Ecological site R040XD026CA
Large, High Intensity, Frequently Flooded Ephemeral Stream

Last updated: 2/08/2019
Accessed: 05/04/2024

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.

MLRA notes

Major Land Resource Area (MLRA): 040X–Sonoran Basin and Range

MLRA Statement:
Major land resource area (MLRA) 31 is the Lower Colorado Desert. This area is in the extreme southeastern part of California, in areas along the Colorado River, and in Western Arizona. The area is comprised of rough, barren, steep, and strongly dissected mountain ranges, generally northwest to southwest trending that are separated by intermontane basins. Elevation ranges from approximately 275 feet below sea level at the lowest point in the Salton Trough to 2700 feet along low northwest to southeast trending mountain ranges. The average annual precipitation is 2 to 6 inches with high temporal and spatial variability. Winter temperatures are mild, summer temperatures are hot, and seasonal and diurnal temperature fluctuations are large. Monthly minimum temperature averages range from 40 to 80 degrees F (4 to 27 degrees C). Monthly maximum temperature averages range from 65 to 110 degrees F (18 to 43 degrees C) (WRCC 2002). Temperatures are rarely below 28 degrees F, and extremely rarely fall below 24 degrees F. Precipitation is bimodal, with approximately 20 to 40 percent of annual precipitation falling between July and September. This summer rainfall, in combination with very hot temperatures and very few to no days of hard freeze are what characterize this MLRA and distinguish it from the Mojave Desert (MLRA 30).

XD LRU concept:

The XD LRU is an extremely hot and dry portion of the MLRA. Mean annual precipitation is about 4 inches or less where the majority of the precipitation can arrive in only a couple storm events during any given year. The very few hard freezing days allows this region to have Plant Hardiness Zones of 9b or warmer. This LRU covers most of the Lower Colorado Desert except elevations above 500 m where Plant Hardiness Zones are less than 9b.

Ecological site concept

This ecological site is associated with relatively large third order or larger streams situated close to mountain slopes where high intensity water inputs occur. Large, frequent flash-flood events create a wide active channel that is barren or with scattered smoketree (Psorothamnus spinosus). The active channel has a shallow braided pattern that spreads across a broad relatively level drainageway. The drainage contains associated higher-relief, occasionally flooded sediment bars that have higher shrub and forb diversity. Soils are very deep, with predominantly very gravelly coarse sand textures. This site is distinguishable by a large active channel, and relatively high cover of desert ironwood (Olneya tesota) and blue paloverde (Parkinsonia florida). Elevations range from 540 to 2660 feet with slopes of 2 to 8 percent.

Data ranges in the physiographic data, climate data, water features, and soil data sections of this Ecological Site Description are based on major and minor components, since it is often only associated with minor components.

This description was copied from and is equivalent to R031XY026CA. There is ongoing LRU concept development and designation where a request was made by the Region 8 Ecological Site Specialist to avoid using the default XY LRU.

Associated sites

R040XD001CA	**Limy Hill 4-6" p.z.** This ecological site is on adjacent alluvial fans, with creosote bush and burrobush.
R040XD009CA	**Gravelly Fan Remnants And Fan Aprons** This ecological site is on fan aprons and fan remnants, with creosote bush, Schott's dalea, and a diversity of other species.
R040XD021CA	**Very Gravelly Wash** This ecological site is the small drainages among desert pavement surfaces, with creosote bush and brittlebush.
R040XD030CA	**Extremely Stony Fan Remnants** This ecological site is on stony fan remnants with significant cover of teddybear cholla.
R040XD034CA	**Gravelly, Braided, Ephemeral Stream** This ecological site is on braided drainageways with desert lavender and burrobrush dominant. It may be below this ecological site in some areas.
R040XD200CA	**Rarely Flooded Fans** This ecological site is on cobbly fan aprons and fan remnants, brittlebush and creosote bush dominate.

Similar sites

R040XD010CA	**Valley Wash** This large ephemeral stream is further from the mountains, has smaller rock fragments, and desert ironwood is absent.
R040XD034CA	**Gravelly, Braided, Ephemeral Stream** This ecological site has similar species, but it does not have a prominent large active wash. It is very braided, less flooded, and desert ironwood is sparse or absent.

Table 1. Dominant plant species

Tree	(1) *Olneya tesota* (2) *Parkinsonia florida*
Shrub	(1) *Hymenoclea salsola* (2) *Hyptis emoryi*
Herbaceous	Not specified

Physiographic features

This ecological site occurs in frequently to rarely flooded drainageways and channels. Rarely to very rarely flooded areas are on inset fans. It occurs at elevations of 540 to 2660 feet and has slopes ranging from 2 to 8 percent. Flooding duration is extremely brief and runoff is very low.

