USDA Natural Resources Conservation Service

Ecological site R030XB171CA
Dissected Pediment

Accessed: 05/11/2025

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.

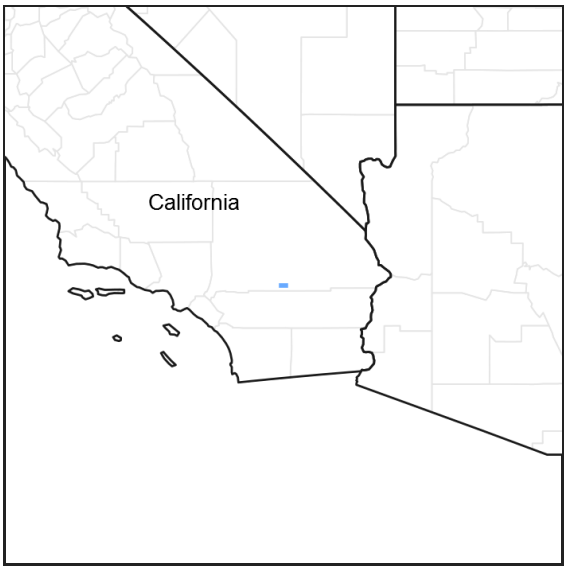

Figure 1. Mapped extent

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 ecological site occurs on dissected, sloping pediments punctuated by monzogranite outcrops at elevations of 2900 to 3800 feet. Soils are very shallow to shallow. Production reference value (RV) is 242 pounds per acre and ranges from 76 to 400 pounds per acre depending on annual precipitation and annual species production. The site is weakly dominated by blackbrush (Coleogyne ramosissima) with a high diversity of secondary shrubs present, including burrobush (Ambrosia dumosa), Parish's goldeneye (Viguiera parishi), desertsenna (Senna armata), creosote bush (Larrea tridentata), and catclaw acacia (Acacia gregii). Additional run-on from adjacent outcrops, and flow in interfluves provides moisture for creosote bush, catclaw acacia and desertsenna, which tend to occupy low points among the pediment. Although blackbrush is well-adapted to shallow soils, this ecological site is found at lower elevations. Blackbrush does not thrive in these warmer climates and individuals are stunted and less competitive than in cooler climates.

Data ranges in the physiographic data, climate data, water features, and soil data sections of this Ecological Site Description are based on components that are 10 percent of a mapunit or greater.

Associated sites

R030XB005NV	**Arid Active Alluvial Fans** This ecological site is found on adjacent fan aprons. Creosote bush (Larra tridentata) and burrobush (Ambrosia dumosa) are dominant species.

Similar sites

R030XB166CA	**Dissected Pediment, Cool** This ecological site occurs on pediments with cool thermic soils. Blackbrush (Coleogyne ramosissima) and California juniper (Juniperus californica) are dominant species.
R030XB225CA	**Warm Sloping Pediments** This ecological site occurs on pediments and is co-dominated by Hall's shrubby spurge (Tetracoccus hallii) and burrobush (Ambrosia dumosa).
R030XB228CA	**Warm Shallow Pediments** This ecological site occurs over a slightly lower precipitation range and warmer temperatures. Creosote bush (Larrea tridentata) and burrobush (Ambrosia dumosa) dominate.
R030XB188CA	**Cool Shallow to Moderately Deep Fans** R030XB188CA occurs on pediments overlain with a thicker layer of alluvium. The site is more productive, and creosote bush (Larrea tridentata) and blackbrush (Coleogyne ramosissima) dominate.
R030XB221CA	**Loamy Fan Remnants And Pediments** This ecological site occurs on pediments and fan remnants with moderately deep soils to a duripan. Hall's shrubby spurge (Tetracoccus hallii) is an important species.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Coleogyne ramosissima* (2) *Ambrosia dumosa*
Herbaceous	Not specified

Physiographic features

This ecological site is found on dissected pediments at elevations of 2900 to 3800 feet. Slopes may range from 8 to 50 percent, but slopes less than 15 percent are typical. Runoff class is high.

