USDA Natural Resources Conservation Service

Ecological site R030XB173CA
Coarse Loamy Very Deep Fan Remnants

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General information

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

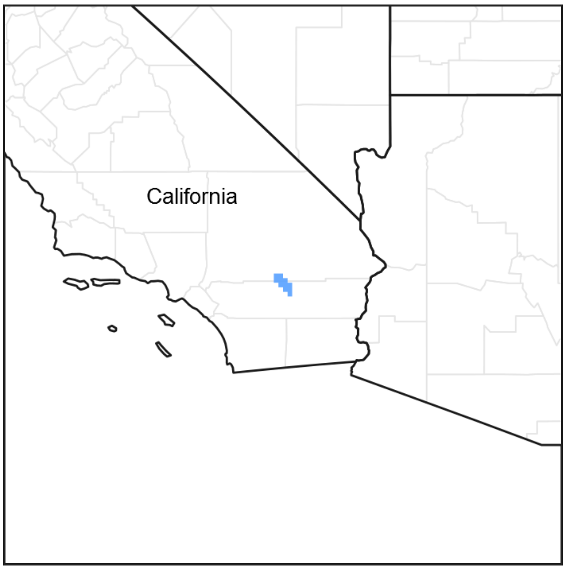

Figure 1. Mapped extent

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 gently sloping fan remnants at elevations of 3510 to 4590 feet. Soils are very deep, with sand and loamy sand surface texture and loamy sand or sandy loam subsurface textures.

Production reference value (RV) is 610 pounds per acres, and ranges from 250 to 900 pounds per acre, with high variation due to annual forb and grass production. Blackbrush (Coleogyne ramosissima) and Joshua Tree (Yucca brevifolia var. brevifolia) dominate the site, and big galleta (Pleuraphis rigida) is an important herbaceous species. This ecological site spans the elevation zone at which Joshua tree and blackbrush can be co-dominant. At higher elevations Joshua Tree is limited by freezing temperatures, and at lower elevations blackbrush is limited by low soil moisture availability. Sandy surface horizons enhance habitat for Joshua tree and big galleta, which have shallow roots systems capable of rapidly responding to intermittently available moisture near the soil surface. Loamy soil textures increase moisture held at shallow depths during the winter wet season, which favors the dominance of blackbrush.

Data ranges in the physiographic data, climate data and soil data are based on components that are 10 percent or greater of any mapunit.

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 brevifolia Association
Yucca brevifolia/Pleuraphis rigida Association
Yucca brevifolia/Coleogyne ramosissima Association

Associated sites

R030XB166CA	**Dissected Pediment, Cool** This ecological site is found on adjacent pediments. Blackbrush (Coleogyne ramosissima) and California juniper (Juniperus californica) dominate.
R030XB174CA	**Sandy Fan Aprons** This ecological site is found on adjacent fan aprons, typically at lower elevation. Creosote bush (Larrea tridentata), Joshua tree (Yucca brevifolia var. brevifolia) and big galleta (Pleuraphis rigida) dominate.

Similar sites

R030XB183CA	**Loamy Very Deep Fan Remnants** R030XB183CA occurs on stable landform positions with less surface sand. Creosote bush (Larrea tridentata) is a dominant species, and big galleta (Pleuraphis rigida) and Joshua tree (Yucca brevifolia var. brevifolia) are minor species if present.
R030XB174CA	**Sandy Fan Aprons** R030XB174CA occurs at slightly lower elevations, and typically has very rare sheet-flooding. Blackbrush (Coleogyne ramosissima) is not present, and creosote bush (Larrea tridentata) is a dominant species.
R030XB168CA	**Cool Deep Sandy Fans** This ecological site occurs at slightly higher elevations, or otherwise moister landform positions. Production is higher, California juniper (Juniperus californica) is a dominant species.

Table 1. Dominant plant species

Tree	(1) *Yucca brevifolia*
Shrub	(1) *Coleogyne ramosissima*

Herbaceous	(1) *Pleuraphis rigida*

Physiographic features

This ecological site is found on fan remnants at elevations of 3510 to 4590 feet and slopes ranging from 2 to 8 percent. Runoff class is very low to medium.

