USDA Natural Resources Conservation Service

Ecological site R042CY001NM
Shallow Limestone

Accessed: 07/17/2024

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 Shallow Limestone Ecological Site predominantly occurs in LRU 42.9, which is a subunit of MLRA 42 (Southern Desertic Basins, Plains, and Mountains)

It is possible, though very rare, that the Shallow Limestone 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: Shallow Limestone Ecological Site < LRU 42.9 Northeastern Chihuahuan Desert Mountains< 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: Shallow Limestone Ecological Site < Guadalupe Mountains Woodland Subsection < Sacramento-Monzano Mountains Section < Arizona-New Mexico Mountains Semi-Desert-Open Woodland-Coniferous Forest-Alpine Meadow Province (Cleland, et al., 2007).

EPA: Shallow Limestone Ecological Site<23b Madrean Lower Montane Woodlands<23 Arizona/New Mexico Mountains. (Griffith, 2006)

Ecological site concept

The Shallow Limestone Ecological Site is positioned across mountain tops, ridge tops, and mesa tops within LRU 42.9. Elevation ranges from 5500 to 7000 feet. Soil depth can range from very shallow to shallow (5-50cm) above limestone, dolomite, and calcareous sandstone. Depth is typically around 15-30 cm. Slopes vary from 1 to 25 percent, but are generally less than 15 percent. Aspect has very little effect on site dynamics.

Associated sites

R042CY901NM	**Very Shallow** The Shallow Limestone Site transitions into the Very Shallow below 5500 feet where a “thermic” soil temperature regime becomes evident.
R042CY002NM	**Limestone Mountains** This site has slopes > 25% and is situated on mountain flanks, adjacent to the Shallow Limestone Site.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Physiographic features

The Shallow Limestone Ecological Site is positioned across mountain tops, ridge tops, and mesa tops within LRU 42.9. Elevation ranges from 5500 to 7000 feet. Soil depth can range from very shallow to shallow (5-50cm) above limestone, dolomite, and calcareous sandstone. Depth is typically around 15-30 cm. Slopes vary from 1 to 25 percent, but are generally less than 15 percent. Aspect has very little effect on site dynamics.

The Shallow Limestone Ecological Site occurs on the crests and summits of mountains, ridges and mesas and is most closely associated with the Limestone Mountains Ecological Site, which occurs on mountain flanks with slopes of 25 percent and greater. The Shallow Limestone Site includes, on average, about 20 percent rock outcrop.

Geology: The primary geologic formations that make up the parent material for the Shallow Limestone Ecological Site include those of the Artesia Group: the Queen, Grayburg, Seven Rivers, Tansil, Yates, and to a lesser extent the Capitan Limestone Formations. 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 Artesia Group developed. The oldest of these formations, the Queen and Grayburg, make up the majority of the Guadalupe Mountains. Much of this geology consists of limestone, dolomite and calcareous sandstone.

Younger than the Queen and Grayburg, the sediments of the Seven Rivers deposited at a time when conditions became drier, and the basin tended toward hypersalinity. The Seven Rivers contain 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.

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 began to rise, creating the

Guadalupe Ridge and Mountains and exposing the Artesia Group. Over the years, at the mountain summit positions, much of the more clastic, layers have eroded away, leaving the very shallow soils with exposed dolomitic limestone and calcareous sandstone rock outcrop which is the makeup of the Shallow Limestone Ecological Site.

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

1. Site is within MLRA 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 on stream terraces and fan remnants. - Loamy Terrace ESD
2. Soils are skeletal (Greater than 35% rock fragments greater than 2 mm by volume)
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 fan remnant-Gravelly ESD
4. Site exists on steep slopes in 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).

Table 2. Representative physiographic features

Landforms	(1) Mountain (2) Plateau (3) Mesa
Flooding frequency	None
Elevation	5,500–7,000 ft

Slope	1–25%
Aspect	Aspect is not a significant factor

Climatic features

The mean annual precipitation is 13.2 inches to 20.1 inches, occurring mostly as high intensity, short-duration afternoon thunderstorms from July through September. Mean annual air temperature is 46 to 72 degrees F. The frost-free season is 212 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 Shallow Limestone 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, species composition, and richness 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 climatic 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 or 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, in1947-1957, 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)	245 days
Freeze-free period (average)	262 days
Precipitation total (average)	20 in

Influencing water features

The Shallow Limestone Ecological Site is not associated with a wetland or riparian systems; 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. To learn about the dynamic processes of the soil component, refer to the "plant communities" section of the ESD.