Table 2. Representative physiographic features

Landforms	(1) Pediment
Flooding frequency	None
Ponding frequency	None
Elevation	2,900–3,800 ft
Slope	8–50%
Aspect	Aspect is not a significant factor

Climatic features

The climate on this site is arid characterized by cool, somewhat moist winters and hot, dry summers. The average annual precipitation ranges from 4 to 7 inches with most falling as rain from November to March with a secondary, smaller peak between July and September occurring as summer convection storms. Mean annual air temperature ranges from 63 to 68 degrees F. The frost free period is 270 to 280 days.

Table 3. Representative climatic features

Frost-free period (average)	320 days
Freeze-free period (average)	0 days
Precipitation total (average)	7 in

Influencing water features

Soil features

The dominant soils associated with this ecological site are very shallow to shallow, and formed from alluvium derived from granite and/or residuum weathered from granite on dissected pediment surfaces. Surface textures are gravelly loamy sand and gravelly loamy fine sand with gravelly loamy sand subsurface textures over bedrock. For rock fragments less than 3 inches in diameter, the percent surface cover is approximately 35 percent, and subsurface volume ranges from 15 to 20 percent (subsurface fragments by volume for a depth of 0 to 7 inches). For rock fragments greater than 3 inches in diameter, the percent surface cover ranges from 20 to 45 percent, and subsurface volume ranges from 0 to 25 percent. Granitic bedrock is encountered at depths of 2 to 14 inches and is slightly weathered with very fine roots common in fractures.. These soils are excessively drained with rapid permeability.

This ecological site is associated with the following soil series: Ironped (mixed, thermic, shallow Typic Torripsamments), Lostpalms (sandy-skeletal, mixed, thermic Lithic Torriorthents), and a minor component of Morongo (mixed, thermic Typic Torripsamments). The Morongo soils are deep sands atypical of this ecological site, and these pockets of deeper sands increase plant diversity. Ironped soils dominate the site, while Morongo soils are found in the dissected areas where deposition of thick sands has occurred. Ironped soils are also sandy throughout. Lostpalms soils are found on more steeply sloping areas of the pediment surface, average greater than 35% rock fragments and have a very shallow to shallow, hard granitic bedrock contact.

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

4805;Rock outcrop-Ironped association, 8 to 15 percent slopes;Ironped;cool;30; Lostpalms;cool;12; Morongo;warm;5

Table 4. Representative soil features

Parent material	(1) Alluvium–granite

Surface texture	(1) Gravelly loamy sand (2) Loamy fine sand
Family particle size	(1) Sandy
Drainage class	Somewhat excessively drained
Permeability class	Rapid
Soil depth	2–14 in
Surface fragment cover <=3"	35%
Surface fragment cover >3"	20–45%
Available water capacity (0-40in)	0.1–0.5 in
Calcium carbonate equivalent (0-40in)	0–1%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0–4
Soil reaction (1:1 water) (0-40in)	6.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	15–20%
Subsurface fragment volume >3" (Depth not specified)	0–25%

Ecological dynamics

Abiotic factors

The most important abiotic factors driving this ecological site are a dissected, eroded pediment landform, shallow soils and a warm thermic climate.

This ecological site occurs on eroded, dissected pediments punctuated by monzogranite outcrops at elevations of 2900 to 3500 feet. Soils are very shallow to shallow gravelly loamy sands. The site is weakly dominated by blackbrush with a high diversity of secondary shrubs and subshrubs. Although blackbrush is well adapted to shallow soils, this ecological site is found at lower elevations where temperatures are warmer and evaporation higher. Blackbrush does not thrive in these warmer climates and individuals are stunted and less competitive than in cooler climates. Since this site represents the warmest extension of the range of blackbrush, it is significant in terms of blackbrush adaptation and response to climate change. At lower elevations soil moisture is too low to support blackbrush, and temperatures are not cold enough for the cold stratification that blackbrush seeds require for germination (Pendleton et al. 1995, Lei 1997, Pendleton and Meyer 2004). However, blackbrush demonstrates ecotypic variation with seed germination, with plants at warmer sites requiring less time for cold-stratification (Lei 1997, Pendleton and Meyer 2004). This trait has likely allowed blackbrush to expand its range to lower elevations in response to historic climate change (Cole and Webb 1985). Conservation of populations at climate extremes is thus important for facilitating blackbrush adaptation to modern day climate change.

