Ecological site R042CY901NM
Very Shallow

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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	**Limestone Hills** Limestone Hills: This site has slopes >25% which make up hillsides, adjacent to the Very Shallow site.
R042CY001NM	**Shallow Limestone** 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 evaproite rocks occurred around the rim of the Delaware basin creating an ideal environment for the development of a large coral reef. The rim was topographically high; the waters were shallow, well-ventilated, agitated, and warm. In this excellent marine-life environment the great Capitan Reef began to form. The Capitan Reef grew rapidly and flourished throughout Guadalupian time, surrounding the Delaware basin, controlling environments and influencing sedimentation. (Kelley, 1971)

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

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

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

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

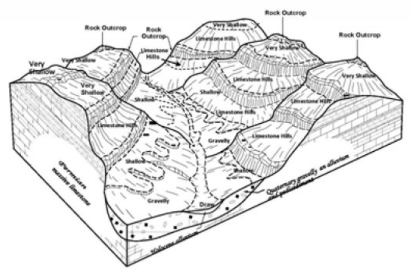

Figure 2. LRU 42.8 Northeastern Chihuahuan Desert Hills

Table 2. Representative physiographic features

Landforms	(1) Hill (2) Ridge (3) Mesa
Flooding frequency	None
Ponding frequency	None
Elevation	1,067–1,676 m
Slope	1–25%
Water table depth	152 cm
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 55to 70 degrees F, and the frost-free season is 207 to 243 days.

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

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

Table 3. Representative climatic features

Frost-free period (average)	225 days

Freeze-free period (average)	246 days
Precipitation total (average)	356 mm

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 meann 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 (2) Eolian deposits–limestone and sandstone
Surface texture	(1) Gravelly loam (2) Very gravelly silt loam (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	3–51 cm
Surface fragment cover <=3"	10–45%
Surface fragment cover >3"	5–35%
Available water capacity (0-101.6cm)	1.02–3.18 cm
Calcium carbonate equivalent (0-101.6cm)	0–25%
Electrical conductivity (0-101.6cm)	0–1 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–1
Soil reaction (1:1 water) (0-101.6cm)	7–7.8
Subsurface fragment volume <=3" (Depth not specified)	5–50%
Subsurface fragment volume >3" (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 mezcal pits still exist where plants, such as sotol were cooked in the ground as an important food source. When Europeans arrived they created change by introducing livestock and building infrastructure.

