USDA Natural Resources Conservation Service

Ecological site R030XB174CA
Sandy Fan Aprons

Accessed: 05/05/2024

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.

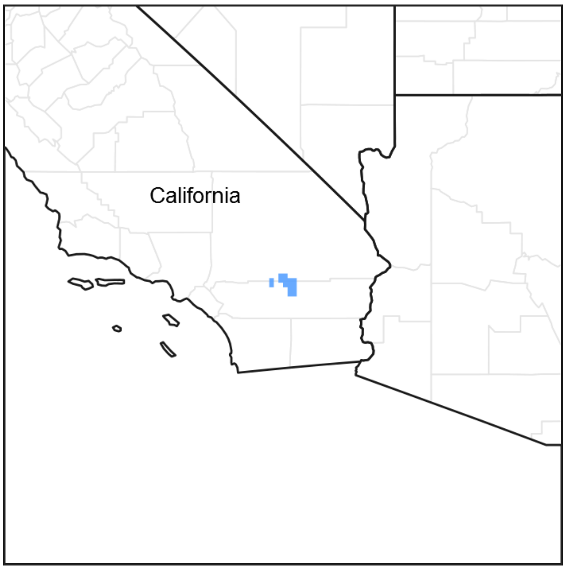

Figure 1. Mapped extent

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 ecological site occurs on fan aprons at elevations from 2950 to 4625 feet. Soils are deep to very deep with sand and sandy loam textures. This site typically experiences very rare sheet-flow due to flash-flooding events. Production reference value (RV) is 275 pounds per acre, and ranges from 131 to 480 pounds per acre depending on annual precipitation and annual species production. Creosote bush (Larrea tridentate), big galleta (Pleuraphis rigida), and Joshua tree (Yucca brevifolia var. brevifolia) dominate the site. All three species are favored by coarser-textured soils; the shallow roots systems of Joshua tree and big galleta are adapted to rapidly respond to available moisture near the soil surface, and the deep roots of creosote bush access deep water that percolates quickly through coarser-textured soils, while shallow lateral roots access shallow water available at the soil surface.

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).

Classification relationships

This ecological site is found within the Yucca brevifolia Woodland Alliance (Sawyer et al. 2009).

The specific associations that occur in this ecological site include:

Yucca breviolia/Larrea tridentata - Pleuraphis rigida Association
Yucca brevifolia Association
Yucca brevifolia/Pleuraphis rigida Association
Yucca brevifolia/Larrea tridentata - *Ambrosia dumosa* - *Eriogonum fasciculatum* Association (lower elevations)
Yucca brevifolia/Larrea tridentata - *Yucca schidigera* Association

Associated sites

R030XB005NV	**Arid Active Alluvial Fans** This ecological site is found on fan aprons at lower elevations bordering this site. Creosote bush (Larrea tridentata) and burrobush (Ambrosia dumosa) dominate.
R030XB166CA	**Dissected Pediment, Cool** This ecological site is found on adjacent pediments at the upper elevation range to this site. Blackbrush (Coleogyne ramosissima) and California juniper (Juniperus californica) dominate.
R030XB173CA	**Coarse Loamy Very Deep Fan Remnants** This ecological site is found on upper fan aprons and fan remnants at higher elevations bordering this site. Blackbrush (Coleogyne ramosissima), Joshua tree (Yucca brevifolia var. brevifolia) and big galleta (Pleuraphis rigida) dominate.
R030XB183CA	**Loamy Very Deep Fan Remnants** This ecological site is found on fan remnants adjacent to this site. Blackbrush (Coleoygne ramosissima) and creosote bush (Larrea tridentata) dominate.

Similar sites

R030XB173CA	**Coarse Loamy Very Deep Fan Remnants** This ecological site is found on upper fan aprons and fan remnants, and tends to occur at slightly higher elevations. Soils have an argillic horizon. Blackbrush (Coleogyne ramosissima) is a dominant species and creosote bush (Larrea tridentata) is trace if present.
R030XB230CA	**Very Rarely Flooded Deep Fan Remnants** R030XB230CA occurs on fan aprons in the eastern Mojave Desert. Jaeger's Joshua tree is a dominant species and Joshua tree is not present. Production is higher.

R030XB192CA	**Very Rarely Flooded, Warm Thermic Fan Piedmonts** This ecological site is found on fan aprons with very rare to occasional sheet-flow. Desertsenna (Senna armata) and jojoba (Simmondsia chinensis) are important species.

Table 1. Dominant plant species

Tree	(1) *Yucca brevifolia*
Shrub	(1) *Larrea tridentata*
Herbaceous	(1) *Pleuraphis rigida*

Physiographic features

This ecological site occurs on fan aprons and fan aprons over fan remnants at elevations of 2950 to 4625 feet. Slopes may range from 2 to 15 percent, but slopes of 2 to 8 percent are typical. Flooding frequency (sheetflow from flashflooding events) is none to very rare, and is of extremely brief duration. Runoff class is very low.

