover, ultimately slowing the nutrient cycle and reducing plant available water. Without a change in management, it is possible for this plant community to degrade further, to a community in which only whitethorn, a few scattered shrubs and fluffgrass exist.

Restoration Pathway:

R2A Restoration Process: An increase in the competitive advantage of non-nitrogen fixing species through physical, chemical, and biological management practices.

Various facilitating and management practices can be used to restore this ecological site back to reference. Chemical, mechanical, and biological practices can all be used to suppress whitethorn and other acacias in the plant community. Also, range seeding, winter feeding, and browsing, and high intensity-short duration livestock grazing can help bring grass seed and organic matter back into the system and start restoring soil carbon and microbial levels. Once adequate fuel levels have been reached, prescribed burning will help reduce shrub competition and improve grass vigor. Monitoring foliar cover by species will help inform the land manager if plant composition is responding to management.

Percent Foliar Cover by Material Type:

Vegetative Cover						Non-Vegetative Cover					
Grass/ Grasslike	Forb	Shrub	Succulents	Non-Vascular Plants	Biological Crust	Litter	Surface Fragments > 1/4 & <= 3"	Surface Fragments > 3"	Bedrock	Water	Bare Ground
10	3	20	7	T	4	30	36	9	12	0	13

Percent Canopy Cover by Height Class (Structure of Canopy Cover)

	Grasses/Grasslike	Forbs	Shrubs	Succulents/Cactus
<=15 cm	8	2	2	1
> 15 cm - < 30 cm	2	1	3	3
> 30 cm - < 70 cm			6	3
> 70 cm - < 100 cm			6	
> 100 cm			3	

Community Phase Annual Production by Plant Type:

Plant Type	Annual Production (lbs/ac)		
	Low	RV	High
Grass/Grass-like	60	120	180
Forbs/Ferns	8	15	23
Shrubs	60	120	180
Succulents	22	45	67
Annual Production Total	150	300	450

Plant Community 2.1 Composition and Group Annual Production:

Plant Type - Grass/Grass-like

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
1	**Warm Season Midgrasses**					15%		
	sideoats grama	BOCU	Bouteloua curtipendula	12	18		1	3
	slim tridens	TRMU	Tridens muticus	6	12		<1	2
	threeawn	ARPU9	Aristida pupurea	6	12		<1	2
	sand dropseed	SPCR	Sporobolus Cryptandrus	3	9		<1	1
	curly leaf muhly	MUSE	Muhlenbergia setifolia	3	9		<1	1
	plains lovegrass	ERIN	Eragrostis intermedia	0	T		0	<1
2	**Warm Season Shortgrasses**					25%		
	hairy grama	BOHI2	Bouteloua hirsuta	12	24		2	5
	black grama	BOER4	Bouteloua eriopoda	3	21		1	3
	hairy tridens	ERPI5	Erioneuron pilosum	6	18		1	2
	halls panicum	PAHA	Panicum hallii	6	18		1	2
	fluff grass	DAPU7	Dasyochloa pulchella	6	18		<1	1

	fall witchgrass	DIPU9	Digitaria pubiflora	3	9		<1	<1
	red grama	BOTR2	Bouteloua trifida Thurb.	2	5		<1	<1

Plant Type – Forbs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
3	**Perennial Forbs**					4%		
	scarlet beeblossom	GACO5	Gaura coccinea	2	5		<1	1
	Other perennial forbs			6	12		<1	<1
4	**Annual Forbs**					1%		
	Annual Sunflower	HEAN3	Helianthus annuus	3	8		<1	1
	Other annual forbs			0	T		<1	<1

Plant Type - Shrubs

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
5	**Shrubs**					40%		
	whitethorn acacia	ACCO2	Acacia constricta	45	81		8	12
	catclaw mimosa	MIACB	Mimosa aculeaticarpa var. biuncifera	9	15		1	3
	mariola	PAIN2	Parthenium incanum	6	18		1	3
	roemer's acacia	ACRO	Acacia roemeriana	6	12		1	3
	redberry juniper	JUPI	Juniperus pinchotii	6	12		1	3
	skeleton leaf goldeneye	VIST	Viguiera stenoloba	3	9		<1	2
	indigo bush	DAFO	Dalea Formosa	2	5		<1	2
	javelina bush	COER5	Condalia ericoides	2	5		<1	2
	algerita	MATR3	Mahonia trifoliolata	2	5		<1	1
6	**Half-Shrubs**					T		
	dyssodia	DYSSO	Dyssodia spp.	0	T		0	<1

