Ecological site R030XB183CA
Loamy Very Deep Fan Remnants

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.

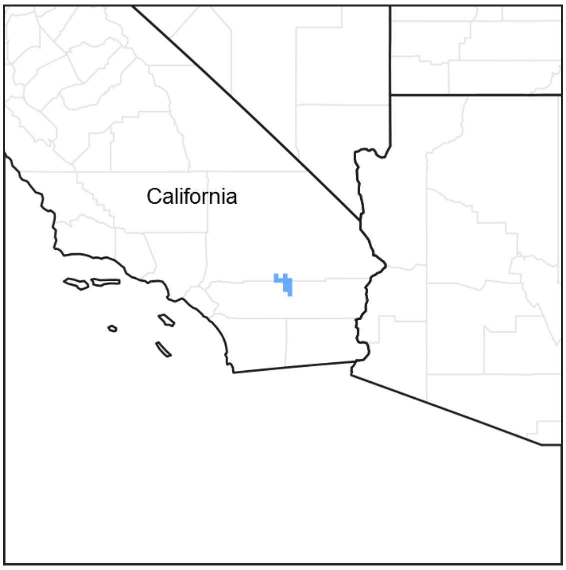

Figure 1. Mapped extent

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 is found on fan aprons, fan remnants and fan aprons over fan remnants at elevations of 2950 to 5130 feet. Soils are very deep, and typically have a well-developed argillic horizon.

The site is dominated by blackbrush (Coleogyne ramosissima) and creosote bush (Larrea tridentata). Production reference value (RV) is 304 pounds per acre and ranges from 140 to 492 pounds per acre depending on annual precipitation and annual species production. This site occurs in the climatic envelope where creosote bush and blackbrush co-occur, 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. At higher elevations, freezing temperatures inhibit creosote bush recruitment and growth. Stable landforms allow the development of mature blackbrush stands. An argillic horizon increases soil moisture held at shallow depths, which increases the competitive ability of blackbrush against the deep-rooted creosote bush, which has lower production on this site relative to similar sites on sandy soils with little horizon development.

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 occurs within the Coleogyne ramosissima Shrubland Alliance (Sawyer et al. 2009) which can be cross-walked to the following classifications:

Manual of California Vegetation 1st edition: Black bush series
National Vegetation Classification System: Coleogyne ramosissima shrubland alliance
USDA Forest Service's CALVEG: Blackbush
California Natural Diversity Database of California Department of Fish and Game: Black bush scrub

Associated sites

R030XB005NV	**Arid Active Alluvial Fans** R030XB005NV is found on adjacent fan aprons where the sites co-occur at lower elevations. Creosote bush (Larrea tridentata) and burrobush (Ambrosia dumosa) dominate.
R030XB173CA	**Coarse Loamy Very Deep Fan Remnants** R030XB173CA occurs on adjacent fan aprons. Blackbrush (Coleogyne ramosissima), Joshua tree (Yucca brevifolia) and big galleta (Pleuraphis rigida) dominate.
R030XB174CA	**Sandy Fan Aprons** R030XB174CA is found an adjacent sandy fan aprons. Creosote bush (Larrea tridentata), Joshua tree (Yucca brevidolia) and big galleta (Pleuraphis rigida) dominate.
R030XB192CA	**Very Rarely Flooded, Warm Thermic Fan Piedmonts** R030XB192CA is found on adjacent fan aprons. Creosote bush (Larrea tridentata) and desertsenna (Senna armata) dominate.

Similar sites

R030XB174CA	**Sandy Fan Aprons** R030XB174CA occurs on sandy soils with little pedogensis. Blackbrush (Coleogyne ramosissima) is not present.
R030XB188CA	**Cool Shallow to Moderately Deep Fans** R030XB188CA is found on pediments with very shallow to shallow sandy soils.
R030XB168CA	**Cool Deep Sandy Fans** R030XB168CA is found on more mesic positions (higher elevations and/or more run-on. Production is higher and California juniper (Juniperus californica) is a dominant species.