Table 2. Representative physiographic features

Landforms	(1) Fan apron
Flooding duration	Extremely brief (0.1 to 4 hours)
Flooding frequency	None to very rare
Ponding frequency	None
Elevation	899–1,410 m
Slope	2–15%
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 4 to 7 inches with most falling as rain from November to March. Mean annual air temperature ranges from 55 to 68 degrees F. June, July and August can experience average maximum temperatures of 100 degrees F while December and January can have average minimum temperatures near 20 degrees F. The frost free period ranges from 210 to 320 days.

Maximum and minimum monthly climate data for this ESD were generated by the Climate Summarizer (http://www.nm.nrcs.usda.gov/technical/handbooks/nrph/Climate_Summarizer.xls) using data
from the following climate stations (results are weighted averages; numbers in square brackets represent relative weights):

44405 JOSHUA TREE, CA (Period of record = 1959 to 2011) [1]

LTHC1 Lost Horse, Joshua Tree National Park (Period of record = 1991 to 2011) [2]

44467 Kee Ranch, CA (Period of record = 1948 to 1979) [1]

The data from multiple weather were combined to most accurately reflect the climatic conditions of this ecological site. The Lost Horse weather station is closest to this ecological site but is limited by the number of years data was collected. The Joshua Tree weather station is also nearby this ecological site but is at slightly lower elevation, and is lacking precipitation data for the years between 1975 and 2008. The Kee Ranch weather station contains precipitation data for all years of the period of record but has no temperature data.

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 deep to very deep and formed in alluvium derived from granite, granitoid and/or gneiss . Surface textures are sand, coarse sand and loamy sand, with gravelly sand, sand, loamy sand and sandy loam beneath. For rock fragments less than 3 inches in diameter, the percent surface cover is 40 to 80 percent, and larger fragments range from 0 to 1 percent. Subsurface volume of rock fragments less than 3 inches in diameter ranges from 2 to 22 percent, and larger fragments range from 0 to 1 percent (subsurface fragments by volume for a depth of 0 to 59 inches). Soils are well to somewhat excessively drained, and permeability is moderate to rapid.

This ecological site is associated with the following soil series: Morongo (mixed, thermic Typic Torripsamments), Burntshack (loamy, mixed, superactive, thermic Arenic Haplargids), and Yander (mixed, thermic Typic Torripsamments), and a minor component of Arizo (sandy-skeletal, mixed, thermic Typic Torriorthents).

The Morongo soils consist of very deep layers of sand. Burntshack soils are very deep, and have an argillic horizon that occurs at depths of 20 to 39 inches below the surface. Yander soils are deep sands over weathered bedrock. Arizo soils consist of very deep, layers of very gravelly sand or coarse sand.

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

3676;Morongo loamy sand, 2 to 4 percent slopes;Morongo;loamy sand, very rarely flooded;80
3611;Burntshack association, 2 to 15 percent slopes;Burntshack;sand surface;50; Burntshack;;35; Morongo;very rarely flooded;10
3677;Morongo sand, 2 to 4 percent slopes;Morongo;very rarely flooded;8
3681;Morongo-Jumborox complex, 4 to 8 percent slopes, warm;Morongo;very rarely flooded;50; Morongo;very rarely flooded,strongly sloping;;5; Yander;very rarely flooded;4
4245;Bluecut-Morongo-Yander association, 2 to 8 percent slopes;Morongo;very rarely flooded;25; Yander;very rarely flooded;15
4605;Pinecity complex, 2 to 8 percent slopes;Morongo;very rarely flooded;2
4606;Pinecity-Rock outcrop association, 4 to 15 percent slopes;Morongo;very rarely flooded;5
4607;Pinecity sand, 4 to 8 percent slopes;Morongo;very rarely flooded;5
3345;Bigcanyon association, 30 to 75 percent slopes;Arizo;very rarely flooded;1

Table 4. Representative soil features

Parent material	(1) Alluvium–granite
Surface texture	(1) Sand (2) Coarse sand (3) Loamy sand
Family particle size	(1) Sandy
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderate to rapid
Soil depth	99 cm
Surface fragment cover <=3"	40–80%
Surface fragment cover >3"	0–1%

Available water capacity (0-101.6cm)	3.81–8.64 cm
Calcium carbonate equivalent (0-101.6cm)	0–5%
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)	6–8.4
Subsurface fragment volume <=3" (Depth not specified)	2–22%
Subsurface fragment volume >3" (Depth not specified)	0–1%

Ecological dynamics

Abiotic Drivers

This ecological site occurs on fan aprons and fan aprons over fan remnants at elevations of 2950 to 4590 feet. Creosote bush, big galleta, and Joshua tree dominate the site. This ecological site spans the climatic window over which creosote bush co-occurs with dense Joshua tree woodland; at the lower elevation range of this ecological site the vegetation transitions to creosote – burrobush dominated communities, and at the upper elevation range the vegetation transitions to blackbrush – creosote and blackbrush – Joshua tree dominated communities.