Table 2. Representative physiographic features

Landforms	(1) Drainageway (2) Channel (3) Inset fan
Flooding duration	Extremely brief (0.1 to 4 hours)
Flooding frequency	Rare to frequent
Ponding frequency	None
Elevation	165–79 m
Slope	2–8%
Aspect	Aspect is not a significant factor

Climatic features

The climate of this ecological site is characterized by hot temperatures, aridity, and a bimodal precipitation pattern. Precipitation falls as rain, with 30 percent falling in summer between July and October, and 60 percent falling in winter between November and March. The mean annual precipitation is 2 to 4 inches and mean annual air temperature is 73 to 79 degrees F. The frost free period is 360 to 365 days, and freeze free period is 363 to 365 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):

42598, Eagle Mountain, CA (Period of record = 1933 to 2011) [2]

43855, Hayfield Reservoir, CA (Period of record = 1933 to 2011) [1]

The data from multiple weather were combined to most accurately reflect the climatic conditions of this ecological site.

Need to add Needles and Parker climate stations?

Table 3. Representative climatic features

Frost-free period (average)	365 days
Freeze-free period (average)	365 days
Precipitation total (average)	102 mm

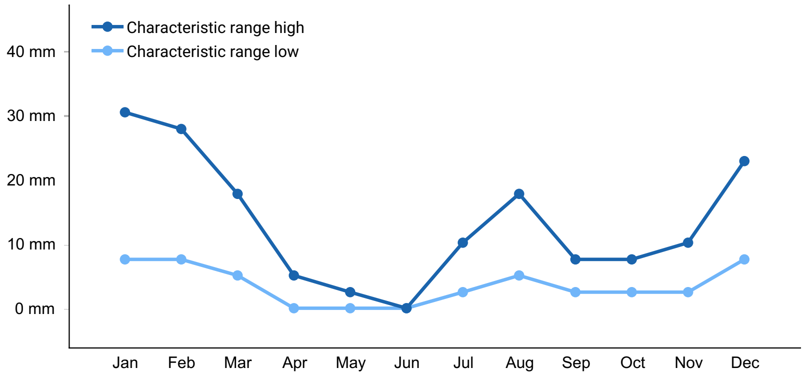

Figure 1. Monthly precipitation range

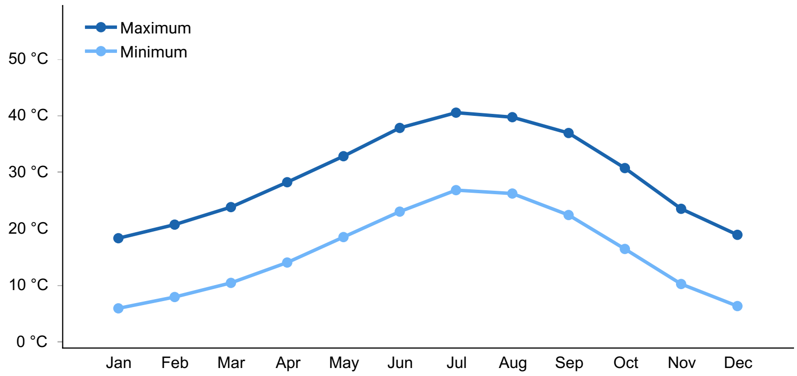

Figure 2. Monthly average minimum and maximum temperature

Influencing water features

These drainageways are subject to frequent, large flash flood events.

Soil features

This ecological site is found on alluvial soils derived from granitoid or igneous parent material. Soils are very deep and typically have very gravelly coarse sandy surface textures. Other surface textures include extremely gravelly coarse sand, gravelly coarse sand, gravelly loamy coarse sand, gravelly fine sandy loam, and extremely gravelly loamy sand. Subsurface textures are very gravelly coarse sand or extremely gravelly coarse sand. Rock fragments less than 3 inches in diameter range from 40 to 80 percent, and subsurface volume ranges from 25 to 50 percent. For rock fragments greater than 3 inches in diameter, the percent surface cover ranges from 1 to 35 percent, and subsurface volume ranges from 0 to 14 percent (for a depth of 60 inches). These soils are somewhat excessively to excessively drained, with moderate to rapid permeability.

This ecological site is associated with the Rizzo and Chemwash soils. The Rizzo and Chemwash soils are both sandy-skeletal, mixed, hyperthermic Typic Torriorthents. Chemwash has 2-5 mm size rock fragments in the particle control section, while Rizzo is dominated by rock fragments larger than 5mm in diameter.

