USDA Natural Resources Conservation Service

Ecological site R030XB172CA
Warm Gravelly Shallow Hills

Accessed: 05/18/2024

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.

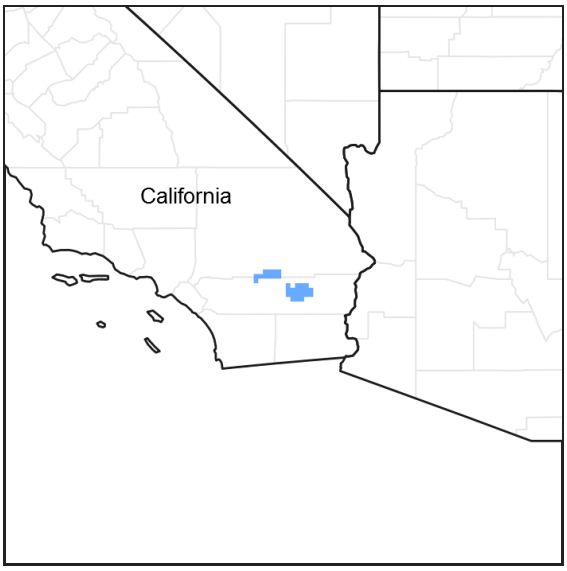

Figure 1. Mapped extent

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): 030X–Mojave Basin and Range

MLRA Description:

Major Land Resource Area (MLRA) 30, Mojave Desert, is found in southern California, southern Nevada, the extreme southwest corner of Utah and northwestern Arizona within the Basin and Range Province of the Intermontane Plateaus. The climate of the area is hot (primarily hyperthermic and thermic; however at higher elevations, generally above 5000 feet, mesic, cryic and frigid) and dry (aridic). Elevations range from below sea level to over 12,000 feet in the higher mountain areas found within the MLRA. Due to the extreme elevational range found within this MLRA, Land Resource Units (LRUs) were designated to group the MLRA into similar land units.

LRU Description:

This LRU (designated by 'XB') is found across the eastern half of California, much of the mid-elevations of Nevada, the southernmost portions of western Utah, and the mid-elevations of northwestern Arizona. Elevations range from 1800 to 5000 feet and precipitation ranges from 4 to 9 inches per year, but is generally between 5-6 inches. This LRU is characterized primarily by the summer precipitation it receives, ranging from 18 – 35% but averages 25%. Summer precipitation falls between July and September in the form of rain, and winter precipitation falls starting in November and ends between February and March, also mostly in the form of rain; however it does receive between 0 and 3 inches of snow, with an average of 1 inch. The soil temperature regime is thermic and the soil moisture

regime is typic-aridic. Vegetation includes creosote bush, burrobush, Nevada jointfir, ratany, Mojave yucca, Joshua tree, chollas, cactus, big galleta grass and several other warm season grasses. At the upper portions of the LRU, plant production and diversity are greater and blackbrush is a common dominant shrub.

Ecological Site Concept -

This site is found on steep stony slopes with shallow to moderately deep soils at elevations of 2100 to 4720 feet. Slopes are generally greater than 30 percent, and surface stones have greater than 10 percent cover. This site is associated with warm thermic soil temperatures. Production reference value (RV) is 246 pounds per acre and ranges from 105 to 442 pounds per acre depending on annual precipitation and annual species production. Creosote bush (Larrea tridentate) and Parish's goldeneye (Viguiera parishi) dominate the site, but a high diversity of other shrub species may be present. A high percentage of large surface fragments restricts plant cover, but the additional run-on provided by surface fragments allows for increased diversity. Creosote bush is tolerant of hot temperatures, and deep taproots can access cracks in fractured or weathered bedrock to obtain moisture. Parish's goldeneye is drought-tolerant, and can efficiently use moisture available from run-on when it is available.

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 mapunit or greater).

Classification relationships

The Viguiera parishii Shrubland Alliance and the Larrea tridentata Shrubland Alliance (Sawyer et al. 2009) occur within this ecological site.

