

# Ecological site R042CY901NM

## Very Shallow

Last updated: 9/16/2020  
Accessed: 04/25/2024

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### General information

**Approved.** An approved ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model, enough information to identify the ecological site, and full documentation for all ecosystem states contained in the state and transition model.

#### Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

### MLRA notes

Major Land Resource Area (MLRA): 042C–Central New Mexico Highlands

To view this ESD in its most complete form refer to the PDF Version found in the New Mexico NRCS Field Office Technical Guide, section 2.

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

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 or contact your local NRCS Conservation District field office.

### 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).

### Ecological site concept

The soils are skeletal (greater than 35% by volume rock fragments greater than 2mm). Soil depth is very shallow to

shallow (1-50cm). The root restrictive layer is bedrock (limestone, dolomite, sandstone). Slopes are less than 25% and are typically around 5-15%.

### Associated sites

|             |  |
|-------------|--|
| R042CY902NM | <b>Limestone Hills</b><br>Limestone Hills: This site has slopes >25% which make up hillsides, adjacent to the Very Shallow site.                                       |
| R042CY001NM | <b>Shallow Limestone</b><br>The Very Shallow site transitions into the Shallow Limestone site above 5500 feet where a “mesic” soil temperature regime becomes evident. |

**Table 1. Dominant plant species**

|            |               |
|------------|---------------|
| Tree       | Not specified |
| Shrub      | Not specified |
| Herbaceous | Not specified |

### Physiographic features

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 5 to 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.

**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 evaporite 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 make s up the Very Shallow Ecological Site.

#### 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:

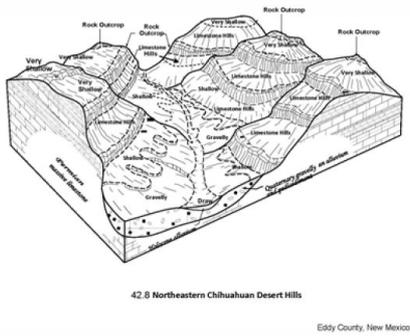
Colluvium: "Unconsolidated, unsorted earth material being transported or deposited on side slopes and/or at the base of slopes by mass movement (e.g. direct gravitational action) and by local, concentrated runoff" (Schoenberger, et al., 2012).

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).



**Figure 2. LRU 42.8 Northeastern Chihuahuan Desert Hills**

**Table 2. Representative physiographic features**

|                    |                                    |
|--------------------|------------------------------------|
| Landforms          | (1) Hill<br>(2) Ridge<br>(3) Mesa  |
| Flooding frequency | None                               |
| Ponding frequency  | None                               |
| Elevation          | 3,500–5,500 ft                     |
| Slope              | 1–25%                              |
| Water table depth  | 60 in                              |
| Aspect             | Aspect is not a significant factor |

### 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 55 to 70 degrees F, and the frost-free season is 207 to 243 days.

Annual weather patterns, influenced by global climate events, such as El Niño and La Niña, 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.

**Table 3. Representative climatic features**

|                             |          |
|-----------------------------|----------|
| Frost-free period (average) | 225 days |
|-----------------------------|----------|

|                               |          |
|-------------------------------|----------|
| Freeze-free period (average)  | 246 days |
| Precipitation total (average) | 14 in    |

## Influencing water features

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

## Soil features

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

Type location:

Geographic Coordinate System: 32° 10' 11.84" north, 104° 28' 37.17" west

## Description

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).

Typical Surface Fragments <=3" (% Cover): 20-30%

Typical Surface Fragments > 3" (% Cover): 15-25%

Typical Subsurface Fragments <=3" (% Volume): 20-40%

Typical Subsurface Fragments > 3" (%% Volume): 30-50%

Typical Soil Depth: 20-40 cm

Calcium Carbonate Equivalent (percent):

A & A2 horizons-0 to 5

Bk horizon-10 to 25



Figure 7. Lechuguilla Soil Component

Table 4. Representative soil features

|   |  |
|---|--|
| Parent material   | (1) Residuum–dolomite<br>(2) Eolian deposits–limestone and sandstone           |
| Surface texture   | (1) Gravelly loam<br>(2) Very gravelly silt loam<br>(3) Cobbly silty clay loam |
| Family particle size                                    | (1) Loamy  |
| Drainage class  | Moderately well drained to well drained  |
| Permeability class                                      | Moderate to rapid  |
| Soil depth  | 1–20 in  |
| Surface fragment cover ≤3"                              | 10–45%   |
| Surface fragment cover >3"                              | 5–35%  |
| Available water capacity<br>(0–40in)                    | 0.4–1.25 in  |
| Calcium carbonate equivalent<br>(0–40in)                | 0–25%  |
| Electrical conductivity<br>(0–40in)                     | 0–1 mmhos/cm   |
| Sodium adsorption ratio<br>(0–40in)                     | 0–1  |
| Soil reaction (1:1 water)<br>(0–40in)                   | 7–7.8  |
| Subsurface fragment volume ≤3"<br>(Depth not specified) | 5–50%  |
| Subsurface fragment volume >3"<br>(Depth not specified) | 10–70%   |

## Ecological dynamics

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 mezcals 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.

## **State and transition model**

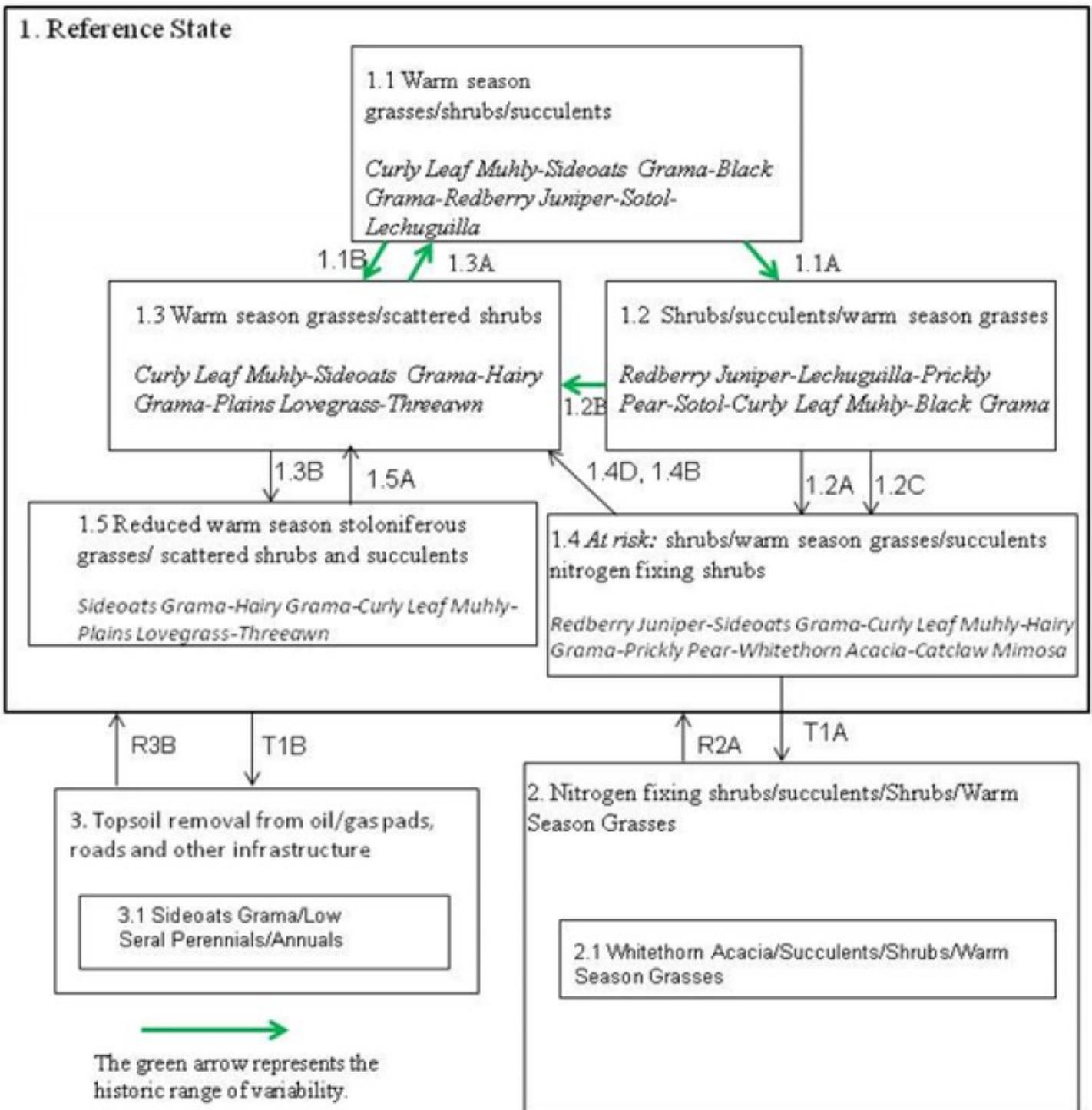


Figure 8. Very Shallow

**State 1 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 mycorrhizal fungi occur on this State. After many years of abandonment, sideoats grama, which is not quite as dependent on native mycorrhizal fungi, can dominate this site. R3B Restoration Process: The replacement of mineral soil, range seeding, and incorporation of organic material.

## Community 1.1

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



Figure 9. Community 1.1; Juniper Ridge; Carlsbad Caverns National Park (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.

