USDA Natural Resources
Conservation Service

Ecological site R040XD004CA
Hyper-Arid Hill 2-4" p.z.

Last updated: 3/11/2025
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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 040X–Sonoran Basin and Range

MLRA Description:
Major land resource area (MLRA) 31 is the Lower Colorado Desert. This area is in the extreme southeastern part of California, in areas along the Colorado River, and in Western Arizona. The area is comprised of rough, barren, steep, and strongly dissected mountain ranges, generally northwest to southwest trending that are separated by intermontane basins. Elevation ranges from approximately 275 feet below sea level at the lowest point in the Salton Trough to 2700 feet along low northwest to southeast trending mountain ranges. The average annual precipitation is 2 to 6 inches with high temporal and spatial variability. Winter temperatures are mild, summer temperatures are hot, and seasonal and diurnal temperature fluctuations are large. Monthly minimum temperature averages range from 40 to 80 degrees F (4 to 27 degrees C). Monthly maximum temperature averages range from 65 to 110 degrees F (18 to 43 degrees C) (WRCC 2002). Temperatures are rarely below 28 degrees F, and extremely rarely fall below 24 degrees F. Precipitation is bimodal, with approximately 20 to 40 percent of annual precipitation falling between July and September. This summer rainfall, in combination with very hot temperatures and very few to no days of hard freeze are what characterize this MLRA and distinguish it from the Mojave Desert (MLRA 30).

XD LRU concept:

The XD LRU is an extremely hot and dry portion of the MLRA. Mean annual precipitation is about 4 inches or less where the majority of the precipitation can arrive in only a couple storm events during any given year. The very few hard freezing days allows this region to have Plant Hardiness Zones of 9b or warmer. This LRU covers most of the Lower Colorado Desert except elevations above 500 m where Plant Hardiness Zones are less than 9b.

Classification relationships

Mojave Creosote Bush (Holland, 1986).
Larrea tridentata Shrubland Alliance (Sawyer et al. 2009).

Ecological site concept

This ecological site occurs on sideslopes of fan remnants and hills at elevations of 460 to 1800 feet. Soils are typically very deep but may be moderately deep over a duripan, or very shallow over bedrock on hills. The most important abiotic factors driving this site are a very dry climate with hyperthermic soil temperatures, steep slopes and rocky soils with low moisture holding capacity.

Production reference value (RV) is 75 pounds per acre with a range from 25 to 125 pounds per acre. The extreme aridity of this site restricts the potential vegetation to a very sparse, widely spaced creosote bush community with annual forbs contributing 50 to 80 percent of annual production during average to above average precipitation conditions.

Data ranges in the physiographic data, climate data, water features, and soil data sections of this Ecological Site Description are based on major components only (15 percent of map unit or greater).

Associated sites

R040XD010CA	**Valley Wash** This ephemeral stream occurs in the broad drainageways with large frequent flood events. Desert willow and blue paloverde are present.
R040XD015CA	**Limy 4-6" p.z.** This ecological site is on fan aprons and fan remnants with creosote bush and burrobush.
R040XD017CA	**Steep Granitic Slope 4-6" p.z.** This ecological site occurs on hills with burrobush, teddybear cholla, creosote bush, and a mix of other species.
R040XD021CA	**Very Gravelly Wash** This small ephemeral stream occurs on interfluves and inset fans among desert pavement surfaces.
R040XD001CA	**Limy Hill 4-6" p.z.** This ecological site is on north facing hills and sideslopes of fan remnants. Burrobush and creosote bush dominate.

Similar sites

R030XD004CA	**Low-Production Hyperthermic Hills** This ecological site is similar but occurs in the Mojave Desert and has higher production.
R040XD001CA	**Limy Hill 4-6" p.z.** This site is higher producing with a significant burrobush component. This site is typically found on north-facing slopes.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Larrea tridentata*
Herbaceous	(1) *Plantago ovata* (2) *Eriogonum deflexum*

Physiographic features

This ecological site occurs on sideslopes of fan remnants and hills. Slopes range from 8 to 75 percent, but are typically between 8 and 30 percent. Elevations range from 460 to 1800 feet.