The soils associated with this ecological site are deep to very deep with coarse sand, sand and loamy sand surface textures and sandy or sandy loam subsurface textures, and typically experience very rare sheet-flow due to flash-flooding events. In arid regions, the availability of moisture is the key resource driving the productivity and composition of vegetation (Noy-Meir 1973, McAuliffe 1994, Martre et al. 2002, Hamerlynk and McAuliffe 2003, Austin et al. 2004). Because water drains rapidly through coarse textured, sandy soils, with minimal loss due to run-off and evaporation, water availability is higher in coarse textured soils in arid regions (Noy-Meir, 1973, Austin et al. 2004). Very rare sheet flow provides additional run-on moisture that increases water availability, and provides soil disturbance, which provides opportunities for establishment of secondary, shorter-lived shrub species.

These deep, sandy soils, often with additional run-on, are optimum habitat for creosote bush, big galleta and Joshua tree. Creosote bush is a long-lived evergreen shrub that occurs throughout the Mojave, Sonoran and Chihuahuan Deserts. In the Mojave and Sonoran Deserts, creosote bush reaches maximum dominance and growth on young, coarse textured, weakly developed soils where water infiltration is rapid (McAuliffe 1994, Hamerlynk et al. 2002, Hamerlynk and McAuliffe 2003, 2008). Creosote cover and biomass is also greater in areas receiving rare and diffuse additional run-on (Schwinning et al. 2010). (Note: although the Burntshack soils are classified as Haplargids with a loamy particle size control section, they are Arenic Haplargids, with 30 inches of rapidly draining sand overlying the argillic horizon (2Bt1). Further, the 2Bt1 is 47 inches thick and has only weak clay accumulation).

Big galleta is a very drought-tolerant C4 grass that occurs on a range of soil types, but is dominant only on sandy soils (McAuliffe 1994). Big galleta exhibits rapid growth in response to warm season moisture, with growth highest in sandy soils where soil moisture is most readily available (Austin et al. 2004). Big galleta cover and biomass also increases in areas receiving additional run-on (NRCS data).

Joshua tree is an arborescent monocot with a shallow, fibrous root system. Like other desert succulents, Joshua tree is able to utilize brief, intermittent moisture near the soil surface by employing high hydraulic conductance in older, proximal root regions that are located closest to the soil surface and are the first to intercept water (North and Baker 2007). Joshua tree also has a contractile root zone that allows individuals to maintain root contact with the soil by pulling the plant into the soil during drought (North and Baker 2007). Both of these adaptations are more effective in sandy soils where water is more readily available, and where the soil poses less resistance to roots.

Disturbance Dynamics

The primary disturbances influencing this ecological site are drought, invasion by non-native annual plants, and fire, all of which interact. Drought is an important shaping force in Mojave Desert plant communities (Webb et al. 2003, Bowers 2005, Hereford et al. 2006, Miriti et al. 2007). 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 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.

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). Annual grass cover and production is directly related to winter precipitation (Beatley 1969, Brooks and Berry 2006, Hereford et al. 2006, Allen et al. 2009, DeFalco et al. 2010, Rao and Allen 2010), and several years of drought may reduce the abundance of non-native annuals in the soil sandbank (Minnich 2003). Non-native annual cover and biomass is highest on sandy soils (Rao et al. 2010), because of the higher availability of water in these soils (Noy-Meir, 1973, Austin et al. 2004). This ecological site is especially susceptible to high densities and production of invasive annuals.

Invasion by non-native annual grasses has increased the flammability of Mojave Desert vegetation communities by providing a continuous fine fuel layer between widely spaced shrubs (Minnich, 1986, Brooks 1999, Brooks et al. 2004, Rao and Allen 2010, Rao et al. 2010). After fire, these communities appear to be more susceptible to invasion by exotic grasses, leading to a grass-fire cycle (D'Antonio and Vitousek 1992). Productive stands of big galleta may also fuel fire (Minnich 2003, Brooks et al. 2007). This site is particularly susceptible to fire due to its invasibility by non-native annual grasses and productive big galleta.