Associated sites

R030XA178CA	**Moderately Deep Sandy Slopes** This ecological site occurs on adjacent slopes in the XA LRU (i.e. areas receiving predominately winter precipitation). It is dominated by California juniper (Juniperus californica) and Parry's jujube (Ziziphus parryi).
R030XB139CA	**Shallow Dry Hill 4-6 P.Z.** This ecological site is found on adjacent slopes with less large fragment cover. Creosote bush (Larrea tridentata) and burrobush (Ambrosia dumosa) dominate.
R030XB170CA	**Bouldery Very Shallow To Shallow Gravelly Slopes** This ecological site is found on higher elevation, cool thermic slopes. Single-leaf pinyon pine (Pinus monophylla), Muller's oak (Quercus cornelius-mulleri), blackbrush (Coleogyne ramosissima) and California juniper (Juniperus californica) dominate.
R030XB171CA	**Dissected Pediment** This ecological site is found on pediment below this site. The dominant species are blackbrush (Coleogyne ramosissima), creosote bush (Larrea tridentata), and burrobush (Ambrosia dumosa).
R030XB189CA	**Shallow Cool Hills** This ecological site is found on adjacent, higher elevation, cool thermic slopes. Blackbrush (Coleogyne ramosissima) and California juniper (Juniperus californica) dominate.
R030XB193CA	**Very Shallow To Moderately Deep Gravelly Slopes** This ecological site is found on adjacent slopes on soils with an argillic horizon. Burrobush (Ambrosia dumosa), jojoba (Simmondsia chinensis), waterjacket (Lycium andersonii), Parish's goldeneye (Viguiera parishii) and Nevada jointfir (Ephedra nevadensis) are all important species.
R030XD003CA	**Hyperthermic Steep South Slopes** This ecological site is found on adjacent, lower elevation, hyperthermic slopes. Brittlebush (Encelia farinosa) dominates the site.

Similar sites

R030XB164CA	**Steep South Slopes** This ecological site is found on soils with fewer large surface fragments, and is dominated by brittlebush (Encelia farinosa).

R030XB140CA	**Shallow Hill 4-6" P.Z.** This ecological site is found on slopes with fewer large surface fragments. White bursage and creosote bush co-dominate and production is higher.
R030XB139CA	**Shallow Dry Hill 4-6 P.Z.** This ecological site is found on slopes with fewer large surface fragments. It is dominated by creosote bush (Larrea tridentata) and burrobush (Ambrosia dumosa) is an important species. Parish's goldeneye (Viguiera parishii) is trace if present.
R030XB193CA	**Very Shallow To Moderately Deep Gravelly Slopes** This ecological site occurs on slopes with fewer large surface fragments, and typically is associated with soils with an argillic horizon. Creosote bush (Larrea tridentata) is not a dominant species.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Viguiera parishii* (2) *Larrea tridentata*
Herbaceous	Not specified

Physiographic features

This ecological site is found on hills and mountain slopes at elevations of 2100 to 4720 feet. Slopes may range from 8 to 75 percent, but slopes above 30 percent are typical. This site may occur on all aspects, but at higher elevations (above 4000 feet), it is limited to south-facing aspects. Runoff class is medium to very high.

Table 2. Representative physiographic features

Landforms	(1) Hill (2) Mountain slope
Flooding frequency	None
Ponding frequency	None
Elevation	640–1,439 m
Slope	8–75%
Aspect	Aspect is not a significant factor

Climatic features

The climate on this site is arid, and characterized by cool, somewhat moist winters and hot, dry summers. The average annual precipitation ranges from 3 to 7 inches with most falling as rain from November to March with a secondary, smaller peak following summer convection storms from July to September. Mean annual air temperature is 62 to 68 degrees F. The frost free period is 270 to 320 days. Freeze free period was not entered and defaults to zero.