R030XB173CA	**Coarse Loamy Very Deep Fan Remnants** R030XB173CA is associated with soils with sandy surfaces and with fewer rock fragments on the surface or in subsurface layers. Big galleta (Pleuraphis rigida) and Joshua tree (Yucca brevifolia) are important species and creosote bush (Larrea tridentata) is not dominant.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Coleogyne ramosissima* (2) *Larrea tridentata*
Herbaceous	Not specified

Physiographic features

This ecological site is found on fan remnants and fan aprons over fan remnants. It occurs at elevations of 2950 to 5160 feet and has slopes ranging from 4 to 8 percent. This site experiences no flooding or ponding. Runoff class is low to medium.

Table 2. Representative physiographic features

Landforms	(1) Fan remnant
Flooding frequency	None
Ponding frequency	None
Elevation	899–1,564 m
Slope	4–8%
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. 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 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 very deep, well-drained soils that formed in alluvium derived from granite and gneiss or granitoid. (An exception is the minor component of Yander, fan apron over pediment, with weathered bedrock at 40 to 59 inches). The surface texture is loamy sand, typically with sandy loam and sandy clay loams beneath. (The exception is the soil Yander which is sandy to the bedrock contact). For rock fragments less than 3 inches in diameter, the percent surface cover ranges from 40 to 60 percent, and subsurface volume ranges from 6 to 35 percent (subsurface fragments by volume for a depth of 0 to 79 inches). For rock fragments greater than 3 inches in diameter, the percent surface cover ranges from 0 to 2 percent, and subsurface volumes range from 0 to 3 percent.

This ecological site is associated with the following soil series: Bluecut (fine-loamy, mixed, superactive, thermic Typic Paleargids) and Jumborox (coarse-loamy, mixed, superactive, thermic Typic Haplargids), and minor components of Ambrosia (sandy, mixed, thermic Typic Haplocalcids) and Yander (mixed, thermic Typic Torripsamments). These soils all formed in alluvium, and, with the exception of Yander, have been stable long enough for pedogenesis of diagnostic horizons to form with the soil profile. Bluecut and Jumborox soils contain argillic horizons, and the Bluecut soils are stable for such a period of time that they have over a 15 percent increase in clay in the argillic compared to the recent alluvium deposited at the soil surface. Ambrosia soils contain a calcic horizon instead of a cambic or an argillic horizon. Yander soils do not have any diagnostic horizons, but do have a weathered bedrock contact at 41 inches.

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

4245;Bluecut-Morongo-Yander association, 2 to 8 percent slopes;Bluecut;;40; Jumborox;warm;5
4610;Jumborox-Desertqueen-Rock outcrop association, 2 to 8 percent slopes;Jumborox;warm;25; Ambrosia;cool;1
3677;Morongo sand, 2 to 4 percent slopes;Jumborox;warm;5
3690;Nasagold gravelly loamy sand, 2 to 4 percent slopes;Jumborox;warm;8; Yander;;5
4605;Pinecity complex, 2 to 8 percent slopes;Jumborox;dry;3

Table 4. Representative soil features

Parent material	(1) Alluvium–granite
Surface texture	(1) Loamy sand
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Slow to moderately rapid
Soil depth	150 cm
Surface fragment cover <=3"	40–60%
Surface fragment cover >3"	0–2%
Available water capacity (0-101.6cm)	5.84–11.68 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)	7.4–8.4
Subsurface fragment volume <=3" (Depth not specified)	6–35%
Subsurface fragment volume >3" (Depth not specified)	0–3%

Ecological dynamics

Abiotic Factors

Climate and soil properties are the most important abiotic factors determining the vegetation community of this ecological site. This ecological site occurs over the mid-elevation range where creosote bush and blackbrush overlap in the southern Mojave Desert (approximately 3000 to 5000 feet). 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). At higher elevations, freezing temperatures inhibit creosote bush recruitment and growth.