Table 2. Representative physiographic features

Landforms	(1) Fan remnant
Flooding frequency	None
Ponding frequency	None
Elevation	1,070–1,399 m
Slope	2–8%
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 is 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 was 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 very deep and formed in alluvium derived from granite and gneiss. Surface textures are sand, loamy sand and gravelly loamy sand, with gravelly loamy sand, sandy loam and gravelly sandy loam beneath. For rock fragments less than 3 inches in diameter, the percent surface cover is 15 to 40 percent, with no larger fragments typically present. Subsurface volume of rock fragments less than 3 inches in diameter ranges from 1 to 20 percent, and larger fragments range from 0 to 3 percent (subsurface fragments by volume for a depth of 0 to 59 inches). Soils are well drained, and permeability is moderately rapid.

This ecological site is associated with the following soil series: Jumborox (coarse-loamy, mixed, superactive, thermic Typic Haplargids) and Nasagold (coarse-loamy, mixed, superactive, thermic Typic Haplocambids).

The Jumborox soils have an argillic horizon that begins at depths of 5 to 10 cm, and the combined thickness of the argillic horizon is 35 cm to greater than 50 cm (Bt1, Bt2 and Bt3 horizons). The Nasagold soils consist of sandy loam horizons that qualify as cambic horizons.

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

3690;Nasagold gravelly loamy sand, 2 to 4 percent slopes;Nasagold;;85
3681;Morongo-Jumborox complex, 4 to 8 percent slopes, warm;Jumborox;dry;35
3676;Morongo loamy sand, 2 to 8 percent slopes;Jumborox;dry;10
4606;Pinecity-Rock outcrop association, 4 to 15 percent slopes;Jumborox;warm;5
4605;Pinecity complex, 2 to 8 percent slopes;Nasagold;;4

Table 4. Representative soil features

Parent material	(1) Alluvium–granite
Surface texture	(1) Sand (2) Loamy sand (3) Gravelly loamy sand
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderately rapid
Soil depth	150 cm
Surface fragment cover <=3"	15–40%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	6.35–11.94 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)	6.1–8.4
Subsurface fragment volume <=3" (Depth not specified)	1–20%
Subsurface fragment volume >3" (Depth not specified)	0–3%

Ecological dynamics

Abiotic Factors

This ecological site occurs on fan remnants and fan aprons at elevations of 3510 to 4650 feet. Blackbrush and Joshua tree dominate the site, and big galleta is an important herbaceous species. Creosote bush may be an important species at the lower elevation range of this site, and California juniper may occur as a trace species at the upper elevation ranges. This ecological site spans the climatic window over which Joshua tree and blackbrush co-occur as community dominants; at the lower elevation range of this ecological site the vegetation transitions to creosote bush – Joshua tree dominated communities, and at the upper elevation range the vegetation transitions to blackbrush – California juniper dominated communities.

The soils associated with this ecological site are very deep with a coarse loamy particle size control section, and sandy textures over an argillic or cambic horizon with sandy loam horizons. 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, in arid regions, water availability is higher in coarser textured soils; consequently productivity is higher on these soils than on finer textured soils (Noy-Meir, 1973, Austin et al. 2004). An argillic horizon (a subsurface horizon with a significantly higher percentage of clay than overlying soil material [NRCS Staff, 2010]) impedes drainage and root growth, and holds water closer to the soil surface, reducing deep-water storage. This can reduce the density and growth of deep-rooted shrubs while enhancing habitat for shallow-rooted shrubs (Hamerlynk et al. 2002, Hamerlynk and McAuliffe 2003).

The sandy surface textures and well-drained soils of this ecological site are optimum habitat for big galleta and Joshua tree. 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). 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 for roots to move through. Blackbrush is a shallow-rooted, long-lived, semi drought-deciduous shrub associated with the Mojave and Great Basin Deserts. It is often associated with shallow soils (Lei 2003, Meyer and Pendleton 2005), but may also be abundant on adjacent deeper soils (Anderson 2001). Here the argillic horizon or stratified sandy loam horizons act to prolong the availability of water at shallow depths during the winter wet season, which enhances blackbrush habitat.

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, 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 and trees are more likely to exhibit branch-pruning, and or limited recruitment during drought (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). Sandy surface textures and prolonged soil moisture at shallow soil depths during the winter annual growing season make this ecological site especially susceptible to high densities and production of non-native 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 (Brown and 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). Because of the high densities typical of blackbrush-dominated communities, these communities are flammable even without the presence of fine fuels (Brooks et al. 2007), and productive stands of big galleta may also fuel fire (Minnich 2003). This site is particularly susceptible to fire due to its invasibility by non-native annual grasses, productive big galleta, and moderately dense blackbrush.