Table 3. Representative climatic features

Frost-free period (average)	320 days
Freeze-free period (average)	0 days
Precipitation total (average)	178 mm

Influencing water features

Soil features

The soils associated with this ecological site are very shallow to moderately deep over granitic or gneissic bedrock.

These soils formed in colluvium and residuum derived from granite or gneiss. Soils are somewhat excessively drained. Surface textures are typically stones, but may be sand, gravelly loamy sand, gravelly loamy sand, or gravelly loamy fine sand. Surface fragments less than 3 inches in diameter range from 30 to 55 percent, and larger fragments range from 5 to 45 percent. The subsurface can range from little to no rock fragments (e.g. Ironped and Bigcanyon soils) and extremely gravelly and cobbly soils (e.g. Aguilareal).

This ecological site is associated with the following soil series: Bigcanyon (mixed, thermic Typic Torripsamments), Aguilareal (loamy-skeletal, mixed, superactive, thermic Lithic Haplocambids), Ironped (mixed, thermic, shallow Typic Torripsamments), Lostpalms (sandy-skeletal, mixed, thermic Lithic Torriorthents), and minor components of Dalvord (loamy-skeletal, mixed, superactive, calcareous, thermic Lithic Torriorthents) and Bigbernie (sandy-skeletal, mixed, thermic Typic Torriorthents. Bigcanyon and Ironped are sandy throughout, and are moderately deep and shallow to weathered bedrock, respectively. Bigbernie soils are moderately deep, are sandy but have greater than 35 percent rock fragments (are skeletal) within the soil profile. The rest of the soils have a lithic contact (hard bedrock contact). All of these soils are predominantly found on hills and mountains, but Lostpalms and Ironped soils are also found on pediments. Aguilareal and Dalvord soils typically have a surface C horizon with more than 85 percent rock fragments.

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

3345;Bigcanyon association, 30 to 75 percent slopes;Bigcanyon;;55; Ironped;;10
3120;Aguilareal-Rock outcrop-Blackeagle complex, 30 to 60 percent slopes;Aguilareal;;40; Bigbernie;warm;10
3213;Dalvord-Aguilareal-Rock outcrop complex, 15 to 60 percent slopes;Aguilareal;;30; Dalvord;bouldery;5
4804;Rock outcrop-Ironped-Pinecity association, 30 to 60 percent slopes;Ironped;;25
4900;Rock outcrop-Aguilareal-Lostpalms complex, 15 to 60 percent slopes;Aguilareal;;15; Lostpalms;;15
3325;Ironped-Rock outcrop-Hexie complex, 30 to 60 percent slopes;Ironped;;15; Aguilareal;;3
2835;Rock outcrop-Blackeagle complex, 30 to 75 percent slopes;Aguilareal;;3
3292;Smithcanyon-Pinecity-Rock outcrop association, 15 to 50 percent slopes;Lostpalms;;5

Table 4. Representative soil features

Parent material	(1) Colluvium–granite (2) Residuum–gneiss
Surface texture	(1) Gravelly loamy sand (2) Gravelly sand (3) Gravelly loamy fine sand
Family particle size	(1) Sandy
Drainage class	Somewhat excessively drained
Permeability class	Moderately rapid to rapid
Soil depth	5–99 cm
Surface fragment cover <=3"	30–55%
Surface fragment cover >3"	5–45%
Available water capacity (0-101.6cm)	0.25–3.56 cm
Calcium carbonate equivalent (0-101.6cm)	0–1%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–4
Soil reaction (1:1 water) (0-101.6cm)	6.6–8.4

Subsurface fragment volume <=3" (Depth not specified)	5–45%
Subsurface fragment volume >3" (Depth not specified)	0–40%

Ecological dynamics

Abiotic Factors

This ecological site occurs on steep, rocky hill and mountain slopes with shallow to moderately deep soils. Creosote bush and Parish's goldeneye dominate the site, and a diverse assemblage of native shrubs and perennial forbs is present. A warm thermic soil temperature regime supports creosote bush and Parish's goldeneye. Shallow sandy soils and a high percentage of large surface fragments restrict plant cover and productivity. Localized areas of run-off from outcrops and large surface fragments allow species more typical of ephemeral washes to persist on this site (e.g. catclaw acacia [*Acacia greggii*], Schott's dalea [*Psorothamnus schottii*], and sweetbush [*Bebbia juncea*]), and increases plant diversity.