This ecological site has been correlated to the following map units and soil components in the Joshua Tree National Park Soil Survey (CA794):

Map unit; Map unit name; Component; Phase; Percent
2090; Deprave-Rockhound-Rizzo complex, 2 to 4 percent slopes ;Rizzo; frequently flooded; 3
2121; Rizzo very cobbly loamy coarse sand, 4 to 15 percent slopes, rubbly; Rizzo; frequently flooded; 10
2402; Rizzo-Rizzo, frequently flooded complex, 2 to 8 percent slopes; Rizzo; frequently flooded; 20
2408; Rizzo complex, 2 to 8 percent slopes; Rizzo; frequently flooded; 55 and Rizzo; very rarely flooded; 35
2409; Rizzo-Chemwash-Carsitas complex, 4 to 8 percent slopes; Rizzo; frequently flooded; 35 and Chemwash; frequently flooded; 30
2421; Carsitas complex, 4 to 8 percent slopes; Chemwash; frequently flooded; 2
2431; Chemwash complex, 2 to 8 percent slopes; Chemwash; frequently flooded; 25

This ecological site has been correlated to the following map units and soil components in the Colorado Desert Area Soil Survey (CA803):
(Note all map units below are also in CA794, except map unit 2417.)

Map unit; Map unit name; Component; Phase; Percent
2090; Deprave-Rockhound-Rizzo complex, 2 to 4 percent slopes; Rizzo; frequently flooded; 3
2121; Rizzo very cobbly loamy coarse sand, 4 to 15 percent slopes, rubbly; Rizzo; frequently flooded; 10
2402; Rizzo-Rizzo, frequently flooded complex, 2 to 8 percent slopes; Rizzo; frequently flooded; 20
2408; Rizzo complex, 2 to 8 percent slopes; Rizzo; frequently flooded; 55 and Rizzo; very rarely flooded; 35

2409; Rizzo-Chemwash-Carsitas complex, 4 to 8 percent slopes; Rizzo;frequently flooded; 35
and Chemwash; frequently flooded; 30
2417; Rizzo extremely gravelly sandy loam, 2 to 8 percent slopes; Rizzo;frequently flooded; 95
2421; Carsitas complex, 4 to 8 percent slopes; Chemwash; frequently flooded; 2
2431; Chemwash complex, 2 to 8 percent slopes; Chemwash; frequently flooded; 25

Table 4. Representative soil features

Surface texture	(1) Very gravelly coarse sand (2) Gravelly coarse sand (3) Gravelly fine sandy loam
Family particle size	(1) Sandy
Drainage class	Excessively drained
Permeability class	Rapid
Soil depth	152 cm

Surface fragment cover <=3"	40–80%
Surface fragment cover >3"	1–35%
Available water capacity (0-101.6cm)	2.03–5.08 cm
Calcium carbonate equivalent (0-101.6cm)	0–5%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–2
Soil reaction (1:1 water) (0-101.6cm)	7.4–8.4
Subsurface fragment volume <=3" (Depth not specified)	25–50%
Subsurface fragment volume >3" (Depth not specified)	0–14%

Ecological dynamics

This ecological site is associated with relatively large third order or larger ephemeral streams, situated close to mountain slopes where high intensity water inputs occur. Large, frequent flash-flood events create a wide active channel that is mostly barren with scattered, patchy smoketree. The active channel has a shallow braided pattern across a broad, relatively level drainageway. Desert ironwood and blue paloverde are present across this area on slightly raised positions, or along channel margins. The associated occasionally flooded bars have higher shrub and forb diversity, with burrobush (*Hymenoclea salsola*), desert lavender (*Hyptis emoryi*), and sweetbush (*Bebbia juncea*) common. Stable islands may occur within the drainageway, and are dominated by brittlebush (*Encelia farinosa*) and creosote bush (*Larrea tridentata*). There is a high range of variability within this ecological site due to variation in flood intensity, stream volume, and flow disruptions due to road crossings.

Soil disturbance from flash flood events is the primary driver of plant community dynamics within this ecological site. Ephemeral streams lack permanent flow except in response to rainfall events (Bull 1997, Levick et al. 2008). These ephemeral streams are characterized by extreme and rapid variations in flooding regime, and a high degree of temporal and spatial variability in hydrologic processes (Bull 1997, Stanley et al. 1997, Levick et al. 2008, Shaw and Cooper 2008). Physical disturbance of soils as a result of flash flooding makes predictability of temporary channel development and configuration very low except when considered at a very coarse scale. Typical runoff events may result in an apparently stable mosaic of plant species distribution and channel configuration while more extreme events may completely reconfigure the mosaic and establish the foundation of a new or modified plant community mosaic until the next extreme runoff event occurs. Channel avulsion of the main channel would cause high mortality of vegetation in the old channel due to water stress, and initiate development of xeroriparian communities in the newly created channel