Plant Type – Succulents

Group Number	Common Name	Scientific Plant Symbol	Scientific Name	Species Annual Production Low	Species Annual Production High	Group Annual Production	Foliar Cover (percent) low	Foliar Cover (percent) high
7	**Cactus**					10%		
	purple pricklypear	OPMAM	Opuntia macrocentra var. macrocentra	6	12		<1	2

	tulip pricklypear	OPPH	Opuntia phaeacantha	6	12		<1	2
	tree cholla	CYIMI	Cylindropuntia imbricata var. imbricata	3	9		<1	2
	cactus apple	OPEN3	Opuntia engelmannii	3	9		<1	<2
	ocotillo	FOSP2	Fouquieria splendens	0	T		0	<1
8	**Yucca-like plants**					5%		
	lechuguilla	AGLE	Agave lechuguilla	6	12		1	3
	Sotol	DALE2	Dasylirion	3	9		<1	2

Growth Curve:
Growth Curve Number: NM4281
Growth Curve Name: Very Shallow Phase 2.1 whitethorn acacia/succulents/shrubs/warm season grasses
Growth Curve Description: R042XH001NM

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0	0	3	10	12	15	24	21	11	4	0	0

3.0 TOPSOIL REMOVAL FROM OIL/GAS PADS, ROADS, AND OTHER INFRASTRUCTURE STATE

3.1 Sideoats grama/low seral perennials/annuals

This state occurs where the topsoil has been removed and the area (be it an old road or oil/gas pad) has been abandoned. Very little soil organic matter and native mycorhizal fungi occur on this site. After many decades of abandonment, sideoats grama, which is not quite as dependent on native mycorhizal fungi, can colonize and dominate this site.

If there are deep soils within cracks and fissures in the area, plants will establish quicker and begin re-building topsoil. Mineral soil will accumulate from wind-blown material and possibly water run-off from adjacent areas. It should be noted that, by the time relatively productive soils have developed, the climate will likely differ markedly from that of today. Thus, this ecosystem will likely proceed towards a different reference community from that of today.

R3B Restoration Process: To restore this site, it is best to have saved the scraped topsoil and re-apply once the activity is concluded. Facilitating practices such as range seeding, weed control, and high intensity-short duration livestock grazing can also expedite the restoration.

Old road; post "Loop fire"; CCNP; 3/10/12

Community 3.1; same old road; pre "Loop fire"; CCNP; 5/21/11

Ecological Site Interpretations

Animal Community

Part I: Wildlife

The Very Shallow Ecological Site lies at the northern extent of the Chihuahuan Desert and provides habitat for many different wildlife species.

Species of Special Interest:

These are species of special interest that have habitat needs associated with the Very Shallow Ecological Site.

***Guadalupe Mountains Tiger Beetle**:* This beetle is endemic to the Guadalupe Ridge and Mountains and is tightly associated with limestone outcroppings (Cleland, et al., 2007). Adults feed on just about anything they can see and catch, including invertebrates that may be larger than themselves. Their vision seems acute, as any movement (even by a human at a distance) causes them to turn and face the source of the motion. Beetles, flies, caterpillars, ants, grasshopper nymphs, and spiders are just a few of the invertebrates reported as tiger beetle prey. Although most tiger beetles are wary and not easily approached, they are also preyed upon. Predators of tiger beetles include dragonflies, robber flies, other tiger beetles, birds, and small vertebrates. Mites are also known to parasitize tiger beetles (Spomer, Hoback, Golick, Higley, 2006).

Rock Rattlesnake: The rare mottled rock rattlesnake is found only in New Mexico, Texas, and Chihuahua, Mexico. In New Mexico, the rattlesnake is limited to the southern Guadalupe Mountains and exists within all canyons throughout the Guadalupe Ridge. It is the most frequently encountered rattlesnake in CCNP and is found around exposed bedrock where it feeds on lizards, snakes, and small mammals (SWCA Environmental Consultants, 2007).

***Texas Horned Lizard**:* Texas horned lizards have habitat needs that require healthy harvester ant communities. Harvester ants are the preferred food of horned lizards and when this food resource declines due to shifts to a degraded plant community, or through infrastructure development, lizard numbers will also decline (Henke and Fair, 1998). Feeding may occur at nest entrances or on ant foraging trails and mature lizards are capable of eating 70 to 100 ants per day. Although ants comprise a majority of the diet, Texas horned lizards are opportunistic predators and will consume crickets, grasshoppers, beetles, centipedes, bees and caterpillars. The diagnostic plant community phase (1.1) is best for providing a wide range of plant and insect species needed for Texas horned lizard habit.