Table 2. Representative physiographic features

Landforms	(1) Fan remnant (2) Hill
Elevation	140–549 m
Slope	8–75%
Aspect	Aspect is not a significant factor

Climatic features

The Colorado Desert of California represents the northwestern most portion of the Sonora Desert. The subtropical Colorado Desert results from the descent of cold air which is heated by compression and arrives hot and dry at the earth's surface. Precipitation is frontal in nature during the winter and convectional in the summer. Reduced summer rainfall and high potential evapotranspiration make the Colorado Desert one of the most arid regions in North America. Summer temperatures frequently exceed 105 degrees F. The average annual precipitation ranges from 2 to 6 inches with most falling as rain. Snowfall is rare. Approximately 35% of annual precipitation occurs from

July to September as a result of intense convection storms. Spring months are the windiest.

Table 3. Representative climatic features

Frost-free period (average)	365 days
Freeze-free period (average)	365 days
Precipitation total (average)	152 mm

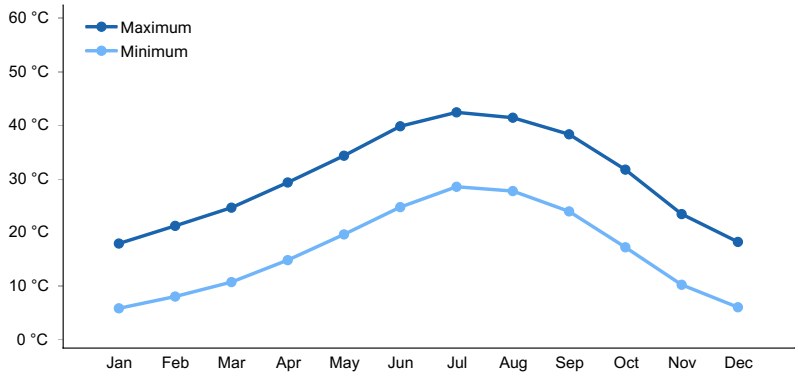

Figure 1. Monthly average minimum and maximum temperature

Influencing water features

Soil features

The soils associated with this ecological site typically very deep, but can also be moderately deep over a duripan or very shallow over bedrock. These soils have formed in alluvium from basalt, rhyolite, igneous rock or mixed sources. This site is also associated with soils formed in colluvium and/or residuum from andesite or basalt (Sunrock soils). These soils are primarily sandy-skeletal, but may also be loamy skeletal in the particle size control section. Surface textures include very gravelly fine sandy loam, very gravelly sandy loam, very gravelly loamy sand, very cobbly fine sandy loam, and very to extremely cobbly fine sandy loam. Subsurface textures are sandy to loamy with very or extremely gravelly modifiers. Surface gravels (< 3 mm in diameter) range from 40 to 85 percent, and larger fragments range from 1 to 30 percent. Subsurface gravels by volume (for a depth of 1 to 59 inches) range from 10 to 70 percent and larger fragments by volume range from 0 to 25 percent.

This ecological site is associated with the following major soil components: Cheme family (loamy-skeletal, mixed, superactive, hyperthermic, shallow Typic Haplodurids), Emptygun (sandy-skeletal, mixed, hyperthermic Typic Haplocalcids), Rizzo soils (sandy-skeletal, mixed, hyperthermic Typic Torriorthents), and Sunrock (loamy-skeletal, mixed, superactive, calcareous, hyperthermic Lithic Torriorthents).

Minor components (not listed above) associated with this ecological site include: Goldroad (loamy-skeletal, mixed, superactive, calcareous, hyperthermic Lithic Torriorthents), Deprave (loamy-skeletal, mixed, superactive, hyperthermic Argidic Argidurids), and Sodic Haplocambids (sandy, mixed, hyperthermic Sodic Haplocambids).