State and transition model

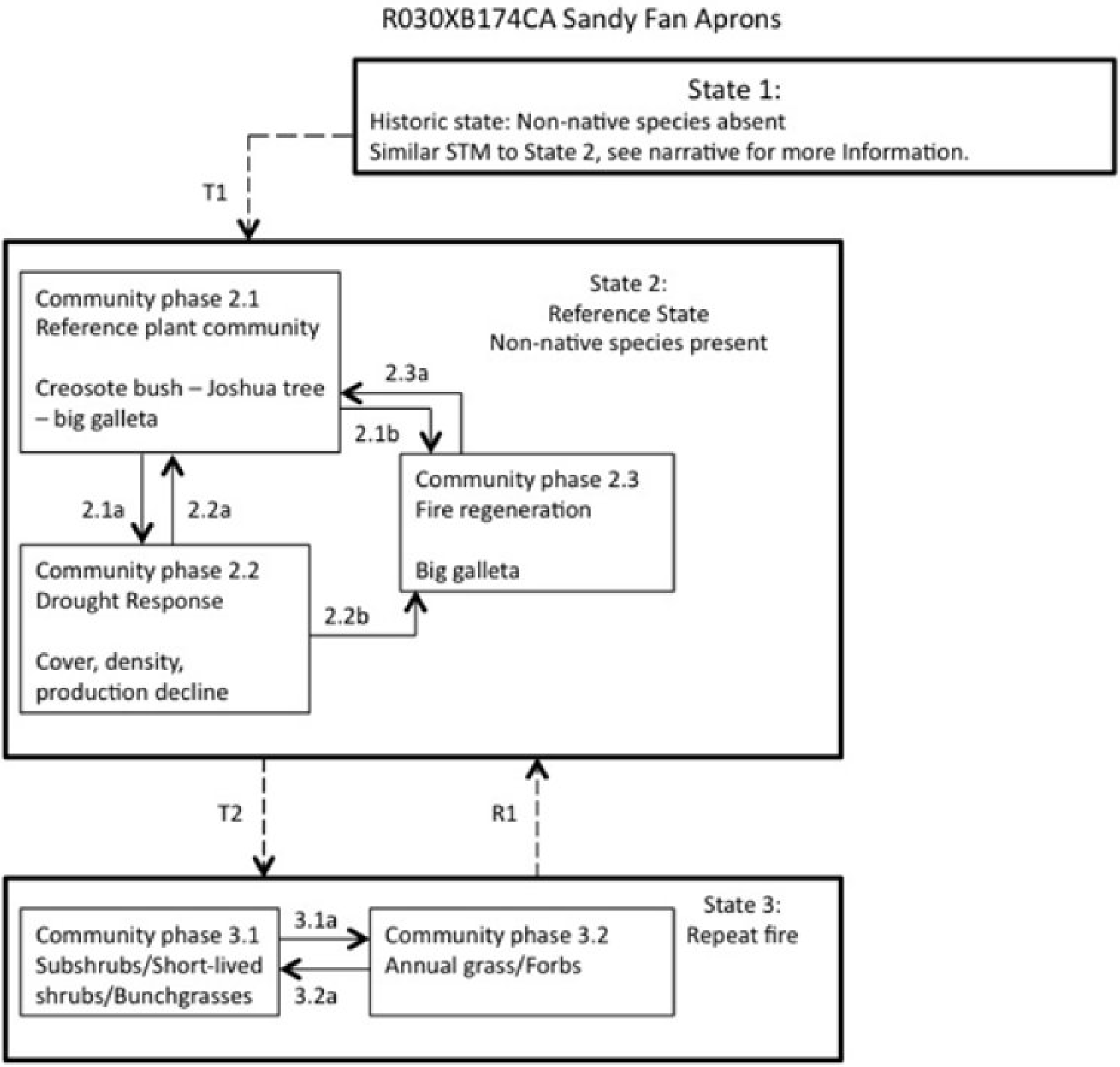

Figure 4. R030XB174CA

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 rare fire were the natural disturbances influencing this ecological site. Fire would have been a very rare occurrence due to the lack of a continuous fine fuel layer between shrubs (Webb 1987, Brooks et al. 2007). Creosote bush is generally killed by fire, and is slow to re-colonize burned areas due to specific recruitment requirements (Brown and Minnich 1986, Brooks et al. 2007, Steers and Allen 2011). Creosote bush communities in the Mojave desert may resemble the natural range of variation found in pre-fire conditions in terms of species composition in as little as nineteen years (Engel and Abella 2011), but creosote communities in the Colorado Desert may show little recovery after 30 years (Steers and Allen 2011). The timing and severity of fire, as well as post-fire climate conditions determines trajectories of recovery (Brown and Minnich 1986, Steers and Allen 2011). Joshua tree suffers high mortality after fire, (Minnich 2003; DeFalco et al. 2010), but with the very long fire return intervals characteristic of the Historic State, recovery to pre-burn densities would have occurred. Data for this State does not exist, but dynamics and composition 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 5. Community Phase 2.1