Channel avulsion is “the diversion of the majority of the surface flow to a different channel, with total or partial abandonment of the original channel” (Field 2001). Because flow in these ephemeral streams is inconsistent in force, volume, and frequency, deposition and scour of sediment varies with each flood event. Changes in sedimentation and erosion alter flow dynamics, potentially redirecting flow to an alternate channel. Cycles of channel avulsion on fan piedmonts is an ongoing and long-term process in the development of alluvial fans and associated landforms, and can occur after any substantial overland flow event when existing channel capacity is very rapidly and dramatically exceeded. If channel avulsion occurs at the apex of the alluvial fan, it is more likely to capture the majority of the stream flow. Upper fans extend into the base of mountains, which provide a direct sediment source that is transported over time, by larger flood events, to distal reaches of the drainage. This ecological site generally occurs on the upper to medial positions of the fan piedmont. At the distal position, the stream loses velocity, and becomes more braided while the large active channel dwindles. This is the transition to another ephemeral ecological site, the Gravelly, Braided Ephemeral Stream (R031XY034CA). Eventually, even the braided channels dissipate, and become vegetated with upland creosote bush plant communities.

The frequency and impact from flood events varies across the drainageway and channel segments, developing a complex of xeroriparian plant communities. Xeroriparian vegetion refers to the drought-tolerant vegetation that exists on ephemeral streams and drainageways. It is distinct from the surrounding landforms due to a difference in species composition, size, and production (Johnson et al. 1984, Levick et al. 2008). Xeroriparian vegetation is present because of the increased availability of water and flood disturbances in these drainageways.

Blue paloverde, smoketree, desert lavender, and catclaw acacia are present along active channel margins. These species are phreatophytes, that is, they have deep roots and primarily rely on a deep water source. A deep water source typically refers to a water table or a zone of saturated soils. However, these ephemeral desert streams do not generally have water tables within reach of plant roots, and here plants are accessing deep ground water in unsaturated soils (Nilsen et al. 1984). This ephemeral stream receives surface run-off from mountain slopes and mountain drainages. When this flow reaches the broad deep sandy channels on the fan piedmont, flow is able to spread out and infiltrate deep into the soils. A high volume of water infiltrates into these coarse soils, which supports the phreotophyte species as well as shallower rooted species.

During larger flood events, flow will sheet flood across the higher areas of the drainageway. These occasionally flooded areas are dominated by shorter-lived shrubs with shallower root systems (burrobush and sweetbush). These species are absent in the active channel because they will uproot during high velocity floods. Shorter lived shrubs are adapted to lower intensity flood disturbance because they have high seed production, high seed viability, and seeds that are light and easily dispersed by wind from nearby sources. The new generation matures quickly, producing more seed.

Many of the species present in this ecological site (Blue paloverde, desert ironwood, Schott's dalea, and desert lavender) are near their northern limit of distribution, along the border of the Mojave and Sonoran Deserts. These species are restricted to the warmer Sonoran desert and its biomodal precipitation pattern and lack of frost. The dominant species are frost-intolerant and rely on summer precipitation for seed germination. Climate data from the climate stations listed above indicate that temperatures below 28 degrees F may occur between late Dec to mid February, but do not occur every year. In the cooler areas (Hayfield Reservoir) temperatures may fall to the low 20s, about every 3 years. The Eagle Mountain Station indicates closer to a 10 year period between frosts. Both stations indicate a prolonged period of freezing temperatures in January, 1950, with temperatures as low as 14 degrees F at Hayfield Reservoir. The prolonged low temperatures in 1950 would likely have caused some mortality throughout this area. Less severe freezes of shorter durations or less severe temperatures will cause die back of frost-sensitive younger stems and branches, but may not kill the mature or hardened plants. The dynamics of frost are not included in the state and transition model (STM), because the incidence of frost is uncommon, and since this site exist because of the relatively frost free conditions of this area.

Another climatic driver for this ecological site is the reliance of several of these species on summer precipitation. This area receives approximately 30 percent of its precipitation from July to October, from monsoons coming up from Mexico. Summer precipitation is important for the germination and survival of desert ironwood, blue paloverde, desert lavender and smoketree. Winter precipitation is important for seed production for desert ironwood and other species. Summer rains and warmer temperatures are needed to initiate germination for desert ironwood, desert lavender, and blue paloverde. Without summer rains and warmer temperatures some of these species would not regenerate well if at all.