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

State and transition model

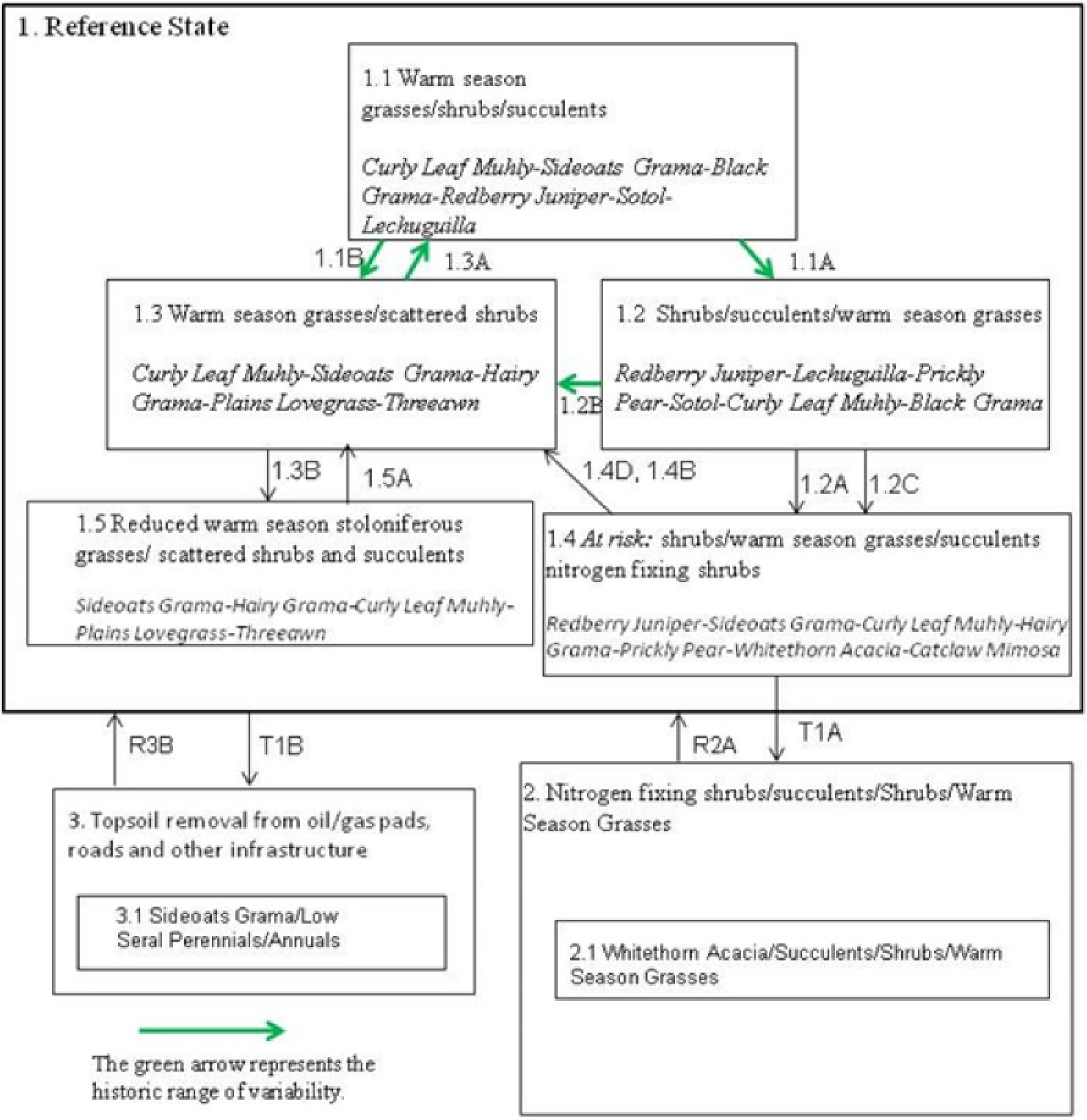

Figure 8. Very Shallow

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

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 (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	437	706	962
Shrub/Vine	106	163	234
Forb	17	28	37
Total	**560**	**897**	**1233**

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 (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	2-6%	5-15%	1-3%
>0.15 <= 0.3	–	3-7%	25-35%	1-2%
>0.3 <= 0.6	–	5-9%	–	–
>0.6 <= 1.4	–	7-11%	–	–
>1.4 <= 4	–	2-6%	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

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

NM4608, R070DY158NM Very Shallow Reference State. R070DY158NM Very Shallow Reference State.

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 (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	336	471	605
Shrub/Vine	207	290	373
Forb	17	24	30
Total	**560**	**785**	**1008**

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 (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	2-6%	5-15%	1-3%
>0.15 <= 0.3	–	4-8%	15-25%	1-2%
>0.3 <= 0.6	–	6-10%	–	–
>0.6 <= 1.4	–	14-18%	–	–
>1.4 <= 4	–	4-8%	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

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 (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	504	757	1009
Shrub/Vine	121	182	242
Forb	47	71	94
Total	**672**	**1010**	**1345**

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 (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	1-2%	5-15%	1-3%
>0.15 <= 0.3	–	4-8%	25-35%	2-4%
>0.3 <= 0.6	–	5-9%	10-20%	–
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

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 (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	185	336	493
Shrub/Vine	135	247	359
Forb	17	34	45
Total	**337**	**617**	**897**

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 (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	3-5%	8-12%	1-3%
>0.15 <= 0.3	–	5-9%	6-10%	2-4%
>0.3 <= 0.6	–	7-11%	1-3%	–
>0.6 <= 1.4	–	6-10%	–	–
>1.4 <= 4	–	1-3%	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

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 (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	538	986	1255
Shrub/Vine	101	185	235
Forb	34	62	78
Total	**673**	**1233**	**1568**

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 (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	4-6%	8-12%	1-3%
>0.15 <= 0.3	–	5-9%	25-35%	2-4%
>0.3 <= 0.6	–	4-8%	15-25%	–
>0.6 <= 1.4	–	1-3%	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

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 (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	92	185	277
Grass/Grasslike	67	135	202
Forb	9	17	26
Total	**168**	**337**	**505**

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 (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	2-4%	6-10%	1-3%
>0.15 <= 0.3	–	5-7%	1-3%	1-2%
>0.3 <= 0.6	–	8-10%	–	–
>0.6 <= 1.4	–	6-8%	–	–
>1.4 <= 4	–	1-3%	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

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 mycorhizal fungi occur on this site. After many decades of abandonment, sideoats grama, which is not quite as dependent on native mycorhizal fungi, can colonize and dominate this site. If there are deep soils within cracks and fissures in the area, plants will establish quicker and begin re-building topsoil. Mineral soil will accumulate from wind-blown material and possibly water run-off from adjacent areas. It should be noted that, by the time relatively productive soils have developed, the climate will likely differ markedly from that of today. Thus, this ecosystem will likely proceed towards a different reference community from that of today.

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 (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm Season Tallgrasses**			34–38	
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	9–27	1–3
	silver beardgrass	BOLA2	*Bothriochloa laguroides*	9–27	1–3
	little bluestem	SCSC	*Schizachyrium scoparium*	1	1
2	**Warm Season Midgrasses**			308–364	
	curlyleaf muhly	MUSE	*Muhlenbergia setifolia*	18–269	2–18
	purple threeawn	ARPU9	*Aristida purpurea*	9–117	1–5
	sideoats grama	BOCU	*Bouteloua curtipendula*	54–90	4–6
	slim tridens	TRMU	*Tridens muticus*	36–54	2–4
	plains lovegrass	ERIN	*Eragrostis intermedia*	9–45	1–3
	green sprangletop	LEDU	*Leptochloa dubia*	9–27	1–2
	sand dropseed	SPCR	*Sporobolus cryptandrus*	4–13	1
3	**Warm Season Shortgrasses**			157–202	
	hairy grama	BOHI2	*Bouteloua hirsuta*	45–81	3–5