Horned Lizard-Photo by Charles Hibner 2011

Gray Vireo*:* The gray vireo is found in the desert Southwest. Over 80 percent of the Gray Vireo territories in New Mexico are found in 12 sites, with the largest site being found in the Guadalupe Mountains (Pierce, 2007). The Gray Vireo appears to not winter in New Mexico but move down to the Big Bend area where it is associated with various shrubs and cacti. Summer habitat in the Guadalupes seems to be linked to juniper and oak plant communities at the upper end of the very shallow ecological site (above 4300 feet). During breeding season (April-July), the Gray Vireo are insectivorous, taking grasshoppers, stinkbugs, crickets, moths, and caterpillars for food. In New Mexico, nests are primarily in Juniper trees. (Pierce, 2007) Plant communities within the historic range of variability are important for the Gray Vireo to find nesting, breeding, and brood-rearing cover. The birds will find nesting cover in plant communities 1.1 and 1.2, while moving to community phase 1.3 to find food.

Grey Vireo, photograph by Greg Lasley

***Peregrine Falcon**:* The Peregrine Falcon is a species of concern that occurs throughout the west. According to experts at the "Living Desert Zoo and Gardens State park" in Carlsbad New Mexico, the peregrine falcon has only been spotted on a rare occasion in the fall or winter.

***Common hog-nosed skunk**:* Hog-nosed skunks are distinguished from striped skunks primarily by the pelage, with a characteristic broad white marking beginning at the top of the head and extending down the back and tail. They make their dens in rocky areas, but probably utilize the Very Shallow Ecological Site for hunting. They are omnivorous, and they eat differently according to the season. They mainly eat insects and grubs but also eat fruit, small mammals, snakes and carrion. Because rattlesnakes react to skunk musk with alarm, it is believed that skunks may feed extensively on rattlesnakes. In search of food, this skunk which roots can turn over large areas of earth with its bare nose and front claws as it searches for food (Buie, 2003).

***Mountain Lion:** :* The mountain lion is an excellent stalk-and-ambush predator, pursuing a wide variety prey. Deer make up its primary food source, but they will also hunt species as small as insects and rodents. The mountain lion stalks through shrubs and across ledges before delivering a powerful leap onto the back of its prey with a suffocating neck bite. The mountain lion is capable of breaking the neck of its prey with a strong bite and momentum bearing the animal to the ground. Kills are generally estimated at around one large ungulate every two weeks. This period shrinks for females raising young, and may be as short as one kill every three days when cubs are nearly mature at around 15 months.

Only females are involved in parenting. Females are fiercely protective of their cubs, and have been seen to successfully fight off animals as large as black bears in their defense. Caves and other alcoves that offer protection are used as litter dens (Cougar, 2013).

The Very Shallow and Limestone Hills ecological sites provide excellent habitat for the mountain lion life cycle. The abundance of shrubs in plant community 1.2 is ideal for lions to hide and stalk prey. Mountain lions can work the edge of hill summits and position themselves above prey where they can pounce with a killing blow.

Eastern White-throated Wood Rat: This large rat is often called a packrat because of the large nest of sticks and other material that it incorporates into nests. The nocturnal rat feeds on a wide variety of plants and finds shelter around dense stands of cacti such as cholla and prickly pear. Plant communities 1.1 and 1.2 are ideal for nesting white-throated wood rats.

Other species associated with the Very Shallow Ecological Site:

Birds	**Mammals**	**Reptiles**
Turkey Vulture	Mexican Ground Squirrel	Green Toad
Mississippi Kite	Yellow-faced Pocket Gopher	Red-spotted toad
Red-tailed Hawk	Merriam's Kangaroo Rat	Rio-Grande Leopard Frog
American Kestrel	Merriam's Pocket Mouse	Eastern Collared Lizard
Great Horned Owl	Western Harvest Mouse	Greater Earless Lizard
Spotted Towhee	Southern Plains Woodrat	Round Tailed Horned Lizard
Canyon Towhee	Cactus Mouse	Crevice Spiny Lizard
Cassin's Sparrow	White-footed Mouse	Prairie Lizard