**Table 5. Annual production by plant type**

| Plant Type      | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|-----------------|---------------|--------------------------------|----------------|
| Grass/Grasslike | 390           | 630                            | 858            |
| Shrub/Vine      | 95            | 145                            | 209            |
| Forb            | 15            | 25                             | 33             |
| <b>Total</b>    | <b>500</b>    | <b>800</b>                     | <b>1100</b>    |

**Table 6. Ground cover**

|                                   |        |
|-----------------------------------|--------|
| Tree foliar cover                 | 0%     |
| Shrub/vine/liana foliar cover     | 25-30% |
| Grass/grasslike foliar cover      | 35-45% |
| Forb foliar cover                 | 3-7%   |
| Non-vascular plants               | 0-1%   |
| Biological crusts                 | 0-3%   |
| Litter                            | 40-60% |
| Surface fragments >0.25" and <=3" | 35-45% |
| Surface fragments >3"             | 5-15%  |
| Bedrock                           | 5-20%  |
| Water                             | 0%     |
| Bare ground                       | 0-3%   |

**Table 7. Canopy structure (% cover)**

| Height Above Ground (Ft) | Tree | Shrub/Vine | Grass/Grasslike | Forb |
|--------------------------|------|------------|-----------------|------|
| <0.5                     | –    | 2-6%       | 5-15%           | 1-3% |
| >0.5 <= 1                | –    | 3-7%       | 25-35%          | 1-2% |
| >1 <= 2                  | –    | 5-9%       | –               | –    |
| >2 <= 4.5                | –    | 7-11%      | –               | –    |
| >4.5 <= 13               | –    | 2-6%       | –               | –    |
| >13 <= 40                | –    | –          | –               | –    |
| >40 <= 80                | –    | –          | –               | –    |
| >80 <= 120               | –    | –          | –               | –    |
| >120                     | –    | –          | –               | –    |

**Figure 11. Plant community growth curve (percent production by month).**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0   | 2   | 6   | 8   | 10  | 15  | 25  | 25  | 8   | 1   | 0   | 0   |

## Community 1.2 Shrubs/succulents/warm season grasses



Figure 12. 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.

Table 8. Annual production by plant type

| Plant Type      | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|-----------------|---------------|--------------------------------|----------------|
| Grass/Grasslike | 300           | 420                            | 540            |
| Shrub/Vine      | 185           | 259                            | 333            |
| Forb            | 15            | 21                             | 27             |
| <b>Total</b>    | <b>500</b>    | <b>700</b>                     | <b>900</b>     |

Table 9. Ground cover

|                               |        |
|-------------------------------|--------|
| Tree foliar cover             | 0%     |
| Shrub/vine/liana foliar cover | 35-45% |
| Grass/grasslike foliar cover  | 25-35% |
| Forb foliar cover             | 2-4%   |

|                                   |        |
|-----------------------------------|--------|
| Non-vascular plants               | 1%     |
| Biological crusts                 | 1-3%   |
| Litter                            | 40-60% |
| Surface fragments >0.25" and <=3" | 35-45% |
| Surface fragments >3"             | 5-15%  |
| Bedrock                           | 5-20%  |
| Water                             | 0%     |
| Bare ground                       | 3-7%   |

**Table 10. Canopy structure (% cover)**

| Height Above Ground (Ft) | Tree | Shrub/Vine | Grass/<br>Grasslike | Forb |
|--------------------------|------|------------|---------------------|------|
| <0.5                     | –    | 2-6%       | 5-15%               | 1-3% |
| >0.5 <= 1                | –    | 4-8%       | 15-25%              | 1-2% |
| >1 <= 2                  | –    | 6-10%      | –                   | –    |
| >2 <= 4.5                | –    | 14-18%     | –                   | –    |
| >4.5 <= 13               | –    | 4-8%       | –                   | –    |
| >13 <= 40                | –    | –          | –                   | –    |
| >40 <= 80                | –    | –          | –                   | –    |
| >80 <= 120               | –    | –          | –                   | –    |
| >120                     | –    | –          | –                   | –    |

## Community 1.3

### Warm season grasses/scattered shrubs



**Figure 14. Community 1.3; Guadalupe Ridge Trail; CCNP; 3-16-1**

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.

**Table 11. Annual production by plant type**

| Plant Type      | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|-----------------|---------------|--------------------------------|----------------|
| Grass/Grasslike | 450           | 675                            | 900            |
| Shrub/Vine      | 108           | 162                            | 216            |
| Forb            | 42            | 63                             | 84             |
| <b>Total</b>    | <b>600</b>    | <b>900</b>                     | <b>1200</b>    |

**Table 12. Ground cover**

|                                   |        |
|-----------------------------------|--------|
| Tree foliar cover                 | 0%     |
| Shrub/vine/liana foliar cover     | 10-20% |
| Grass/grasslike foliar cover      | 50-60% |
| Forb foliar cover                 | 3-7%   |
| Non-vascular plants               | 1%     |
| Biological crusts                 | 1-3%   |
| Litter                            | 60-70% |
| Surface fragments >0.25" and <=3" | 35-45% |
| Surface fragments >3"             | 5-15%  |
| Bedrock                           | 5-20%  |
| Water                             | 0%     |
| Bare ground                       | 2-4%   |

**Table 13. Canopy structure (% cover)**

| Height Above Ground (Ft) | Tree | Shrub/Vine | Grass/Grasslike | Forb |
|--------------------------|------|------------|-----------------|------|
| <0.5                     | –    | 1-2%       | 5-15%           | 1-3% |
| >0.5 <= 1                | –    | 4-8%       | 25-35%          | 2-4% |
| >1 <= 2                  | –    | 5-9%       | 10-20%          | –    |
| >2 <= 4.5                | –    | –          | –               | –    |
| >4.5 <= 13               | –    | –          | –               | –    |
| >13 <= 40                | –    | –          | –               | –    |
| >40 <= 80                | –    | –          | –               | –    |
| >80 <= 120               | –    | –          | –               | –    |
| >120                     | –    | –          | –               | –    |

## Community 1.4

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



Figure 16. 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.

Table 14. Annual production by plant type

| Plant Type      | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|-----------------|---------------|--------------------------------|----------------|
| Grass/Grasslike | 165           | 300                            | 440            |
| Shrub/Vine      | 120           | 220                            | 320            |
| Forb            | 15            | 30                             | 40             |
| <b>Total</b>    | <b>300</b>    | <b>550</b>                     | <b>800</b>     |

Table 15. Ground cover

|                               |        |
|-------------------------------|--------|
| Tree foliar cover             | 0%     |
| Shrub/vine/liana foliar cover | 25-35% |
| Grass/grasslike foliar cover  | 15-25% |
| Forb foliar cover             | 3-7%   |
| Non-vascular plants           | 1%     |

|                                   |        |
|-----------------------------------|--------|
| Biological crusts                 | 2-6%   |
| Litter                            | 35-45% |
| Surface fragments >0.25" and <=3" | 35-45% |
| Surface fragments >3"             | 5-15%  |
| Bedrock                           | 5-20%  |
| Water                             | 0%     |
| Bare ground                       | 4-8%   |

**Table 16. Canopy structure (% cover)**

| Height Above Ground (Ft) | Tree | Shrub/Vine | Grass/<br>Grasslike | Forb |
|--------------------------|------|------------|---------------------|------|
| <0.5                     | –    | 3-5%       | 8-12%               | 1-3% |
| >0.5 <= 1                | –    | 5-9%       | 6-10%               | 2-4% |
| >1 <= 2                  | –    | 7-11%      | 1-3%                | –    |
| >2 <= 4.5                | –    | 6-10%      | –                   | –    |
| >4.5 <= 13               | –    | 1-3%       | –                   | –    |
| >13 <= 40                | –    | –          | –                   | –    |
| >40 <= 80                | –    | –          | –                   | –    |
| >80 <= 120               | –    | –          | –                   | –    |
| >120                     | –    | –          | –                   | –    |

## Community 1.5

### Reduced warm stoloniferous grasses/ scattered shrubs and succulents



**Figure 18. Community 1.5; Loop Road; CCNP; 4-19-11**

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.

**Table 17. Annual production by plant type**

| Plant Type      | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|-----------------|---------------|--------------------------------|----------------|
| Grass/Grasslike | 480           | 880                            | 1120           |
| Shrub/Vine      | 90            | 165                            | 210            |
| Forb            | 30            | 55                             | 70             |
| <b>Total</b>    | <b>600</b>    | <b>1100</b>                    | <b>1400</b>    |

**Table 18. Ground cover**

|                                   |         |
|-----------------------------------|---------|
| Tree foliar cover                 | 0%      |
| Shrub/vine/liana foliar cover     | 15-25%  |
| Grass/grasslike foliar cover      | 55-65%  |
| Forb foliar cover                 | 3-7%    |
| Non-vascular plants               | 1%      |
| Biological crusts                 | 1-3%    |
| Litter                            | 80-100% |
| Surface fragments >0.25" and <=3" | 35-45%  |
| Surface fragments >3"             | 5-15%   |
| Bedrock                           | 5-20%   |
| Water                             | 0%      |
| Bare ground                       | 1-2%    |

**Table 19. Canopy structure (% cover)**

| Height Above Ground (Ft) | Tree | Shrub/Vine | Grass/Grasslike | Forb |
|--------------------------|------|------------|-----------------|------|
| <0.5                     | —    | 4-6%       | 8-12%           | 1-3% |
| >0.5 <= 1                | —    | 5-9%       | 25-35%          | 2-4% |
| >1 <= 2                  | —    | 4-8%       | 15-25%          | —    |
| >2 <= 4.5                | —    | 1-3%       | —               | —    |
| >4.5 <= 13               | —    | —          | —               | —    |
| >13 <= 40                | —    | —          | —               | —    |
| >40 <= 80                | —    | —          | —               | —    |
| >80 <= 120               | —    | —          | —               | —    |
| >120                     | —    | —          | —               | —    |

## Pathway 1.1A

## Community 1.1 to 1.2



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



Shrubs/succulents/warm  
season grasses

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.

## Pathway 1.1B Community 1.1 to 1.3



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



Warm season  
grasses/scattered shrubs

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. 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)

## Pathway 1.2B Community 1.2 to 1.3



Shrubs/succulents/warm  
season grasses



Warm season  
grasses/scattered shrubs

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.

## Pathway 1.2C Community 1.2 to 1.4



Shrubs/succulents/warm season grasses



At risk: shrubs/ warm season grasses/ succulents/nitrogen fixing shrubs

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.