Precipitation in this northern portion of the Sonoran desert is limited, with about 2 to 4 inches falling in a given year. The amount of total precipitation, and the timing and frequency of precipitation is highly variable from year to year. In addition, the spatial distribution of precipitation is patchy, as squalls may downpour on one area, but completely miss adjacent mountains or valleys. Hereford et al. (2006) describes shifts from dry to wet periods which may last several decades. During wetter cycles plant species show increases in cover, size, and regeneration; while during drier periods and droughts, regeneration is low and shorter-lived shrubs have high mortality (Hereford et al. 2006, Miriti et al. 2007). Severe droughts have even more pronounced mortality. In the STM below, the drought phase is referring to the more severe droughts, which cause high mortality, lack of regeneration and affect plant community composition. Although it is somewhat ambiguous to define, the "Reference plant community" phase implies that the area is receiving average or above average precipitation, and vegetation is not in decline due to drought.

When precipitation events occur, these ephemeral streams provide important hydrologic functions, such as maintaining water quality by allowing energy dissipation during high water flow. They transport nutrients and sediments, store sediments and nutrients in deposition zones, provide temporary storage of surface water, and longer duration storage of subsurface water. These streams are important ecologically because they provide water and habitat for a variety of plant and animal species. The structure and forage provided by xeroriparian vegetation, and the availability of water (although brief), significantly increases animal abundance along ephemeral streams relative to upland areas. The open channels also provide important migration corridors for wildlife (Levick et al. 2008).

Fire is historically rare in desert ephemeral drainageway communities. An increase in the abundance of invasive annual grasses and annual forb cover in associated upland communities has led to an increase in fire frequency (Brown and Minnich 1986, Brooks et al. 2004, Brooks and Matchett 2006, Rao et al. 2010, Steers and Allen 2011) in upland communities as well as ephemeral drainageways.

When modifications affect the hydrologic function of this ephemeral stream system, this ecological site has the potential to transition to a hydrologically altered state (State 3). Once this threshold is crossed, it is extremely difficult to repair the hydrology of the system. Modifications to hydrology such as surface flow alterations, ground water depletion, and loss of the xeroriparian vegetation can have irreversible impacts on hydrologic processes (Nishikawa et al. 2004, Levick et al. 2008). An increase in cover of impermeable surfaces (such as pavement, homes, malls, etc.) reduces the amount of runoff that can infiltrate into the soil creating higher surface runoff and greater peak flows. The runoff is collected in ditches, culverts, and drainage networks, and diverted to the nearest ephemeral stream. In some areas, retaining walls are built along ephemeral streams to reduce damage to property from flood events. These confined channels reduce the ability for the stream to spread out and decrease flow velocity to allow sediment deposition. As a result, the channels generally scour and incise. These processes eventually cause higher peak flows due to increased runoff and concentrated flows. Higher flow velocities may cause uprooting, stem breakage or scour under the roots of xeroriparian vegetation. This loss of root structure along the stream increases scour potential, and the loss of above ground vegetation will increase flow velocity. When the xeroriparian community is lost, important animal species dependent upon this community may be lost from the area as well. Ground water drawdown from household wells (Nishikawa et al. 2004) can deplete the water source for phreatophytes, such as blue paloverde, desert lavender, smoketree, and catclaw acacia, potentially eliminating these species from certain areas.