The reference plant community is maintained by periods of average climatic conditions and the absence of fire. It is co-dominated by creosote bush, Joshua tree, and big galleta. Mojave yucca (*Yucca schidigera*), eastern Mojave buckwheat (*Eriogonum fasciculatum*), white ratany (*Krameria grayi*), Nevada ephedra (*Ephedra nevadensis*), range ratany (*Krameria erecta*) and burrobush (*Hymenoclea salsola*) are typically present as secondary shrubs, and burrobush (*Ambrosia dumosa*) is often present at lower elevation ranges. A diverse assemblage of native winter annuals may be present, including but not limited to pincushion flower (*Chaenactis fremontii*), bristly fiddleneck (*Amsinckia tessellata*), curvenut combseed (*Pectocarya recurvata*), whitemargin sandmat (*Chamaesyce albomarginata*), miniature woollystar (*Eriastrum diffusum*) and smooth desert dandelion (*Malacothrix glabrata*). Red-stem stork’s bill is typically present. Red brome is present at moderate levels (10 to 80 pounds per acre) following adequate winter precipitation. The native annual grasses sixweeks grama (*Bouteloua barbata*) and needle grama (Bouteloua aristoides) may be abundant following summer precipitation events, as may the native summer annual forb manybristle chinchweed (Pectus papposa). One or multiple years of heavy winter precipitation such as occurs during El Niño events (Hereford et al. 2006) leads to a heavy standing crop of non-native and native annuals in intershrub spaces, providing a continuous fine fuel layer that puts this community at high risk of fire. Native annuals may fuel fire (Brown and Minnich 1986, Minnich 2003), but pose a threat only in the first dry year following a wet year (Minnich 2003). The thatch created from non-native annual grasses is much slower to break down, and can create high-risk fire conditions for several years following heavy precipitation (Minnich 2003, Brooks and Matchett 2006, Brooks et al. 2007, Rao et al. 2010). Years of heavy summer or early fall precipitation that lead to high production in big galleta also increases fire risk (Minnich 2003). Unlike the historic state, where fire return intervals were long enough to allow for recovery of burned communities, fire in the reference state may trigger a cycle of increased fire frequency, which may lead to transition to a new state characterized by the absence of creosote bush and Joshua tree. However, if the burned community remains undisturbed for a long enough time period, the natural community will eventually recover.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	112	191	241
Grass/Grasslike	34	67	219
Forb	–	45	67
Tree	1	6	11
Total	**147**	**309**	**538**

Community 2.2
Drought Response

This community phase is characterized by an overall decline in cover due to branch-pruning and lack of recruitment of longer-lived species, mortality of shorter-lived perennials, and lack of emergence of annual forbs and grasses. Joshua tree and big galleta are likely to decline due to drought-induced mortality, while creosote bush remains stable. We do not have data to support this community phase, and this description is based on research. Creosote bush is an evergreen species capable of utilizing moisture at any time of the year. This ability buffers populations from the effects of drought that occur as the absence of the winter rains (the primary source of moisture for this ecological site). Further, creosote bush germinates in response to moisture during the warm season, so may still recruit if warm season rains occur during winter drought (Hereford et al. 2006). Creosote bush exhibits branch-pruning during severe drought, but mortality during drought in the Mojave Desert is very low (Webb et al. 2003, Hereford et al. 2006). Joshua tree may suffer relatively high mortality rates during severe drought, especially in drier parts of its range, such as this ecological site. DeFalco et al. (2010) measured 26 percent mortality in Joshua trees growing in undisturbed vegetation in Joshua Tree National Park during drought in the early 2000s. However, long-term monitoring in the northern portion of the range of Joshua tree showed a net increase in Joshua trees size and density over a thirty-six year period (Webb et al. 2003) that included periods of drought. Modeling has predicted loss of Joshua tree from southern, warmer and drier regions of its current range, with extension into northern areas under future climate change scenarios (Dole et al. 2003), which appears to be supported by the differing effects of drought observed in the southern and northern extensions of the Joshua tree range. Joshua tree recruitment is likely to be negatively impacted by drought. Joshua tree recruitment is a rare phenomenon, with fruit set occurring irregularly, and seed germination dependent on soil moisture (Esque et al. 2010). Demographic monitoring of Joshua tree throughout Mojave Desert National Parks has found virtually no recruitment over the last several years (Esque et al. 2010). Joshua trees depend on rodents for dispersal and possibly release of seeds from hard fruit pods (Vander Wall et al. 2006), and rodent populations decline during drought (Beatley 1969, 1974). Thus, Joshua tree fruit set, seed dispersal, and seed germination is likely to decline or be absent during drought. Big galleta may suffer very high rates of drought-induced mortality (Webb et al. 2003; Hereford et al. 2006); however, big galleta can respond very quickly to brief, intermittent rain during rare summer monsoonal events, which can buffer big galleta populations in the absence of more predictable winter rains. This community is at reduced risk of burning, and if it is ignited, will experience lower severity, smaller fires because of reductions in annual and perennial biomass (Minnich 2003). However, drought immediately after a period of heavy moisture, results in standing biomass of native fuels that may carry a fire one year post-production (Minnich 2003), and standing dead biomass of non-native annuals that may provide fuel for 2 -3 years post-fire (Minnich 2003; Rao et al. 2010).