NOTE: The Goldrose and Sunrock soils are improperly linked with the (CA803) Chemehuevi Wash OHV area. They are MLRA 30 (Mojave Desert) soils that need to be reviewed and developed as MLRA 31 soils (Colorado Desert).

This ecological site is correlated with the following map units and soil components in the Colorado Desert Soil Survey Area (CA803):

Mapunit; Mapunit name; Component; Phase; Percent
2090;Deprave-Rockhound-Rizzo complex, 2 to 4 percent slopes;Deprave;moderately steep;2
1200;Goldroad very gravelly sandy loam, 15 to 50 percent slopes;Emptygun;;10 and Goldroad;;3
1210;Stormjade-Goldroad complex, 8 to 50 percent slopes;Lithic Torriorthents;;7
1400;Sunrock complex, 8 to 50 percent slopes;Sunrock;dry;60
1401;Sunrock-Cheme family association, 8 to 50 percent slopes;Sunrock;cobbly;45 and Sunrock;dry;6 and

Emptygun;Strongly sloping;8
1403;Sunrock-Emptygun-Rock outcrop association, 8 to 50 percent slopes;Emptygun;;25
1500;Rizzo extremely gravelly fine sandy loam, 2 to 8 percent slopes;Emptygun;;2
1501;Rizzo gravelly loamy sand, 30 to 75 percent slopes;Rizzo;steep;85
1502;Rizzo-Lithic Torriorthents-Emptygun association, 8 to 75 percent slopes; Rizzo;steep; 40 and Emptygun;; 20
1506;Rizzo extremely gravelly loamy sand, 2 to 8 percent slopes;Emptygun;;2
2000;Emptygun very gravelly fine sandy loam, 8 to 30 percent slopes;Emptygun;;85
2001;Emptygun-Chemehuevi association, 2 to 30 percent slopes;Emptygun;;55
2002;Emptygun association, 8 to 60 percent slopes;Emptygun;steep; 65 and Emptygun;;20
2003;Emptygun-Havasulake association, 0 to 50 percent slopes;Emptygun;;60
2010;Chemehuevi-Rizzo-Emptygun complex, 2 to 30 percent slopes;Emptygun;;20 and Rizzo; steep;2
2011;Havasulake gravelly silt loam, 1 to 4 percent slopes;Emptygun;;3
2012;Havasulake gravelly sandy loam, 1 to 4 percent slopes;Emptygun;;3
2020;Snaggletooth-Rizzo association, 1 to 8 percent slopes;Emptygun;Moderately sloping;5
2031;Garywash-Chemehuevi complex, 2 to 8 percent slopes;Emptygun;;3
2050;Havasulake-Rizzo association, 1 to 8 percent slopes;Emptygun;;3
2056;Catfishbay loamy fine sand, 4 to 15 percent slopes;Emptygun;;4
2003;Emptygun-Havasulake association, 0 to 50 percent slopes;Sodic Haplocambids;;4
2400;Rizzo-Chemwash association, 2 to 8 percent slopes;Emptygun;;3 and Rizzo; steep;5
2401;Rizzo-Chemwash association, eroded, 2 to 8 percent slopes;Rizzo;steep;4
2415;Rizzo association, dry, 2 to 4 percent slopes;Emptygun;Moderately sloping;5
2416;Rizzo very gravelly loam, 2 to 8 percent slopes;Emptygun;;3

This ecological site is correlated with the following map units and soil components in the Joshua Tree National Park Soil Survey (CA794):

Mapunit; Mapunit name; Component; Phase; Percent
2090;Deprave-Rockhound-Rizzo complex, 2 to 4 percent slopes;Deprave;moderately steep;2
2403;Rizzo-Rizzo, occasionally flooded complex, 2 to 8 percent slopes;Rizzo;;2