Disturbance dynamics

The major disturbances affecting this ecological site are invasion by non-native species, drought and fire.

Areas of localized run-off provided by outcrops and large surface fragments provide refugia from drought in which localized recruitment may be maintained, thus increasing resilience of this site to periods of drought. Shrubs may experience canopy die-bank and mortality during drought (Bowers 2005, Miriti et al. 2007, Hamerlynk and McAuliffe 2008). However, with the resilience provided by areas of localized run-off, and already sparse cover and low production, drought is unlikely to produce a new community phase for this ecological site.

Shallow soils and a hot climate reduces available soil moisture, which limits the susceptibility of this site to invasion by non-native annuals, relative to the levels of invasion seen on adjacent more mesic slopes. However, cooler aspects and microsites that are sheltered by large rock fragments and/or that receive additional run-on are susceptible to invasion by non-native annuals including red brome (*Bromus rubens*), red-stemmed stork’s bill (Erodium cicutarum) and Mediterranean grass (*Schismus barbatus*). These non-native annuals may usurp space from native annuals that also depend on these microsites for establishment. Red brome has been shown to reduce productivity of native perennials (DeFalco et al. 2007). Mediteranean grass inhibits recruitment of burrobush (*Ambrosia dumosa*) (Rodriguez-Buritica and Miriti 2009), and may reduce recruitment of other shrub species. Thus, over time, invasion by non-native annuals could reduce the diversity and abundance of native annuals and perennials in this site. The current potential plant community includes naturalized non-native annuals. Data demonstrating reduced diversity and/or abundance of native species resulting from the presence of non-native annuals in this site is not available.

A high cover of rock fragments and a relatively low cover of vegetation reduces the continuity of fuel in this site, which reduces the susceptibility of this site to fire, and reduces the intensity of fires that do occur. Fewer shrubs are top-killed by fire, and unburned islands are likely to survive fire. Run-off provided by large fragments and outcrops provides areas that recover more quickly from fire. However, since this site occurs on steep slopes over which fire may rapidly move, during extreme fire conditions this site may burn.