Pediments are gently sloping, bedrock erosional surfaces of low relief that form at the base of receding mountain fronts. Pediment surfaces are covered by a discontinuous layer of alluvium that is typically thinner closer to the mountain front and eventually thick enough that the pediment is no longer distinct from the alluvial fan (Dohrenwend and Parsons 2009). Closer to the mountain front, erosion is active, and exposed bedrock is dissected and undulating (Dohrenwend and Parsons 2009). Different topographical positions within these dissected pediment landscapes experience different rates of overland flow and rainsplash erosion (Edinger-Marshall and Lund 1999).

The dissected pediment landscape, with contrasting and localized areas of soil erosion and deposition, and run-off and run-on, supports a diverse plant community. The majority of the landscape is characterized by shallow soils

subject to active erosion, which support a sparse but diverse community of shallow-rooted woody shrubs and subshrubs. Species that are capable of sprouting after mechanical damage are more common in this ecological site; these include catclaw acacia, desertsenna, Nevada jointfir (*Ephedra nevadensis*) and white ratany (*Krameria grayi*). The frequency of disturbance supports the continuous presence of shorter-lived subshrubs, which in more stable landforms are eventually replaced by longer-lived dominants. Annual species are limited in this site by the lack of soil moisture, and by soil erosion which limits seedling establishment (Guerrero-Campo et al. 2008). Interfluves transport material, receive run-on from higher positions, and are mantled by a deeper layer of alluvium, which supports deeper-rooted species like creosote bush, and species more typical of washes, such as catclaw acacia and desertsenna. Areas of additional run-on also occur around outcrops, and pockets of annual species and/or higher shrub productivity may occur in these locations.

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

Drought is an important shaping force in Mojave Desert plant communities (Webb et al. 2003, Hereford et al. 2006). Short-lived perennial shrubs and perennial grasses 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 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. Because this ecological site already has sparse cover, further loss of cover due drought-induced mortality increases the susceptibility of this site to increased damages from erosion.

Non-native annual grasses (red brome [*Bromus rubens*], cheatgrass [*Bromus tectorum*] and Mediterranean grass [Schismus species]) have become naturalized throughout the Mojave Desert over the past century (Rickard and Beatley 1965, D'Antonio and Vitousek 1992, Brooks 1999, Reid et al. 2006, Norton et al. 2007). Although non-native annuals are present in this ecological site, the site is relatively resistant to invasion. The active erosion that characterizes this site limits seedling establishment annual species (Guerrero-Campo and Montserrat-Marti 2000), and shallow soils and a hot climate reduce available soil moisture, which limits biomass of annuals.

The inability of this site to support a high biomass of annuals, and overall sparse vegetation cover, makes this site resistant to fire, which has increased in other Mojave Desert plant communities due to the continuous fine fuel layer created by non-native annuals in wet years (D'Antonio and Vitousek 1992, Brooks et al. 2004). In the very unlikely instance of ignition in this ecological site, fire is likely to be small and of low intensity so the effects are insignificant at the landscape scale.

Water erosion is the dominant process modifying and maintaining exposed pediment surfaces (Edinger-Marshall and Lund 1999, Dohrenwend and Parsons 2009), and is an important process modifying and maintaining the vegetation community. Without additional disturbance, the affects of erosion are within the natural range of variability of the reference plant community. However, with additional disturbance (anthropogenic or natural), the effects of erosion may be more severe leading to vegetation and soil loss and potentially a new community phase or state. For example, shrub cover protects the gravelly soils of this ecological site from erosion (Edinger-Marshall and Lund 1999). If shrub cover is reduced due to drought, erosion will remove more soil, which reduces the availability of safe sites for plant establishment, which further reduces shrub cover.