The soils typically associated with this ecological site have a subsurface argillic horizon, which is indicative of long-periods of stability over which pedogenesis can occur. Mature, dense blackbrush communities can take centuries to develop (e.g. Webb 1987), and these communities are often associated with such stable landforms. Creosote bush is often excluded from, or at least exhibits reduced growth and density, on soils with a well-developed argillic horizon (McAuliffe 1994, Hamerlynk et al. 2002, Hamerlynk and McAuliffe 2003, 2008) due to reduced rooting volumes and reduced access to soil moisture (McAuliffe 1994, Hamerlynk and McAuliffe 2003). Here, the argillic horizon does not exclude creosote bush, but creosote bush is less productive and present at lower densities relative to adjacent soils with less horizon development. For example, mean creosote bush production in the Sandy Fan Apron (R030XB174CA) ecological site on nearby Morongo soils, which are deep sands without significant pedogenesis, is three times higher than on this ecological site. Blackbrush has extraordinarily high water use efficiency, and is shallow-rooted, (Pendleton and Meyer 2004), so the longer duration of water availability held by the argillic horizon at shallow depths is more important than shorter periods of higher water availability.

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 (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). Clay-rich or rocky soils are less susceptible to high biomass loads of non-native annuals, but density of these species may still be significant, which can negatively impact diversity and abundance of native annuals (DeFalco et al. 2003, Allen et al. 2009).

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). However, where blackbrush is co-dominant with other shrubs, such as in this ecological site, densities are typically lower, which reduces flammability unless fine fuels are present in intershrub spaces.