The Shallow Limestone Ecological Site is correlated to the Queen component of map units CC4 and QR1 within LRU 42.9. The CC4 and QR1 map units are very similar, each consisting of complexes of soil components which are dominated by about 75 percent Queen and similar soils, and 20 percent rock outcrop. These soils are formed in residuum from limestone, dolomite and calcareous sandstones, along with additions of eolian dust.

In normal years this soil is driest during May and June and moist in some part for more than 90 consecutive days during the growing season. The soil moisture regime is ustic bordering on aridic. The mean annual soil temperature: is 55 to 59 degrees F, which is classified as the mesic temperature regime.

This soil is well drained with negligible runoff and a saturated hydraulic conductivity ranging from 1.0 to 10

µm/second over impermeable bedrock. Queen's taxonomic class is: Loamy-skeletal, mixed, superactive, mesic Aridic Lithic Argiustolls. Due to its dark mollic horizon, it is believed that this soil developed under a grassland plant community.

TYPICAL PEDON: Queen very stony silty clay loam - savanna. (Colors are for dry soil unless otherwise noted.)

A--0 to 3 inches (0 to 8 cm); very dark gray (5YR 3/1) cobbly silt loam, black (5YR 2.5/1), moist; 25 percent clay; weak medium subangular blocky parts to coarse granular structure; slightly hard, very friable, slightly sticky, slightly plastic; common very fine roots and common fine roots; common very fine interstitial pores; 15 percent gravel and 10 percent cobble; noneffervescent, 1 percent calcium carbonate equivalent; slightly alkaline, pH 7.4.

Bt--3 to 8.5 inches (8 to 22 cm); very dark gray (5YR 3/1) cobbly silty clay loam, black (5YR 2.5/1), moist; 34 percent clay; moderate medium subangular blocky structure; very hard, friable, moderately sticky, moderately plastic; few medium roots and few coarse roots and common very fine roots and common fine roots; common very fine interstitial pores; common distinct clay films on vertical faces of peds; 10 percent gravel and 5 percent cobble; slightly effervescent, 4 percent calcium carbonate equivalent; moderately alkaline, pH 7.9; clear smooth boundary.

Btk--8.5 to 17.5 inches (22 to 44 cm); reddish brown (5YR 4/3) very cobbly clay loam, dark reddish brown (5YR 3/3), moist; 31 percent clay; moderate medium subangular blocky structure; hard, friable, moderately sticky, moderately plastic; common very fine roots and few fine roots; common very fine interstitial pores; common distinct clay films on faces of peds; common fine and medium distinct irregular carbonate masses throughout; 40 percent gravel and 20 percent cobble; strongly effervescent, 26 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; abrupt wavy boundary.

R--17.5 to 78.5 inches (44 to 200 cm); indurated limestone or dolomite bedrock.

TYPE LOCATION: Eddy County, New Mexico within Carlsbad Caverns National Park; 110 feet south of the Yucca trail, USGS Gunsight 7.5 minute topographic quadrangle, NE quarter; UTM zone 13S 3550248 N 533735 W

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

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

Typical Subsurface Fragments <=3" (% Volume): 15-30%

Typical Subsurface Fragments > 3" (%% Volume): 15-25%

Typical Soil Depth: 20-40 cm

Calcium Carbonate Equivalent (percent):
A horizons-0 to 2
Bt horizon-1 to 6
Btk- 5 to 25

Total average available water capacity: 4.09 cm H2O/cm soil.

Figure 4. Queen Component

Table 4. Representative soil features

Parent material	(1) Eolian deposits–dolomite (2) Residuum–limestone and sandstone
Surface texture	(1) Gravelly loam (2) Cobbly silty clay loam
Family particle size	(1) Loamy
Drainage class	Moderately well drained to well drained
Permeability class	Slow to moderate
Soil depth	1–20 in
Surface fragment cover <=3"	20–30%
Surface fragment cover >3"	18–33%
Available water capacity (0-40in)	1–2 in
Calcium carbonate equivalent (0-40in)	0–25%
Electrical conductivity (0-40in)	0 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	6.9–8.2
Subsurface fragment volume <=3" (Depth not specified)	15–30%
Subsurface fragment volume >3" (Depth not specified)	13–30%