### Pathway 1.2A Community 1.2 to 1.4



Shrubs/succulents/warm season grasses



At risk: shrubs/ warm season grasses/ succulents/nitrogen fixing shrubs

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.

### Pathway 1.3A Community 1.3 to 1.1



Warm season grasses/scattered shrubs



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

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.

### Pathway 1.3B Community 1.3 to 1.5



Warm season grasses/scattered shrubs



Reduced warm stoloniferous grasses/ scattered shrubs and succulents

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.

### Pathway 1.4B Community 1.4 to 1.3



At risk: shrubs/ warm season grasses/ succulents/nitrogen fixing shrubs



Warm season grasses/scattered shrubs

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.

### Pathway 1.4D Community 1.4 to 1.3



At risk: shrubs/ warm season grasses/ succulents/nitrogen fixing shrubs



Warm season grasses/scattered shrubs

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.

### Pathway 1.5A Community 1.5 to 1.3



Reduced warm stoloniferous grasses/ scattered shrubs and succulents



Warm season grasses/scattered shrubs

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.

### State 2 Nitrogen fixing shrubs/succulents/shrubs/warm season grasses State

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.

## Community 2.1

### Whitethorn acacia/succulents/shrubs/warm season grasses



Figure 20. 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.

Table 20. Annual production by plant type

| Plant Type      | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|-----------------|---------------|--------------------------------|----------------|
| Shrub/Vine      | 82            | 165                            | 247            |
| Grass/Grasslike | 60            | 120                            | 180            |
| Forb            | 8             | 15                             | 23             |
| <b>Total</b>    | <b>150</b>    | <b>300</b>                     | <b>450</b>     |

Table 21. Ground cover

|                               |        |
|-------------------------------|--------|
| Tree foliar cover             | 0%     |
| Shrub/vine/liana foliar cover | 25-30% |

|                                   |        |
|-----------------------------------|--------|
| Grass/grasslike foliar cover      | 5-15%  |
| Forb foliar cover                 | 2-4%   |
| Non-vascular plants               | 1%     |
| Biological crusts                 | 2-6%   |
| Litter                            | 25-35% |
| Surface fragments >0.25" and <=3" | 35-45% |
| Surface fragments >3"             | 5-15%  |
| Bedrock                           | 5-20%  |
| Water                             | 0%     |
| Bare ground                       | 10-15% |

**Table 22. Canopy structure (% cover)**

| Height Above Ground (Ft) | Tree | Shrub/Vine | Grass/<br>Grasslike | Forb |
|--------------------------|------|------------|---------------------|------|
| <0.5                     | –    | 2-4%       | 6-10%               | 1-3% |
| >0.5 <= 1                | –    | 5-7%       | 1-3%                | 1-2% |
| >1 <= 2                  | –    | 8-10%      | –                   | –    |
| >2 <= 4.5                | –    | 6-8%       | –                   | –    |
| >4.5 <= 13               | –    | 1-3%       | –                   | –    |
| >13 <= 40                | –    | –          | –                   | –    |
| >40 <= 80                | –    | –          | –                   | –    |
| >80 <= 120               | –    | –          | –                   | –    |
| >120                     | –    | –          | –                   | –    |

### State 3

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

#### Community 3.1

#### Sideoats grama/low seral perennials/annuals



**Figure 22. Community 3.1; old road; pre “Loop fire”; CCNP; 5/**

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 mycorrhizal fungi occur on this site. After many decades of abandonment, sideoats grama, which is not quite as dependent on native mycorrhizal 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.

## Transition T1A

### State 1 to 2

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.

## Restoration pathway R2A

### State 2 to 1

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.

## Restoration pathway R3B

### State 3 to 1

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.

## Additional community tables

Table 23. Community 1.1 plant community composition

| Group                  | Common Name                     | Symbol | Scientific Name                | Annual Production (Lb/Acre) | Foliar Cover (%) |
|------------------------|---------------------------------|--------|--------------------------------|-----------------------------|------------------|
| <b>Grass/Grasslike</b> |                                 |        |                                |                             |                  |
| 1                      | <b>Warm Season Tallgrasses</b>  |        |                                | 30–34                       |                  |
|                        | cane bluestem                   | BOBA3  | <i>Bothriochloa barbinodis</i> | 8–24                        | 1–3              |
|                        | silver beardgrass               | BOLA2  | <i>Bothriochloa laguroides</i> | 8–24                        | 1–3              |
|                        | little bluestem                 | SCSC   | <i>Schizachyrium scoparium</i> | 1                           | 1                |
| 2                      | <b>Warm Season Midgrasses</b>   |        |                                | 275–325                     |                  |
|                        | curlyleaf muhly                 | MUSE   | <i>Muhlenbergia setifolia</i>  | 16–240                      | 2–18             |
|                        | purple threeawn                 | ARPU9  | <i>Aristida purpurea</i>       | 8–104                       | 1–5              |
|                        | sideoats grama                  | BOCU   | <i>Bouteloua curtipendula</i>  | 48–80                       | 4–6              |
|                        | slim tridens                    | TRMU   | <i>Tridens muticus</i>         | 32–48                       | 2–4              |
|                        | plains lovegrass                | ERIN   | <i>Eragrostis intermedia</i>   | 8–40                        | 1–3              |
|                        | green sprangletop               | LEDU   | <i>Leptochloa dubia</i>        | 8–24                        | 1–2              |
|                        | sand dropseed                   | SPCR   | <i>Sporobolus cryptandrus</i>  | 4–12                        | 1                |
| 3                      | <b>Warm Season Shortgrasses</b> |        |                                | 140–180                     |                  |
|                        | hairy grama                     | BOHI2  | <i>Bouteloua hirsuta</i>       | 40–72                       | 3–5              |

|                   |                                 |        |   |         |     |
|-------------------|---------------------------------|--------|---|---------|-----|
|                   | black grama                     | BOER4  | <i>Bouteloua eriopoda</i>                     | 16–64   | 2–6 |
|                   | hairy woollygrass               | ERPI5  | <i>Erioneuron pilosum</i>                     | 8–24    | 1–2 |
|                   | sand muhly                      | MUAR2  | <i>Muhlenbergia arenicola</i>                 | 0–16    | 0–1 |
|                   | red grama                       | BOTR2  | <i>Bouteloua trifida</i>                      | 0–16    | 0–1 |
|                   | blue grama                      | BOGR2  | <i>Bouteloua gracilis</i>                     | 4–12    | 1–2 |
|                   | Hall's panicgrass               | PAHA   | <i>Panicum hallii</i>                         | 4–12    | 1–2 |
|                   | common wolfstail                | LYPH   | <i>Lycurus phleoides</i>                      | 6–10    | 1   |
|                   | streambed bristlegrass          | SELE6  | <i>Setaria leucopila</i>                      | 6–10    | 1   |
|                   | tobosagrass                     | PLMU3  | <i>Pleuraphis mutica</i>                      | 0–1     | 0–1 |
|                   | low woollygrass                 | DAPU7  | <i>Dasyochloa pulchella</i>                   | 0–1     | 0–1 |
|                   | Carolina crabgrass              | DIPU9  | <i>Digitaria pubiflora</i>                    | 0–1     | 0–1 |
|                   | nineawn pappusgrass             | ENDE   | <i>Enneapogon desvauxii</i>                   | 0–1     | 0–1 |
| 4                 | <b>Cool Season Tall Grasses</b> |        |   | 0–16    |     |
|                   | New Mexico feathergrass         | HENE5  | <i>Hesperostipa neomexicana</i>               | 0–16    | 0–1 |
| <b>Forb</b>       |                                 |        |   |         |     |
| 5                 | <b>Perennial Forbs</b>          |        |   | 35–45   |     |
|                   | croton                          | CROTO  | <i>Croton</i>                                 | 4–12    | 1–2 |
|                   | hawkweed buckwheat              | ERHI3  | <i>Eriogonum hieraciifolium</i>               | 4–12    | 1–2 |
|                   | James' nailwort                 | PAJA   | <i>Paronychia jamesii</i>                     | 4–12    | 1   |
|                   | Havard's buckwheat              | ERHA   | <i>Eriogonum havardii</i>                     | 4–12    | 1   |
|                   | polygala                        | POLYG  | <i>Polygala</i>                               | 0–1     | 0–1 |
|                   | Douglas' ragwort                | SEFLD  | <i>Senecio flaccidus var. douglasii</i>       | 0–1     | 0–1 |
|                   | resurrection plant              | SEPI   | <i>Selaginella pilifera</i>                   | 0–1     | 0–1 |
|                   | early shaggytuft                | STBA   | <i>Stenandrium barbatum</i>                   | 0–1     | 0–1 |
|                   | Davis Mountain mock vervain     | GLBIC  | <i>Glandularia bipinnatifida var. ciliata</i> | 0–1     | 0–1 |
|                   | Fendler's bladderpod            | LEFE   | <i>Lesquerella fendleri</i>                   | 0–1     | 0–1 |
|                   | Texas tansyaster                | MABL2  | <i>Machaeranthera blephariphylla</i>          | 0–1     | 0–1 |
|                   | spreading fleabane              | ERDI4  | <i>Erigeron divergens</i>                     | 0–1     | 0–1 |
|                   | whitemargin sandmat             | CHAL11 | <i>Chamaesyce albomarginata</i>               | 0–1     | 0–1 |
|                   | greenleaf five eyes             | CHCO2  | <i>Chamaesaracha coronopus</i>                | 0–1     | 0–1 |
| 6                 | <b>Annual Forbs</b>             |        |   | 2–14    |     |
|                   | lemonscent                      | PEAN   | <i>Pectis angustifolia</i>                    | 0–1     | 0–1 |
| 12                | <b>Fern</b>                     |        |   | 6–10    |     |
|                   | Cochise scaly cloakfern         | ASCO42 | <i>Astrolepis cochisensis</i>                 | 6–10    | 1–3 |
|                   | Cochise scaly cloakfern         | ASCO42 | <i>Astrolepis cochisensis</i>                 | 6–10    | 1–3 |
| <b>Shrub/Vine</b> |                                 |        |   |         |     |
| 7                 | <b>Shrubs</b>                   |        |   | 100–124 |     |
|                   | Pinchot's juniper               | JUPI   | <i>Juniperus pinchotii</i>                    | 16–32   | 2–6 |
|                   | mariola                         | PAIN2  | <i>Parthenium incanum</i>                     | 16–32   | 1–5 |
|                   | pungent oak                     | QUPU   | <i>Quercus pungens</i>                        | 0–32    | 0–4 |
|                   | featherplume                    | DAFO   | <i>Dalea formosa</i>                          | 8–24    | 1–3 |
|                   | littleleaf ratany               | KRER   | <i>Krameria erecta</i>                        | 4–12    | 1–2 |
|                   | javelina bush                   | COER5  | <i>Condalia ericoides</i>                     | 4–12    | 1–2 |