State and transition model

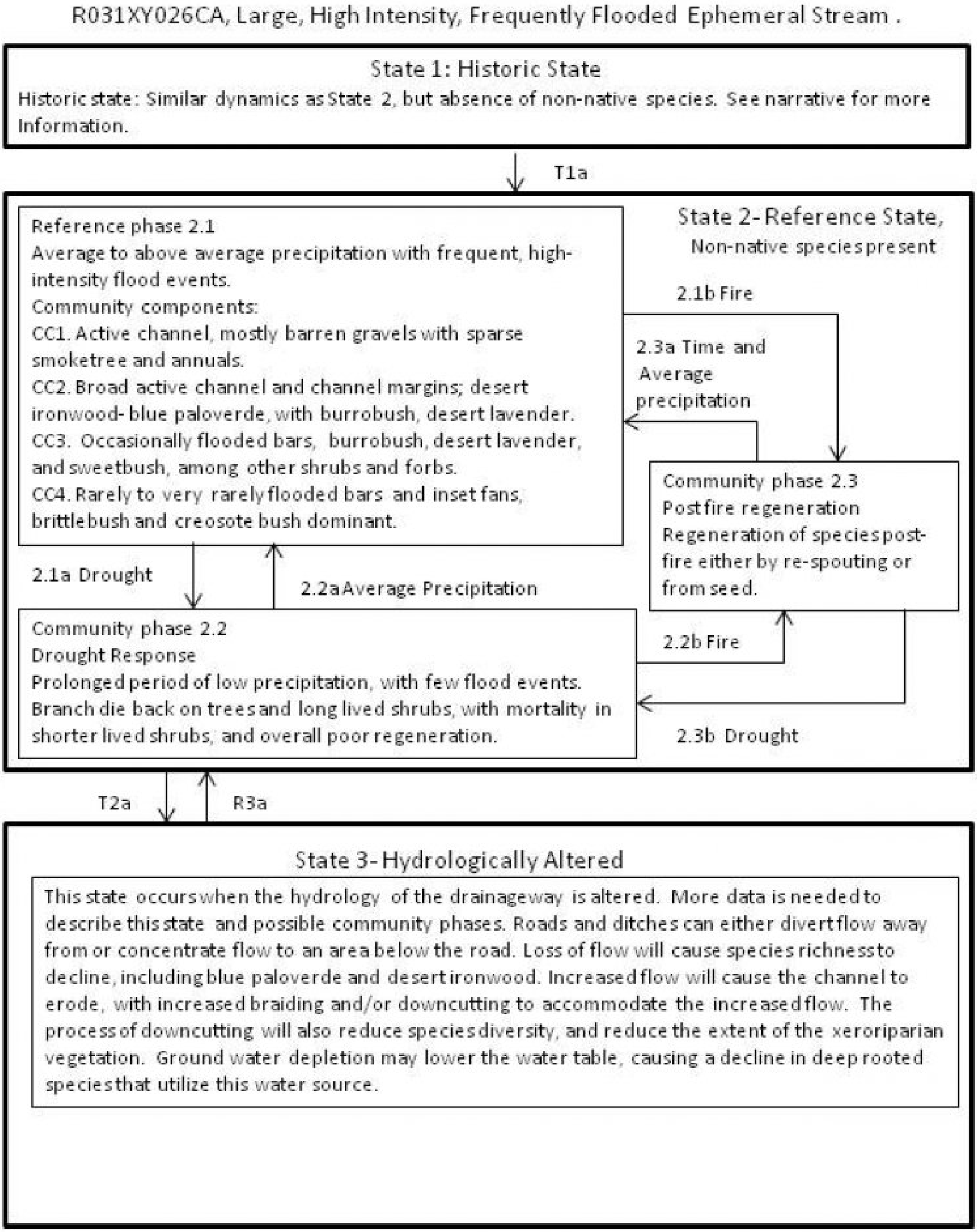

Figure 3. R031XY026CA Model

State 1
Historic State

State 1 represents the historic-natural condition for this ecological site. It is similar to State 2, but has only native species. If we were to include dynamics for this state it would be the same as displayed in State 2. The presence of non-native species is minimal in State 2, and has not altered the hydrology or fire frequency.

State 2
Reference State

This state represents the most common and most ecologically intact condition for this ecological site at the present time.