Ecological dynamics

The Shallow Limestone Ecological Site contains a mix of grass, shrubs, trees, forbs, and succulents. It is often dry due to its very shallow depth and exposure to many dry, windy days. Overall, this site is a grassland/shrub savannah with scattered juniper, pinon, and ponderosa pine. As typical with desert communities, wet springs and summers can lead to 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 5500 feet) the climate is warmest and driest, and tends to promote more succulents and less trees. Succulents that are prominent include: slimfooted agave, sotol, sacahuista, and various cacti. As elevation increases, toward the upper extreme, (at about 7000 feet), cool season grasses become more abundant and more shrub and tree species populate the landscape. Above 7000 feet on this landform, this site transitions into the MLRA 39 Ponderosa Pine-Gambel Oak Ecological site. Below 5500 feet this site transitions into the 42.8 Very Shallow Ecological 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 resources. Species such as blue grama and silver bluestem prefer somewhat deeper soils, while curly leaf muhly and slimfooted agave prefer shallower 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). The number and depth of cracks and fissures influences vegetative production and species composition. For instance, sotol will increase in dominance where higher fracturing is evident.

Fire is a consistent disturbance regime that suppresses succulents and some 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 (Gebow, 2001)”. Fire researchers in the area and region suggest a 10-to-15-year fire regime is common.

Small fires occurred with greater frequency before the mid-1800’s, with the Apache likely responsible for many small burns. Since 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 habitat for many wildlife 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 plants which were used to meet many human needs. Ancient mezcal pits still exist where plants, such as sotol and mezcal were cooked in the ground as an important food source. When Europeans arrived, they created change by introducing livestock and building infrastructure.