|    |                           |       |  |       |     |
|----|---------------------------|-------|--|-------|-----|
|    | algerita                  | MATR3 | <i>Mahonia trifoliolata</i>                            | 4–12  | 1–2 |
|    | resinbush                 | VIST  | <i>Viguiera stenoloba</i>                              | 4–12  | 1–2 |
|    | Wright's beebrush         | ALWR  | <i>Aloysia wrightii</i>                                | 2–6   | 1   |
|    | longleaf jointfir         | EPTR  | <i>Ephedra trifurca</i>                                | 0–1   | 0–1 |
|    | creosote bush             | LATR2 | <i>Larrea tridentata</i>                               | 0–1   | 0–1 |
|    | lotebush                  | ZIOB  | <i>Ziziphus obtusifolia</i>                            | 0–1   | 0–1 |
|    | skunkbush sumac           | RHTRT | <i>Rhus trilobata</i> var. <i>trilobata</i>            | 0–1   | 0–1 |
|    | catclaw acacia            | ACGR  | <i>Acacia greggii</i>                                  | 0–1   | 0–1 |
|    | roundflower catclaw       | ACRO  | <i>Acacia roemeriana</i>                               | 0–1   | 0–1 |
| 8  | <b>Half-Shrubs</b>        |       |  | 20–28 |     |
|    | dyssodia                  | DYSSO | <i>Dyssodia</i>  | 4–12  | 1   |
|    | broom snakeweed           | GUSA2 | <i>Gutierrezia sarothrae</i>                           | 4–12  | 1   |
|    | desert zinnia             | ZIAC  | <i>Zinnia acerosa</i>                                  | 4–12  | 1   |
|    | rough menodora            | MESC  | <i>Menodora scabra</i>                                 | 0–1   | 0–1 |
|    | five needle pricklyleaf   | THPEP | <i>Thymophylla pentachaeta</i> var. <i>pentachaeta</i> | 0–1   | 0–1 |
|    | hairy crinklemat          | TIHI  | <i>Tiquilia hispidissima</i>                           | 0–1   | 0–1 |
| 9  | <b>Cactus</b>             |       |  | 30–34 |     |
|    | purple pricklypear        | OPMAM | <i>Opuntia macrocentra</i> var. <i>macrocentra</i>     | 8–40  | 1–3 |
|    | tulip pricklypear         | OPPH  | <i>Opuntia phaeacantha</i>                             | 2–14  | 1–2 |
|    | tree cholla               | CYIMI | <i>Cylindropuntia imbricata</i> var. <i>imbricata</i>  | 0–1   | 0–1 |
|    | pitaya                    | ECEN2 | <i>Echinocereus enneacanthus</i>                       | 0–1   | 0–1 |
|    | devilshead                | ECHO  | <i>Echinocactus horzonthalonius</i>                    | 0–1   | 0–1 |
|    | rainbow cactus            | ECPE  | <i>Echinocereus pectinatus</i>                         | 0–1   | 0–1 |
|    | horse cripper             | ECTE  | <i>Echinocactus texensis</i>                           | 0–1   | 0–1 |
|    | kingcup cactus            | ECTR  | <i>Echinocereus triglochidiatus</i>                    | 0–1   | 0–1 |
|    | nylon hedgehog cactus     | ECVI2 | <i>Echinocereus viridiflorus</i>                       | 0–1   | 0–1 |
|    | Sneed's pincushion cactus | ESSNL | <i>Escobaria sneedii</i> var. <i>leei</i>              | 0–1   | 0–1 |
|    | ocotillo                  | FOSP2 | <i>Fouquieria splendens</i>                            | 0–1   | 0–1 |
|    | cactus apple              | OPEN3 | <i>Opuntia engelmannii</i>                             | 0–1   | 0–1 |
| 10 | <b>Yucca</b>              |       |  | 14–20 |     |
|    | Torrey's yucca            | YUTO  | <i>Yucca torreyi</i>                                   | 8–24  | 1–2 |
|    | soaptree yucca            | YUEL  | <i>Yucca elata</i>                                     | 0–1   | 0–1 |
| 11 | <b>Yucca-like Plants</b>  |       |  | 44–52 |     |
|    | lechuguilla               | AGLE  | <i>Agave lechuguilla</i>                               | 24–40 | 2–6 |
|    | green sotol               | DALE2 | <i>Dasyilirion leiophyllum</i>                         | 8–24  | 2–4 |
|    | Texas sacahuista          | NOTE  | <i>Nolina texana</i>                                   | 6–10  | 1–3 |

Table 24. Community 1.2 plant community composition

| Group                  | Common Name                    | Symbol | Scientific Name | Annual Production (Lb/Acre) | Foliar Cover (%) |
|------------------------|--------------------------------|--------|-----------------|-----------------------------|------------------|
| <b>Grass/Grasslike</b> |                                |        |                 |                             |                  |
| 1                      | <b>Warm Season Tallgrasses</b> |        |                 | 20–36                       |                  |

|                   |                                 |        |   |         |      |
|-------------------|---------------------------------|--------|---|---------|------|
|                   | cane bluestem                   | BOBA3  | <i>Bothriochloa barbinodis</i>                | 7-14    | 1-3  |
|                   | silver beardgrass               | BOLA2  | <i>Bothriochloa laguroides</i>                | 7-14    | 1-3  |
| 2                 | <b>Warm Season Midgrasses</b>   |        |   | 165-297 |      |
|                   | curlyleaf muhly                 | MUSE   | <i>Muhlenbergia setifolia</i>                 | 14-154  | 2-10 |
|                   | sideoats grama                  | BOCU   | <i>Bouteloua curtipendula</i>                 | 42-56   | 3-5  |
|                   | purple threeawn                 | ARPU9  | <i>Aristida purpurea</i>                      | 35-49   | 1-3  |
|                   | slim tridens                    | TRMU   | <i>Tridens muticus</i>                        | 28-42   | 1-3  |
|                   | plains lovegrass                | ERIN   | <i>Eragrostis intermedia</i>                  | 7-35    | 1-3  |
|                   | green sprangletop               | LEDU   | <i>Leptochloa dubia</i>                       | 7-21    | 1    |
|                   | sand dropseed                   | SPCR   | <i>Sporobolus cryptandrus</i>                 | 4-11    | 1    |
| 3                 | <b>Warm Season Shortgrasses</b> |        |   | 100-180 |      |
|                   | black grama                     | BOER4  | <i>Bouteloua eriopoda</i>                     | 21-63   | 1-5  |
|                   | hairy grama                     | BOHI2  | <i>Bouteloua hirsuta</i>                      | 35-63   | 2-4  |
|                   | hairy woollygrass               | ERPI5  | <i>Erioneuron pilosum</i>                     | 7-35    | 1-2  |
|                   | Hall's panicgrass               | PAHA   | <i>Panicum hallii</i>                         | 7-21    | 1-2  |
|                   | blue grama                      | BOGR2  | <i>Bouteloua gracilis</i>                     | 4-11    | 1-2  |
|                   | common wolfstail                | LYPH   | <i>Lycurus phleoides</i>                      | 4-11    | 1-2  |
|                   | low woollygrass                 | DAPU7  | <i>Dasyochloa pulchella</i>                   | 0-1     | 0-1  |
|                   | Carolina crabgrass              | DIPU9  | <i>Digitaria pubiflora</i>                    | 0-1     | 0-1  |
| 4                 | <b>Cool-season Tallgrasses</b>  |        |   | 5-9     |      |
|                   | New Mexico feathergrass         | HENE5  | <i>Hesperostipa neomexicana</i>               | 0-14    | 0-2  |
| <b>Forb</b>       |                                 |        |   |         |      |
| 5                 | <b>Perennial Forbs</b>          |        |   | 20-36   |      |
|                   | whitemargin sandmat             | CHAL11 | <i>Chamaesyce albomarginata</i>               | 4-11    | 1-2  |
|                   | croton                          | CROTO  | <i>Croton</i>                                 | 4-11    | 1-2  |
|                   | hawkweed buckwheat              | ERHI3  | <i>Eriogonum hieraciifolium</i>               | 4-11    | 1-2  |
|                   | Davis Mountain mock vervain     | GLBIC  | <i>Glandularia bipinnatifida var. ciliata</i> | 0-1     | 0-1  |
|                   | Fendler's bladderpod            | LEFE   | <i>Lesquerella fendleri</i>                   | 0-1     | 0-1  |
|                   | James' nailwort                 | PAJA   | <i>Paronychia jamesii</i>                     | 0-1     | 0-1  |
|                   | polygala                        | POLYG  | <i>Polygala</i>                               | 0-1     | 0-1  |
|                   | Douglas' ragwort                | SEFLD  | <i>Senecio flaccidus var. douglasii</i>       | 0-1     | 0-1  |
|                   | resurrection plant              | SEPI   | <i>Selaginella pilifera</i>                   | 0-1     | 0-1  |
|                   | spreading fleabane              | ERDI4  | <i>Erigeron divergens</i>                     | 0-1     | 0-1  |
| 6                 | <b>Annual Forbs</b>             |        |   | 1       |      |
| 12                | <b>Fern</b>                     |        |   | 6-10    |      |
|                   | Cochise scaly cloakfern         | ASCO42 | <i>Astrolepis cochisensis</i>                 | 6-10    | 1-3  |
| <b>Shrub/Vine</b> |                                 |        |   |         |      |
| 7                 | <b>Shrubs</b>                   |        |   | 100-180 |      |
|                   | Pinchot's juniper               | JUPI   | <i>Juniperus pinchotii</i>                    | 21-63   | 4-12 |
|                   | mariola                         | PAIN2  | <i>Parthenium incanum</i>                     | 14-42   | 2-6  |
|                   | featherplume                    | DAFO   | <i>Dalea formosa</i>                          | 4-28    | 1-3  |
|                   | javelina bush                   | COER5  | <i>Condalia ericoides</i>                     | 7-21    | 1-2  |
|                   | littleleaf ratany               | KRER   | <i>Krameria erecta</i>                        | 4-11    | 1-2  |