Community 2.3
Post-fire regeneration community

Figure 7. Community Phase 2.3

This community phase is characterized by severe declines in creosote bush and Joshua tree (80 to 100 percent mortality), and an increase in big galleta (10 to 50 percent increase in cover). Mortality rates are highest for younger Joshua trees that are exposed to higher fire temperatures or that have leaf ladders that allow flames to reach the canopy (DeFalco et al. 2010). Joshua tree is capable of sprouting after fire, but this is not a guarantee of survival (Minnich 2003; DeFalco et al. 2010). If drought follows fire, individuals that initially survived are subject to increased herbivory, which often causes mortality (DeFalco et al. 2010). Recruitment of Joshua tree is negatively impacted by fire (DeFalco et al. 2010), because of a loss of shrub cover that acts to facilitate seedling establishment (Brittingham and Walker 2000), and because of declines in rodent populations due to the loss of vegetation structure (Vamstad 2009). Thus, fire may shift Joshua tree communities towards a sparse cover of older, taller populations of Joshua tree with little recruitment or chance of survival beyond the Joshua tree lifespan (DeFalco et al. 2010). Initially, the post-burn community is dominated by big galleta, non-native grasses (*Bromus rubens*), native annuals and native subshrubs. Native annuals likely to be present include desert dandelion, bristly fiddleneck, and pincushion flower but many different species could be at a particular site. Subshrubs that often become dominant after fire include desert globemallow (*Sphaeralcea ambigua*), desert trumpet (*Eriogonum inflatum*), brownplume wirelettuce (*Stephanomeria pauciflora*), and desert marigold (*Baileya multiradiata*). With time, shrub cover increases with the recovery of species capable of resprouting (including Mojave yucca, white ratany, Mexican bladdersage [*Salazaria mexicana*], Nevada ephedra [*Ephedra nevadensis*], water jacket [*Lycium andersonii*], and Mojave cottonthorn [*Tetradymia stenolepis*], and colonization by short-lived shrubs from off-site dispersal (including Cooper's goldenbush, burrobush, eastern Mojave buckwheat, white bursage). As shrub cover increases, safe sites for creosote bush and Joshua tree recruitment increases, and as vegetation structure becomes more complex, rodent populations important for the dispersal and recruitment of Joshua tree increase (Vamstad 2009), facilitating colonization. With a long period of time without fire, creosote bush begins to regain dominance as shorter-lived species die out (Vasek 1983, Abella 2009, Vamstad 2009). This community is an at-risk phase, as the increased cover and biomass of big galleta and non-native annual grasses increases the likelihood of repeat burning (D'Antonio and Vitousek 1992, Brooks et al. 2004, Brooks and Matchett 2006). If the fire return interval is less than 20 years, this community is very likely to transition to State 3.

Table 6. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Forb	56	196	336
Grass/Grasslike	45	67	202
Shrub/Vine	6	13	22
Tree	–	1	3
Total	**107**	**277**	**563**

Pathway 2.1a
Community 2.1 to 2.2

This pathway occurs with prolonged or severe drought.

Pathway 2.1b
Community 2.1 to 2.3

Reference Plant Community

Post-fire regeneration community

This pathway occurs with moderate to severe fire.

Pathway 2.2a
Community 2.2 to 2.1

This pathway occurs with a return to average or above average precipitation.

Pathway 2.2b
Community 2.2 to 2.3

This pathway occurs with moderate to severe fire, and takes place within three years of a very wet period. At longer than three years of drought, the community is at low risk of burning.

Pathway 2.3a
Community 2.3 to 2.1

Post-fire regeneration community

Reference Plant Community

This pathway occurs with time without fire.

State 3
Repeat fire

This state develops when the fire return interval is less than 20 years. This state has been significantly altered from the natural range of variability found in States 1 and 2. Creosote bush and Joshua tree are lost, and big galleta, non-native annual grasses, native sub-shrubs, and short-lived shrubs dominate the community. Annual grasses and forbs are abundant immediately post-fire, with dominance by big galleta, subshrubs and short-lived perennials several years post-fire.

Community 3.1
Subshrubs/Short-lived shrubs

This community phase develops with time without fire (5-20 years), and is dominated by big galleta, subshrubs (desert globemallow, desert trumpet, brownplume wirelettuce and desert marigold) and short-lived shrubs (Cooper's goldenbush, snakeweed species, burrobush, eastern Mojave buckwheat). Longer-lived shrubs that have resprouted may be patchily present. There is high cover of non-native and native annuals during wet years. This community is at high risk of repeat burning due to high cover of fine fuels.

Community 3.2
Annual grass/forbs

This community phase typically occurs one to five years post-fire. The community is dominated by non-native annual species including red brome, cheatgrass, Mediterranean grass and red-stem stork's bill, and native forbs, including desert dandelion, bristly fiddleneck and pincushion flower (many other native forbs could also be present). Native subshrubs including globemallow, desert trumpet, brownplume wirelettuce and desert marigold may be abundant. Big galleta cover is high, and there may be very sparse cover of resprouting shrubs including Mojave yucca, water jacket, catclaw acacia and Nevada ephedra. Seedlings of short-lived shrubs may be present, and may include Cooper's goldenbush, snakeweed species (Gutierrezia spp.), burrobush, eastern Mojave buckwheat and rayless goldenhead (*Acamptopappus sphaerocephalus*). This community is at high-risk of repeat burning due to high fine fuel cover. This community is also susceptible to wind and water erosion, due to the loss of stabilizing shrub cover (Bull 1997). This can lead to arroyo development near ephemeral drainage channels. Furthermore, the loss of vegetation structure present in the historic and reference state decreases the suitability of this habitat for wildlife (Brooks et al. 2007, Vamstad 2009). Since rodent seed caching is important for the dispersal and establishment of many desert species this can further inhibit recovery.