State and transition model

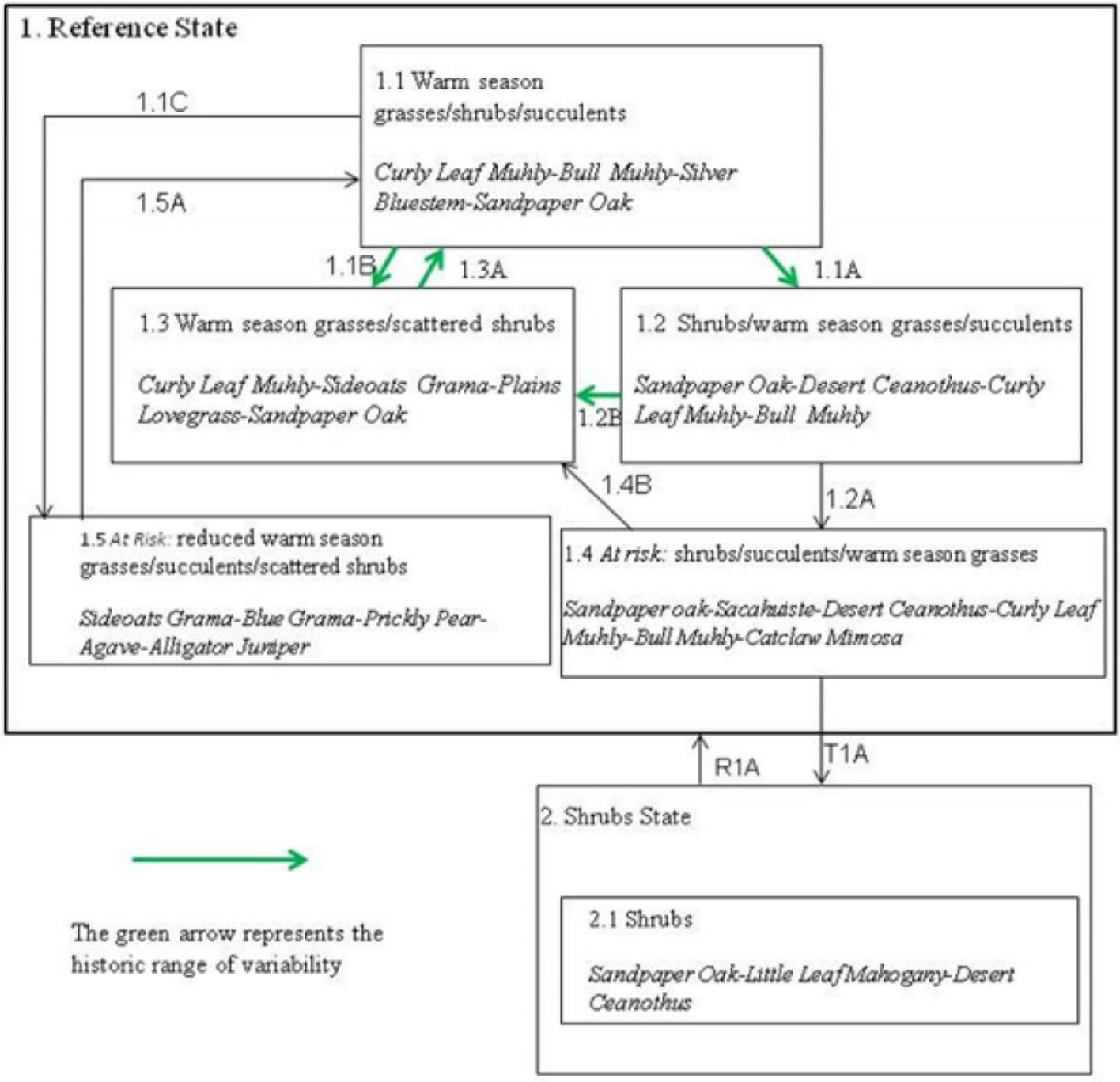


Figure 5. Shallow Limestone State and Transition Model

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 suppress grass production and percent composition. 1.1B Community Pathway: This pathway represents fire. Fire sets back succulents and many shrubs, giving grasses a competitive advantage. 1.1C Community Pathway: This pathway represents intensive, season long browsing and grazing, decreasing rangeland health. 1.2 Shrubs/warm season grasses/succulents: Over time, foliar cover of shrubs and succulents increases and that of warm season grasses decreases. 1.2A 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 some shrubs, giving grasses a competitive advantage. 1.3 Warm season grasses/scattered shrubs: This plant phase exists after fire. Grasses respond well to fire, while many shrubs and succulents are suppressed. 1.3A Community Pathway: This pathway represents intervals between fires where natural processes increases shrub and succulent vigor and decreases grass production and composition. 1.4 At risk: shrubs/succulents/warm season grasses: Due to gradual changes in hydrologic function and soil chemistry, shrubs and succulents increase over time. Fire suppression has pushed this community beyond the historic range of variability. 1.4B Community Pathway: This pathway represents a decrease in shrubs and an increase in grasses, through either anthropogenic or natural processes. T1A Transition one: Slow variables: Continued increase of shrubs due to fire suppression, coupled with the loss of grasses due to a decrease in soil organic matter, leading to a decrease in plant available water. Trigger events: A severe drought, or a severe wildfire causing a loss of organic carbon. Threshold: A hydrologic function threshold is crossed. 1.5 At risk: reduced warm season grasses/succulents/ scattered shrubs: This plant community is a departure from the historic range of variability because of excessive browsing and grazing. Foliar cover is less than 50 percent. 1.5A Community Pathway: This pathway represents a long, slow passage of time coupled with the end of excessive defoliation of shrubs and grasses. Slowly, range health improves and the plant community moves back into the historic range of variability. 2.0 Shrub State 2.1 Shrubs: Very few grasses exist as the bulk of the foliar cover is made of shrubs. R1A Restoration Process: An increase in the competitive advantage of grasses through physical, chemical, and biological management practices.

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

Figure 6. Community 1.1; Gunsight Ridge; 6750 feet; USFS; 12

This community phase combines a mix of warm season grasses, shrubs and succulents. Foliar cover is between 70 and 80 percent; basal cover is between 15 and 20 percent; and bare ground is around 5 percent. Warm season grasses make up about 40 percent foliar cover, shrubs, 25 percent; and succulents, 10 percent. The average surface soil stability rating (Herrick, Whiteford, De Soyza, Van Zee, Havstad, Seybokd, Walton, 2001), is 5 under canopy and 4.8 in the interspaces. Annual production averages around 1200 lbs/ac, but can span between 800 and 1600 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 5-7 years after low intensity fire. Curly leaf muhly is the dominant grass while bull muhly and sideoats grama are present at all elevations. At the upper elevation of this site, cool season grasses such as muttongrass and Arizona fescue begin to appear. Oaks are the dominant shrub through all elevations. At the lower elevations: sandpaper oak, desert scrub oak and mohr shin oak dominate the site. In the upper elevations: Gambel oak, gray oak, and wavy leaf oak often dominates the shrubs. A few scattered trees dot the landscape, especially alligator juniper, pinon pine, ponderosa pine, and Texas Madrone. This plant community phase optimizes energy flow, hydrologic function and nutrient cycling. The diversity of root systems takes 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 vigor.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	440	660	880
Shrub/Vine	320	480	640
Forb	40	60	80
Total	**800**	**1200**	**1600**

Table 6. Ground cover

Tree foliar cover	2-6%
Shrub/vine/liana foliar cover	30-40%
Grass/grasslike foliar cover	35-45%
Forb foliar cover	2-4%
Non-vascular plants	1%
Biological crusts	1-3%
Litter	65-75%
Surface fragments >0.25" and <=3"	20-30%
Surface fragments >3"	15-25%
Bedrock	15-25%
Water	0%
Bare ground	3-7%