	black grama	BOER4	*Bouteloua eriopoda*	18–72	2–6
	hairy woollygrass	ERPI5	*Erioneuron pilosum*	9–27	1–2
	sand muhly	MUAR2	*Muhlenbergia arenicola*	0–18	0–1
	red grama	BOTR2	*Bouteloua trifida*	0–18	0–1
	blue grama	BOGR2	*Bouteloua gracilis*	4–13	1–2
	Hall's panicgrass	PAHA	*Panicum hallii*	4–13	1–2
	common wolfstail	LYPH	*Lycurus phleoides*	7–11	1
	streambed bristlegrass	SELE6	*Setaria leucopila*	7–11	1
	tobosagrass	PLMU3	*Pleuraphis mutica*	0–1	0–1
	low woollygrass	DAPU7	*Dasyochloa pulchella*	0–1	0–1
	Carolina crabgrass	DIPU9	*Digitaria pubiflora*	0–1	0–1
	nineawn pappusgrass	ENDE	*Enneapogon desvauxii*	0–1	0–1
4	**Cool Season Tall Grasses**			0–18	
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	0–18	0–1
Forb					
5	**Perennial Forbs**			39–50	
	croton	CROTO	*Croton*	4–13	1–2
	hawkweed buckwheat	ERHI3	*Eriogonum hieraciifolium*	4–13	1–2
	James' nailwort	PAJA	*Paronychia jamesii*	4–13	1
	Havard's buckwheat	ERHA	*Eriogonum havardii*	4–13	1
	polygala	POLYG	*Polygala*	0–1	0–1
	Douglas' ragwort	SEFLD	*Senecio flaccidus var. douglasii*	0–1	0–1
	resurrection plant	SEPI	*Selaginella pilifera*	0–1	0–1
	early shaggytuft	STBA	*Stenandrium barbatum*	0–1	0–1
	Davis Mountain mock vervain	GLBIC	*Glandularia bipinnatifida var. ciliata*	0–1	0–1
	Fendler's bladderpod	LEFE	*Lesquerella fendleri*	0–1	0–1
	Texas tansyaster	MABL2	*Machaeranthera blephariphylla*	0–1	0–1
	spreading fleabane	ERDI4	*Erigeron divergens*	0–1	0–1
	whitemargin sandmat	CHAL11	*Chamaesyce albomarginata*	0–1	0–1
	greenleaf five eyes	CHCO2	*Chamaesaracha coronopus*	0–1	0–1
6	**Annual Forbs**			2–16	
	lemonscent	PEAN	*Pectis angustifolia*	0–1	0–1
12	**Fern**			7–11	
	Cochise scaly cloakfern	ASCO42	*Astrolepis cochisensis*	7–11	1–3
	Cochise scaly cloakfern	ASCO42	*Astrolepis cochisensis*	7–11	1–3
Shrub/Vine					
7	**Shrubs**			112–139	
	Pinchot's juniper	JUPI	*Juniperus pinchotii*	18–36	2–6
	mariola	PAIN2	*Parthenium incanum*	18–36	1–5
	pungent oak	QUPU	*Quercus pungens*	0–36	0–4
	featherplume	DAFO	*Dalea formosa*	9–27	1–3
	littleleaf ratany	KRER	*Krameria erecta*	4–13	1–2
	javelina bush	COER5	*Condalia ericoides*	4–13	1–2

	algerita	MATR3	*Mahonia trifoliolata*	4–13	1–2
	resinbush	VIST	*Viguiera stenoloba*	4–13	1–2
	Wright's beebrush	ALWR	*Aloysia wrightii*	2–7	1
	longleaf jointfir	EPTR	*Ephedra trifurca*	0–1	0–1
	creosote bush	LATR2	*Larrea tridentata*	0–1	0–1
	lotebush	ZIOB	*Ziziphus obtusifolia*	0–1	0–1
	skunkbush sumac	RHTRT	*Rhus trilobata var. trilobata*	0–1	0–1
	catclaw acacia	ACGR	*Acacia greggii*	0–1	0–1
	roundflower catclaw	ACRO	*Acacia roemeriana*	0–1	0–1
8	**Half-Shrubs**			22–31	
	dyssodia	DYSSO	*Dyssodia*	4–13	1
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	4–13	1
	desert zinnia	ZIAC	*Zinnia acerosa*	4–13	1
	rough menodora	MESC	*Menodora scabra*	0–1	0–1
	fiveneedle pricklyleaf	THPEP	*Thymophylla pentachaeta var. pentachaeta*	0–1	0–1
	hairy crinklemat	TIHI	*Tiquilia hispidissima*	0–1	0–1
9	**Cactus**			34–38	
	purple pricklypear	OPMAM	*Opuntia macrocentra var. macrocentra*	9–45	1–3
	tulip pricklypear	OPPH	*Opuntia phaeacantha*	2–16	1–2
	tree cholla	CYIMI	*Cylindropuntia imbricata var. imbricata*	0–1	0–1
	pitaya	ECEN2	*Echinocereus enneacanthus*	0–1	0–1
	devilshead	ECHO	*Echinocactus horizonthalonius*	0–1	0–1
	rainbow cactus	ECPE	*Echinocereus pectinatus*	0–1	0–1
	horse crippler	ECTE	*Echinocactus texensis*	0–1	0–1
	kingcup cactus	ECTR	*Echinocereus triglochidiatus*	0–1	0–1
	nylon hedgehog cactus	ECVI2	*Echinocereus viridiflorus*	0–1	0–1
	Sneed's pincushion cactus	ESSNL	*Escobaria sneedii var. leei*	0–1	0–1
	ocotillo	FOSP2	*Fouquieria splendens*	0–1	0–1
	cactus apple	OPEN3	*Opuntia engelmannii*	0–1	0–1
10	**Yucca**			16–22	
	Torrey's yucca	YUTO	*Yucca torreyi*	9–27	1–2
	soaptree yucca	YUEL	*Yucca elata*	0–1	0–1
11	**Yucca-like Plants**			49–58	
	lechuguilla	AGLE	*Agave lechuguilla*	27–45	2–6
	green sotol	DALE2	*Dasylirion leiophyllum*	9–27	2–4
	Texas sacahuista	NOTE	*Nolina texana*	7–11	1–3