State and transition model

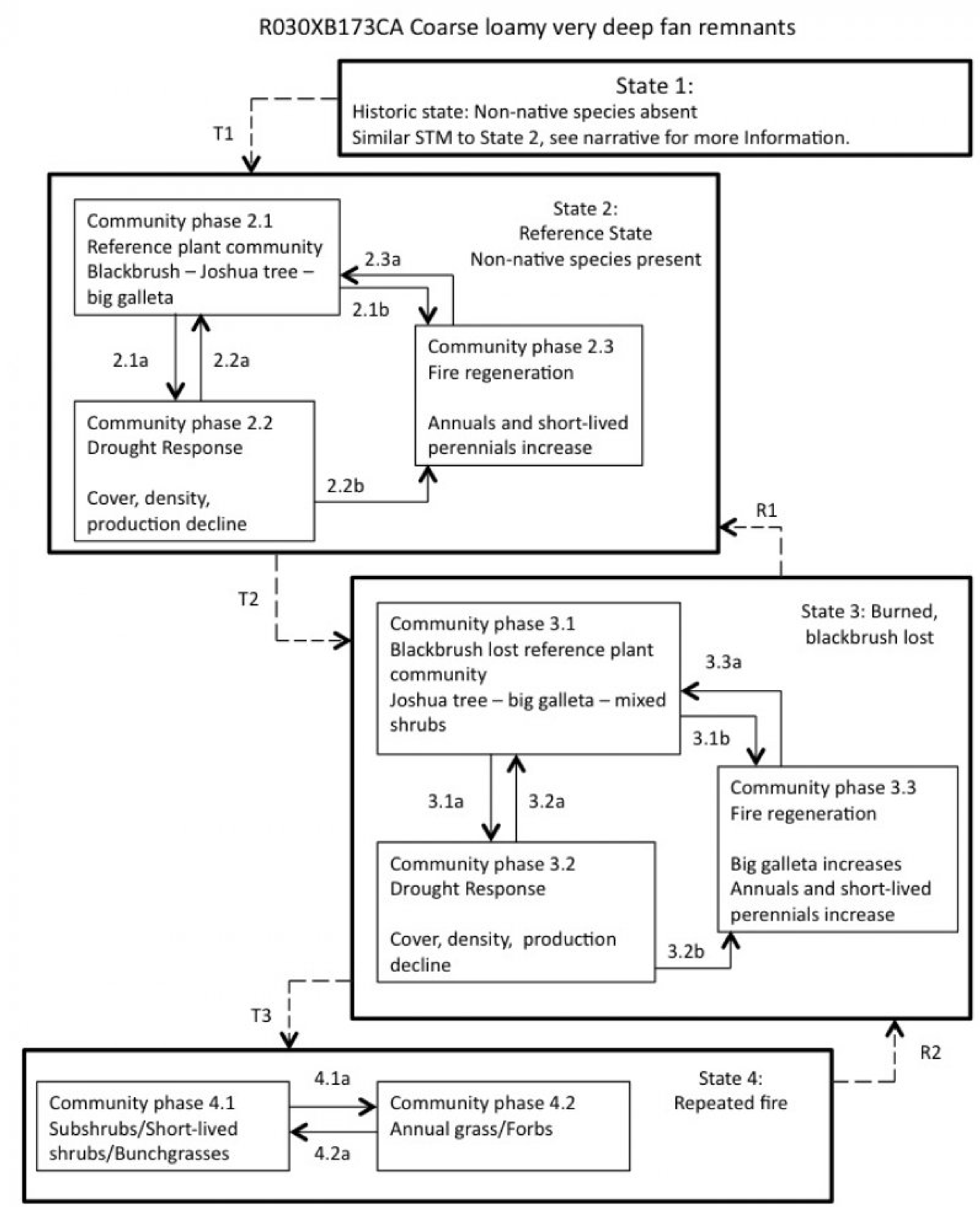

Figure 4. R030XB173CA

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 (Minnich 2003, Webb et al. 1987). Blackbrush is killed by moderate to severe fire, and the historic fire return interval is suggested to be upwards of 100 years (Webb et al. 1987, Brooks et al. 2007, Abella et al. 2009). With the absence of non-native species to fuel recurrent fires, this long fire-return interval allowed for recovery to pre-burn densities. Joshua tree suffers high mortality in response to fire (Minnich 2003; DeFalco et al. 2010), but the long historic fire return intervals allowed for recovery to pre-burn densities. 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 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 blackbrush and Joshua tree, and big galleta is an important species. Mojave yucca (*Yucca schidigera*), Nevada ephedra (*Ephedra nevadensis*) and water jacket (*Lycium andersonii*) are typically present, and creosote bush (*Larrea tridentata*) may be an important species at lower elevations. California juniper (*Juniperus californica*) may be sparsely present at higher elevations. A range of minor shrubs may be present, including but not limited to, burrobush (*Hymenoclea salsola*), catclaw acacia (*Acacia greggii*) and Cooper's goldenbush (Ericameria cooperi). A diverse assemblage of native winter annuals may be present, including but not limited to pincushion flower (*Chaenactis fremontii*), bristly fiddleneck (*Amsinckia tessellata*), chuckwalla combseed (*Pectocarya heterocarpa*), small wirelettuce (Stephanmeria exigua), and smooth desert dandelion (*Malacothrix glabrata*). Red-stem stork's bill is typically present. Red brome is present at relatively high levels (7 to 14 percent cover) following adequate winter precipitation. 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 (Minnich 2003, Brooks et al. 2007, Rao et al. 2010). Years of heavy summer or early fall precipitation that lead to high production of big galleta also increase 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, resulting in a transition to a new state characterized by the absence of blackbrush. However, if the burned community remains undisturbed for a long enough time period (100 plus years), the natural community may recover.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	135	247	359
Tree	140	247	353
Forb	–	157	224
Grass/Grasslike	6	34	73
Total	**281**	**685**	**1009**

Table 6. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-1%	3-5%	5-15%
>0.15 <= 0.3	–	5-10%	5-7%	5-15%
>0.3 <= 0.6	–	15-20%	1-2%	1-3%
>0.6 <= 1.4	–	1-2%	–	–
>1.4 <= 4	–	1-2%	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.2
Drought Response