State and transition model

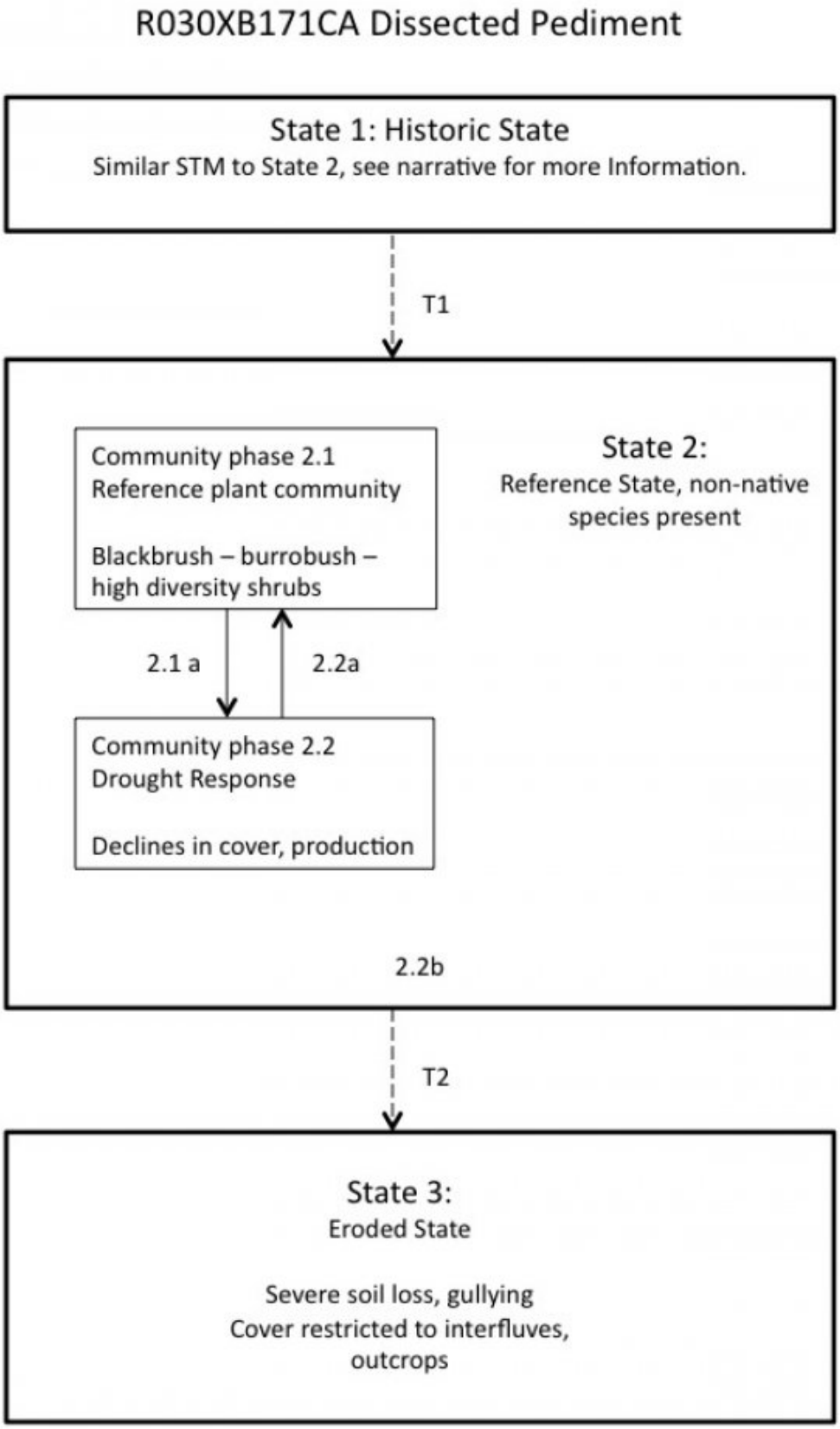

Figure 3. R030XB171CA

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 Mojave Desert. Periodic drought and water erosion 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 red brome and red-stem stork's bill (*Erodium cicutarium*) 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).