Table 24. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm Season Tallgrasses**			22–40	

	cane bluestem	BOBA3	*Bothriochloa barbinodis*	8–16	1–3
	silver beardgrass	BOLA2	*Bothriochloa laguroides*	8–16	1–3
2	**Warm Season Midgrasses**			185–333	
	curlyleaf muhly	MUSE	*Muhlenbergia setifolia*	16–173	2–10
	sideoats grama	BOCU	*Bouteloua curtipendula*	47–63	3–5
	purple threeawn	ARPU9	*Aristida purpurea*	39–55	1–3
	slim tridens	TRMU	*Tridens muticus*	31–47	1–3
	plains lovegrass	ERIN	*Eragrostis intermedia*	8–39	1–3
	green sprangletop	LEDU	*Leptochloa dubia*	8–24	1
	sand dropseed	SPCR	*Sporobolus cryptandrus*	4–12	1
3	**Warm Season Shortgrasses**			112–202	
	black grama	BOER4	*Bouteloua eriopoda*	24–71	1–5
	hairy grama	BOHI2	*Bouteloua hirsuta*	39–71	2–4
	hairy woollygrass	ERPI5	*Erioneuron pilosum*	8–39	1–2
	Hall's panicgrass	PAHA	*Panicum hallii*	8–24	1–2
	blue grama	BOGR2	*Bouteloua gracilis*	4–12	1–2
	common wolfstail	LYPH	*Lycurus phleoides*	4–12	1–2
	low woollygrass	DAPU7	*Dasyochloa pulchella*	0–1	0–1
	Carolina crabgrass	DIPU9	*Digitaria pubiflora*	0–1	0–1
4	**Cool-season Tallgrasses**			6–10	
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	0–16	0–2
Forb					
5	**Perennial Forbs**			22–40	
	whitemargin sandmat	CHAL11	*Chamaesyce albomarginata*	4–12	1–2
	croton	CROTO	*Croton*	4–12	1–2
	hawkweed buckwheat	ERHI3	*Eriogonum hieraciifolium*	4–12	1–2
	Davis Mountain mock vervain	GLBIC	*Glandularia bipinnatifida var. ciliata*	0–1	0–1
	Fendler's bladderpod	LEFE	*Lesquerella fendleri*	0–1	0–1
	James' nailwort	PAJA	*Paronychia jamesii*	0–1	0–1
	polygala	POLYG	*Polygala*	0–1	0–1
	Douglas' ragwort	SEFLD	*Senecio flaccidus var. douglasii*	0–1	0–1
	resurrection plant	SEPI	*Selaginella pilifera*	0–1	0–1
	spreading fleabane	ERDI4	*Erigeron divergens*	0–1	0–1
6	**Annual Forbs**			1	
12	**Fern**			7–11	
	Cochise scaly cloakfern	ASCO42	*Astrolepis cochisensis*	7–11	1–3
Shrub/Vine					
7	**Shrubs**			112–202	
	Pinchot's juniper	JUPI	*Juniperus pinchotii*	24–71	4–12
	mariola	PAIN2	*Parthenium incanum*	16–47	2–6
	featherplume	DAFO	*Dalea formosa*	4–31	1–3
	javelina bush	COER5	*Condalia ericoides*	8–24	1–2
	littleleaf ratany	KRER	*Krameria erecta*	4–12	1–2