Table 7. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	0%	1-3%	5-15%	1-3%
>0.5 <= 1	1-3%	2-4%	10-20%	1-2%
>1 <= 2	1-3%	6-10%	5-15%	–
>2 <= 4.5	1-3%	13-21%	3-7%	–
>4.5 <= 13	2-4%	3-7%	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Figure 8. Plant community growth curve (percent production by month). NM4271, Shallow Limestone Reference State.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	5	7	10	15	25	25	8	5	0	0

Community 1.2
Shrubs/warm season grasses/succulents

Figure 9. Community 1.2; Wilderness Ridge; Guadalupe Mountai

This community combines a mix of shrubs, warm season grasses, and succulents. Foliar cover is between 70 and 80 percent; basal cover is between 15 and 20 percent; and bare ground is around 1 to 4 percent. Warm season grasses make up about 25 percent foliar cover; shrubs, 35 percent; succulents, 10 percent; and trees 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 700 and 1500 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 throughout all elevations. Bull muhly and sideoats grama are also quite prevalent. Various oaks, including sandpaper oak, mohr shin oak, Gambel oak, wavy leaf oak, desert scrub oak, and grey oak, are often quite thick in this phase. Other abundant shrubs include: desert ceanothus, shaggy mountain mahogany, and lotebush. Abundant succulents include: sacahuista, sotol, banana yucca, and slimfooted agave. Parry's agave (mescal) and alligator juniper are scattered across the plant community. 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 the grasses for water and nutrients. As shrubs increase, energy flow begins to lessen, and fine-root turnover decreases, causing a decrease in labile carbon and soil organic matter. Fire is a natural event that keeps shrub species from gaining a competitive advantage and stimulates colonization by grasses.

Community 1.3
Warm season grasses/scattered shrubs

Figure 10. Community 1.3; Guadalupe Ridge; USFS; 6250 feet; 5

This community phase consists of a mix of warm season grasses, shrubs, and succulents. This plant phase exists shortly after fire has recently burned the site reducing 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 and if adequate precipitation has followed. Basal cover is between 15 and 30 percent, and bare ground is around 3 to 6 percent. Warm season grasses make up about 45 percent foliar cover, shrubs, 20 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 1300 lbs/ac, but can span between 800 and 1800 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. Curly leaf muhly is the dominant grass across elevations, followed by sideoats grama, plains lovegrass, and bull muhly. Oak species re-sprout quickly after fire and make up large portions of the plant community. Forbs such as desert verbena may flourish after fire. This plant community is the ecological site's response to fire within the reference state. Fire is a natural event that keeps shrub species from gaining a competitive advantage and stimulates colonization by grasses. Following fire, labile carbon increases, creating more soil organic matter which improves aggregate stability and eventually increases plant available water.

Community 1.4
At risk: shrubs/succulents/warm season grasses

Figure 11. Community 1.4; Guadalupe Ridge; USFS; 6067 feet; 8

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, but 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 50 and 70 percent, basal cover is between 10 and 20 percent, and bare ground is around 2 to 10 percent. Warm season grasses make up about 17 percent foliar cover; shrubs, 30 percent; and succulents, 13 percent. The average surface soil stability rating is 5 under canopy and 4.5 in the interspaces. Annual production averages around 900 lbs/ac, but can span between 500 and 1300 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 a historical corridor for livestock travel as well as for sheep and goats to use as bedding grounds. More short, warm season grasses tend to occur in this community phase along with a small percentage of nitrogen fixing shrubs such as catclaw acacia and catclaw mimosa. 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 resulting 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 leading to the establishment of this community is the loose management of herbivory over many years. Livestock contribute to the distribution of seed from nitrogen fixing shrubs and grazing can lessen grass and forb vigor. As the vigor of grasses and forbs decreases, shrubs, succulents and nitrogen fixing plants start to increase, and begin to change the chemistry and hydrology of the site. This site is "at risk" of crossing a threshold into state two.