Community 2.1
Reference Phase

Figure 4. CC2 - Desert ironwood-blue paloverde

Figure 5. CC1-Active wash-smoketree

Figure 6. CC3-Burrobush-desert lavender

Figure 7. CC4 Brittlebush- mixed shrubs

This community phase is dependent upon unimpaired hydrologic function and average to above average precipitation. At any given point along the stream the following community components are generally present. The relative spatial extent of these communities varies as the channel morphology fluctuates from flash flood events. Plant composition for the following community components is combined in the tables below, but characteristic features are described below. Three community components are present, including: Community Component 1, (CC1) This community occurs in the active channel, which may be a single channel or braided channels with low relief. It is dominated by bare sands and gravels, with smoketree patchily present. Annuals have low cover, but may be diverse and have higher cover in years with above average precipitation. Community Component 2 (CC2) This community is present in the active channel on slightly raised braided areas, or along the channel margins. It is dominated by 8 to 20 percent cover of desert ironwood and blue paloverde. The understory can be nearly absent or somewhat diverse. Desert lavender, burrobush, and sweetbush are common with low cover. Catclaw acacia (*Acacia greggii*), bladderpod spiderflower (*Cleome isomeris*) are occasionally present, and other shrubs may be present in different drainages. This community is dominated by phreatophytes, such as smoketree, desert lavender, and blue paloverde. Smoketree and blue paloverde have hard seed coats that need physical scarification before they can imbibe water in order to germinate. During floods the seeds are washed down the channel in a mixture of sand and gravels, which scratch, cut, and grind openings in the hard the seed coat. When the seed coat is cracked, the flood waters soak into the seed, and initiate germination. The seeds of smoketree may also have growth inhibitors, which are water soluble, and are removed by running water (Bainbridge 2007). Smoketree produces few leaves, is summer deciduous, and conducts most of its photosynthesis through the stem, which helps it withstand drought conditions by preventing water loss through the leaves (Nilsen et al. 1984). Blue paloverde is also stem photosynthetic and summer deciduous (Pavek 1994). Blue paloverde is generally confined to washes, but may exist on more upland sites if soil moisture is sufficient. Desert lavender is found on rocky mountains slopes where additional run-on is available, but is confined to washes in more arid zones of its distribution, which is where this site is located. The range of desert ironwood occurs almost entirely within the Sonoran Desert. It is largely confined to drainagways in this area, but is not an obligate xeroriparian species. It occurs on alluvial fans, mountain slopes, and over bedrock in some of its range. However, this area has lower total precipitation and less of that precipitation comes during summer than other regions of the Sonoran Desert. Desert ironwood is a long lived, slow growing tree with very dense wood. Desert ironwood is an important nurse tree for a variety of shrubs and cacti in parts of its range. Dead ironwood trees and stumps take centuries to decompose because of toxic, non-biodegradable chemicals in the wood (Phillips and Wentworth 2000), and thus remain on the landscape for centuries. These deep rooted species help slow flood waters, and are able to re-sprout from the root crown after stem breakage. Their deep roots help them remain anchored during floods, and hold soil in place. The cover of forbs is dependent upon precipitation and flood events. Common annuals include bristly fiddleneck (*Amsinckia tessellata*), Abrams' sandmat (*Chamaesyce abramsiana*), cryptantha (Cryptantha sp.), Western Mojave buckwheat (*Eriogonum mohavense*), pygmy poppy (*Eschscholzia minutiflora*), smooth desertdandelion (*Malacothrix glabrata*), phacelia (Phacelia sp.), and chia (*Salvia columbariae*). A few perennial forbs are present including whitemargin sandmat (*Chamaesyce albomarginata*) and brownplume wirelettuce (*Stephanomeria pauciflora*). Community component 3 (CC3) This community is present on occasionally flooded sediment bars alongside the main channel or on high topographic positions within the drainageway. It has higher diversity than the frequently flooded areas. It is dominated by burrobush, desert lavender, and sweetbush. Desert ironwood and blue paloverde are present, with low cover. Burrobrush and sweetbush are considered pioneer species, because they readily establish from on-site and off-site seed after disturbance. They produce abundant seeds, which have high viability. Burrobush is believed to live for a few decades, maintaining dominance with reoccurring disturbances that promote flushes of regeneration (Tesky, 2003). Other shrubs that may be present include Wiggins' cholla (*Cylindropuntia echinocarpa*), branched pencil cholla (*Cylindropuntia ramosissima*), brittlebush (*Encelia farinosa*), creosote bush, (*Larrea tridentata*), and beavertail pricklypear (*Opuntia basilaris*). The forbs listed in CC2 are also present in this community. Community Component 4 (CC4) This community is present on rarely to very rarely flooded islands within or alongside the drainageway. Brittlebrush is dominant, with 100 lbs acre, and 18 percent cover. Schott's dalea can locally abundant, and creosote bush increases in cover. Other species listed in CC3 are present as well. These raised islands only receive overwash from floods during the largest flood events, so have less flood or disturbance dependent species. Non-native species are present primarily in CC2, CC3, and CC4 and include, Mediterranean grass Schismus sp.), red brome (*Bromus rubens*), and Asian mustard (*Brassica tournefortii*). These species have low cover and frequency.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Tree	45	196	530
Shrub/Vine	28	106	224
Forb	17	78	112
Grass/Grasslike	–	–	1
Total	**90**	**380**	**867**

Table 6. Ground cover

Tree foliar cover	5-10%
Shrub/vine/liana foliar cover	1-5%
Grass/grasslike foliar cover	1-5%
Forb foliar cover	5-15%
Non-vascular plants	0%
Biological crusts	0%
Litter	1-10%
Surface fragments >0.25" and <=3"	55-65%
Surface fragments >3"	5-10%
Bedrock	0%
Water	0%
Bare ground	5-15%