State and transition model

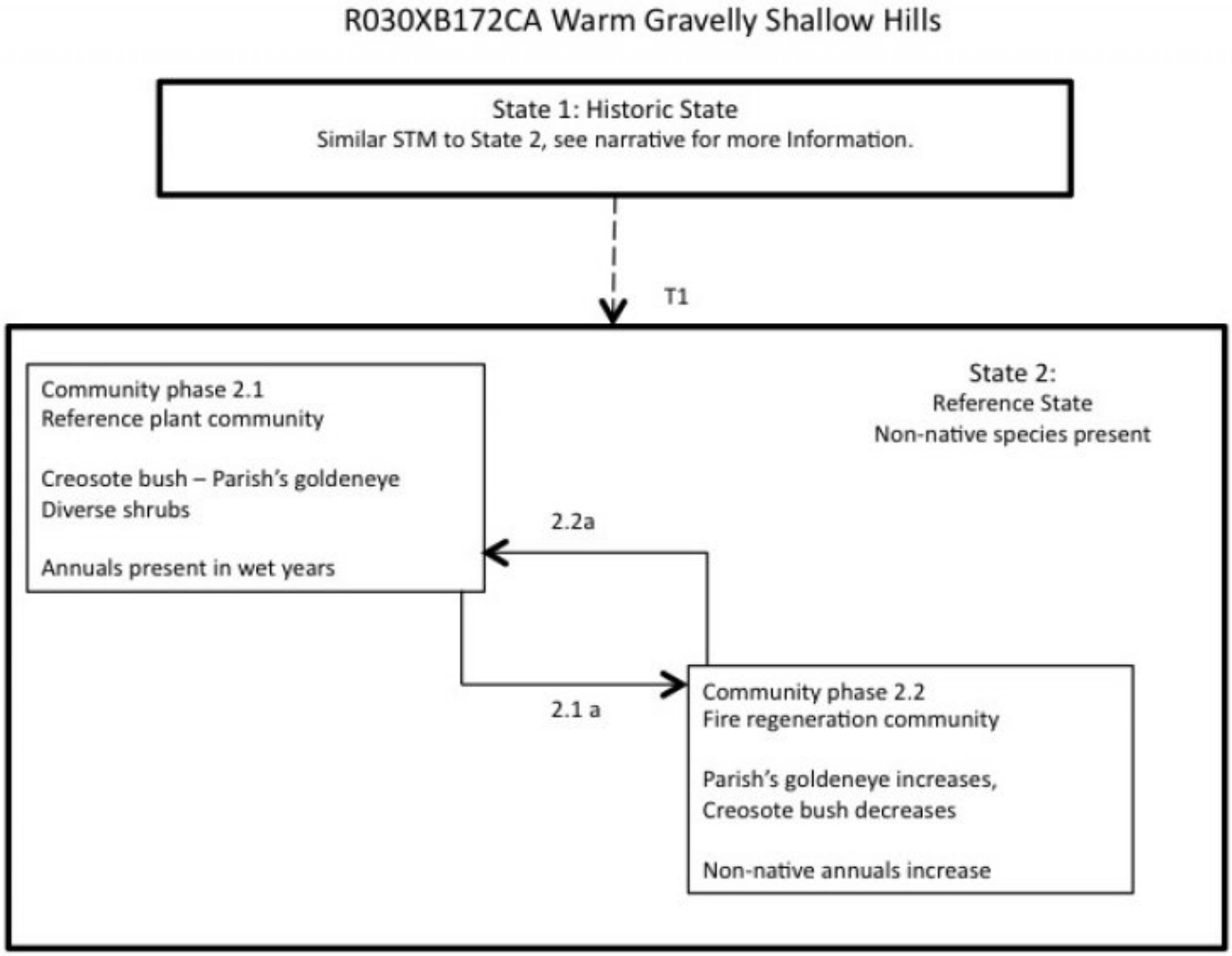

Figure 3. R030XB172CA

State 1
Historic state

State 1 represents the historic range of variability for this ecological site. Primary natural disturbance mechanisms include drought and wildfire. This site is inherently resilient to disturbance due to a high cover of large surface fragments and rock outcrops which: 1. limits vegetation cover and biomass, thereby limiting the flammability of the site; 2. provides localized microsites in which the plant community is protected from fire which can then serve as propagule sources for recovery; and 3. provides additional run-on which promotes recovery after fire and provides refugia from drought (e.g. Green et al. 1993). Historically, fire in this state would have been very rare, since adjacent communities, which drive the occurrence of fire in this ecological site, were much less likely to experience large fires. However, long periods of heavy precipitation could have promoted native annual growth such that fire (e.g. Brown and Minnich 1986) could be carried in adjacent plant communities, and spread to this ecological site.

State 2
Reference State

State 2 represents the current range of variability for this site. Non-native annuals including red brome, Mediterranean grass, and redstem stork's bill are naturalized in this plant community. Their abundance varies with precipitation, but they are at least sparsely present (as current year's growth or present in the soil seedbank). The ecological dynamics for the site have not changed significantly.