	littleleaf ratany	KRER	*Krameria erecta*	4–12	1–2
	resinbush	VIST	*Viguiera stenoloba*	4–12	1–2
	algerita	MATR3	*Mahonia trifoliolata*	4–12	1–2
	Wright's beebrush	ALWR	*Aloysia wrightii*	3–10	1
	creosote bush	LATR2	*Larrea tridentata*	0–1	0–1
	longleaf jointfir	EPTR	*Ephedra trifurca*	0–1	0–1
	whitethorn acacia	ACCO2	*Acacia constricta*	0–1	0–1
	catclaw acacia	ACGR	*Acacia greggii*	0–1	0–1
	roundflower catclaw	ACRO	*Acacia roemeriana*	0–1	0–1
	catclaw mimosa	MIACB	*Mimosa aculeaticarpa var. biuncifera*	0–1	0–1
8	**Half-Shrubs**			28–50	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	16–47	2–4
	desert zinnia	ZIAC	*Zinnia acerosa*	4–12	1
9	**Cactus**			22–40	
	purple pricklypear	OPMAM	*Opuntia macrocentra var. macrocentra*	9–45	2–4
	tulip pricklypear	OPPH	*Opuntia phaeacantha*	2–16	1–3
	tree cholla	CYIMI	*Cylindropuntia imbricata var. imbricata*	0–1	0–2
	horse crippler	ECTE	*Echinocactus texensis*	0–1	0–1
	nylon hedgehog cactus	ECVI2	*Echinocereus viridiflorus*	0–1	0–1
	Sneed's pincushion cactus	ESSNL	*Escobaria sneedii var. leei*	0–1	0–1
	ocotillo	FOSP2	*Fouquieria splendens*	0–1	0–1
	cactus apple	OPEN3	*Opuntia engelmannii*	0–1	0–1
10	**Yucca**			11–20	
	Torrey's yucca	YUTO	*Yucca torreyi*	9–27	1–3
	soaptree yucca	YUEL	*Yucca elata*	0–1	0–1
11	**Yucca-like plants**			34–61	
	lechuguilla	AGLE	*Agave lechuguilla*	27–45	4–8
	green sotol	DALE2	*Dasylirion leiophyllum*	9–27	2–4

Table 25. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm Season Tallgrasses**			27–54	
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	10–30	1–3
	silver beardgrass	BOLA2	*Bothriochloa laguroides*	10–30	1–3
	little bluestem	SCSC	*Schizachyrium scoparium*	1	1
2	**Warm Season Midgrasses**			303–605	
	curlyleaf muhly	MUSE	*Muhlenbergia setifolia*	50–293	4–24
	sideoats grama	BOCU	*Bouteloua curtipendula*	111–151	7–9
	purple threeawn	ARPU9	*Aristida purpurea*	50–71	1–5
	slim tridens	TRMU	*Tridens muticus*	36–54	2–4
	plains lovegrass	ERIN	*Eragrostis intermedia*	10–50	1–3

	green sprangletop	LEDU	*Leptochloa dubia*	9–27	1–2
	sand dropseed	SPCR	*Sporobolus cryptandrus*	6–16	1
3	**Warm Season Shortgrasses**			168–336	
	hairy grama	BOHI2	*Bouteloua hirsuta*	61–121	5–9
	black grama	BOER4	*Bouteloua eriopoda*	30–91	2–10
	blue grama	BOGR2	*Bouteloua gracilis*	10–30	1–3
	hairy woollygrass	ERPI5	*Erioneuron pilosum*	10–30	1–3
	Hall's panicgrass	PAHA	*Panicum hallii*	10–30	1–3
	red grama	BOTR2	*Bouteloua trifida*	0–20	0–1
	sand muhly	MUAR2	*Muhlenbergia arenicola*	0–20	0–1
	streambed bristlegrass	SELE6	*Setaria leucopila*	6–16	1–2
	common wolfstail	LYPH	*Lycurus phleoides*	6–16	1–2
	low woollygrass	DAPU7	*Dasyochloa pulchella*	0–1	0–1
	Carolina crabgrass	DIPU9	*Digitaria pubiflora*	0–1	0–1
	nineawn pappusgrass	ENDE	*Enneapogon desvauxii*	0–1	0–1
4	**Cool-season Tallgrasses**			7–13	
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	0–20	0–3
Forb					
5	**Perennial Forbs**			27–54	
	Davis Mountain mock vervain	GLBIC	*Glandularia bipinnatifida var. ciliata*	10–30	1–3
	spreading fleabane	ERDI4	*Erigeron divergens*	6–16	1–2
	hawkweed buckwheat	ERHI3	*Eriogonum hieraciifolium*	6–16	1–2
	croton	CROTO	*Croton*	0–1	0–1
	Havard's buckwheat	ERHA	*Eriogonum havardii*	0–1	0–1
	Fendler's bladderpod	LEFE	*Lesquerella fendleri*	0–1	0–1
	Texas tansyaster	MABL2	*Machaeranthera blephariphylla*	0–1	0–1
	James' nailwort	PAJA	*Paronychia jamesii*	0–1	0–1
	polygala	POLYG	*Polygala*	0–1	0–1
	Douglas' ragwort	SEFLD	*Senecio flaccidus var. douglasii*	0–1	0–1
	early shaggytuft	STBA	*Stenandrium barbatum*	0–1	0–1
6	**Annual Forbs**			7–16	
	common sunflower	HEAN3	*Helianthus annuus*	2–16	1–3
12	**Fern**			1	
	Cochise scaly cloakfern	ASCO42	*Astrolepis cochisensis*	0–1	0–1
Shrub/Vine					
7	**Shrub**			81–161	
	Pinchot's juniper	JUPI	*Juniperus pinchotii*	10–50	1–3
	mariola	PAIN2	*Parthenium incanum*	10–50	1–3
	pungent oak	QUPU	*Quercus pungens*	0–30	0–3
	featherplume	DAFO	*Dalea formosa*	10–30	1–2
	javelina bush	COER5	*Condalia ericoides*	6–16	1–2
	resinbush	VIST	*Viguiera stenoloba*	6–16	1–2
	lotebush	ZIOB	*Ziziphus obtusifolia*	0–1	0–1