Community 1.5
At risk: reduced warm season grasses/succulents/ scattered shrubs

Figure 12. Community 1.5; Yucca Mesa; 6030 feet; CCNP; 3-21-1

This community phase combines a mix of warm season grasses, succulents, and a few scattered shrubs. This plant phase exists from repeated and continued grazing and browsing by both sheep and goats. Grasses and shrubs have become depleted, leaving succulents such as prickly pear and slimfooted agave able to spread. Foliar cover is between 40 and 60 percent, basal cover is between 4 and 8 percent, and bare ground is around 4 to 8 percent. Warm season grasses make up about 35 percent foliar cover; succulents, 10 percent; and shrubs, 5 percent. The average surface soil stability rating is 4.5 under canopy and 4.0 in the interspaces. Annual production averages around 550 lbs/ac, but can span between 300 and 700 lbs/ac, depending on the percentage of rock outcrop, cracks and fissures in the bedrock, soil depth and annual weather patterns. In the case of Yucca Mesa, this community is slowly recovering from overuse in the early to mid 20th century. At one time this site had probably crossed a threshold where soil organic matter, aggregate stability and plant available water had all decreased substantially. It has taken over 40 years for the site to work its way back to an “at risk” plant community. Eventually, we think, this area will once again be functioning within the historic range of variability. Succulents such as prickly pear, sacahuista, and various agaves are greatly enhanced in this plant community. Sideoats grama seems to be the main grass that re-colonizes the quickest. Trees, such as alligator juniper and pinon pine also increase on this site due to the lack of fuel needed to carry fire. Shrubs are greatly suppressed.

Pathway 1.1A
Community 1.1 to 1.2

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

Shrubs/warm season grasses/succulents

This pathway is the slow movement, from Community 1.1 to Community 1.2. This pathway represents intervals between fires within the historic range of variability. It will take 10 to 14 years after fire for shrubs and succulents to achieve foliar cover > 30%. The vigor of shrubs and succulents increases as grass vigor decreases due to various ecological processes. One such process is through direct competition for resources. In the absence of fire, shrubs are at a competitive advantage due to their greater access to moisture deep in cracks and fissures within the bedrock strata. Another process is the slow decrease in labile carbon, thus decreasing soil organic matter. This, in turn leads to a decrease in water-holding capacity and a resulting suppression 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 historic range of variability. Many shrubs and succulents take a while to respond after a fire event. They must either re-grow from root systems or else come back from seed. Grasses can colonize quickly via tillering, especially when precipitation follows closely after fire.

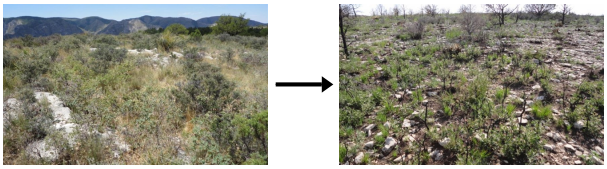
Pathway 1.1C
Community 1.1 to 1.5

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

At risk: reduced warm season grasses/succulents/ scattered shrubs

This pathway represents intensive, season long browsing and grazing, which diminishes rangeland health. Fine root turnover, labile carbon, soil organic matter, aggregate stability and infiltration all decrease, causing a decrease in the vigor of both shrubs and grasses 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. big bluestem does not occur at 5500 feet)

Pathway 1.2B
Community 1.2 to 1.3



Shrubs/warm season grasses/succulents

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 either re-grow from root systems or else come back from seed. Grasses colonize quickly after a fire event through tillering, especially when precipitation follows closely after fire.

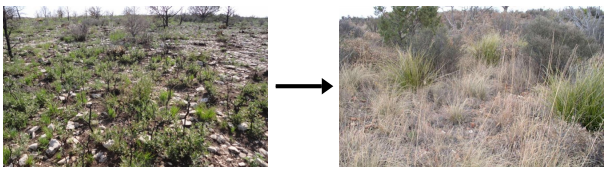
Pathway 1.2A
Community 1.2 to 1.4

Shrubs/warm season grasses/succulents

At risk: shrubs/succulents/warm season grasses

This pathway is the slow movement from Community 1.2 to 1.4. This pathway represents an interval between fires which has exceeded the historic range of variability. The vigor of shrubs and succulents increases as grass vigor decreases due to various ecological processes. One such process is through direct competition for resources. In the absence of fire, shrubs are at a competitive advantage due to their greater access to moisture deep in cracks and fissures within the bedrock strata. Also, grass vigor diminishes because of a slow decrease in labile carbon. This, in turn, reduces soil organic matter and leads to a decrease in plant available water.

Pathway 1.3A
Community 1.3 to 1.1

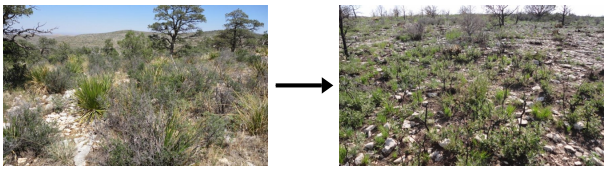


Warm season grasses/scattered shrubs

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

This pathway is the slow movement from Community 1.3 to 1.1. This pathway represents an interval between fires, during which natural processes increase shrub and succulent vigor and decrease grass species production and composition. The vigor of shrubs and succulents increases as grass vigor decreases due to various ecological processes. One such process is through direct competition for resources. Shrubs have greater access to moisture deep in cracks and fissures within the bedrock strata. Another is a slow decrease in organic matter by a diminishing bank of labile carbon which eventually leads to a decrease in plant available water and ultimately grass vigor.