Community 2.1
Reference plant community

Figure 4. Community Phase 2.1

This community represents the current potential plant community for this ecological site. Creosote bush and Parish's goldeneye weakly dominate the site, with a high diversity of secondary shrubs and perennial forbs. Secondary shrubs typically present include Nevada jointfir (*Ephedra nevadensis*), eastern Mojave buckwheat (*Eriogonum fasciculatum*), and jojoba (*Simmondsia chinensis*). Subshrubs include desert trumpet (*Eriogonum inflatum*), wishbone bush (*Mirabilis laevis* var. villosa) and desert globemallow (*Sphaeralcea ambigua*). Native and non-native winter annuals are seasonally abundant during wet years, and especially where additional run-off occurs.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	112	247	241
Grass/Grasslike	–	11	168
Forb	6	17	84
Lichen	–	1	2
Total	**118**	**276**	**495**

Table 6. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	1-2%	1-2%	1-2%
>0.15 <= 0.3	–	5-10%	1-2%	1-2%
>0.3 <= 0.6	–	15-25%	0-1%	0-1%
>0.6 <= 1.4	–	1-5%	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.2
Fire regeneration community

This community phase is characterized by reduced abundance of creosote bush, increased dominance by Parish's

goldeneye, and an increase in species evenness. Creosote bush is generally killed by fire and is slow to re-colonize burned areas due to specific recruitment requirements (Brown and Minnich 1986, Marshall 1995). Parish's goldeneye is also killed by fire and has no to low sprouting ability, but may quickly colonize burned areas from off-site dispersal (Sawyer et al. 2009). Other shrubs likely to recover quickly after fire that are present in this plant community include catclaw acacia, Nevada jointfir, eastern Mojave buckwheat, and Mojave yucca. Burned communities are more susceptible to invasion by non-native annuals, so the abundance of non-natives may increase if adequate winter precipitation is available.

Pathway 2.1a
Community 2.1 to 2.2

This pathway occurs with large fire. A high cover of rock fragments and a relatively low cover of vegetation reduces the continuity of fuel in this site, which reduces the susceptibility of this site to fire, and reduces the intensity of fires that do occur. Nevertheless, since this site occurs on steep slopes over which fire may rapidly move, in the right conditions (low relative humidity, high winds), this site may burn.

Pathway 2.2a
Community 2.2 to 2.1

This pathway occurs with time without fire (> 40 years). Creosote bush dominated communities may return to pre-burn species composition in as little as 19 years, though return to pre-burn cover takes longer (Engel and Abella, 2011). Since this plant community is already characterized by relatively high shrub diversity, and since unburned pockets are likely to provide sources for re-colonization, we estimate that this community will return to pre-burn status within 40 years.

Transition T1
State 1 to 2

This transition occurred with the introduction and naturalization of non-native species due to propagule pressure from surrounding invaded shrublands. This transition is irreversible.

Additional community tables

Table 7. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
1	**Native shrubs**			112–353	
	Parish's goldeneye	VIPA14	*Viguiera parishii*	22–146	3–10
	creosote bush	LATR2	*Larrea tridentata*	34–78	4–8
	Nevada jointfir	EPNE	*Ephedra nevadensis*	7–62	1–5
	Eastern Mojave buckwheat	ERFA2	*Eriogonum fasciculatum*	1–56	0–2
	Mojave yucca	YUSC2	*Yucca schidigera*	0–28	0–2
	jojoba	SICH	*Simmondsia chinensis*	1–22	0–5
	water jacket	LYAN	*Lycium andersonii*	0–17	0–2
	burrobush	AMDU2	*Ambrosia dumosa*	0–6	1
Grass/Grasslike					
2	**Native perennial grasses**			0–34	
	desert needlegrass	ACSP12	*Achnatherum speciosum*	0–6	0–1
	big galleta	PLRI3	*Pleuraphis rigida*	0–2	0–1
5	**Non-native annual grasses**			0–135	
	red brome	BRRU2	*Bromus rubens*	0–118	0–5
	Mediterranean grass	SCHIS	*Schismus*	0–11	0–1
Forb					
3	**Forbs**			6–84	
	desert trumpet	ERIN4	*Eriogonum inflatum*	0–47	0–4
	bristly fiddleneck	AMTE3	*Amsinckia tessellata*	0–22	0–2
	chia	SACO6	*Salvia columbariae*	0–13	0–7
	cryptantha	CRYPT	*Cryptantha*	0–11	0–4
	wishbone-bush	MILAV	*Mirabilis laevis var. villosa*	0–6	0–1
	desert globemallow	SPAM2	*Sphaeralcea ambigua*	0–6	0–1
4	**Non-native annual forbs**			0–67	
	redstem stork's bill	ERCI6	*Erodium cicutarium*	0–67	0–7
Lichen					
6	**Lichen**			0–2	
	Lichen	2LICHN	*Lichen*	0–2	–