	skunkbush sumac	RHTRT	*Rhus trilobata var. trilobata*	0–1	0–1
	longleaf jointfir	EPTR	*Ephedra trifurca*	0–1	0–1
	littleleaf ratany	KRER	*Krameria erecta*	0–1	0–1
	creosote bush	LATR2	*Larrea tridentata*	0–1	0–1
	algerita	MATR3	*Mahonia trifoliolata*	0–1	0–1
	catclaw acacia	ACGR	*Acacia greggii*	0–1	0–1
	roundflower catclaw	ACRO	*Acacia roemeriana*	0–1	0–1
8	**Half-Shrubs**			20–40	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	10–30	1–3
	rough menodora	MESC	*Menodora scabra*	0–1	0–1
	fiveneedle pricklyleaf	THPEP	*Thymophylla pentachaeta var. pentachaeta*	0–1	0–1
	hairy crinklemat	TIHI	*Tiquilia hispidissima*	0–1	0–1
	desert zinnia	ZIAC	*Zinnia acerosa*	0–1	0–1
	dyssodia	DYSSO	*Dyssodia*	0–1	0–1
9	**Cactus**			7–13	
	purple pricklypear	OPMAM	*Opuntia macrocentra var. macrocentra*	6–16	1–3
	tulip pricklypear	OPPH	*Opuntia phaeacantha*	0–1	0–1
	tree cholla	CYIMI	*Cylindropuntia imbricata var. imbricata*	0–1	0–1
	pitaya	ECEN2	*Echinocereus enneacanthus*	0–1	0–1
	devilshead	ECHO	*Echinocactus horizonthalonius*	0–1	0–1
	horse crippler	ECTE	*Echinocactus texensis*	0–1	0–1
	kingcup cactus	ECTR	*Echinocereus triglochidiatus*	0–1	0–1
	nylon hedgehog cactus	ECVI2	*Echinocereus viridiflorus*	0–1	0–1
	Sneed's pincushion cactus	ESSNL	*Escobaria sneedii var. leei*	0–1	0–1
	ocotillo	FOSP2	*Fouquieria splendens*	0–1	0–1
	cactus apple	OPEN3	*Opuntia engelmannii*	0–1	0–1
10	**Yucca**			7–16	
	Torrey's yucca	YUTO	*Yucca torreyi*	6–16	1–2
	soaptree yucca	YUEL	*Yucca elata*	0–1	0–1
11	**Yucca-like plants**			13–27	
	lechuguilla	AGLE	*Agave lechuguilla*	6–16	1–2
	Texas sacahuista	NOTE	*Nolina texana*	6–16	1–2
	green sotol	DALE2	*Dasylirion leiophyllum*	0–1	0–1

Table 26. Community 1.4 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm Season Tallgrasses**			7–19	
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	7–19	1–2
2	**Warm Season Midgrasses**			87–233	
	sideoats grama	BOCU	*Bouteloua curtipendula*	56–81	2–5

	curlyleaf muhly	MUSE	*Muhlenbergia setifolia*	7–68	1–3
	slim tridens	TRMU	*Tridens muticus*	19–31	1–2
	purple threeawn	ARPU9	*Aristida purpurea*	12–25	1–2
	sand dropseed	SPCR	*Sporobolus cryptandrus*	7–19	1–2
	plains lovegrass	ERIN	*Eragrostis intermedia*	3–9	1–2
3	**Warm Season Shortgrasses**			81–215	
	hairy grama	BOHI2	*Bouteloua hirsuta*	37–74	2–5
	black grama	BOER4	*Bouteloua eriopoda*	7–56	1–3
	nineawn pappusgrass	ENDE	*Enneapogon desvauxii*	3–21	1–2
	hairy woollygrass	ERPI5	*Erioneuron pilosum*	7–19	1–2
	Hall's panicgrass	PAHA	*Panicum hallii*	7–19	1–2
	blue grama	BOGR2	*Bouteloua gracilis*	7–19	1–2
	common wolfstail	LYPH	*Lycurus phleoides*	3–9	1–2
	low woollygrass	DAPU7	*Dasyochloa pulchella*	3–9	1
	streambed bristlegrass	SELE6	*Setaria leucopila*	3–9	1
	Carolina crabgrass	DIPU9	*Digitaria pubiflora*	0–1	0–1
4	**Cool-season Tallgrasses**			3–9	
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	3–9	1
Forb					
5	**Perennial Forbs**			17–45	
	croton	CROTO	*Croton*	3–9	1–2
	hawkweed buckwheat	ERHI3	*Eriogonum hieraciifolium*	3–9	1–2
	Davis Mountain mock vervain	GLBIC	*Glandularia bipinnatifida var. ciliata*	3–9	1–2
	James' nailwort	PAJA	*Paronychia jamesii*	3–9	1–2
	polygala	POLYG	*Polygala*	3–9	1–2
	resurrection plant	SEPI	*Selaginella pilifera*	0–1	0–1
	whitemargin sandmat	CHAL11	*Chamaesyce albomarginata*	0–1	0–1
6	**Annual Forbs**			3–9	
	common sunflower	HEAN3	*Helianthus annuus*	3–9	1
12	**Fern**			3–9	
	Cochise scaly cloakfern	ASCO42	*Astrolepis cochisensis*	3–9	1–2
Shrub/Vine					
7	**Shrubs**			91–242	
	Pinchot's juniper	JUPI	*Juniperus pinchotii*	7–56	1–7
	mariola	PAIN2	*Parthenium incanum*	7–44	1–5
	pungent oak	QUPU	*Quercus pungens*	0–37	0–4
	whitethorn acacia	ACCO2	*Acacia constricta*	7–31	1–3
	featherplume	DAFO	*Dalea formosa*	12–25	1–3
	catclaw acacia	ACGR	*Acacia greggii*	7–19	1–3
	resinbush	VIST	*Viguiera stenoloba*	7–19	1–3
	catclaw mimosa	MIACB	*Mimosa aculeaticarpa var. biuncifera*	7–19	1–3
	roundflower catclaw	ACRO	*Acacia roemeriana*	3–9	1–2
	javelina bush	COER5	*Condalia ericoides*	3–9	1–2