Community 2.1
Reference Plant Community

Figure 4. Community Phase 2.1

The current potential plant community is weakly dominated by blackbrush, with a high diversity of secondary shrubs present. Secondary shrubs include burrobush, creosote bush, Acton's brittlebush (*Encelia actonii*), white ratany, Mojave yucca (*Yucca schidigera*), Parish's goldeneye, Nevada jointfir, desertsenna, and catclaw acacia. Blackbrush and burrobush are typical of summits and backslopes, while creosote bush, catclaw acacia and desertsenna are more abundant in interfluves and concave surfaces. Subshrubs are an important component of the vegetation community, and include Mojave aster (*Xylorhiza tortifolia*), shrubby deervetch (*Lotus rigidus*), desert pepperweed (*Lepidium fremontii*), desert globemallow (*Sphaeralcea ambigua*), and whishbone bush (*Mirabilis laevis* var. villosa). The perennial bunchgrasses desert needlegrass (*Achnatherum speciosum*) and big galleta (*Pleuraphis rigida*) may be sparsely present. Native winter annuals are seasonally present, as are the non-native annual grasses red brome and Mediterranean grass. The non-native annual forb redstem stork's bill may be relatively abundant. Biological soil crusts (BSC) are often associated with the grussy granite (granite that is granulated but not decomposed) typical of soil surfaces on this ecological site. These crusts are important for improving soil stability, infiltration, and nutrient cycling on these shallow soils (Belnap et al. 2001). Biological soil crusts form slowly, and are very sensitive to physical disturbance (such as from trampling or off-road vehicle disturbance).

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Shrub/Vine	75	190	300
Forb	1	50	90
Grass/Grasslike	0	2	10
Total	**76**	**242**	**400**

Community 2.2
Drought Response

This community phase is characterized by a decline in cover and production due to branch-pruning of long-lived shrubs (including blackbrush, creosote bush, Nevada jointfir, white ratany, and Mojave yucca), and mortality of shorter-lived perennials (including burrobush, Acton's brittlebush, Parish's goldeneye, eastern Mojave buckwheat, desert needlegrass, big galleta), and lack of emergence of annual forbs and grasses. This is an at-risk phase, as the increase in bare ground that occurs during drought increases the susceptibility of this site to erosion. Biological soil crusts are dormant during drought, and are especially susceptible to damage by mechanical disturbance when dry (Warren and Eldridge 2003). Thus, any additional disturbance threatens to transition this community phase to a phase of increased erosion, or a new state, where significant loss of ecological function has occurred.

Pathway 2.1a
Community 2.1 to 2.2

This pathway occurs with severe or prolonged drought.

Pathway 2.2a
Community 2.2 to 2.1

This pathway occurs with a return to average climatic conditions. Growth of long-lived shrubs and colonization by shorter-lived shrubs increases cover.

State 3
Eroded State

This state is characterized by severe soil erosion. Biological soil crusts are largely absent, gullying is pronounced, and soil surfaces have no protective surface gravels. Vegetative cover is restricted to interfluves or sheltered locations around rock outcrops. Shrubs capable of resprouting or of quickly colonizing after disturbance increase in importance, including subshrubs (see Community phase 2.1 list), and catclaw acacia, desertsenna, parish's goldeneye, Acton's encelia, burrobrush (*Hymenoclea salsola*) and burrobush. Blackbrush is absent or only trace.