This community phase is characterized by an overall decline in cover (10 to 15 percent) 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 blackbrush remains stable. We do not have data to support this community phase, and this description is based on research. 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, if drought immediately follows a period of heavy moisture, standing biomass of native fuels may carry a fire one year post-production (Minnich 2003), and standing dead biomass of non-native annuals may provide fuel for 2 -3 years post-fire (Minnich 2003; Rao et al. 2010). Blackbrush populations remain very stable during drought, but cover may decline due to branch-pruning (Webb et al. 2003, Pendleton and Meyer, 2004). Blackbrush is capable of utilizing soil moisture at any time of the year, which provides a buffer from the effects of winter drought (which is typical of this ecological site where the majority of precipitation comes during winter). Blackbrush recruitment is episodic, and only occurs after heavy winter and spring rain (Summers et al. 2009), so recruitment will be absent during periods of drought. 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% 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. Big galleta may suffer very high rates of drought-induced mortality (Webb et al. 2003; Hereford 2006); however, big galleta can respond very quickly to rainfall at any time of the year (Matthews 2000), so rare monsoonal rainstorms can buffer big galleta populations in the absence of more predictable winter rains.

Community 2.3
Fire regeneration community

This community phase is characterized by the loss of blackbrush, a severe decline in 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*], catclaw acacia [Acacia gregii], 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, and eastern Mojave buckwheat). As shrub cover increases, safe sites for Joshua tree recruitment increases, and as vegetation structure becomes more complex, rodent populations important for the dispersal and recruitment of Joshua tree and blackbrush increase (Vamstad 2009), and early colonization of these species may begin to occur. With a long period of time without fire (100 plus years), shorter-lived species die out and are very gradually replaced by longer-lived species (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.

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

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

This pathway occurs with time, on the order of 100 years, without fire.

State 3
Burned, blackbrush lost

This state is characterized by the loss of blackbrush from the plant community due to severe or recurrent fire.

Community 3.1
Blackbrush lost reference plant community

Figure 7. Community Phase 3.1

This community represents the reference plant community for this State. The vegetation community is dominated by big galleta, with a sparse cover of Joshua tree, and a high diversity of short- and long-lived shrubs, including Mojave yucca, Nevada ephedra, creosote bush (at lower elevations), catclaw acacia, Wiggin's cholla (*Cylindropuntia echinocarpa*), Cooper's goldenbush, eastern Mojave buckwheat, burrobush, Mexican bladdersage, turpentine broom (*Thamnosma montana*), and rayless goldenhead (*Acamptopappus sphaerocephalus*). Non-native and native annuals are seasonally abundant, and are more abundant than in the State 2 reference plant community.