	algerita	MATR3	*Mahonia trifoliolata*	3–9	1–2
	littleleaf sumac	RHMI3	*Rhus microphylla*	0–1	0–1
	longleaf jointfir	EPTR	*Ephedra trifurca*	0–1	0–1
	creosote bush	LATR2	*Larrea tridentata*	0–1	0–1
8	**Half-Shrubs**			10–27	
	dyssodia	DYSSO	*Dyssodia*	7–19	1–2
	rough menodora	MESC	*Menodora scabra*	3–9	1
	fiveneedle pricklyleaf	THPEP	*Thymophylla pentachaeta var. pentachaeta*	0–1	0–1
	hairy crinklemat	TIHI	*Tiquilia hispidissima*	0–1	0–1
9	**Cactus**			13–36	
	purple pricklypear	OPMAM	*Opuntia macrocentra var. macrocentra*	7–19	2–4
	tulip pricklypear	OPPH	*Opuntia phaeacantha*	3–9	1–2
	tree cholla	CYIMI	*Cylindropuntia imbricata var. imbricata*	3–9	1
	horse crippler	ECTE	*Echinocactus texensis*	0–1	0–1
	kingcup cactus	ECTR	*Echinocereus triglochidiatus*	0–1	0–1
	nylon hedgehog cactus	ECVI2	*Echinocereus viridiflorus*	0–1	0–1
	Sneed's pincushion cactus	ESSNL	*Escobaria sneedii var. leei*	0–1	0–1
	ocotillo	FOSP2	*Fouquieria splendens*	0–1	0–1
	cactus apple	OPEN3	*Opuntia engelmannii*	0–1	0–1
10	**Yucca**			3–9	
	Torrey's yucca	YUTO	*Yucca torreyi*	3–9	1
	soaptree yucca	YUEL	*Yucca elata*	0–1	0–1
11	**Yucca-like plants**			17–45	
	lechuguilla	AGLE	*Agave lechuguilla*	12–25	1–2
	green sotol	DALE2	*Dasylirion leiophyllum*	12–25	1–2

Table 27. Community 1.5 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Warn Season Tallgrasses**			62–86	
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	62–86	1–3
2	**Warm Season Midgrasses**			336–785	
	curlyleaf muhly	MUSE	*Muhlenbergia setifolia*	123–321	4–24
	sideoats grama	BOCU	*Bouteloua curtipendula*	99–148	6–8
	slim tridens	TRMU	*Tridens muticus*	62–86	2–4
	green sprangletop	LEDU	*Leptochloa dubia*	25–74	1–2
	sand dropseed	SPCR	*Sporobolus cryptandrus*	49–74	1
	purple threeawn	ARPU9	*Aristida purpurea*	37–62	1–5
	plains lovegrass	ERIN	*Eragrostis intermedia*	12–62	1–3
3	**Warm Season Shortgrasses**			155–361	
	hairy grama	BOHI2	*Bouteloua hirsuta*	148–222	5–9