Brewer's Sparrow	White-ankled Mouse	Common Side-blotched Lizard
Black-throated Sparrow	Hispid Cotton Rat	Texas Banded Gecko
White-crowned Sparrow	North American Porcupine	Chihuahuan Spotted Whiptail
Dark-eyed Junco	Black-tailed Jackrabbit	Common Checkered Whiptail
Scaled Quail	Desert Cottontail	Ring-necked snake
White-winged Dove	American Badger	Striped Whipsnake
Mourning Dove	Striped Skunk	Western Ground Snake
Eurasian Collared Dove *(introduced)*	Grey Fox	
Lesser Nighthawk	Coyote	
Common Nighthawk	Bobcat	
Black-chinned Hummingbird	Mule Deer	
Ladder-backed Woodpecker	Barbary Sheep *(introduced)*	
Western Kingbird	Ringtail	
Cliff Swallow		
Barn Swallow		
Verdin		
Cactus Wren		
Rock Wren		
Northern Mockingbird		
Curved-billed Thrasher		
House Finch		
House Sparrow		

Note: This species list was composed with help from the Living Desert Zoo and Gardens State Park, Carlsbad, New Mexico.

Desert Bighorn and Barbary sheep: By 1946 the desert bighorn was extirpated from the Guadalupe Mountains. Illegal hunting and excessive competition from livestock are the major culprits. Disease from livestock played a role as well.

Currently, there is an estimated 400-770 Barbary sheep in the Guadalupe Mountains. This species fills the niche that desert bighorn once held. There has been consideration given to re-introducing the desert bighorn, but this will most likely not happen unless the population of Barbary sheep can be reduced.

Barbary sheep are native to North Africa, and were released in the Hondo Valley, Largo Canyon, and the Canadian River drainage between 1955 and 1970. Viable populations have become established in historic bighorn habitat in the Guadalupe and Sacramento Mountains. They compete with desert bighorn due to their higher rate of reproduction, ability to subsist on lower quality forage, and preference for habitat similar to that of bighorn. Barbary sheep are socially aggressive when they encounter bighorn and may disrupt the rut (Goldstein and Rominger, 2003).

Part II Livestock:

The Very Shallow Ecological Site has traditionally been grazed by all kinds and classes of livestock, during all seasons of the year. In the early part of the 20th century, goats and sheep were used extensively along the Guadalupe Ridge, taking advantage of browse species. Currently though, there are very few goat and sheep operations in the area due to many market factors. Cattle numbers are down as well due to drought and extensive wildfire from 2001-2011.

With a planned livestock grazing system, the very shallow ecological site could be managed for sustained agriculture while maintaining the historic range of variability. Also, prescribed fire may be a part of the management mix to move the system to community phase 1.5, which is primarily a grassland plant community.

Plant Preference by Animal Kind:

This rating system provides general guidance as to animal preference for plant species. It also indicates possible competition between kinds of herbivores for various plants. Grazing and browsing preference changes from time to time, especially between seasons, and between animal kinds and classes. Grazing and browsing preference does not necessarily reflect the ecological status of the plant within the plant community.

Legend: P=Preferred D=Desirable U=Undesirable N=Not Consumed T=Toxic
Preferred – Percentage of plant in animal diet is greater than it occurs on the land
Desirable – Percentage of plant in animal diet is similar to the percentage composition on the land
Undesirable – Percentage of plant in animal diet is less than it occurs on the land
Not Consumed – Plant would not be eaten under normal conditions. It is only consumed when other forages not available.
Toxic – Rare occurrence in diet and, if consumed in any tangible amounts results in death or severe illness in animal.

Animal Kind: Cattle
Animal Type: Cows

Common Name	Scientific Name	Plant Part	Forage Preferences											
			J	F	M	A	M	J	J	A	S	O	N	D
curly leaf muhly	Muhlenbergia setifolia	whole	D	D	D	P	P	P	P	P	P	P	D	D
sideoats grama	Bouteloua curtipendula	whole	P	P	P	P	P	P	P	P	P	P	P	P
hairy grama	Bouteloua hirsuta	whole	P	P	P	D	D	D	D	D	D	D	P	P
black grama	Bouteloua eriopoda	whole	P	P	P	D	D	D	D	D	D	D	P	P
threeawn	Aristida pupurea	whole	U	U	D	D	D	D	U	U	U	U	U	U
slim tridens	Tridens muticus	whole	P	P	P	P	P	P	P	P	P	P	P	P
hairy tridens	Erioneuron pilosum	whole	U	U	U	D	D	D	D	D	D	D	U	U
plains lovegrass	Eragrostis intermedia	whole	D	D	P	P	P	P	P	P	P	P	D	D
green sprangletop	Leptochloa dubia	whole	U	U	D	D	D	U	U	U	U	U	U	U