Pathway 1.4B
Community 1.4 to 1.3



At risk: shrubs/succulents/warm season grasses

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 1.5A
Community 1.5 to 1.1

At risk: reduced warm season grasses/succulents/ scattered shrubs

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

This pathway is the slow movement from Community 1.5 to 1.1. This pathway represents time where natural

processes increase shrub and grass vigor.

State 2
Shrub State

Very few grasses exist as the bulk of the foliar cover is made of shrubs.

Community 2.1
Very few grasses exist as the bulk of the foliar cover is made of shrubs.

Figure 13. Community 2.0;Lonesome Ridge; 6600 feet; BLM; 4-15

This community phase consists of a mix of shrubs, succulents and warm season grasses. 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 500 lbs/ac, but can span between 300 and 700 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. Continuous, season-long grazing by livestock can exasperate the situation by decreasing grass vigor due to lesser herbaceous cover, soil organic matter, and plant available water. As grass vigor decreases, shrubs gain a competitive advantage, creating a change in the hydrology of the system.

Transition T1A
State 1 to 2

Slow variables: Continued increase of shrubs due to fire suppression, coupled with the loss of grasses due to a decrease in soil organic matter, leading to diminished plant available water. Trigger events: A severe drought, or a severe wildfire causing a loss of grasses and organic carbon. Threshold: A hydrologic function threshold is crossed.

Restoration pathway R1A
State 2 to 1

An increase in the competitive advantage of grass 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 reduce shrubs. Also, range seeding, winter feeding, and high intensity-short duration livestock grazing can help bring grass and organic matter back into

the system while restoring soil carbon and microbial levels. Eventually, once fuel loads are adequate, prescribed burning will help reduce shrub competition and improve grass vigor. Monitoring foliar cover by species will help inform the land manager if plant species composition is responding to management.

Additional community tables

Table 8. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm Season Tallgrasses**			80–160	
	silver beardgrass	BOLA2	*Bothriochloa laguroides*	24–96	1–9
	little bluestem	SCSC	*Schizachyrium scoparium*	24–48	1–3
	big bluestem	ANGE	*Andropogon gerardii*	0–48	0–2
2	**Warm Season Midgrasses**			240–480	
	curlyleaf muhly	MUSE	*Muhlenbergia setifolia*	48–168	2–12
	bullgrass	MUEM	*Muhlenbergia emersleyi*	36–132	2–8
	sideoats grama	BOCU	*Bouteloua curtipendula*	24–96	2–6
	plains lovegrass	ERIN	*Eragrostis intermedia*	12–60	1–3
	purple threeawn	ARPU9	*Aristida purpurea*	12–60	1–3
	New Mexico muhly	MUPA2	*Muhlenbergia pauciflora*	1–48	1–2
	slim tridens	TRMU	*Tridens muticus*	1–14	1
	Mexican muhly	MUME2	*Muhlenbergia mexicana*	0–1	0–1
	mountain muhly	MUMO	*Muhlenbergia montana*	0–1	0–1
	green sprangletop	LEDU	*Leptochloa dubia*	0–1	0–1
	pine muhly	MUDU	*Muhlenbergia dubia*	0–1	0–1
3	**Warm Season Shortgrasses**			64–128	
	blue grama	BOGR2	*Bouteloua gracilis*	12–84	1–5
	hairy grama	BOHI2	*Bouteloua hirsuta*	12–84	1–5
	common wolfstail	LYPH	*Lycurus phleoides*	0–24	0–2
	sixweeks threeawn	ARAD	*Aristida adscensionis*	0–1	0–1
	black grama	BOER4	*Bouteloua eriopoda*	0–1	0–1
4	**Cool-season Tallgrasses**			32–64	
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	24–72	1–5
	needle and thread	HECO26	*Hesperostipa comata*	0–1	0–1
5	**Cool-season Midgrasses**			16–32	
	Arizona fescue	FEAR2	*Festuca arizonica*	0–24	0–2
	muttongrass	POFE	*Poa fendleriana*	0–24	0–2
Forb					
6	**Perennial Forbs**			32–64	
	Davis Mountain mock vervain	GLBIC	*Glandularia bipinnatifida var. ciliata*	0–24	1–2
	Fendler's bladderpod	LEFE	*Lesquerella fendleri*	0–1	0–1
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–1	0–1
	nodding onion	ALCE2	*Allium cernuum*	0–1	0–1
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–1	0–1