Transition 1
State 1 to 2

This transition occurred with the naturalization of non-native species in this ecological site. Non-native species were introduced with settlement of the Mojave Desert region in the 1860s.

Transition 2
State 2 to 3

This transition occurs with severe or continuous anthropogenic disturbance that increases the effects of erosion.

Additional community tables

Table 6. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Shrub/Vine					
1	**Native shrubs**			125–275	
	blackbrush	CORA	*Coleogyne ramosissima*	8–60	5–15
	burrobush	AMDU2	*Ambrosia dumosa*	5–55	1–5
	Acton's brittlebush	ENAC	*Encelia actonii*	10–55	1–3
	Mojave yucca	YUSC2	*Yucca schidigera*	5–45	0–1
	desertsenna	SEAR8	*Senna armata*	5–25	0–4
	Nevada jointfir	EPNE	*Ephedra nevadensis*	15–25	1–3
	Parish's goldeneye	VIPA14	*Viguiera parishii*	5–25	0–1
	catclaw acacia	ACGR	*Acacia greggii*	10–25	0–1
	white ratany	KRGR	*Krameria grayi*	5–15	1–2
	creosote bush	LATR2	*Larrea tridentata*	1–15	0–1
	Eastern Mojave buckwheat	ERFA2	*Eriogonum fasciculatum*	0–10	0–1
	littleleaf ratany	KRER	*Krameria erecta*	0–5	0–1
	Mojave woodyaster	XYTO2	*Xylorhiza tortifolia*	0–5	0–1
Grass/Grasslike					
2	**Native perennial grasses**			0–2	
	big galleta	PLRI3	*Pleuraphis rigida*	0–2	0–1
4	**Non-native annual grasses**			0–1	
	red brome	BRRU2	*Bromus rubens*	0–1	0–1
	Mediterranean grass	SCHIS	*Schismus*	0–1	0–1
Forb					
3	**Native forbs**			1–80	
	shrubby deervetch	LORI3	*Lotus rigidus*	0–40	0–1
	pincushion flower	CHFR	*Chaenactis fremontii*	0–5	0–5
	redroot cryptantha	CRMI	*Cryptantha micrantha*	0–5	0–1
	smooth desertdandelion	MAGL3	*Malacothrix glabrata*	0–5	0–1
	wishbone-bush	MILAV	*Mirabilis laevis var. villosa*	0–2	0–1
	desert pepperweed	LEFR2	*Lepidium fremontii*	0–2	0–1
	desert globemallow	SPAM2	*Sphaeralcea ambigua*	0–2	0–1
	woolly easterbonnets	ANWA	*Antheropeas wallacei*	0–1	0–1
	western tansymustard	DEPI	*Descurainia pinnata*	0–1	0–1
	chia	SACO6	*Salvia columbariae*	0–1	0–1
5	**Non-native annual forbs**			0–50	
	redstem stork's bill	ERCI6	*Erodium cicutarium*	0–50	0–5

Animal community

This ecological site provides habitat for many reptiles and mammals. Blackbrush is used as winter forage by desert bighorn sheep and mule deer. 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 can be used for hiking and aesthetic enjoyment. Pediment landscapes are an unusual and interesting feature of arid environments.

Inventory data references

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

Community Phase 2.1:
1249719926 (Type location)
12497-199-23

Type locality

Location 1: San Bernardino County, CA	
UTM zone	N
UTM northing	3774022
UTM easting	570126
General legal description	The type location is approximately 1.2 miles south of the intersection of Lawrence and Baseline Road (Joshua Tree, CA), in Joshua Tree National Park.

Other references

Beatley, J. C. 1969. Dependence of desert rodents on winter annuals and precipitation. Ecology 50:721-724.

Beatley, J. C. 1974. Effects of rainfall and temperature on the distribution and behavior of Larrea tridentata (Creosote-bush) in the Mojave Desert of Nevada. Ecology 55:245-261.

Beatley, J. C. 1976. Rainfall and fluctuating plant populations in relation to distributions and numbers of desert rodents in southern Nevada. Oecologia 24:21-42.