Animal Kind: Sheep
Animal Type: Ewe

Common Name	Scientific Name	Plant Part	Forage Preferences J	F	M	A	M	J	J	A	S	O	N	D
curly leaf muhly	Muhlenbergia setifolia	whole	D	D	D	P	P	P	D	D	D	D	D	D
sideoats grama	Bouteloua curtipendula	whole	P	P	P	P	P	P	P	P	P	P	P	P
hairy grama	Bouteloua hirsuta	whole	P	P	P	P	P	P	P	P	P	P	P	P
black grama	Bouteloua eriopoda	whole	P	P	P	D	D	D	D	D	D	D	P	P
slim tridens	Tridens muticus	whole	D	D	D	P	P	P	D	D	D	D	D	D
plains lovegrass	Eragrostis intermedia	whole	D	D	D	P	P	P	P	P	D	D	D	D
green sprangletop	Leptochloa dubia	whole	U	U	D	D	D	U	U	U	U	U	U	U
mariola	Parthenium incanum	Leaves	D	D	D	U	U	U	U	U	U	U	D	D
indigo bush	Dalea Formosa	Leaves	U	U	U	U	U	U	U	U	U	D	D	U

Animal Kind: Goats
Animal Type: Spanish, Angora and Boer

Common Name	Scientific Name	Plant Part	Forage Preferences J	F	M	A	M	J	J	A	S	O	N	D
curly leaf muhly	Muhlenbergia setifolia	Whole	U	U	U	D	D	D	U	U	U	U	U	U
sideoats grama	Bouteloua curtipendula	Whole	D	D	D	D	D	D	D	D	D	D	D	D
hairy grama	Bouteloua hirsuta	Whole	D	D	D	D	D	D	D	D	D	D	D	D
black grama	Bouteloua eriopoda	Whole	D	D	D	U	U	U	U	U	U	U	D	D
mariola	Parthenium incanum	Leaves	P	P	P	D	D	D	D	D	D	P	P	P
indigo bush	Dalea Formosa	Leaves	P	P	P	P	P	P	P	P	P	P	P	P
javelina bush	Condalia ericoides	Leaves	P	P	P	D	D	D	D	D	D	P	P	P
range ratany	Krameria erecta	Leaves	P	P	P	P	P	P	P	P	P	P	P	P
redberry juniper	Juniperus pinchotii	Leaves	D	D	D	U	U	U	U	U	U	U	D	D
sandpaper oak	Quercus pungens	Leaves	U	U	U	P	P	P	P	P	P	U	U	U

Animal Kind: Deer
Animal Type: Mule Deer

Common Name	Scientific Name	Plant Part	Forage Preferences J	F	M	A	M	J	J	A	S	O	N	D
curly leaf muhly	Muhlenbergia setifolia	Whole	U	U	U	D	D	D	U	U	U	U	U	U
sideoats grama	Bouteloua curtipendula	Whole	D	D	D	D	D	D	D	D	D	D	D	D
hairy grama	Bouteloua hirsuta	Whole	D	D	D	D	D	D	D	D	D	D	D	D
black grama	Bouteloua eriopoda	Whole	D	D	D	U	U	U	U	U	U	U	D	D
mariola	Parthenium incanum	Leaves	P	P	P	D	D	D	D	D	D	P	P	P
indigo bush	Dalea Formosa	Leaves	P	P	P	P	P	P	P	P	P	P	P	P
javelina bush	Condalia ericoides	Leaves	P	P	P	D	D	D	D	D	D	P	P	P
range ratany	Krameria erecta	Leaves	U	U	P	P	P	P	P	P	P	P	U	U
sandpaper oak	Quercus pungens	Leaves	U	U	U	P	P	P	P	P	P	P	U	U

Hydrology Functions:

The Lechuguilla soil component is in hydrologic group “D”; as are all soils that have a depth to impenetrable layer of less than 50 cm. During heavy rainstorms runoff from this site is common. The soil is highly

permeable and shallow, and when it becomes saturated, surface sheet flow may occur. The severity of sheet flow depends on the plant community and the amount of gravel armoring. As the plant community changes from the historic range of variability to the "at risk" plant community, surface sheet flow increases due to a lack of vegetation and a decrease in soil aggregate stability.