State and transition model

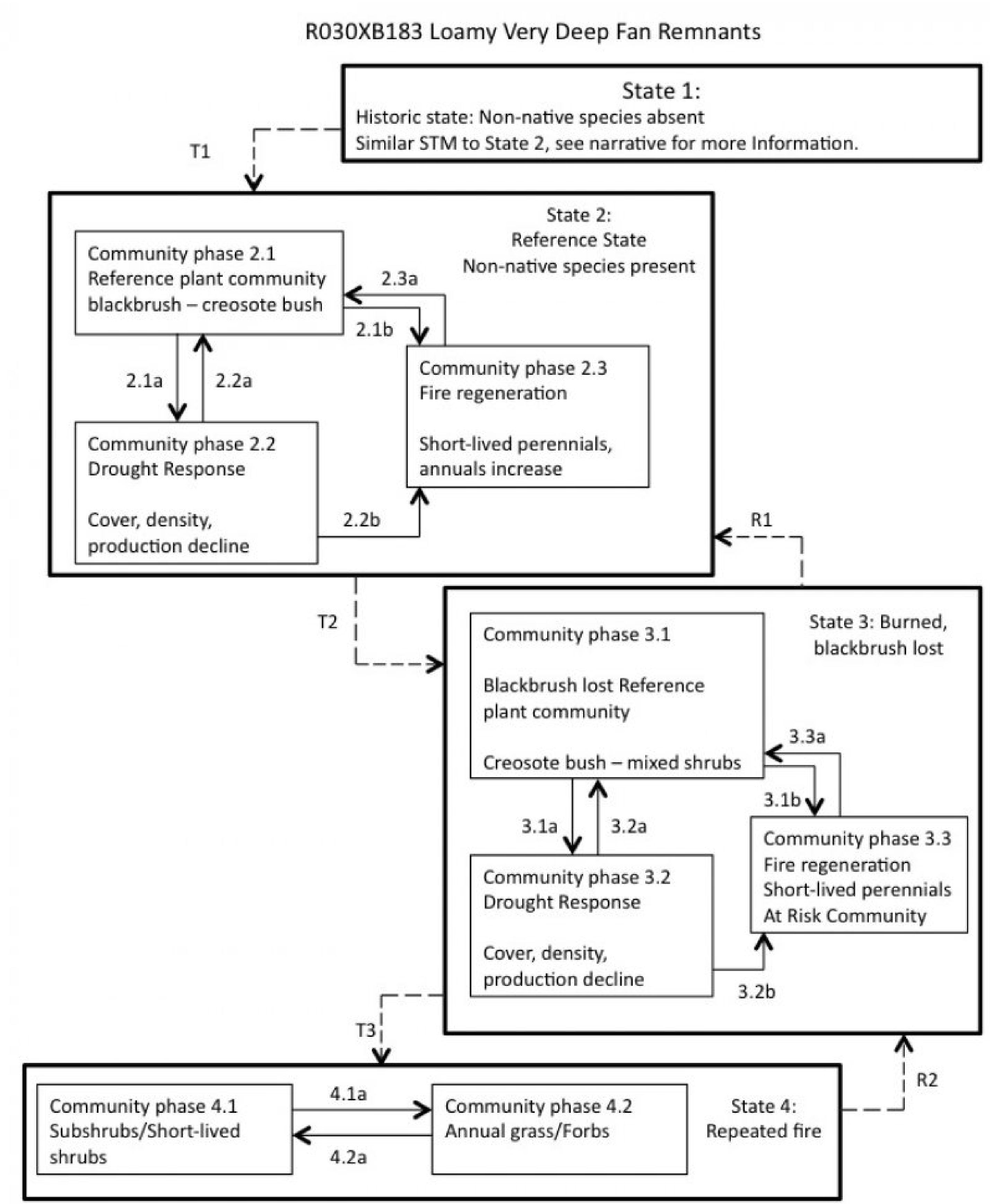

Figure 4. R030XB183CA

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), occurring only in the year immediately following heavy winter precipitation and during periods of extreme fire behavior (Brooks et al. 2007). 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. 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), however 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). 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 current potential plant community is maintained by periods of average climatic conditions and the absence of fire. It is co-dominated by blackbush and creosote bush. Mojave yucca (*Yucca schidigera*) and white ratany (*Krameria grayi*) are important species. Run-off during heavy precipitation events due to high surface fragments and clay-rich soils supports the presence of desertsenna (*Senna armata*) and burrobrush (*Hymenoclea salsola*), both of which are typically related to low-level soil disturbance. A diversity of minor shrub species may be present, including but not limited to, Nevada jointfir (*Ephedra nevadensis*), Wiggin's cholla (Cylindropuntia echincarpa), branched pencil cholla (*Cylindropuntia ramosissima*), Cooper's goldenbush (Ericamerica cooperi) and eastern Mojave buckwheat (*Eriogonum fasciculatum*). The perennial bunchgrass big galleta (*Pleuraphis rigida*) may be present at relatively low cover with low production. 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 forbs fringed amaranth (*Amaranthus fimbriatus*) and manybristle chinchweed (Pectus papposa). Red brome is present at relatively low levels following adequate winter precipitation, as are a diverse assemblage of native winter annuals. 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 Minnich 2006, Brooks et al. 2007, Rao et al. 2010). 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	157	241	325
Forb	–	90	135
Grass/Grasslike	–	9	78
Tree	–	1	13
Total	**157**	**341**	**551**

Community 2.2
Drought Response

This community phase is characterized by a decline in cover (10 to 15 percent) and production due to branch-pruning of community dominants and longer-lived minor species (including Nevada jointfir, white ratany, and Mojave yucca), and mortality of shorter-lived perennials (including burrobrush, Cooper's goldenbush, eastern Mojave buckwheat, and big galleta), and lack of emergence of annual forbs and grasses. The dominant species of this ecological site are long-lived, drought-tolerant species that exhibit low levels of mortality during drought. Both blackbrush and creosote bush are capable of utilizing moisture at any time of the year. This ability buffers these plants from the effects of winter season drought (which is typical of this ecological site where winter precipitation is most reliable). Creosote bush germinates in response to moisture during the warm season, so may 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). 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. However, blackbrush individuals are capable of remaining dormant during periods of drought exceeding three years (Pendleton and Meyer, 2004). Blackbrush also exhibits branch-pruning during drought, with very rare mortality (Webb et al. 2003, Pendleton and Meyer, 2004).

Community 2.3
Fire regeneration community

This community phase is characterized by high species evenness following the loss of blackbrush and creosote bush. Initially the post-burn community is dominated by annual forbs (including desert dandelion [*Malacothrix glabrata*], bristly fiddleneck [*Amsinckia tessellata*] and pincushion flower [*Chaenactis fremontii*]) and subshrubs (including desert globemallow [*Sphaeralcea ambigua*], desert trumpet [*Eriogonum inflatum*], brownplume wirelettuce [*Stephanomeria pauciflora*] and desert marigold [*Baileya multiradiata*]). With time, species capable of resprouting after fire become more important, including Mojave yucca, Nevada jointfir, white ratany and big galleta. Species capable of quickly colonizing after fire include desertsenna, Cooper's goldenbush, burrobrush, and eastern Mojave buckwheat. With very long periods of time with no disturbance, 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 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 100 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. Although live annuals are largely absent from Community Phase 2.2, standing annual biomass in drought years immediately following a period of heavy precipitation poses a severe risk for fire. Cured native annual cover may pose a risk during the first year of drought, and non-native annual grasses pose a risk for three or more years (Minnich 2003, Brooks et al. 2007, Rao et al. 2010).