|    |                           |       |  |       |     |
|----|---------------------------|-------|--|-------|-----|
|    | resinbush                 | VIST  | <i>Viguiera stenoloba</i>                                | 4–11  | 1–2 |
|    | algerita                  | MATR3 | <i>Mahonia trifoliolata</i>                              | 4–11  | 1–2 |
|    | Wright's beebrush         | ALWR  | <i>Aloysia wrightii</i>                                  | 3–9   | 1   |
|    | creosote bush             | LATR2 | <i>Larrea tridentata</i>                                 | 0–1   | 0–1 |
|    | longleaf jointfir         | EPTR  | <i>Ephedra trifurca</i>                                  | 0–1   | 0–1 |
|    | whitethorn acacia         | ACCO2 | <i>Acacia constricta</i>                                 | 0–1   | 0–1 |
|    | catclaw acacia            | ACGR  | <i>Acacia greggii</i>                                    | 0–1   | 0–1 |
|    | roundflower catclaw       | ACRO  | <i>Acacia roemeriana</i>                                 | 0–1   | 0–1 |
|    | catclaw mimosa            | MIACB | <i>Mimosa aculeaticarpa</i> var.<br><i>biuncifera</i>    | 0–1   | 0–1 |
| 8  | <b>Half-Shrubs</b>        |       |  | 25–45 |     |
|    | broom snakeweed           | GUSA2 | <i>Gutierrezia sarothrae</i>                             | 14–42 | 2–4 |
|    | desert zinnia             | ZIAC  | <i>Zinnia acerosa</i>                                    | 4–11  | 1   |
| 9  | <b>Cactus</b>             |       |  | 20–36 |     |
|    | purple pricklypear        | OPMAM | <i>Opuntia macrocentra</i> var.<br><i>macrocentra</i>    | 8–40  | 2–4 |
|    | tulip pricklypear         | OPPH  | <i>Opuntia phaeacantha</i>                               | 2–14  | 1–3 |
|    | tree cholla               | CYIMI | <i>Cylindropuntia imbricata</i> var.<br><i>imbricata</i> | 0–1   | 0–2 |
|    | horse crippler            | ECTE  | <i>Echinocactus texensis</i>                             | 0–1   | 0–1 |
|    | nylon hedgehog cactus     | ECVI2 | <i>Echinocereus viridiflorus</i>                         | 0–1   | 0–1 |
|    | Sneed's pincushion cactus | ESSNL | <i>Escobaria sneedii</i> var. <i>leei</i>                | 0–1   | 0–1 |
|    | ocotillo                  | FOSP2 | <i>Fouquieria splendens</i>                              | 0–1   | 0–1 |
|    | cactus apple              | OPEN3 | <i>Opuntia engelmannii</i>                               | 0–1   | 0–1 |
| 10 | <b>Yucca</b>              |       |  | 10–18 |     |
|    | Torrey's yucca            | YUTO  | <i>Yucca torreyi</i>                                     | 8–24  | 1–3 |
|    | soaptree yucca            | YUEL  | <i>Yucca elata</i>                                       | 0–1   | 0–1 |
| 11 | <b>Yucca-like plants</b>  |       |  | 30–54 |     |
|    | lechuguilla               | AGLE  | <i>Agave lechuguilla</i>                                 | 24–40 | 4–8 |
|    | green sotol               | DALE2 | <i>Dasyilirion leiophyllum</i>                           | 8–24  | 2–4 |

Table 25. Community 1.3 plant community composition

| Group                  | Common Name                    | Symbol | Scientific Name                | Annual Production (Lb/Acre) | Foliar Cover (%) |
|------------------------|--------------------------------|--------|--------------------------------|-----------------------------|------------------|
| <b>Grass/Grasslike</b> |                                |        |                                |                             |                  |
| 1                      | <b>Warm Season Tallgrasses</b> |        |                                | 24–48                       |                  |
|                        | cane bluestem                  | BOBA3  | <i>Bothriochloa barbinodis</i> | 9–27                        | 1–3              |
|                        | silver beardgrass              | BOLA2  | <i>Bothriochloa laguroides</i> | 9–27                        | 1–3              |
|                        | little bluestem                | SCSC   | <i>Schizachyrium scoparium</i> | 1                           | 1                |
| 2                      | <b>Warm Season Midgrasses</b>  |        |                                | 270–540                     |                  |
|                        | curlyleaf muhly                | MUSE   | <i>Muhlenbergia setifolia</i>  | 45–261                      | 4–24             |
|                        | sideoats grama                 | BOCU   | <i>Bouteloua curtipendula</i>  | 99–135                      | 7–9              |
|                        | purple threeawn                | ARPU9  | <i>Aristida purpurea</i>       | 45–63                       | 1–5              |
|                        | slim tridens                   | TRMU   | <i>Tridens muticus</i>         | 32–48                       | 2–4              |
|                        | plains lovegrass               | ERIN   | <i>Eragrostis intermedia</i>   | 9–45                        | 1–3              |
|                        | green sprangletop              | LEDU   | <i>Leptochloa dubia</i>        | 8–24                        | 1–2              |

|                   |                                 |        |  |         |      |
|-------------------|---------------------------------|--------|--|---------|------|
|                   | sand dropseed                   | SPCR   | <i>Sporobolus cryptandrus</i>                        | 5–14    | 1    |
| 3                 | <b>Warm Season Shortgrasses</b> |        |  | 150–300 |      |
|                   | hairy grama                     | BOHI2  | <i>Bouteloua hirsuta</i>                             | 54–108  | 5–9  |
|                   | black grama                     | BOER4  | <i>Bouteloua eriopoda</i>                            | 27–81   | 2–10 |
|                   | blue grama                      | BOGR2  | <i>Bouteloua gracilis</i>                            | 9–27    | 1–3  |
|                   | hairy woollygrass               | ERPI5  | <i>Erioneuron pilosum</i>                            | 9–27    | 1–3  |
|                   | Hall's panicgrass               | PAHA   | <i>Panicum hallii</i>                                | 9–27    | 1–3  |
|                   | red grama                       | BOTR2  | <i>Bouteloua trifida</i>                             | 0–18    | 0–1  |
|                   | sand muhly                      | MUAR2  | <i>Muhlenbergia arenicola</i>                        | 0–18    | 0–1  |
|                   | streambed bristlegrass          | SELE6  | <i>Setaria leucopila</i>                             | 5–14    | 1–2  |
|                   | common wolfstail                | LYPH   | <i>Lycurus phleoides</i>                             | 5–14    | 1–2  |
|                   | low woollygrass                 | DAPU7  | <i>Dasyochloa pulchella</i>                          | 0–1     | 0–1  |
|                   | Carolina crabgrass              | DIPU9  | <i>Digitaria pubiflora</i>                           | 0–1     | 0–1  |
|                   | nineawn pappusgrass             | ENDE   | <i>Enneapogon desvauxii</i>                          | 0–1     | 0–1  |
| 4                 | <b>Cool-season Tallgrasses</b>  |        |  | 6–12    |      |
|                   | New Mexico feathergrass         | HENE5  | <i>Hesperostipa neomexicana</i>                      | 0–18    | 0–3  |
| <b>Forb</b>       |                                 |        |  |         |      |
| 5                 | <b>Perennial Forbs</b>          |        |  | 24–48   |      |
|                   | Davis Mountain mock vervain     | GLBIC  | <i>Glandularia bipinnatifida</i> var. <i>ciliata</i> | 9–27    | 1–3  |
|                   | spreading fleabane              | ERDI4  | <i>Erigeron divergens</i>                            | 5–14    | 1–2  |
|                   | hawkweed buckwheat              | ERHI3  | <i>Eriogonum hieraciifolium</i>                      | 5–14    | 1–2  |
|                   | croton                          | CROTO  | <i>Croton</i>  | 0–1     | 0–1  |
|                   | Havard's buckwheat              | ERHA   | <i>Eriogonum havardii</i>                            | 0–1     | 0–1  |
|                   | Fendler's bladderpod            | LEFE   | <i>Lesquerella fendleri</i>                          | 0–1     | 0–1  |
|                   | Texas tansyaster                | MABL2  | <i>Machaeranthera blephariphylla</i>                 | 0–1     | 0–1  |
|                   | James' nailwort                 | PAJA   | <i>Paronychia jamesii</i>                            | 0–1     | 0–1  |
|                   | polygala                        | POLYG  | <i>Polygala</i>                                      | 0–1     | 0–1  |
|                   | Douglas' ragwort                | SEFLD  | <i>Senecio flaccidus</i> var. <i>douglasii</i>       | 0–1     | 0–1  |
|                   | early shaggytuft                | STBA   | <i>Stenandrium barbatum</i>                          | 0–1     | 0–1  |
| 6                 | <b>Annual Forbs</b>             |        |  | 6–14    |      |
|                   | common sunflower                | HEAN3  | <i>Helianthus annuus</i>                             | 2–14    | 1–3  |
| 12                | <b>Fern</b>                     |        |  | 1       |      |
|                   | Cochise scaly cloakfern         | ASCO42 | <i>Astrolepis cochisensis</i>                        | 0–1     | 0–1  |
| <b>Shrub/Vine</b> |                                 |        |  |         |      |
| 7                 | <b>Shrub</b>                    |        |  | 72–144  |      |
|                   | Pinchot's juniper               | JUPI   | <i>Juniperus pinchotii</i>                           | 9–45    | 1–3  |
|                   | mariola                         | PAIN2  | <i>Parthenium incanum</i>                            | 9–45    | 1–3  |
|                   | pungent oak                     | QUPU   | <i>Quercus pungens</i>                               | 0–27    | 0–3  |
|                   | featherplume                    | DAFO   | <i>Dalea formosa</i>                                 | 9–27    | 1–2  |
|                   | javelina bush                   | COER5  | <i>Condalia ericoides</i>                            | 5–14    | 1–2  |
|                   | resinbush                       | VIST   | <i>Viguiera stenoloba</i>                            | 5–14    | 1–2  |
|                   | lotebush                        | ZIOB   | <i>Ziziphus obtusifolia</i>                          | 0–1     | 0–1  |
|                   | skunkbush sumac                 | RHTRT  | <i>Rhus trilobata</i> var. <i>trilobata</i>          | 0–1     | 0–1  |