Fire can temporarily change the soil surface chemistry, making it hydrophobic for a time and causing more sediment to move off site. It is important for vegetation to re-establish and provide structure and organic matter for infiltration and water storage.

Limestone has low permeability, but plant communities depend on deep cracks and fissures to hold soil, nutrients, and organic matter. In these deep cracks, organic matter acts like a sponge, storing water and keeping plants alive through dry periods.

Potholes sometimes form in limestone from a dissolution process. Deeper soils gradually accumulate in these potholes, and produce the most productive vegetation communities.

Recreational Uses:

The very shallow ecological site provides limited recreational use due to its lack of drinking water. Hiking is limited to day trips and should not be attempted without adequate water and a large hat. Some hunting may be possible, but the site is fairly exposed on summit positions, providing poor cover. Exploring the area's unique cultural resources may be an interesting recreational activity on this site. Ring middens and metates both occur on this site bringing to life some of the rich history of this area. Ring middens (also known as midden circles, sotol pits, or mezcal pits) are doughnut-shaped structures of burned rock, ash, and occupational debris (Kayser, 2010).

Rangeland Health Indicators (for the diagnostic plant community)**:**

1. Rills: No rills are present due to the gravel armoring of the surface and slopes less than 25%.

2. Water Flow Patterns: Following intense rainfall events, there may be a few and short (1-3 feet) water flow patterns, which may not be connected. Water flow patterns will be serpentine and wind around stones and bedrock.

3. Pedestals and/or Terracettes: Very few pedestals and terracettes are present due to minimal soil movement. The presence of gravel, cobble and stone on the surface keeps the soil in place. Small, minor pedestals will occur under rock fragments and perennial plants following fire and intense rainfall events.

4. Bare Ground: Interpatch areas among the persistent plants are less than 30 cm in size. The soil is rarely exposed; it is covered by plants, lichen, moss, and rock fragments, with an extensive amount of rock outcrop. The site has less than 5% bare ground.

5. Gullies: There are no gullies present on this site. Because this site occurs on hill summits it receives very little runoff from adjacent areas.

6. Wind Scoured, Blowout, and/or depositional areas: This soil is protected by gravel mulch, cobble, plants, spike moss, and weak biological crusts. Thus, soil redistribution is minimal. Less than 5% of the site would have wind scoured, blowout, and depositional areas.

7. Litter Movement: There is very minor movement of litter off site. Wind may cause some litter to accumulate under shrubs. After intense rainstorms, some litter may move up to three feet along water flow patterns.

8. Soil Surface Resistance to Erosion: The soil surface is very stable due to the presence of gravel, cobble, plants, and weak biological crusts. Stability class (Herrick, et al., 2001) of 5 to 6 is common both under and between plants at the surface and subsurface.

9. Soil Surface Loss or Degradation: The top (A1**)** horizon is 0 to 4 inches, (0 to 10 cm); it is a dark brown (10YR 3/3), very cobbly loam. Soil organic matter is 1-2%. There is very little soil surface loss or degradation on this site.

10. Plant Community Composition and Distribution Relative to Infiltration and Runoff: Runoff is affected by the amount of rock outcrop, soil depth, and the severity of bedrock fracturing. In the diagnostic plant community phase, this site has a fairly even canopy of grasses and shrubs. The runoff is naturally high, due to a very shallow depth class. All structural-functional groups are important in promoting infiltration and slowing runoff.

11. Compaction Layer: This site is not characterized by a compaction layer but the root-restricting layer is very shallow to shallow.

12. Functional/Structural Groups: *Dominant:* warm season midgrasses. *Sub-dominant:* warm season shortgrasses > shrubs > succulents. *Minor component:* forbs > warm season tallgrasses. *Trace component:* nitrogen fixing shrubs.

13. Plant Mortality/Decadence: Grasses will show some decadence, especially in non-grazed areas. Shrubs are long-lived and will continue to increase until fire disturbs the site.

14. Litter Amount: Considering that about 12% of the area is rock outcrop, litter cover would be expected at about 50-60%, with a depth of about 1 cm.

15. Annual Production: 500-1100 lbs/ac.

16. Invasive Plants: Native nitrogen fixing shrubs such as whitethorn and catclaw mimosa can greatly increase on this site when a threshold is crossed, but should only be a minor presence (<2%) in the diagnostic plant community.