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

This community represents the post-fire potential plant community for this site. This community is weakly dominated by creosote bush, with a high diversity of other shrubs, including desertsenna, white ratany, Nevada jointfir, Mojave yucca, Mojave cottonthorn (*Tetradymia stenolepis*), eastern Mojave buckwheat, Cooper's goldenbush, burrobrush, water jacket (*Lycium andersonii*) and peachthorn (*Lycium cooperi*). Data does not exist for this community, and it is based on research and observations.

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 including creosote bush, Nevada jointfir, white ratany, and Mojave yucca), and mortality of shorter-lived perennials (including burrobrush, Cooper's goldenbush, eastern Mojave buckwheat, and big galleta), 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. Creosote bush is largely lost from the community due to fire-induced mortality, and this community phase is characterized by high species evenness. The plant community is comprised of a high diversity of short- and long-lived shrubs. Species capable of resprouting after fire become more important, including Mojave yucca, Nevada jointfir, white ratany and big galleta. Species capable of quickly colonizing after fire include desertsenna, Cooper's goldenbush, burrobrush, and eastern Mojave buckwheat. With time, creosote bush will re-establish and very gradually increase in abundance. This community is an at-risk phase, as the increased cover and biomass of 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 100 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 3.1

This pathway occurs with fire. Although live annuals are largely absent from Community Phase 3.2, standing annual biomass in drought years immediately following a period of heavy precipitation poses a severe risk for fire. Cured native annual cover may pose a risk during the first year of drought, and non-native annual grasses pose a risk for three or more years (Minnich 2003, Brooks et al. 2007, Rao et al. 2010).

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. Creosote bush and blackbrush have been lost, and non-native annual grasses, native sub-shrubs, perennial grasses, and short-lived shrubs dominate the community. Annual grasses and forbs are abundant immediately post-fire, with dominance by shubshrubs and short-lived perennials several years post-fire.

Community 4.1
Subshrubs/Short-lived shrubs

This community phase develops with time without fire (5-20 years), and is dominated by subshrubs (desert globemallow, desert trumpet, brownplume wirelettuce and desert marigold) and short-lived shrubs (Cooper's goldenbush, snakeweed species, burrobrush, 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 desert globemallow, desert trumpet, brownplume wirelettuce and desert marigold may be abundant. The perennial bunchgrasses big galleta and desert needlegrass are capable of resprouting and may be present. There may be very sparse cover of resprouting shrubs including Mojave yucca, peachthorn, and Nevada jointfir. Seedlings of short-lived shrubs may be present, and may include Cooper's goldenbush, snakeweed species (Guttierezia spp.), burrobrush, and eastern Mojave buckwheat. 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 2
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). Creosote bush 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 6. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
1	**Native shrubs**			157–325	
	creosote bush	LATR2	*Larrea tridentata*	22–202	2–7
	blackbrush	CORA	*Coleogyne ramosissima*	34–146	5–15
	Mojave yucca	YUSC2	*Yucca schidigera*	11–129	1–4
	white ratany	KRGR	*Krameria grayi*	6–67	0–3
	desertsenna	SEAR8	*Senna armata*	2–56	1–2
	burrobrush	HYSA	*Hymenoclea salsola*	3–17	0–2
	Eastern Mojave buckwheat	ERFA2	*Eriogonum fasciculatum*	2–17	0–1
	Nevada jointfir	EPNE	*Ephedra nevadensis*	0–11	0–2
	Cooper's goldenbush	ERCO23	*Ericameria cooperi*	0–4	0–1
	Wiggins' cholla	CYEC3	*Cylindropuntia echinocarpa*	0–1	0–1
	branched pencil cholla	CYRA9	*Cylindropuntia ramosissima*	0–1	0–1
Tree					
2	**Trees**			0–13	
	Joshua tree	YUBR	*Yucca brevifolia*	0–13	0–1
Grass/Grasslike					
3	**Native perennial grasses**			0–28	
	big galleta	PLRI3	*Pleuraphis rigida*	2–28	0–2
4	**Native annual grasses**			0–78	
	sixweeks grama	BOBA2	*Bouteloua barbata*	0–45	0–2
	needle grama	BOAR	*Bouteloua aristidoides*	0–34	0–2
Forb					
5	**Native forbs**			0–90	
	pincushion flower	CHFR	*Chaenactis fremontii*	0–56	0–5
	fringed amaranth	AMFI	*Amaranthus fimbriatus*	0–56	0–3
	bristly fiddleneck	AMTE3	*Amsinckia tessellata*	0–45	0–2
	manybristle chinchweed	PEPA2	*Pectis papposa*	0–34	0–4
	chuckwalla combseed	PEHE	*Pectocarya heterocarpa*	0–22	0–1
	small wirelettuce	STEX	*Stephanomeria exigua*	0–11	0–1
	Panamint cryptantha	CRAN4	*Cryptantha angustifolia*	0–11	0–1
	Great Basin langloisia	LASES	*Langloisia setosissima ssp. setosissima*	0–11	0–1
6	**Non-native annual forbs**			0–45	
	redstem stork's bill	ERCI6	*Erodium cicutarium*	0–45	0–3