Table 4. Representative soil features

Parent material	(1) Alluvium–granite (2) Colluvium–basalt (3) Residuum–rhyolite
Surface texture	(1) Very gravelly fine sandy loam (2) Very gravelly sandy loam (3) Very cobbly fine sandy loam
Family particle size	(1) Sandy
Drainage class	Well drained to excessively drained
Permeability class	Slow to moderately rapid
Soil depth	10 cm
Surface fragment cover <=3"	40–85%
Surface fragment cover >3"	1–30%
Available water capacity (0-101.6cm)	0.76–6.86 cm
Calcium carbonate equivalent (0-101.6cm)	0–25%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–5
Soil reaction (1:1 water) (0-101.6cm)	7.4–8.4

Subsurface fragment volume <=3" (Depth not specified)	10–70%
Subsurface fragment volume >3" (Depth not specified)	0–25%

Ecological dynamics

The most important abiotic factors driving this site are a very dry climate with hyperthermic soil temperatures, steep slopes and rocky soils with low moisture holding capacity. The extreme aridity of this site restricts the potential vegetation to a very sparse creosote bush community with annual forbs contributing 50 to 80 percent of annual production during average to above average precipitation conditions.

This ecological site occurs in the lower Colorado Desert which has extreme aridity and strong winds. Steeper slopes experience greater degrees of water stress (Monson et al. 1992, Martre et al. 2002), and skeletal soils have little water holding capacity. Lack of available shallow soil moisture prevents survival of the shallow rooted burrobush (*Ambrosia dumosa*) and brittlebush (*Encelia farinosa*), which commonly co-occur with creosote bush in this environment. Creosote bush is a very long-lived, deep-rooted evergreen shrub that tends to be associated with coarse textured soils with little horizon development, and reaches greatest biomass and age on deep soils with large deep water reserves (McAuliffe 1994, Hamerlynk et al. 2002, Hamerlynk and McAuliffe 2008). On steep slopes, biomass and age are limited by erosional processes that cause shrub mortality, and by reduced deep soil water availability. On the shallow lithic soils of this ecological site, the deep-rooted creosote bush can access water held in fractured bedrock, allowing it persist on these very dry slopes. Similarly, it can access cracks in the duripan. On the deep soils of this site, the deep-roots of creosote bush can access deep water sources that rapidly permeate through the skeletal soils.

Disturbance Dynamics

The disturbances impacting this ecological site include drought and invasion by non-native species.

Desert regions are characterized by low mean annual precipitation and extreme variability in the amount of precipitation received in any year or decade (Hereford et al. 2006). Thus, episodic mortality in response to periods of drought is important in shaping desert community dynamics (Hereford et al. 2006, Miriti et al. 2007). Short-lived perennial shrubs demonstrate the highest rates of mortality (Webb et al. 2003, Bowers 2005, Hereford et al. 2006, Miriti et al. 2007), and annual species remain dormant in the soil seedbank (Beatley 1969, 1974, 1976). Long-lived shrubs and trees are more likely to exhibit branch-pruning, and or limited recruitment during drought (e.g. Hereford et al. 2006, Miriti et al. 2007), leading to reduced cover and biomass in drought-afflicted communities.

The hot temperatures and skeletal soils of this ecological site reduce available soil moisture, which limits the susceptibility of this site to invasion by non-native annuals. However, microsites that are sheltered by large rock fragments and/or that receive additional run-on are susceptible to invasion by Mediterranean grass (*Schismus barbatus*). This non-native annual may usurp space from native annuals that also depend on these microsites for establishment.

The extremely sparse vegetation of this ecological site, with the low potential for high biomass of annual species limits the continuity of fine fuels in this site, and means that this site is extremely unlikely to burn.