Animal community

This ecological site provides habitat for many reptiles and mammals. The species most likely to be encountered in this ecological site (based on preferred habitat characteristics) are listed below.

Lizards:
Desert banded Gecko (Coleonyx variegatus variegatus)
Long-nosed leopard lizard (Gambelia wislizenii wislizenii)
Mojave collared lizard (Crotaphytus bicinctores)
Western chuckwalla (Sauromalus aster obesus)
San Diego horned lizard (Phrynosoma coronatum blainvillii)
Yellow-backed spiny lizard (Sceloporus magister uniformus)
Great Basin fence lizard (Sceloporus biseriatus longipes)
Western brush lizard (Urosaurus graciosus graciosus)
Desert side-blotched lizard (Uta stansburiana stejnegeri)

Desert night lizard (Xantusia vigilis vigilis)
Great Basin Whiptail (Aspidoscelis tigris tigris)

Snakes:
Mojave glossy snake (Arizona occidentalis candida) California kingsnake (Lampropeltis getula californae)
Red coachwhip (Masticophis flagellum piceus)
Desert night snake (Hypsiglena torquata deserticola)
California kingsnake (Lampropeltis getula californae)
Western leaf-nosed snake (Phyllorynchus decurtatus perkinsi)
Great Basin gopher snake (Pituophis catenifer deserticola)
California lyre snake (Trimorphodon biscutatus vandenburghi)
Mojave Desert sidewinder (Crotalus cerastes cerastes)
Southwestern speckled rattlesnake (Crotalus mitchelli Pyrrhus)
Red diamond rattlesnake (Crotalus ruber ruber)
The following mammals are likely to occur in this ecological site:
Long-tailed weasel (Mustela frenata latirosta)

Mammals:
Long-tailed weasel (Mustela latirosta)
California desert bat (Myotis californicus stephensi)
Western pipistrelle (Pipistrellus hesperus hesperus)
Desert big brown bat (Eptesicus fuscus pallidus)
Hoary bat (Lasiurus cinereus cinereus)
Pallid bat (Antrozous pallidus minor)
Desert coyote (Canis macrotis arsipus)
Common gray fox (Urocyon cinereoargenteus scottii)
Desert bobcat (Lynx rufus baileyi)
California ringtail (Bassariscus astutus ocatvus)
Southern mule deer (Odoceileus hemionus fuliginatus)
Desert bighorn sheep (Ovis canadensis nelson)
Southern Desert cottontail (Sylvilagus audobonii arizonae)
Desert blacktail jackrabbit (Lepus californicus deserticola)
Whitetail antelope squirrel (Ammospermphilus leucurus leucurus)
Western Mojave ground squirrel (Spermophilus beecheyi parvulus)
Pallid (San Diego) pocket mouse (Chaetodipus fallax pallidus)
Mojave little pocket mouse (Perognathus longimembris longimembris)
Long-tailed pocket mouse (Chaetodipus mojavensis)
Merriam's kangaroo rat (Dipodomys deserti)
Desert wood rat (Neotoma fuscipes simplex)
White-throated wood rat (Neotoma albigula venusta)
Desert canyon mouse (Peromyscus crinitus stephensi)
Cactus mouse (Peromyscus eremicus eremicus)
Southern brush mouse (Peromyscus boylii rowleyi)
Sonoran deer mouse (Peromyscus maniculatus sonoriensis)
Desert grasshopper mouse (Onychomys torridus pulcher)
Desert shrew (Notiosorex crawfordi crawfordi

Recreational uses

This ecological site may be used for cross-country hiking and aesthetic enjoyment.