Animal community

The following mammals and reptiles are likely to occur in this ecological site (based on habitat preference):

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)
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)
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 site may be used for hiking and aesthetic enjoyment.

Other products

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

The Kawaiisu used a decoction of blackbrush bark for treating gonorrhea Drug (http://herb.umd.umich.edu/herb/search.pl?searchstring=Coleogyne+ramosissima.

The Havasupai used blackbrush as source of fodder when grass was not available (http://herb.umd.umich.edu/herb/search.pl?searchstring=Coleogyne+ramosissima).

Inventory data references

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

Community Phase 2.1:
12497-057-09
12497-057-G
12497-059-08
12497-127-10 (Type location)
12497-199-16

Type locality

Location 1: San Bernardino County, CA	
Township/Range/Section	T2 R9E S9
UTM zone	N
UTM northing	3754418
UTM easting	583498
Latitude	34° 0′ 46″
Longitude	116° 2′ 18″
General legal description	The type location is approximately 1.6 kilometers northwest of the turnoff of Park Boulevard for Split Rock Tank, about 710 meters south and 155 meters west of the northeast corner of Section 9, Township 2.

Other references

Abella, S. R., D. J. Craig, S. D. Smith, and A. C. Newton. 2012. Identifying native vegetation for reducing exotic species during the restoration of desert ecossytems. Restoration Ecology.

Abella, S. R. 2009. Post-fire plant recovery in the Mojave and Sonoran Deserts of western North America. Journal of Arid Environments 73:699-707.

Abella, S. R., J. L. Gunn, M. L. Daniels, J. D. Springer, and S. E. Nyoka. 2009. Using a diverse seed mix to establish native plants on a Sonoran Desert burn. Native Plants Journal 10:21-31.

Allen, E. B., L. E. Rao, R. J. Steers, A. Bytnerowicz, and M. E. Fenn. 2009. Impacts of atmospheric nitrogen deposition on vegetation and soils at Joshua Tree National Park. Pages 78-100 in R. H. Webb, L. F. Fenstermaker, J. S. Heaton, D. L. Hughson, E. V. McDonald, and D. M. Miller, editors. The Mojave Desert. University of Nevada Press, Reno, Nevada.

Allen, E. B. 1993. Restoration ecology: limits and possibilities in arid and semiarid lands. Pages 7-15 in Wildland shrub and arid land restoration symposium. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Las Vegas, NV.

Austin, A. T., L. Yahdjian, J. M. Stark, J. Belnap, A. Porporato, U. Norton, D. A. Ravetta, and S. M. Scheaeffer. 2004. Water pulses and biogeochemical cycles in arid and semiarid ecosystems. Oecologia 141:221-235.

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.

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. and K. H. Berry. 2006. Dominance and environmental correlates of alien annual plants in the Mojave Desert, USA. Journal of Arid Environments 67:100-124.

Brooks, M. L. and J. R. Matchett. 2006. Spatial and temporal patterns of wildfires in the Mojave Desert, 1980-2004. Journal of Arid Environments 67:148-164.