State and transition model

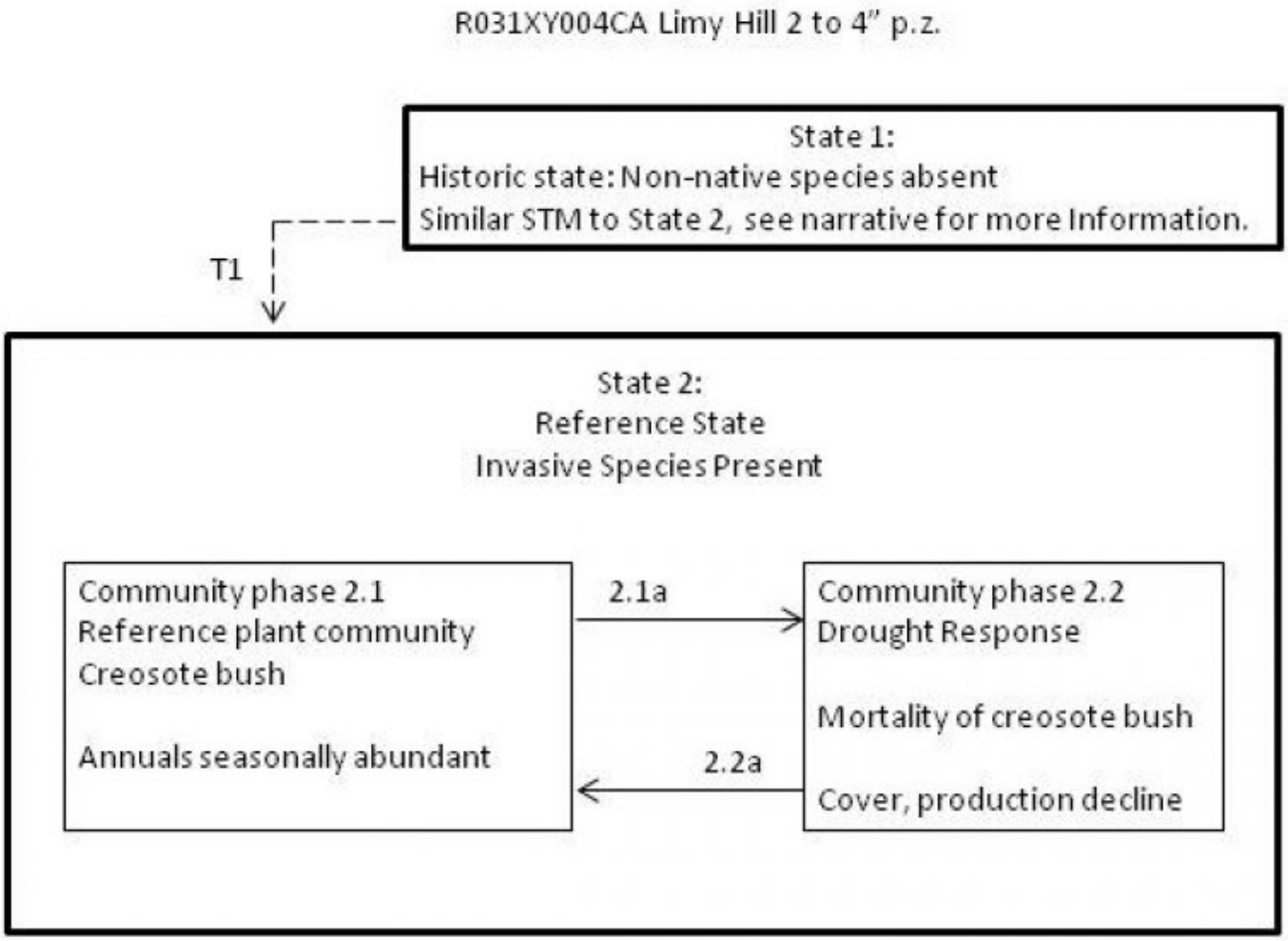

Figure 2. R031XY004CA Model

State 1
Historic State

State 1 represents the historic range of variability for this ecological site. This state no longer exists due to the ubiquitous naturalization of non-native species in the Colorado Desert. Drought and very rare fire were the natural disturbances influencing this ecological site. Data for this State does not exist, but it would have been similar to State 2, except with only native species present. See State 2 narrative for more detailed information.