Table 7. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	135	202	269
Shrub/Vine	129	140	191
Forb	9	140	191
Tree	–	9	19
Total	**273**	**491**	**670**

Community 3.2
Drought Response

This community phase is characterized by a decline in cover (10 to 15 percent) and production due to branch-pruning of long-lived shrubs, mortality of shorter-lived perennials, and lack of emergence of annual forbs and grasses. See narrative for Community Phase 2.2 for more information.

Community 3.3
Fire regeneration community

This community phase develops after a moderate to severe burn. This community phase resembles Community phase 2.3, but with even lower Joshua tree density. 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.

Pathway 3.1a
Community 3.1 to 3.2

This pathway occurs in response to prolonged or severe drought.

Pathway 3.1b
Community 3.1 to 3.3

This pathway occurs in response to moderate or severe fire.

Pathway 3.2a
Community 3.2 to 3.1

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

Pathway 3.2b
Community 3.2 to 3.3

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 3.3a
Community 3.3 to 3.1

This pathway occurs with time without fire.

State 4
Repeated fire

This state develops when the fire return interval is 5 to 20 years. This state has been significantly altered from the natural range of variability found in States 1 through 3. Blackbrush and Joshua tree have been 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 4.1
Big galleta/subshrubs

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 4.2

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. 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 gullying, loss of important topsoil, and exposure of subsurface horizons that are not conducive to plant establishment, and further degrade the site. Furthermore, the loss of vegetation structure present in States 2 and 3 reduces 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 4.1a
Community 4.1 to 4.2

This pathway occurs with fire.

Pathway 4.2a
Community 4.2 to 4.1

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

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. 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 T2
State 2 to 3

This transition occurs with extensive, severe fire when blackbrush seed sources are not available to colonize burned areas, or with recurrent fire in Community Phase 2.3.

Restoration pathway 1
State 3 to 2

Restoration of arid desert communities severely altered by repeat fire at the landscape scale is very difficult (Allen 1993). Reducing invasion of non-native grasses that increase after fire may help promote native plant recovery, and reduce the probability of repeat burning (Fuhrmann et al. 2009, Matchett et al. 2009, Steers and Allen 2010); however, accomplishing this at a landscape scale, for a time period long enough to be effective, has not yet been accomplished. In small-scale trials, Fusilade, a grass-specific herbicide, was successful in reducing invasive grasses in burned creosote bush communities in the Colorado Desert in the initial three years after fire (Steers and Allen 2010). The long-term efficacy of such treatments on a landscape scale, and non-target effects have not yet been determined. The pre-emergent herbicide Plateau was applied in conjunction with aerial seeding of natives after fire in Zion National Park (Fuhrmann et al. 2009, Matchett et al. 2009). Initial results indicate that autumn application of Plateau after fire is most effective for reducing cheatgrass (*Bromus tectorum*), but longer-term monitoring is needed to evaluate long-term and non-target effects. In addition to controlling invasive species, active recovery of native vegetation may be attempted. Methods may include seeding of early native colonizers such as desert globemallow, burrobrush, threeawns (Aristida spp.), and desert marigold (e.g. Abella et al. 2009, Abella et al. 2012). 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 blackbrush 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 (Allen 1993). Joshua tree is readily cultivated for outplanting, but blackbrush is difficult to cultivate for outplanting due to susceptibility to fungal pathogens in the greenhouse environment.

Transition 3
State 3 to 4

This transition occurs when the fire return interval in State 3 is less than 20 years.

Restoration pathway 2
State 4 to 3

See narrative for restoration pathway 1.