Brooks, M. L., T. C. Esque, and T. Duck. 2007. Creosotebush, blackbrush, and interior chaparral shrublands. RMRS-GTR-202.

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

Bull, W. B. 1997. Discontinuous ephemeral streams. Geomorphology 19:227-276.

Cerda, A. 2001. Effects of rock fragment cover on soil infiltration, interrill runoff and erosion. European Journal of Soil Science 52:59-68.

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.

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

DeFalco, L. A., T. C. Esque, S. J. Scoles-Sciulla, and J. Rodgers. 2010. Desert wildfire and severe drought diminish survivorship of the long-lived Joshua tree (Yucca brevifolia; Agavaceae). American Journal of Botany 97:243-250.

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

Fuhrmann, K., K. Weber, and C. Decker. 2009. Restoring burned areas at Zion National Park (Utah). Restoration Ecology 27:132-133.

Hamerlynk, E. P. and J. R. McAuliffe. 2003. Effects of surface and sub-surface soil horizons on the seasonal performance of Larrea tridentata (creosotebush). Functional Ecology 14:596-606.

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

Hamerlynk, E. P., J. R. McAuliffe, E. V. McDonald, and S. D. Smith. 2002. Ecological responses of two Mojave desert shrubs to soil horizon development and soil water dynamics. Ecology 83:768-779.

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.

Li, X.-Y., S. Contreras, and A. Sole-Benet. 2007. Spatial distribution of rock fragments in dolines: A case study in a semiarid Mediterranean mountain-range (Sierra de Gador, SE Spain). Catena 70:366-374.

Martre, P., G. B. North, E. G. Bobich, and P. S. Nobel. 2002. Root deployment and shoot growth for two desert species in response to soil rockiness. American Journal of Botany 89:1933-1939.

Matchett, J. R., A. O'Neill, M. Brooks, C. Decker, J. Vollmer, and C. Deuser. 2009. Reducing fine fuel loads, controlling invasive annual grasses, and manipulating vegetation composition in Zion Canyon, Utah. Joint Fire Science Program, El Portal, California.

McAuliffe, J. R. 1994. Landscape evolution, soil formation, and ecological patterns and processes in Sonoran Desert bajadas. Ecological Monographs 64:112-148.

Minnich, R. A. 2003. Fire and dynamics of temperature desert woodlands in Joshua Tree National Park. Contract, Joshua Tree National Park.

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.

Noy-Meir, I. 1973. Desert ecosystems: environment and producers. Annual Review of Ecology and Systematics 4:25-51.

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.

Poesen, J. and H. Lavee. 1994. Rock fragments in top soils: significance and processes. Catena 23:1-28.

Rao, L. E. and E. B. Allen. 2010. Combined effects of precipitation and nitrogen deposition on native and invasive winter annual production in California deserts. Oecologia 162:1035-1046.

Rao, L. E., E. B. Allen, and T. M. Meixner. 2010. Risk-based determination of critical nitrogen depositiion loads for fire spread in southern California deserts. Ecological Applications 20:1320-1335.

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.

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

Steers, R. J. and E. B. Allen. 2010. Post-fire control of invasive plants promotes native recovery in a burned desert shrubland. Restoration Ecology 18:334-343.

Steers, R. J. and E. B. Allen. 2011. Fire effects on perennial vegetation in the western Colorado Desert, USA. Fire Ecology 7:59-74.

Summers, H. A., B. N. Smith, and L. D. Hansen. 2009. Comparison of respiratory and growth characteristics of two co-occurring shrubs from a cold desert, Coleogyne ramosissima (blackbrush) and Atriplex confertifolia (shadscale). Journal of Arid Environments 73:1-6.

Vamstad, M. S. 2009. Effects of fire on vegetation and small mammal communities in a Mojave Desert joshua tree woodland. M.S. Unversity of California, Riverside, Riverside, Ca.

Vasek, F. C. 1983. Plant succession in the Mojave Desert. Crossosoma 9:1-23.

Webb, R. H., Steiger, J.W., Turner, R.M. 1987. Dynamics of Mojave Desert shrub assemblages in the Panamint Mountains, California. Ecology 68:478-490.

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.

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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:**