State 2
Reference State

State 2 represents the current range of variability for this site. Non-native annuals, including Mediterranean grass (*Schismus barbatus*) are naturalized in this plant community. Abundance varies with precipitation, but it is at least sparsely present (as current year's growth or present in the soil seedbank).

Community 2.1
Reference Community

Figure 3. Reference Community

This community phase is dominated by sparse, very small creosote bush at 1 to 3 percent cover, with an occasional burrobush or white ratany (*Krameria grayi*) shrub. Certain areas can have a diversity of cacti as a minor component. The small statured native perennial grass low woollygrass (*Dasyochloa pulchella*) may be sparsely present. Annuals forb species contribute high production during years of above average precipitation. Most of this biomass comes from desert Indianwheat (*Plantago ovata*) and flatcrown buckwheat (*Eriogonum deflexum*). The non-native annual grass Mediterranean grass is sparsely present.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	28	81	130
Forb	–	3	6
Grass/Grasslike	–	–	4
Total	**28**	**84**	**140**

Table 6. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	7-10%
Grass/grasslike foliar cover	0-1%
Forb foliar cover	7-10%
Non-vascular plants	0%
Biological crusts	0%
Litter	0%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	0%

Table 7. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	3-5%
Grass/grasslike basal cover	0-1%
Forb basal cover	0-1%

Non-vascular plants	0%
Biological crusts	0%
Litter	15-20%
Surface fragments >0.25" and <=3"	60-63%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	7-10%

Table 8. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	0-1%	7-10%
>0.15 <= 0.3	–	0-1%	–	–
>0.3 <= 0.6	–	1-2%	–	–
>0.6 <= 1.4	–	2-3%	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.2
Drought Response

This community phase is characterized by an overall decline in cover due branch-pruning, lack of recruitment and mortality of creosote bush, and lack of emergence of annual forbs.

Pathway 2.1a
Community 2.1 to 2.2

This pathway occurs with prolonged or severe drought.

Pathway 2.2a
Community 2.2 to 2.1

This pathway occurs with time and a return to average or above average climatic conditions.

Additional community tables

Table 9. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
1	**Shrubs**			28–130	
	Virginia wildrye	ELVI3	*Elymus virginicus*	1608–2746	–
	sedge	CAREX	*Carex*	1608–2746	–
	squirreltail	ELELE	*Elymus elymoides ssp. elymoides*	224–336	–
	creosote bush	LATR2	*Larrea tridentata*	21–101	–
	burrobush	AMDU2	*Ambrosia dumosa*	3–15	–
	white ratany	KRGR	*Krameria grayi*	3–15	–
2	**Cacti**			0–2	
	teddybear cholla	CYBI9	*Cylindropuntia bigelovii*	0–1	–
	beavertail pricklypear	OPBA2	*Opuntia basilaris*	0–1	–
Forb					
3	**Forbs**			0–6	
	desert Indianwheat	PLOV	*Plantago ovata*	0–3	–
	flatcrown buckwheat	ERDE6	*Eriogonum deflexum*	0–2	–
Grass/Grasslike					
4	**Perennial Grasses**			0–2	
	ticktrefoil	DESMO	*Desmodium*	196–336	–
	lespedeza	LESPE	*Lespedeza*	196–336	–
	prairie snoutbean	RHLA5	*Rhynchosia latifolia*	196–336	–
	fuzzybean	STROP	*Strophostyles*	196–336	–
	low woollygrass	DAPU7	*Dasyochloa pulchella*	0–2	–
5	**Annual Grasses**			0–2	
	sixweeks threeawn	ARAD	*Aristida adscensionis*	0–1	–
	sixweeks grama	BOBA2	*Bouteloua barbata*	0–1	–
6	**Non-native grass**			0–3	
	Alabama supplejack	BESC	*Berchemia scandens*	224–392	–
	parsley hawthorn	CRMA5	*Crataegus marshallii*	224–392	–
	possumhaw	ILDE	*Ilex decidua*	224–392	–
	yaupon	ILVO	*Ilex vomitoria*	224–392	–
	Japanese honeysuckle	LOJA	*Lonicera japonica*	224–392	–
	oakwoods dewberry	RULA5	*Rubus largus*	224–392	–
	saw greenbrier	SMBO2	*Smilax bona-nox*	224–392	–
	cat greenbrier	SMGL	*Smilax glauca*	224–392	–
	Mediterranean grass	SCHIS	*Schismus*	0–3	–