	streambed bristlegrass	SELE6	*Setaria leucopila*	37–62	1–2
	mat muhly	MURI	*Muhlenbergia richardsonis*	25–49	1–2
	Hall's panicgrass	PAHA	*Panicum hallii*	12–37	1–3
Forb					
4	**Perennial Forbs**			27–58	
	Davis Mountain mock vervain	GLBIC	*Glandularia bipinnatifida var. ciliata*	7–19	1–3
	hawkweed buckwheat	ERHI3	*Eriogonum hieraciifolium*	7–19	1–2
	early shaggytuft	STBA	*Stenandrium barbatum*	7–19	1
	Havard's buckwheat	ERHA	*Eriogonum havardii*	0–1	0–1
	James' nailwort	PAJA	*Paronychia jamesii*	0–1	0–1
5	**Annual Forbs**			7–19	
	common sunflower	HEAN3	*Helianthus annuus*	7–19	1–3
11	**Fern**			7–19	
	Cochise scaly cloakfern	ASCO42	*Astrolepis cochisensis*	7–19	1
Shrub/Vine					
6	**Shrubs**			54–126	
	Pinchot's juniper	JUPI	*Juniperus pinchotii*	12–62	1–3
	pungent oak	QUPU	*Quercus pungens*	0–49	0–3
	featherplume	DAFO	*Dalea formosa*	12–37	1–2
	resinbush	VIST	*Viguiera stenoloba*	7–19	1–2
	javelina bush	COER5	*Condalia ericoides*	7–19	1–2
	catclaw acacia	ACGR	*Acacia greggii*	0–1	0–1
	roundflower catclaw	ACRO	*Acacia roemeriana*	0–1	0–1
	algerita	MATR3	*Mahonia trifoliolata*	0–1	0–1
7	**Half-Shrubs**			20–58	
	desert zinnia	ZIAC	*Zinnia acerosa*	12–37	1
	dyssodia	DYSSO	*Dyssodia*	7–19	1–2
	rough menodora	MESC	*Menodora scabra*	0–1	0–1
	fiveneedle pricklyleaf	THPEP	*Thymophylla pentachaeta var. pentachaeta*	0–1	0–1
	hairy crinklemat	TIHI	*Tiquilia hispidissima*	0–1	0–1
8	**Cactus**			7–19	
	purple pricklypear	OPMAM	*Opuntia macrocentra var. macrocentra*	7–19	1–3
	tree cholla	CYIMI	*Cylindropuntia imbricata var. imbricata*	0–1	0–1
	devilshead	ECHO	*Echinocactus horizonthalonius*	0–1	0–1
	rainbow cactus	ECPE	*Echinocereus pectinatus*	0–1	0–1
	horse crippler	ECTE	*Echinocactus texensis*	0–1	0–1
	ocotillo	FOSP2	*Fouquieria splendens*	0–1	0–1
9	**Yucca**			0–1	
	soaptree yucca	YUEL	*Yucca elata*	0–1	0–1
	Torrey's yucca	YUTO	*Yucca torreyi*	0–1	0–1
10	**Yucca-like plants**			20–58	

	green sotol	DALE2	*Dasylirion leiophyllum*	12–37	1
	lechuguilla	AGLE	*Agave lechuguilla*	7–19	1–2
	Texas sacahuista	NOTE	*Nolina texana*	0–1	0–2

Table 28. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm Season Midgrasses**			25–76	
	sideoats grama	BOCU	*Bouteloua curtipendula*	13–20	1–3
	slim tridens	TRMU	*Tridens muticus*	7–13	1–2
	purple threeawn	ARPU9	*Aristida purpurea*	7–13	1–2
	curlyleaf muhly	MUSE	*Muhlenbergia setifolia*	3–10	1
	sand dropseed	SPCR	*Sporobolus cryptandrus*	3–10	1
	plains lovegrass	ERIN	*Eragrostis intermedia*	0–1	0–1
2	**Warm Season Shortgrasses**			41–127	
	hairy grama	BOHI2	*Bouteloua hirsuta*	13–27	2–5
	black grama	BOER4	*Bouteloua eriopoda*	3–24	1–3
	hairy woollygrass	ERPI5	*Erioneuron pilosum*	7–20	1–2
	Hall's panicgrass	PAHA	*Panicum hallii*	7–20	1–2
	low woollygrass	DAPU7	*Dasyochloa pulchella*	7–20	1
	Carolina crabgrass	DIPU9	*Digitaria pubiflora*	3–10	1
	red grama	BOTR2	*Bouteloua trifida*	2–6	1
Forb					
3	**Perennial Forbs**			7–20	
	scarlet beeblossom	GACO5	*Gaura coccinea*	2–6	1
4	**Annual Forbs**			3–9	
	common sunflower	HEAN3	*Helianthus annuus*	3–9	1
Shrub/Vine					
5	**Shrubs**			67–202	
	whitethorn acacia	ACCO2	*Acacia constricta*	50–91	8–12
	mariola	PAIN2	*Parthenium incanum*	7–20	1–3
	catclaw mimosa	MIACB	*Mimosa aculeaticarpa var. biuncifera*	10–17	1–3
	Pinchot's juniper	JUPI	*Juniperus pinchotii*	7–13	1–3
	roundflower catclaw	ACRO	*Acacia roemeriana*	7–13	1–3
	resinbush	VIST	*Viguiera stenoloba*	3–10	1–2
	javelina bush	COER5	*Condalia ericoides*	2–6	1–2
	featherplume	DAFO	*Dalea formosa*	2–6	1–2
	algerita	MATR3	*Mahonia trifoliolata*	2–6	1
6	**Half-Shrubs**			0–1	
	dyssodia	DYSSO	*Dyssodia*	0–1	0–1
7	**Cactus**			17–50	
	purple pricklypear	OPMAM	*Opuntia macrocentra var. macrocentra*	7–13	1–2

	tulip pricklypear	OPPH	*Opuntia phaeacantha*	7–13	1–2
	cactus apple	OPEN3	*Opuntia engelmannii*	3–10	1–2
	tree cholla	CYIMI	*Cylindropuntia imbricata var. imbricata*	3–10	1–2
	ocotillo	FOSP2	*Fouquieria splendens*	0–1	0–1
8	**Yucca-like plants**			8–26	
	lechuguilla	AGLE	*Agave lechuguilla*	7–13	1–3
	green sotol	DALE2	*Dasylirion leiophyllum*	3–10	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 mezcal 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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Approval

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Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	05/06/2024
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:**

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

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

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

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

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

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

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

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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

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

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

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

17. **Perennial plant reproductive capability:**