|    |                           |       |  |       |     |
|----|---------------------------|-------|--|-------|-----|
|    | longleaf jointfir         | EPTR  | <i>Ephedra trifurca</i>                                | 0–1   | 0–1 |
|    | littleleaf ratany         | KRER  | <i>Krameria erecta</i>                                 | 0–1   | 0–1 |
|    | creosote bush             | LATR2 | <i>Larrea tridentata</i>                               | 0–1   | 0–1 |
|    | algerita                  | MATR3 | <i>Mahonia trifoliolata</i>                            | 0–1   | 0–1 |
|    | catclaw acacia            | ACGR  | <i>Acacia greggii</i>                                  | 0–1   | 0–1 |
|    | roundflower catclaw       | ACRO  | <i>Acacia roemeriana</i>                               | 0–1   | 0–1 |
| 8  | <b>Half-Shrubs</b>        |       |  | 18–36 |     |
|    | broom snakeweed           | GUSA2 | <i>Gutierrezia sarothrae</i>                           | 9–27  | 1–3 |
|    | rough menodora            | MESC  | <i>Menodora scabra</i>                                 | 0–1   | 0–1 |
|    | fiveneedle pricklyleaf    | THPEP | <i>Thymophylla pentachaeta</i> var. <i>pentachaeta</i> | 0–1   | 0–1 |
|    | hairy crinklemat          | TIHI  | <i>Tiquilia hispidissima</i>                           | 0–1   | 0–1 |
|    | desert zinnia             | ZIAC  | <i>Zinnia acerosa</i>                                  | 0–1   | 0–1 |
|    | dyssodia                  | DYSSO | <i>Dyssodia</i>  | 0–1   | 0–1 |
| 9  | <b>Cactus</b>             |       |  | 6–12  |     |
|    | purple pricklypear        | OPMAM | <i>Opuntia macrocentra</i> var. <i>macrocentra</i>     | 5–14  | 1–3 |
|    | tulip pricklypear         | OPPH  | <i>Opuntia phaeacantha</i>                             | 0–1   | 0–1 |
|    | tree cholla               | CYIMI | <i>Cylindropuntia imbricata</i> var. <i>imbricata</i>  | 0–1   | 0–1 |
|    | pitaya                    | ECEN2 | <i>Echinocereus enneacanthus</i>                       | 0–1   | 0–1 |
|    | devilshead                | ECHO  | <i>Echinocactus horzonthalonius</i>                    | 0–1   | 0–1 |
|    | horse crippler            | ECTE  | <i>Echinocactus texensis</i>                           | 0–1   | 0–1 |
|    | kingcup cactus            | ECTR  | <i>Echinocereus triglochidiatus</i>                    | 0–1   | 0–1 |
|    | nylon hedgehog cactus     | ECVI2 | <i>Echinocereus viridiflorus</i>                       | 0–1   | 0–1 |
|    | Sneed's pincushion cactus | ESSNL | <i>Escobaria sneedii</i> var. <i>leei</i>              | 0–1   | 0–1 |
|    | ocotillo                  | FOSP2 | <i>Fouquieria splendens</i>                            | 0–1   | 0–1 |
|    | cactus apple              | OPEN3 | <i>Opuntia engelmannii</i>                             | 0–1   | 0–1 |
| 10 | <b>Yucca</b>              |       |  | 6–14  |     |
|    | Torrey's yucca            | YUTO  | <i>Yucca torreyi</i>                                   | 5–14  | 1–2 |
|    | soaptree yucca            | YUEL  | <i>Yucca elata</i>                                     | 0–1   | 0–1 |
| 11 | <b>Yucca-like plants</b>  |       |  | 12–24 |     |
|    | lechuguilla               | AGLE  | <i>Agave lechuguilla</i>                               | 5–14  | 1–2 |
|    | Texas sacahuista          | NOTE  | <i>Nolina texana</i>                                   | 5–14  | 1–2 |
|    | green sotol               | DALE2 | <i>Dasyllirion leiophyllum</i>                         | 0–1   | 0–1 |

Table 26. Community 1.4 plant community composition

| Group                  | Common Name                    | Symbol | Scientific Name                | Annual Production (Lb/Acre) | Foliar Cover (%) |
|------------------------|--------------------------------|--------|--------------------------------|-----------------------------|------------------|
| <b>Grass/Grasslike</b> |                                |        |                                |                             |                  |
| 1                      | <b>Warm Season Tallgrasses</b> |        |                                | 6–17                        |                  |
|                        | cane bluestem                  | BOBA3  | <i>Bothriochloa barbinodis</i> | 6–17                        | 1–2              |
| 2                      | <b>Warm Season Midgrasses</b>  |        |                                | 78–208                      |                  |
|                        | sideoats grama                 | BOCU   | <i>Bouteloua curtipendula</i>  | 50–72                       | 2–5              |
|                        | curlyleaf muhly                | MUSE   | <i>Muhlenbergia setifolia</i>  | 6–61                        | 1–3              |

|                   |                                 |        |   |        |     |
|-------------------|---------------------------------|--------|---|--------|-----|
|                   | slim tridens                    | TRMU   | <i>Tridens muticus</i>                        | 17–28  | 1–2 |
|                   | purple threeawn                 | ARPU9  | <i>Aristida purpurea</i>                      | 11–22  | 1–2 |
|                   | sand dropseed                   | SPCR   | <i>Sporobolus cryptandrus</i>                 | 6–17   | 1–2 |
|                   | plains lovegrass                | ERIN   | <i>Eragrostis intermedia</i>                  | 3–8    | 1–2 |
| 3                 | <b>Warm Season Shortgrasses</b> |        |   | 72–192 |     |
|                   | hairy grama                     | BOHI2  | <i>Bouteloua hirsuta</i>                      | 33–66  | 2–5 |
|                   | black grama                     | BOER4  | <i>Bouteloua eriopoda</i>                     | 6–50   | 1–3 |
|                   | nineawn pappusgrass             | ENDE   | <i>Enneapogon desvauxii</i>                   | 3–19   | 1–2 |
|                   | hairy woollygrass               | ERPI5  | <i>Erioneuron pilosum</i>                     | 6–17   | 1–2 |
|                   | Hall's panicgrass               | PAHA   | <i>Panicum hallii</i>                         | 6–17   | 1–2 |
|                   | blue grama                      | BOGR2  | <i>Bouteloua gracilis</i>                     | 6–17   | 1–2 |
|                   | common wolfstail                | LYPH   | <i>Lycurus phleoides</i>                      | 3–8    | 1–2 |
|                   | low woollygrass                 | DAPU7  | <i>Dasyochloa pulchella</i>                   | 3–8    | 1   |
|                   | streambed bristlegrass          | SELE6  | <i>Setaria leucopila</i>                      | 3–8    | 1   |
|                   | Carolina crabgrass              | DIPU9  | <i>Digitaria pubiflora</i>                    | 0–1    | 0–1 |
| 4                 | <b>Cool-season Tallgrasses</b>  |        |   | 3–8    |     |
|                   | New Mexico feathergrass         | HENE5  | <i>Hesperostipa neomexicana</i>               | 3–8    | 1   |
| <b>Forb</b>       |                                 |        |   |        |     |
| 5                 | <b>Perennial Forbs</b>          |        |   | 15–40  |     |
|                   | croton                          | CROTO  | <i>Croton</i>                                 | 3–8    | 1–2 |
|                   | hawkweed buckwheat              | ERHI3  | <i>Eriogonum hieraciifolium</i>               | 3–8    | 1–2 |
|                   | Davis Mountain mock vervain     | GLBIC  | <i>Glandularia bipinnatifida var. ciliata</i> | 3–8    | 1–2 |
|                   | James' nailwort                 | PAJA   | <i>Paronychia jamesii</i>                     | 3–8    | 1–2 |
|                   | polygala                        | POLYG  | <i>Polygala</i>                               | 3–8    | 1–2 |
|                   | resurrection plant              | SEPI   | <i>Selaginella pilifera</i>                   | 0–1    | 0–1 |
|                   | whitemargin sandmat             | CHAL11 | <i>Chamaesyce albomarginata</i>               | 0–1    | 0–1 |
| 6                 | <b>Annual Forbs</b>             |        |   | 3–8    |     |
|                   | common sunflower                | HEAN3  | <i>Helianthus annuus</i>                      | 3–8    | 1   |
| 12                | <b>Fern</b>                     |        |   | 3–8    |     |
|                   | Cochise scaly cloakfern         | ASCO42 | <i>Astrolepis cochisensis</i>                 | 3–8    | 1–2 |
| <b>Shrub/Vine</b> |                                 |        |   |        |     |
| 7                 | <b>Shrubs</b>                   |        |   | 81–216 |     |
|                   | Pinchot's juniper               | JUPI   | <i>Juniperus pinchotii</i>                    | 6–50   | 1–7 |
|                   | mariola                         | PAIN2  | <i>Parthenium incanum</i>                     | 6–39   | 1–5 |
|                   | pungent oak                     | QUPU   | <i>Quercus pungens</i>                        | 0–33   | 0–4 |
|                   | whitethorn acacia               | ACCO2  | <i>Acacia constricta</i>                      | 6–28   | 1–3 |
|                   | featherplume                    | DAFO   | <i>Dalea formosa</i>                          | 11–22  | 1–3 |
|                   | catclaw acacia                  | ACGR   | <i>Acacia greggii</i>                         | 6–17   | 1–3 |
|                   | resinbush                       | VIST   | <i>Viguiera stenoloba</i>                     | 6–17   | 1–3 |
|                   | catclaw mimosa                  | MIACB  | <i>Mimosa aculeaticarpa var. biuncifera</i>   | 6–17   | 1–3 |
|                   | roundflower catclaw             | ACRO   | <i>Acacia roemeriana</i>                      | 3–8    | 1–2 |
|                   | javelina bush                   | COER5  | <i>Condalia ericoides</i>                     | 3–8    | 1–2 |
|                   | algerita                        | MATR3  | <i>Mahonia trifoliolata</i>                   | 3–8    | 1–2 |