Other products

Creosote bush is an important medicinal plant for Native Americans. It has a very wide range of uses from treatment for consumption, bowl complaints, and menstrual cramps, to induce vomiting, relief for arthritis, rheumatism, aching bones and sprains, congestion and cold, as an antiseptic and disinfectant, dandruff, antispasmodic, to induce urination, gonorrhea, and to cancer treatment. (This list is not exhaustive).

http://herb.umd.umich.edu/herb/search.pl?searchstring=Larrea+tridentata.

Creosote bush stems are used to make weapons, digging tools, and basket handles, and creosote gum is used for knife and awl handles. Creosote bush branches are used as thatch in dwelling construction. http://herb.umd.umich.edu/herb/search.pl?searchstring=Larrea+tridentata.

Inventory data references

The following NRCS plots were used to describe this ecological site:

Community Phase 2.1:
1251503629
12497-199-22 (Type location)
12497-199-B
POWA36

Type locality

Location 1: San Bernardino County, CA	
UTM zone	N
UTM northing	3770127
UTM easting	571867
Latitude	34° 4′ 9″
Longitude	116° 13′ 16″
General legal description	The type location is approximately 3 miles southeast of the West Entrance Station to Joshua Tree National Park.

Other references

Bowers, J. E. 2005. Effects of drought on shrub survival and longevity in the northern Sonoran Desert. Journal of the Torrey Botanical Society 132:421-431.

Brown, D. E. and R. A. Minnich. 1986. Fire and Changes in Creosote Bush Scrub of the Western Sonoran Desert, California. American Midland Naturalist 116:411-422.

DeFalco, L. A., D. R. D.R. Bryla, V. Smith-Longozo, and R. S. Nowak. 2003. Are Mojave Desert annual species equal? Resource acquisition and allocation for the invasive grass Bromus madritensis subsp. rubens (Poaceae) and two native species. American Journal of Botany 90:1045-1053.

DeFalco, L. A., G. C. J. G.C.J. Fernandez, and R. S. Nowak. 2007. Variation in the establishment of a non-native annual grass influences competitive interactions with Mojave Desert perennials. Biological Invasions 9:293-307.

Engel, E. C. and S. R. Abella. 2011. Vegetation recovery in a desert landscape after wildfires: influences of community type, time since fire and contingency effects. Journal of Applied Ecology 48:1401-1410.

Green, J. F., D. H. Headrick, and R. D. Goeden. 1993. Life history and description of immature stages of Procecidochares stonei Blanc & Foote on Viguiera spp. in southern California (Diptera: Tephritidae). Pan-Pacific Entomologist 69:18-32.

Hamerlynk, E. P. and J. R. McAuliffe. 2008. Soil-dependent canopy die-back and plant mortality in two Mojave Desert shrubs. Journal of Arid Environments 72:1793-1802.

Hereford, R., R. H. R.H. Webb, and C. I. Longpre. 2006. Precipitation history and ecosystem response to multidecadal precipitation variability in the Mojave Desert region, 1893–2001. Journal of Arid Environments 67:13-34.

Marshall, K. A. 1995. Larrea tridentata. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Miriti, M. N., S. Rodriguez-Buritica, S. J. Wright, and H. F. Howe. 2007. Episodic death across species of desert shrubs. Ecology 88:32-36.

Rodriguez-Buritica, S., Miriti, M.N. 2009. Biting the hand that feeds: the invasive grass *Schismus barbatus* (Poaceae) is facilitated by, but reduces establishment of, the native shrub *Ambrosia dumosa* (Asteraceae). Journal of Vegetation Science 20:241-250.

Sawyer, J. O., T. Keeler-Woolf, and J. M. Evans. 2009. A manual of California vegetation. 2nd edition. California Native Plant Society, Sacramento, California.

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:**

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

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

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

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

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

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

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

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

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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:**