Pathway 3.1a
Community 3.1 to 3.2

This pathway occurs with fire.

Pathway 3.2a
Community 3.2 to 3.1

This pathway occurs with time without fire (> 5 years).

Transition T1
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. Post-settlement cattle and sheep grazing, as well as dryland farming, helped to spread and facilitate their establishment (Brooks and Pyke 2000, Brooks et al. 2007).

Transition 2
State 2 to 3

This transition occurs when the fire return interval is less than 20 years.

Restoration pathway 1
State 3 to 2

Restoration of communities severely altered by repeat fire at the landscape scale is difficult. Methods may include aerial seeding of early native colonizers such as desert globemallow, desert trumpet, brownplume wirelettuce, desert marigold, and big galleta. Increased native cover may help to reduce non-native plant invasion, helps to stabilize soils, provides a source of food and cover for wildlife, including desert tortoise (Gopherus agassizii), and provides microsites that facilitate creosote bush and Joshua tree establishment. However, the amount of seed required for success is often prohibitive. Large-scale planting of both early colonizers and community dominants tends to be more successful in terms of plant survival, especially if outplants receive supplemental watering during the first two years. Creosote bush and Joshua tree can be successfully propagated from seed for outplanting. Pre-emergent herbicides (Plateau) have been used in the year immediately post-fire to attempt to inhibit or reduce brome invasion. How successful this is on a landscape scale, and the non-target effects have not yet been determined.

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**			112–241	
	creosote bush	LATR2	*Larrea tridentata*	56–101	5–10
	burrobrush	HYSA	*Hymenoclea salsola*	11–45	0–2
	white ratany	KRGR	*Krameria grayi*	11–39	2–4
	Mojave yucca	YUSC2	*Yucca schidigera*	11–34	0–2
	Nevada jointfir	EPNE	*Ephedra nevadensis*	6–22	1–3
	burrobush	AMDU2	*Ambrosia dumosa*	0–17	0–3
	Eastern Mojave buckwheat	ERFA2	*Eriogonum fasciculatum*	6–11	0–1
Tree					
2	**Trees**			1–11	
	Joshua tree	YUBR	*Yucca brevifolia*	1–11	0–2
Grass/Grasslike					
3	**Perennial grasses**			34–219	
	big galleta	PLRI3	*Pleuraphis rigida*	34–129	4–15
	desert needlegrass	ACSP12	*Achnatherum speciosum*	0–2	0–1
5	**Non-native annual grasses**			0–90	
	red brome	BRRU2	*Bromus rubens*	0–90	0–4
Forb					
4	**Native forbs**			0–67	
	smooth desertdandelion	MAGL3	*Malacothrix glabrata*	0–28	0–4
	bristly fiddleneck	AMTE3	*Amsinckia tessellata*	0–22	0–4
	pincushion flower	CHFR	*Chaenactis fremontii*	0–11	0–3
	miniature woollystar	ERDI2	*Eriastrum diffusum*	0–1	0–1
	whitemargin sandmat	CHAL11	*Chamaesyce albomarginata*	0–1	0–1
	curvenut combseed	PERE	*Pectocarya recurvata*	0–1	0–1
6	**Non-native annual forbs**			0–11	
	redstem stork's bill	ERCI6	*Erodium cicutarium*	0–11	0–2

Table 8. Community 2.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
1	**Native shrubs**			6–22	
	Nevada jointfir	EPNE	*Ephedra nevadensis*	0–17	0–3
	water jacket	LYAN	*Lycium andersonii*	0–4	0–1
	Mexican bladdersage	SAME	*Salazaria mexicana*	0–4	0–1
	Mojave cottonthorn	TEST2	*Tetradymia stenolepis*	0–2	0–1
	burrobrush	HYSA	*Hymenoclea salsola*	0–2	0–1
Grass/Grasslike					
2	**Native perennial grasses**			22–73	
	big galleta	PLRI3	*Pleuraphis rigida*	22–73	3–11
5	**Non-native annual grasses**			0–135	
	red brome	BRRU2	*Bromus rubens*	0–67	0–6
	cheatgrass	BRTE	*Bromus tectorum*	0–34	0–4
	common Mediterranean grass	SCBA	*Schismus barbatus*	0–34	0–2
Forb					
3	**Native forbs**			56–336	
	pincushion flower	CHFR	*Chaenactis fremontii*	0–90	0–3
	Forb, annual	2FA	*Forb, annual*	0–67	0–2
	bristly fiddleneck	AMTE3	*Amsinckia tessellata*	0–67	0–2
	small wirelettuce	STEX	*Stephanomeria exigua*	0–22	0–1
	chuckwalla combseed	PEHE	*Pectocarya heterocarpa*	0–11	0–1
Tree					
4	**Trees**			0–4	
	Joshua tree	YUBR	*Yucca brevifolia*	0–4	0–1