Belnap, J., J. H. Kaltenecker, R. Rosentreter, J. Williams, S. Leonard, and D. Eldridge. 2001. Biological soil crusts: ecology and management. Technical Reference 1730-2, United States Department of the Interior Bureau of Land Management, Denver, CO.

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.

Brooks, M. L. 1999. Habitat invasibility and dominance by alien annual plants in the western Mojave Desert. Biological Invasions 1:325-337.

Brooks, M. L., C. M. D'Antonio, D. M. Richardson, J. B. Grace, J. E. Keeley, J. M. DiTomaso, R. J. Hobbs, M. Pellant, and D. Pyke. 2004. Effects of invasive alien plants on fire regimes. Bioscience 54:677-689.

Cole, R. H. and R. H. Webb. 1985. Late Holocene Vegetation Changes in Greenwater Valley, Mojave Desert, California. Quaternary Research 23:227-235.

D'Antonio, C. M. and P. M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology and Systematics 23:63-87.

Dohrenwend, J. C. and A. J. Parsons. 2009. Pediments in arid environments. Pages 375-412 in A. J. Parsons and A. D. Abrahams, editors. Geomorphology of desert environments. Springer-Verlag.

Edinger-Marshall, S. B. and L. J. Lund. 1999. Gravel dispersion on a granite pediment (East Mojave Desert, California): a short-term look at erosional processes. Earth Surface Processes and Landforms 24:349-359.

Guerrero-Campo, J. and G. Montserrat-Marti. 2000. Effects of soil erosion on the floristic composition of plant communities on marl in northeast Spain. Journal of Vegetation Science 11:329-336.

Guerrero-Campo, J., S. Palacio, and G. Montserrat-Marti. 2008. Plant traits enabling survival in Mediterranean badlands in northeastern Spain suffering from soil erosion. Journal of Vegetation Science 19:457-464.

Hereford, R., 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.

Lei, S. A. 1997. Variation in germination response to temperature and water availability in blackbrush (Coleogyne ramosissima) and its ecological significance. Great Basin Naturalist 57:172-177.

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.

Norton, J. B., T. A. Monaco, and U. Norton. 2007. Mediterranean annual grasses in western North America: kids in a candy store. Plant Soil 298:1-5.

Pendleton, B. K. and S. E. Meyer. 2004. Habitat-correlated variation in blackbrush (Coleogyne ramosissima: Rosaceae) seed germination response. Journal of Arid Environments 59:229-243.

Pendleton, B. K., S. E. Meyer, and R. L. Pendleton. 1995. Blackbrush biology: insights after three years of a long-term study. Pages 223-228 in Wildland shrub and arid land restoration symposium. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Las Vegas, NV.

Reid, C. R., S. Goodrich, and J. E. Bowns. 2006. Cheatgrass and red brome: history and biology of two invaders. Pages 27-32 in Shrublands under fire: disturbance and recovery in a changing world. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Cedar City, Utah.

Rickard, W. H. and J. C. Beatley. 1965. Canopy-coverage of the desert shrub vegetation mosaic of the Nevada test site. Ecology 46:524-529.

Warren, S. D. and D. J. Eldridge. 2003. Biological soil crusts and livestock in arid ecosystems are they compatible? Pages 401-416 in J. Belnap and O. L. Lange, editors. Biological soil crusts: structure, function, and management. Springer-Verlag, Berlin, Germany.

Webb, R. H., M. B. Muroy, T. C. Esque, D. E. Boyer, L. A. DeFalco, D. F. Haines, D. Oldershaw, S. J. Scoles, K. A. Thomas, J. B. Blainey, and P. A. Medica. 2003. Perennial vegetation data from permanent plots on the Nevada Test Site, Nye County, Nevada. U.S. Geological Society, Tucson, AZ.

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:**

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

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

    Dominant:

Sub-dominant:

Other:

Additional:

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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:**