|    |                           |       |  |       |     |
|----|---------------------------|-------|--|-------|-----|
|    | littleleaf sumac          | RHMI3 | <i>Rhus microphylla</i>                                | 0–1   | 0–1 |
|    | longleaf jointfir         | EPTR  | <i>Ephedra trifurca</i>                                | 0–1   | 0–1 |
|    | creosote bush             | LATR2 | <i>Larrea tridentata</i>                               | 0–1   | 0–1 |
| 8  | <b>Half-Shrubs</b>        |       |  | 9–24  |     |
|    | dyssodia                  | DYSSO | <i>Dyssodia</i>  | 6–17  | 1–2 |
|    | rough menodora            | MESC  | <i>Menodora scabra</i>                                 | 3–8   | 1   |
|    | fiveneedle pricklyleaf    | THPEP | <i>Thymophylla pentachaeta</i> var. <i>pentachaeta</i> | 0–1   | 0–1 |
|    | hairy crinklemat          | TIHI  | <i>Tiquilia hispidissima</i>                           | 0–1   | 0–1 |
| 9  | <b>Cactus</b>             |       |  | 12–32 |     |
|    | purple pricklypear        | OPMAM | <i>Opuntia macrocentra</i> var. <i>macrocentra</i>     | 6–17  | 2–4 |
|    | tulip pricklypear         | OPPH  | <i>Opuntia phaeacantha</i>                             | 3–8   | 1–2 |
|    | tree cholla               | CYIMI | <i>Cylindropuntia imbricata</i> var. <i>imbricata</i>  | 3–8   | 1   |
|    | horse crippler            | ECTE  | <i>Echinocactus texensis</i>                           | 0–1   | 0–1 |
|    | kingcup cactus            | ECTR  | <i>Echinocereus triglochidiatus</i>                    | 0–1   | 0–1 |
|    | nylon hedgehog cactus     | ECVI2 | <i>Echinocereus viridiflorus</i>                       | 0–1   | 0–1 |
|    | Sneed's pincushion cactus | ESSNL | <i>Escobaria sneedii</i> var. <i>leei</i>              | 0–1   | 0–1 |
|    | ocotillo                  | FOSP2 | <i>Fouquieria splendens</i>                            | 0–1   | 0–1 |
|    | cactus apple              | OPEN3 | <i>Opuntia engelmannii</i>                             | 0–1   | 0–1 |
| 10 | <b>Yucca</b>              |       |  | 3–8   |     |
|    | Torrey's yucca            | YUTO  | <i>Yucca torreyi</i>                                   | 3–8   | 1   |
|    | soaptree yucca            | YUEL  | <i>Yucca elata</i>                                     | 0–1   | 0–1 |
| 11 | <b>Yucca-like plants</b>  |       |  | 15–40 |     |
|    | lechuguilla               | AGLE  | <i>Agave lechuguilla</i>                               | 11–22 | 1–2 |
|    | green sotol               | DALE2 | <i>Dasyilirion leiophyllum</i>                         | 11–22 | 1–2 |

Table 27. Community 1.5 plant community composition

| Group                  | Common Name                     | Symbol | Scientific Name                  | Annual Production (Lb/Acre) | Foliar Cover (%) |
|------------------------|---------------------------------|--------|----------------------------------|-----------------------------|------------------|
| <b>Grass/Grasslike</b> |                                 |        |                                  |                             |                  |
| 1                      | <b>Warm Season Tallgrasses</b>  |        |                                  | 55–77                       |                  |
|                        | cane bluestem                   | BOBA3  | <i>Bothriochloa barbinodis</i>   | 55–77                       | 1–3              |
| 2                      | <b>Warm Season Midgrasses</b>   |        |                                  | 300–700                     |                  |
|                        | curlyleaf muhly                 | MUSE   | <i>Muhlenbergia setifolia</i>    | 110–286                     | 4–24             |
|                        | sideoats grama                  | BOCU   | <i>Bouteloua curtipendula</i>    | 88–132                      | 6–8              |
|                        | slim tridens                    | TRMU   | <i>Tridens muticus</i>           | 55–77                       | 2–4              |
|                        | green sprangletop               | LEDU   | <i>Leptochloa dubia</i>          | 22–66                       | 1–2              |
|                        | sand dropseed                   | SPCR   | <i>Sporobolus cryptandrus</i>    | 44–66                       | 1                |
|                        | purple threeawn                 | ARPU9  | <i>Aristida purpurea</i>         | 33–55                       | 1–5              |
|                        | plains lovegrass                | ERIN   | <i>Eragrostis intermedia</i>     | 11–55                       | 1–3              |
| 3                      | <b>Warm Season Shortgrasses</b> |        |                                  | 138–322                     |                  |
|                        | hairy grama                     | BOHI2  | <i>Bouteloua hirsuta</i>         | 132–198                     | 5–9              |
|                        | streambed bristlegrass          | SELE6  | <i>Setaria leucopila</i>         | 33–55                       | 1–2              |
|                        | mat muhly                       | MURI   | <i>Muhlenbergia richardsonis</i> | 22–44                       | 1–2              |

|                   |                             |        |   |        |     |
|-------------------|-----------------------------|--------|---|--------|-----|
|                   | Hall's panicgrass           | PAHA   | <i>Panicum hallii</i>                           | 11–33  | 1–3 |
| <b>Forb</b>       |                             |        |   |        |     |
| 4                 | <b>Perennial Forbs</b>      |        |   | 24–52  |     |
|                   | Davis Mountain mock vervain | GLBIC  | <i>Glandularia bipinnatifida var. ciliata</i>   | 6–17   | 1–3 |
|                   | hawkweed buckwheat          | ERHI3  | <i>Eriogonum hieraciifolium</i>                 | 6–17   | 1–2 |
|                   | early shaggytuft            | STBA   | <i>Stenandrium barbatum</i>                     | 6–17   | 1   |
|                   | Havard's buckwheat          | ERHA   | <i>Eriogonum havardii</i>                       | 0–1    | 0–1 |
|                   | James' nailwort             | PAJA   | <i>Paronychia jamesii</i>                       | 0–1    | 0–1 |
| 5                 | <b>Annual Forbs</b>         |        |   | 6–17   |     |
|                   | common sunflower            | HEAN3  | <i>Helianthus annuus</i>                        | 6–17   | 1–3 |
| 11                | <b>Fern</b>                 |        |   | 6–17   |     |
|                   | Cochise scaly cloakfern     | ASCO42 | <i>Astrolepsis cochisensis</i>                  | 6–17   | 1   |
| <b>Shrub/Vine</b> |                             |        |   |        |     |
| 6                 | <b>Shrubs</b>               |        |   | 48–112 |     |
|                   | Pinchot's juniper           | JUPI   | <i>Juniperus pinchotii</i>                      | 11–55  | 1–3 |
|                   | pungent oak                 | QUPU   | <i>Quercus pungens</i>                          | 0–44   | 0–3 |
|                   | featherplume                | DAFO   | <i>Dalea formosa</i>                            | 11–33  | 1–2 |
|                   | resinbush                   | VIST   | <i>Viguiera stenoloba</i>                       | 6–17   | 1–2 |
|                   | javelina bush               | COER5  | <i>Condalia ericoides</i>                       | 6–17   | 1–2 |
|                   | catclaw acacia              | ACGR   | <i>Acacia greggii</i>                           | 0–1    | 0–1 |
|                   | roundflower catclaw         | ACRO   | <i>Acacia roemeriana</i>                        | 0–1    | 0–1 |
|                   | algerita                    | MATR3  | <i>Mahonia trifoliolata</i>                     | 0–1    | 0–1 |
| 7                 | <b>Half-Shrubs</b>          |        |   | 18–52  |     |
|                   | desert zinnia               | ZIAC   | <i>Zinnia acerosa</i>                           | 11–33  | 1   |
|                   | dyssodia                    | DYSSO  | <i>Dyssodia</i>                                 | 6–17   | 1–2 |
|                   | rough menodora              | MESC   | <i>Menodora scabra</i>                          | 0–1    | 0–1 |
|                   | fiveneedle pricklyleaf      | THPEP  | <i>Thymophylla pentachaeta var. pentachaeta</i> | 0–1    | 0–1 |
|                   | hairy crinklemat            | TIHI   | <i>Tiquilia hispidissima</i>                    | 0–1    | 0–1 |
| 8                 | <b>Cactus</b>               |        |   | 6–17   |     |
|                   | purple pricklypear          | OPMAM  | <i>Opuntia macrocentra var. macrocentra</i>     | 6–17   | 1–3 |
|                   | tree cholla                 | CYIMI  | <i>Cylindropuntia imbricata var. imbricata</i>  | 0–1    | 0–1 |
|                   | devilshead                  | ECHO   | <i>Echinocactus horizonthalonius</i>            | 0–1    | 0–1 |
|                   | rainbow cactus              | ECPE   | <i>Echinocereus pectinatus</i>                  | 0–1    | 0–1 |
|                   | horse crippler              | ECTE   | <i>Echinocactus texensis</i>                    | 0–1    | 0–1 |
|                   | ocotillo                    | FOSP2  | <i>Fouquieria splendens</i>                     | 0–1    | 0–1 |
| 9                 | <b>Yucca</b>                |        |   | 0–1    |     |
|                   | soaptree yucca              | YUEL   | <i>Yucca elata</i>                              | 0–1    | 0–1 |
|                   | Torrey's yucca              | YUTO   | <i>Yucca torreyi</i>                            | 0–1    | 0–1 |
| 10                | <b>Yucca-like plants</b>    |        |   | 18–52  |     |
|                   | green sotol                 | DALE2  | <i>Dasylirion leiophyllum</i>                   | 11–33  | 1   |
|                   | lechuguilla                 | AGLE   | <i>Agave lechuguilla</i>                        | 6–17   | 1–2 |