Animal community

This site is dominated by creosote bush, which is highly valued by burrowing animals. Desert tortoise (Gopherus agassizii), lizards, ground squirrels and other rodents all make burrows in the root-mounds of the creosote bush. The medium stature of creosote bush also allows for some perching by both birds and rodents. The partially shaded apron around the creosote bush is more nutrient rich than surrounding areas and gives rise to abundant annual plants when rainfall allows. This then provides a food source for the above-mentioned wildlife.

Recreational uses

This site is highly valued for open space and those interested in desert ecology. Uses include mountain biking, hiking, bird watching and botanizing. Desert tortoise and wildflowers may also attract visitors during the spring.

Type locality

Location 1: San Bernardino County, CA	
UTM zone	N
UTM northing	3807108
UTM easting	729703
Latitude	34° 22′ 47″
Longitude	114° 30′ 6″
General legal description	This site occurs on hillslopes surrounding Chemehuevi wash in the Chemehuevi Wash OVH area. It can be reached by taking the Needles-Parker trail south several miles from the Lake Havasu Rd.

Other references

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Approval

Kendra Moseley, 3/11/2025

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)	P. Novak-Echenique, Dustin Detweiler
Contact for lead author	State Rangeland Management Specialist
Date	07/14/2009
Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are none to rare. Rock fragments armor the soil surface against erosion.

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2. **Presence of water flow patterns:** Water flow patterns are none to few. Rock fragments armor the soils preventing water flow patterns from developing.

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3. **Number and height of erosional pedestals or terracettes:** Pedestals and terracettes are none.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is variable (5-10%); although there is little vegetation cover, bare ground cover is low due to the amount of surface rock fragments.

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5. **Number of gullies and erosion associated with gullies:** Gullies are rare to none. Natural drainages may be observed on steeper side slopes.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None

7. **Amount of litter movement (describe size and distance expected to travel):** Litter typically remains in place or will move until it is trapped under a plant. Persistent litter (large woody material) will remain in place except during large rainfall events.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil stability values should be 3 to 6 on most soil textures and varies depending on canopy cover.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface structure is typically medium to thick platy or weak fine granular. Soil surface colors are light and the soils have an ochric epipedon. Organic matter of the surface 2 to 3 inches is less than 1 percent.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Sparse shrub canopy and associated litter break raindrop impact.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None. Subangular blocky structure, or massive or calcic sub-surface horizons are not to be interpreted as compacted layers.

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: Creosote bush

    Sub-dominant: desert shrubs > annual forbs > annual grasses and perennial grasses

    Other:

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Dead branches within individual shrubs are common and standing dead shrub canopy material may be as much as 25% of total woody canopy.

14. **Average percent litter cover (%) and depth (in):** Litter is concentrated under shrubs and generally stays in place.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season ~75lbs/ac

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: Red brome, red-stem filaree, mustards, and Mediterranean grass are invaders on this site.

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17. **Perennial plant reproductive capability:** All functional groups should reproduce in normal and above-normal rainfall years.