Additional community tables

Table 8. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
1	**Native shrubs**			135–359	
	blackbrush	CORA	*Coleogyne ramosissima*	78–179	1–15
	creosote bush	LATR2	*Larrea tridentata*	0–90	0–2
	Nevada jointfir	EPNE	*Ephedra nevadensis*	6–28	1–3
	Mojave yucca	YUSC2	*Yucca schidigera*	17–22	1–2
	water jacket	LYAN	*Lycium andersonii*	2–11	0–1
	Cooper's goldenbush	ERCO23	*Ericameria cooperi*	0–11	0–1
	burrobrush	HYSA	*Hymenoclea salsola*	0–11	0–1
	catclaw acacia	ACGR	*Acacia greggii*	0–2	0–1
Tree					
2	**Trees**			140–353	
	Joshua tree	YUBR	*Yucca brevifolia*	140–353	1–3
Grass/Grasslike					
2	**Native perennial grasses**			6–56	
	big galleta	PLRI3	*Pleuraphis rigida*	6–56	0–8
5	**Non-native annual grasses**			0–17	
	compact brome	BRMA3	*Bromus madritensis*	0–17	0–5
Forb					
4	**Native forbs**			0–224	
	Forb, annual	2FA	*Forb, annual*	0–112	0–15
	pincushion flower	CHFR	*Chaenactis fremontii*	0–112	0–10
	bristly fiddleneck	AMTE3	*Amsinckia tessellata*	0–56	0–3
	smooth desertdandelion	MAGL3	*Malacothrix glabrata*	0–6	0–1
	chuckwalla combseed	PEHE	*Pectocarya heterocarpa*	0–6	0–1
	small wirelettuce	STEX	*Stephanomeria exigua*	0–6	0–1

Table 9. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)

Table 10. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Tree					
1	**Trees**			0–19	
	Joshua tree	YUBR	*Yucca brevifolia*	0–19	0–2
Shrub/Vine					
2	**Native shrubs**			129–191	
	creosote bush	LATR2	*Larrea tridentata*	0–90	0–5
	rayless goldenhead	ACSP	*Acamptopappus sphaerocephalus*	0–22	0–2
	Mexican bladdersage	SAME	*Salazaria mexicana*	0–17	0–2
	Cooper's goldenbush	ERCO23	*Ericameria cooperi*	0–13	0–2
	California jointfir	EPCA2	*Ephedra californica*	0–13	0–1
	Mojave yucca	YUSC2	*Yucca schidigera*	0–11	0–2
	Eastern Mojave buckwheat	ERFA2	*Eriogonum fasciculatum*	0–11	0–1
	burrobrush	HYSA	*Hymenoclea salsola*	0–7	0–2
	turpentinebroom	THMO	*Thamnosma montana*	0–7	0–1
	Nevada jointfir	EPNE	*Ephedra nevadensis*	0–6	0–1
	Wiggins' cholla	CYEC3	*Cylindropuntia echinocarpa*	0–2	0–1
Grass/Grasslike					
3	**Native perennial grasses**			73–263	
	big galleta	PLRI3	*Pleuraphis rigida*	73–262	8–11
5	**Non-native annual grasses**			0–118	
	compact brome	BRMA3	*Bromus madritensis*	0–118	0–14
Forb					
4	**Native forbs**			9–191	
	small wirelettuce	STEX	*Stephanomeria exigua*	0–135	0–2
	bristly fiddleneck	AMTE3	*Amsinckia tessellata*	0–73	0–7
	pincushion flower	CHFR	*Chaenactis fremontii*	0–45	0–3
	whitedaisy tidytips	LAGL5	*Layia glandulosa*	0–15	0–2
	chia	SACO6	*Salvia columbariae*	0–15	0–1
	woolly easterbonnets	ANWA	*Antheropeas wallacei*	0–11	0–1
	brittle spineflower	CHBR	*Chorizanthe brevicornu*	0–8	0–1
	chuckwalla combseed	PEHE	*Pectocarya heterocarpa*	0–8	0–1
	New Mexico plumeseed	RANE	*Rafinesquia neomexicana*	0–1	0–1
	scented cryptantha	CRUT	*Cryptantha utahensis*	0–1	0–1
	miniature woollystar	ERDI2	*Eriastrum diffusum*	0–1	0–1
6	**Non-native annual forbs**			0–8	
	redstem stork's bill	ERCI6	*Erodium cicutarium*	0–8	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). (Smith et al. 1983, Pavlik 2008, Esque et al. 2010). Joshua tree 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 may be 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 were 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).

Inventory data references

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

Community Phase 2.1:
12497-201-17 (Type location)
12497-138-05
12497-138-08

Type locality

Location 1: San Bernardino County, CA	
UTM zone	N
UTM northing	3767317
UTM easting	575063
General legal description	The type location is seven tenths of a mile northwest of the Boyscout Trail Head Parking Lot Joshua Tree National Park.

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Rangeland health reference sheet

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

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

Indicators

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

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

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

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

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

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

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

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

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

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial**

distribution on infiltration and runoff:

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

---

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:**

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17. **Perennial plant reproductive capability:**