Table 28. Community 2.1 plant community composition

| Group                  | Common Name                     | Symbol | Scientific Name                                | Annual Production (Lb/Acre) | Foliar Cover (%) |
|------------------------|---------------------------------|--------|--|-----------------------------|------------------|
| <b>Grass/Grasslike</b> |                                 |        |  |                             |                  |
| 1                      | <b>Warm Season Midgrasses</b>   |        |  | 22–68                       |                  |
|                        | sideoats grama                  | BOCU   | <i>Bouteloua curtipendula</i>                  | 12–18                       | 1–3              |
|                        | slim tridens                    | TRMU   | <i>Tridens muticus</i>                         | 6–12                        | 1–2              |
|                        | purple threeawn                 | ARPU9  | <i>Aristida purpurea</i>                       | 6–12                        | 1–2              |
|                        | curlyleaf muhly                 | MUSE   | <i>Muhlenbergia setifolia</i>                  | 3–9                         | 1                |
|                        | sand dropseed                   | SPCR   | <i>Sporobolus cryptandrus</i>                  | 3–9                         | 1                |
|                        | plains lovegrass                | ERIN   | <i>Eragrostis intermedia</i>                   | 0–1                         | 0–1              |
| 2                      | <b>Warm Season Shortgrasses</b> |        |  | 37–113                      |                  |
|                        | hairy grama                     | BOHI2  | <i>Bouteloua hirsuta</i>                       | 12–24                       | 2–5              |
|                        | black grama                     | BOER4  | <i>Bouteloua eriopoda</i>                      | 3–21                        | 1–3              |
|                        | hairy woollygrass               | ERPI5  | <i>Erioneuron pilosum</i>                      | 6–18                        | 1–2              |
|                        | Hall's panicgrass               | PAHA   | <i>Panicum hallii</i>                          | 6–18                        | 1–2              |
|                        | low woollygrass                 | DAPU7  | <i>Dasyochloa pulchella</i>                    | 6–18                        | 1                |
|                        | Carolina crabgrass              | DIPU9  | <i>Digitaria pubiflora</i>                     | 3–9                         | 1                |
|                        | red grama                       | BOTR2  | <i>Bouteloua trifida</i>                       | 2–5                         | 1                |
| <b>Forb</b>            |                                 |        |  |                             |                  |
| 3                      | <b>Perennial Forbs</b>          |        |  | 6–18                        |                  |
|                        | scarlet beeblossom              | GACO5  | <i>Gaura coccinea</i>                          | 2–5                         | 1                |
| 4                      | <b>Annual Forbs</b>             |        |  | 3–8                         |                  |
|                        | common sunflower                | HEAN3  | <i>Helianthus annuus</i>                       | 3–8                         | 1                |
| <b>Shrub/Vine</b>      |                                 |        |  |                             |                  |
| 5                      | <b>Shrubs</b>                   |        |  | 60–180                      |                  |
|                        | whitethorn acacia               | ACCO2  | <i>Acacia constricta</i>                       | 45–81                       | 8–12             |
|                        | mariola                         | PAIN2  | <i>Parthenium incanum</i>                      | 6–18                        | 1–3              |
|                        | catclaw mimosa                  | MIACB  | <i>Mimosa aculeaticarpa var. biuncifera</i>    | 9–15                        | 1–3              |
|                        | Pinchot's juniper               | JUPI   | <i>Juniperus pinchotii</i>                     | 6–12                        | 1–3              |
|                        | roundflower catclaw             | ACRO   | <i>Acacia roemeriana</i>                       | 6–12                        | 1–3              |
|                        | resinbush                       | VIST   | <i>Viguiera stenoloba</i>                      | 3–9                         | 1–2              |
|                        | javelina bush                   | COER5  | <i>Condalia ericoides</i>                      | 2–5                         | 1–2              |
|                        | featherplume                    | DAFO   | <i>Dalea formosa</i>                           | 2–5                         | 1–2              |
|                        | algerita                        | MATR3  | <i>Mahonia trifoliolata</i>                    | 2–5                         | 1                |
| 6                      | <b>Half-Shrubs</b>              |        |  | 0–1                         |                  |
|                        | dyssodia                        | DYSSO  | <i>Dyssodia</i>                                | 0–1                         | 0–1              |
| 7                      | <b>Cactus</b>                   |        |  | 15–45                       |                  |
|                        | purple pricklypear              | OPMAM  | <i>Opuntia macrocentra var. macrocentra</i>    | 6–12                        | 1–2              |
|                        | tulip pricklypear               | OPPH   | <i>Opuntia phaeacantha</i>                     | 6–12                        | 1–2              |
|                        | cactus apple                    | OPEN3  | <i>Opuntia engelmannii</i>                     | 3–9                         | 1–2              |
|                        | tree cholla                     | CYIMI  | <i>Cylindropuntia imbricata var. imbricata</i> | 3–9                         | 1–2              |
|                        | ocotillo                        | FOSP2  | <i>Fouquieria splendens</i>                    | 0–1                         | 0–1              |

|   |                   |       |                                |      |     |
|---|-------------------|-------|--------------------------------|------|-----|
| 8 | Yucca-like plants |       |                                | 7-23 |     |
|   | lechuguilla       | AGLE  | <i>Agave lechuguilla</i>       | 6-12 | 1-3 |
|   | green sotol       | DALE2 | <i>Dasyilirion leiophyllum</i> | 3-9  | 1-2 |

## 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.

#### Wildlife species

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

**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:

- Turkey Vulture
- Mississippi Kite
- Red-tailed Hawk
- American Kestrel
- Great Horned Owl
- Spotted Towhee

Canyon Towhee  
Cassin's Sparrow  
Brewer's Sparrow  
Black-throated Sparrow  
White-crowned Sparrow  
Dark-eyed Junco  
Scaled Quail  
White-winged Dove  
Mourning Dove  
Eurasian Collared Dove (introduced)  
Lesser Nighthawk  
Common Nighthawk  
Black-chinned Hummingbird  
Ladder-backed Woodpecker  
Western Kingbird  
Cliff Swallow  
Barn Swallow  
Verdin  
Cactus Wren  
Rock Wren  
Northern Mockingbird  
Curved-billed Thrasher  
House Finch  
House Sparrow

Mammals:

Mexican Ground Squirrel  
Yellow-faced Pocket Gopher  
Merriam's Kangaroo Rat  
Merriam's Pocket Mouse  
Western Harvest Mouse  
Southern Plains Woodrat  
Cactus Mouse  
White-footed Mouse  
White-ankled Mouse  
Hispid Cotton Rat  
North American Porcupine  
Black-tailed Jackrabbit  
Desert Cottontail  
American Badger  
Striped Skunk  
Grey Fox  
Coyote  
Bobcat  
Mule Deer  
Barbary Sheep (introduced)  
Ringtail

Reptiles:

Green Toad  
Red-spotted toad  
Rio-Grande Leopard Frog  
Eastern Collared Lizard  
Greater Earless Lizard  
Round Tailed Horned Lizard  
Crevice Spiny Lizard  
Prairie Lizard  
Common Side-blotched Lizard

Texas Banded Gecko  
Chihuahuan Spotted Whiptail  
Common Checkered Whiptail  
Ring-necked Snake  
Striped Whip Snake  
Western Ground Snake

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 increase, 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.

## Hydrological 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 mezcals pits) are doughnut-shaped structures of burned rock, ash, and occupational debris (Kayser, 2010).

## Inventory data references

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.

## Type locality

|                             |  |
|-----------------------------|--|
| Location 1: Eddy County, NM |  |
| UTM zone                    | N  |
| UTM northing                | 3562068  |
| UTM easting                 | 551584   |
| General legal description   | This site occurs on Azotea Mesa, close to highway 137. It is BLM land and is the location of the Tier 3 sample site. |

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#### 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

#### 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:

- 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
- Pete Biggam-Soils Program Manager, National Park Service, Lakewood Colorado

**Contributors**

Scott Woodall

**Approval**

Scott Woodall, 9/16/2020

**Rangeland health reference sheet**

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

|   |                   |
|---|-------------------|
| Author(s)/participant(s)                    |                   |
| Contact for lead author                     |                   |
| Date  | 04/25/2024        |
| Approved by                                 | Scott Woodall     |
| Approval date                               |                   |
| Composition (Indicators 10 and 12) based on | Annual Production |

**Indicators**

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

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

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

---

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

---

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

---

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

---

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

---

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

---

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

---

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

---

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

---

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

Dominant:

Sub-dominant:

Other:

Additional:

---

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

---

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

---

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

---

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**

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