	hawkweed buckwheat	ERHI3	*Eriogonum hieraciifolium*	0–1	0–1
7	**Annual Forbs**			8–24	
	common sunflower	HEAN3	*Helianthus annuus*	0–1	0–1
Shrub/Vine					
8	**Shrubs**			184–368	
	pungent oak	QUPU	*Quercus pungens*	12–156	2–12
	hairy mountain mahogany	CEMOP	*Cercocarpus montanus var. paucidentatus*	24–72	2–4
	skunkbush sumac	RHTRT	*Rhus trilobata var. trilobata*	12–60	2–4
		QUPA4	*Quercus ×pauciloba*	0–48	0–6
	desert ceanothus	CEGR	*Ceanothus greggii*	12–36	1–5
	Gambel oak	QUGA	*Quercus gambelii*	0–24	0–4
	gray oak	QUGR3	*Quercus grisea*	0–24	0–4
	Mohr oak	QUMO	*Quercus mohriana*	0–24	0–4
	Sonoran scrub oak	QUTU2	*Quercus turbinella*	0–24	0–4
	New Mexico locust	RONE	*Robinia neomexicana*	0–1	0–1
	resinbush	VIST	*Viguiera stenoloba*	0–1	0–1
	catclaw mimosa	MIACB	*Mimosa aculeaticarpa var. biuncifera*	0–1	0–1
9	**Half-Shrubs**			16–48	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–48	0–2
	dyssodia	DYSSO	*Dyssodia*	0–1	0–1
10	**Cactus**			32–64	
	purple pricklypear	OPMAM	*Opuntia macrocentra var. macrocentra*	0–72	0–2
	tree cholla	CYIMI	*Cylindropuntia imbricata var. imbricata*	0–24	0–1
	rainbow cactus	ECPE	*Echinocereus pectinatus*	0–1	0–1
	tulip pricklypear	OPPH	*Opuntia phaeacantha*	0–1	0–1
11	**Yucca**			6–18	
	banana yucca	YUBA	*Yucca baccata*	6–18	1–2
12	**Yucca-like plants**			64–128	
	green sotol	DALE2	*Dasylirion leiophyllum*	0–48	0–4
	sacahuista	NOMI	*Nolina microcarpa*	0–48	0–4
	Texas sacahuista	NOTE	*Nolina texana*	0–48	0–4
	slimfoot century plant	AGGR4	*Agave gracilipes*	0–24	0–3
	Parry's agave	AGPAN6	*Agave parryi ssp. neomexicana*	6–18	1–2
Tree					
13	**Trees**			40–80	
	alligator juniper	JUDE2	*Juniperus deppeana*	12–60	2–5
	oneseed juniper	JUMO	*Juniperus monosperma*	0–24	0–2
	twoneedle pinyon	PIED	*Pinus edulis*	0–24	0–2
	ponderosa pine	PIPO	*Pinus ponderosa*	0–1	0–1
	Texas madrone	ARXA80	*Arbutus xalapensis*	0–1	0–1

Animal community

Part I: Wildlife

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

Species of Special Interest:

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

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

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

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

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

Peregrine Falcon: The Peregrine Falcon is a species 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 reaction, it is believed that skunks may feed extensively on rattlesnakes. In search of food, this skunk 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 Shallow Limestone and Limestone Mountains 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 bundle 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)
Elk
Ringtail
Black Bear
Raccoon

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 thought about re-introducing the desert bighorn, but this will never happen unless the population of Barbary sheep can be reduced.

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

Part II Livestock

The Shallow Limestone 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 Shallow Limestone Ecological Site could be managed for sustained agriculture while maintaining the historic range of variability

Hydrological functions

The Queen soil component is in hydrologic group “D”; as are all soils that have a depth to impenetrable layer of less than 50 cm. Runoff from this site is extremely uncommon because the soil is highly permeable and well drained. During extremely heavy rain events, once the soil is saturated, surface sheet flow can 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 for infiltration and organic matter for 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 stored water helps keep plants alive through dry periods.

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

Recreational uses

The shallow limestone 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, as it occurs on summit positions and provides 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 mescal 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 was used as well.

Type locality

Location 1: Eddy County, NM	
UTM zone	N
UTM northing	3550248
UTM easting	533735
General legal description	Yucca Mesa would be a type locality for state 1.5.

Other references

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Contributors

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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	
Approved by	
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:

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

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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:

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

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

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

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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:**