Animal community

This ecological site has some of the highest densities of Joshua tree in existence (Esque et al. 2010). Joshua tree is a keystone species of the Mojave Desert. It is the tallest and largest plant of mid to low elevation plant communities (excluding drainageways and springs), and as such, is vital in providing food, shelter and structure to wildlife (Smith 1983, Pavlik 2008, Esque et al. 2010). The branches of Joshua Tree provide nesting sites for over twenty species of birds. The yucca moth (Tegeticula synthetica) shares an obligate mutualism with Joshua tree (Pellmyr 2003, Smith et al. 2009). The preferred food of the yucca weevil (Scyphophorus yuccae) are apical meristems at the terminus of each branch of the Joshua Tree (Pavlik 2008). The Navaho giant yucca skipper butterfly (Megathymus yuccae navajo) lay their eggs in the underground sprouts of Joshua tree rhizomes (Pavlik 2008).

The following reptile and mammal species are likely to be encountered in this ecological site (based on habitat preferences):

REPTILES:
Desert banded Gecko (Coleonyx variegatus variegatus)
Long-nosed leapard lizard (Gambelia wislizenii wislizenii)
Mojave zebra-tailed lizard (Callisaurus draconoides rhodostictus)
San Diego horned lizard (Phrynosoma coronatum blainvillii)
Southern deserthored lizard (Phrynosoma platyrhinos calidiarum)
Yellow-backed spiny lizard (Sceloporus magister uniformus)
Western brush lizard (Urosaurus graciosus graciosus)

Desert side-blotched lizard (Uta stansburiana stejnegeri)
Desert night lizard (Xantusia vigilis vigilis)
Silvery legless lizard (Anniella pulchra pulchra)
Mojave glossy snake (Arizona occidentalis candida)
Desert glossy snake (Arizona occidentalis eburnata)
Mojave shovel-nosed snake (Chionactis occipitalis occipitalis)
California kingsnake (Lampropeltis getula californae)
Red coachwhip (Masticophis flagellum piceus)
Western leaf-nosed snake (Phyllorynchus decurtatus perkinsi)
Great Basin gopher snake (Pituophis catenifer deserticola)
Western long-nosed snake (Rhinocheilus lecontei lecontei)
Mojave patch-nosed snake (Salvadora hexalepis mojavensis)
Smith's black-headed snake (Tantilla hobartsmithi)
Mojave Desert sidewinder (Crotalus cerastes cerastes)
Red diamond rattlesnake (Crotalus ruber ruber)
Mojave rattlesnake (Crotalus scutulatus scutulatus)

MAMMALS:
Long-tailed weasel (Mustela latirosta)
California desert bat (Myotis californicus stephensi)
Western pipistrelle (Pipistrellus hesperus hesperus)
Desert big brown bat (Eptesicus fuscus pallidus)
Pallid bat (Antrozous pallidus minor)
Desert coyote (Canis macrotis arsipus)
Common kit fox (Vulpes macrotis arsipus)
Southern Desert cottontail (Sylvilagus audobonii arizonae)
Desert blacktail jackrabbit (Lepus californicus deserticola)
Whitetail antelope squirrel (Ammospermphilus leucurus leucurus)
Mojave pocket gopher (Thomomys bottae mojavensis)
Coachella pocket gopher (Thomomys bottae rupestris)
Pallid (San Diego) pocket mouse (Chaetodipus fallax pallidus)
Mojave little pocket mouse (Perognathus longimembris longimembris)
Merriam's kangaroo rat (Dipodomys deserti)
Desert wood rat (Neotoma fuscipes simplex)
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 is used for hiking and aesthetic enjoyment. It includes some of the highest densities of Joshua tree which is an iconic species of the Mojave Desert.

Other products

Joshua tree leaves are used by the Cahuilla for making ropes, baskets, sandals, clothing and mats. Red and black dyes are obtained from the roots (http://herb.umd.umich.edu/herb/search.pl?searchstring=Yucca+brevifolia).

Flowers and fruit pods of Joshua tree are used as food by the Cahuilla (http://herb.umd.umich.edu/herb/search.pl?searchstring=Yucca+brevifolia).

The Cahuilla use creosote stems and leaves to make a medicinal tea. A solution was also may be applied to open wounds to draw out poisons (http://www.malkimuseum.org/garden.htm).

Inventory data references

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

Community Phase 2.1:
124975503
12497-125-07 (Type location)
12497055B

Community Phase 2.3:
12497-201-02
G10

Type locality

Location 1: San Bernardino County, CA	
UTM zone	N
UTM northing	3758570
UTM easting	584684
General legal description	The type location is approximately two miles north of Malapai Hill, and one third of a mile west of Geology Tour Road in Joshua Tree National Park.

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Contributors

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Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

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

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

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

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

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

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

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

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

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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

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

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

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

17. **Perennial plant reproductive capability:**