17. Reproductive Capability of Perennial Plants: Most grasses reproduce vegetatively and shrubs by seed. In good weather years, all plants should be capable of reproduction (Pellant, et al., 2005).

Supporting Information

Associated Sites:

Site Name	Site ID	Site Narrative
Limestone Hills	R042XH002NM	This site has slopes >25% which make up hillsides, adjacent to the Very Shallow site.

Site Name	Site ID	Site Narrative
Shallow Limestone	R042XI001NM	The Very Shallow site transitions into the Shallow Limestone site above 5500 feet where a "mesic" soil temperature regime becomes evident.

Inventory Data References (narrative)

Data was collected during the years of 2011 and 2012. For all tier one data points, ocular methods were used to collect estimates of production, ground cover, and canopy cover. The *Doman-Krajina* method was used for canopy cover estimates. Soil pits were dug for verification on many tier one plots. Tier two and three protocols always were verified and analyzed with soil pits. Other methods used were line-point-intercept (LPI), double-sampling (DS), canopy gap (CG), and soil stability (SS). This ecological site had a number of tier one and tier two plots, with one tier three at the diagnostic plant community. Historic data from BLM monitoring points were used as well.

Listed are plots and methods used.

Tier 1 *D-K method was used for all plots*	Tier 2	Tier 3
VS010101B1	VS021511A2 *D-K, soil pit*	VS022212A3 *LPI, DS, CG, SS, soil pit*
VS111987A1	VS021511B2 *D-K, soil pit*	
VS011402A1	VS021511C2 *D-K , soil pit*	
VS050295A1	VS021511D2 *D-K, soil pit*	
VS042902A1	VS021511E2 *D-K, soil pit*	
VS010101A1	VS021511F2 *D-K, soil pit*	
VS120695A1	VS021511G2 *D-K, soil pit*	
VS120892A1	VS021411A2 *D-K, soil pit*	
VS040308A1	VS041911A2 *D-K, soil pit*	
VS121093C1	VS051011A2 *D-K, soil pit*	
VS121093B1	VS070611A2 *D-K, soil pit*	
VS121093A1	VS072012A2 *LPI*	

VS021511A1	VS040712A2 *LPI, DS*	
VS041911B1	VS041012A2 *LPI*	
VS031611A1		
VS031611B1		
VS051911A1		
VS051911B1		
VS052011A1		
VS052111A1		
VS070611A1		
VS070711A1		
VS070811A1		
VS070811B1		
VS070811A1		
VS070811B1		
VS041012A1		

State Correlation:

This site has been correlated with the Carlsbad Caverns National Park soil survey and the Guadalupe Mountains and Ridge 2012 soil update. Both the survey and update are within New Mexico, and were completed by the Santa Fe Soil Survey Office.

Type Locality:

The tier 3 sample data was collected on BLM land on top of Azotea Mesa. The UTM coordinates are: NAD 83; Zone 13; Northing: - 3584211; Easting-544051

Another type locality is in CCNP on Juniper Ridge: Northing- 3562068; Easting-551584

Coauthors:

Aaron Miller-MLRA 70 Project Leader, NRCS
Logan Peterson-MLRA 70 Soil Scientist, NRCS

Special Contributors:

Steve Daly-Soil/Range Conservationist, Carlsbad Field Office, BLM
Herman Garcia-Ecological Site Inventory Specialist, Southwest Region 8, NRCS
Tracy Hughes-Range Conservation Technician, Carlsbad Field Office, NRCS
Darren James-Researcher, USDA, Jornada ARS

Michael Margo-Rangeland Management Specialist, MLRA 42.3 SSO, NRCS

Reviewers:

Steve Daly-Soil Conservationist, Carlsbad Field Office, BLM
Herman Garcia-Ecological Site Inventory Specialist, Southwest Region 8, NRCS
Mark Moseley-Ecological Site Inventory Specialist, Texas Region 9, NRCS
Richard Strait-State Soil Scientist, New Mexico NRCS
John Tunberg-State Rangeland Management Specialist, New Mexico NRCS
Renee West-Biologist, Carlsbad Caverns National Park

ESD Workgroup:

Pete Biggam-Soils Program Manager, National Park Service, Lakewood CO
Lu Burger-Natural Resource Specialist, State Office, BLM
Steve Daly-Soil Conservationist, Carlsbad Field Office, BLM
Samuel Denman-Cultural Resource Specialist, Carlsbad Caverns National Park
Garth Grizzle, District Conservationist, Area Range Conservationist, NRCS, retired
Charles Hibner-MLRA 70 SS Leader, NRCS, retired
Tracy Hughes-Range Conservation Technician, Carlsbad, NRCS
Laurie Kincaid-Rancher, Carlsbad
Michael McGee- Hydrologist, Roswell Field Office, BLM
Aaron Miller-MLRA 70 Project Leader, NRCS
Susan Norman-GIS Specialist, Carlsbad Caverns National Park
Logan Peterson-MLRA 70 Soil Scientist, NRCS
Mark Sando-Rangeland Management Specialist, Guadalupe District, USFS
Kent Schwartzkopf-Chief, Stewardship and Science Div., Carlsbad Caverns National Park
Renee West-Biologist, Carlsbad Caverns National Park

References:

Ahlstrand, G., 1981. *Ecology of fire in the Guadalupe Mountains and adjacent Chihuahuan Desert.* Carlsbad(New Mexico): Carlsbad Caverns and Guadalupe Mountains National Park.

Bestelmeyer, et al., 2010. Practical Guidance for Developing State-and-Transition Models. *Rangelands*, p. 26.

Buie, L., 2003. *Hog-nosed skunk.* [Online]
Available at: http://itech.pensacolastate.edu/sctag/hn_skunk/index.htm
[Accessed 26 10 2012].

Burger, P., 2007. *Walking Guide to the Geology of Carlsbad Cavern.* Carlsbad, NM: Carlsbad Caverns and Guadalupe Mountains Association.

Burkett, B., Version 1.1. *A Field Guide to Pedoderm and Pattern Classes*, Las Cruces, New Mexico: USDA-ARS Jornada Experimental Range.

Cleland, D. T. et al., 2007. *Ecological Subregions: Sections and Subsections of the Conterminiuos United States.*. s.l.:United States Forest Service.

Cougar. (2013, September 8). In Wikipedia, The Free Encyclopedia. Retrieved 21:37, September 19, 2013, from http://en.wikipedia.org/w/index.php?title=Cougar&oldid=571991990

Duniway, Bestelmeyer, Tugel, 2010. Soil Processes and Properties That Distinguish Ecological Sites and States. *Rangelands,* pp. 9-15.

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

Goldstein and Rominger, 2003. *Plan for the Recovery of Desert Bighorn Sheep in New Mexico,* Santa Fe: New MExico Department of Game and Fish.
Griffith, et al., 2006. *Ecoregions of New Mixico.* Reston(Virginia): U.S. Geological Survey.

Henke and Fair, 1998. *Management of Texas Horned Lizards,* Kingsville, Tx.: Caesar Kleberg WIldlife Research Institute.

Herrick, Whiteford, De Soyza, Van Zee, Havstad, Seybokd, Walton, 2001. *Soil aggregate stability kit for field-based soil quality and rangeland health evalutations.*. s.l.:s.n.

Kayser, D. W., 2010. *Prehistory: SHort and Seet. "Different peoples over a long period of time vistied, used the abundant resoruces or lived here at CASVE.",* s.l.: s.n.

Kelley, V., 1971. *Geology of the Pecos Country, Southeastern New Mexico.* s.l.:New Mexico bureau of Mines and Mineral Resources.

Keys to Soil Taxonomy; United States Department of Agriculture, Natural Resources Conservation District; Eleventh Edition; 2010

New Mexico Game and Fish, n.d. *Wildlife Notes-Ringtail,* s.l.: New Mexico Game and Fish.

Pellant, Pyke, Shaver, Herrick, 2005. *Interpreting Indicators of Rangeland Health.* Version 4 ed. Denver(CO.): United States Department of the Interior, Bureau of Land Managment, National science and Technology Center, Division of Science Integration.

Pierce, L. J., 2007. *Gray Vireo (Vireo vicinior) Recovery Plan,* Santa Fe, NM: New Mexico Department of Game and Fish.

Schoeneberger, P.J., and Wysocki, D.A. 2012. Geomorphic Description System, Version 4.2. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

Spomer, Hoback, Golick, Higley, 2006. *Biology, Lifecycle, and Behavior.* [Online]
Available at: http://drshigley.com/lgh/netigers/index.htm
[Accessed 26 10 2012].

SWCA Environmental Consultants, 2007. *Carlsbad Caverns National Park, Environmental Assessment,* s.l.: U.S. Department of Interior.

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.* s.l.:s.n.

Site Description Approval:

Author: Scott Woodall 10/31/2013
Approval: John Tunberg 10/31/2013