Community 2.2
Drought Response

This community develops with prolonged or severe drought. Drought is an important shaping force in Sonoran Desert plant communities. Short-lived perennials, such burrobrush, sweetbush, and brittlebush demonstrate the highest rates of mortality (Webb et al. 2003, Bowers 2005, Hereford et al. 2006, Miriti et al. 2007). Annual species remain dormant in the soil seedbank. Long-lived shrubs (such as creosote bush and desert lavender) 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. Desert ironwood is very drought tolerant, but it may slough off large branches to conserve water. There is evidence that desert ironwood may successively resprout from the trunk after being top-killed by droughts (Phillips and Wentworth 2000). Desert lavender is a deep rooted species that can assess deep water. It adjusts its leaf pubescence and size to reduce water loss. Brittlebush is an extremely drought-tolerant, drought-deciduous shrub, which can adapt its leaf pubescence similar to desert lavender. With prolonged drought and the absence of flood events, deep rooted phreatophytes along the channel margin will decline. They will initially suffer branch die-back, but if drought conditions persist or channel avulsion diverts flood waters from the previously active channel, they may suffer high mortality. Smoketree and blue paloverde will not regenerate without floods to scarify and soak the seeds. Creosote bush may suffer branch die-back, but may persist in long term drought, and become dominant as other species die off. With an overall decrease in cover and the potential loss of root structure, this site is susceptible to erosion when floods return to the drainageway.

Community 2.3
Post-fire Regeneration

Fire is very unlikely in this ecological site, but there is a rare chance that it may occur. There will be high mortality of species after fire, but desert ironwood, desert lavender and catclaw acacia may resprout if only top-killed. There is little information about the effects of fire on desert ironwood but there is some evidence that it can re-sprout, with survival dependent upon burn severity. Desert iron wood establishment from seed requires normal to above normal winter precipitation for seed production and summer rains for seed germination (Phillips and Wentworth 2000). Tree growth is very slow, and may take 100 years to regain the large tree stature, and previous cover. Blue paloverde has thin bark and is likely to be killed by fire. It may be able to resprout after low intensity fire, but resprouting is likely uncommon (Pavek 1994). Creosote bush rarely resprouts after fire, and it will take time to re-establish from seed due to specific recruitment requirements. Burrobush, sweetbush and brittlebrush may increase in dominance after fire, because they quickly reestablish from seed (Brown and Minnich 1986, Brooks et al. 2007, Steers and Allen 2011).

Pathway 2.1a
Community 2.1 to 2.2

This pathway occurs in response to drought, and an absence of flood events. The active, freshly scoured portion of the channel declines, and a lack of freshly deposited sediment and moist conditions inhibits recruitment of blue paloverde, smoketree and catclaw acacia among other species.

Pathway 2.1b
Community 2.1 to 2.3

This pathway occurs in response to fire. Desert washes historically burn very infrequently, but an increase in the abundance of invasive annual grasses and annual forb cover in general in associated upland communities (Brown and Minnich 1986, Brooks et al. 2004, Brooks and Matchett 2006, Rao et al. 2010, Steers and Allen 2011) has led to an increase in fire frequency in desert wash communities.

Pathway 2.2a
Community 2.2 to 2.1

This pathway occurs in response to a return to the average or above average precipitation and associated flooding.

Pathway 2.2b
Community 2.2 to 2.3

This pathway occurs as a result of fire. Given low cover of annuals during drought, this pathway is unlikely except in periods immediately following heavy precipitation years.

Pathway 2.3a
Community 2.3 to 2.1

This pathway occurs in response to the passing of time with average to above average precipitation and associated flooding.

Pathway 2.3b
Community 2.3 to 2.2

This pathway occurs in response to the passing of time with drought conditions and absence of flooding.

State 3
Hydrologically Altered

State 3 represents altered hydrological conditions from surface flow modifications, increased run-off from impervious surfaces and/or ground water depletion. Data is needed to develop a successional diagram for this state, and it is unknown to what extent hydrologic modifications have affected this ecological site.

Community 3.1
Hydrologically Altered

Figure 9. Surface Flow Diversions

Landform alterations or road development can divert water away from natural drainageways and redirect flow to landforms that are not natural drainageways. In the image above, a road and an aqueduct, dissect several drainageways, capturing flow above the road, redirecting it along the aqueduct to several breaks. In the image, abandonment of channels below the road (to the right or east) is evident by the darker colors, as compared to the still active channel above the road. Surface flow has been diverted away from these channels, eliminating flood disturbances. Over time, disturbance or flood-adapted species like burrobush, desert lavender, blue paloverde, and smoketree die out. The darker blue spots along the active channels to the left of the road are mostly blue paloverde, and there is a noticeable decline to the right of the road where flow has been diverted away from the channel. Stable upland species such as brittlebush and creosote bush establish in the abandoned channels. Production and cover may increase, but diversity decreases, and the risk of fire may increase due to the increase in uniform cover of vegetation. Channel entrenchment can develop due to a range of interacting factors (Bull 1997), including the creation of drainage ditches and concentration of flow though culverts or breaks. Incised arroyos may form due to extreme climatic events, especially if they follow a period of drought or a fire that also burns upslope hill communities (Bull 1997). Research in other arid lands ephemeral stream systems has shown that channel entrenchment can lead to mortality in xeroriparian communities in a time span of only decades (Bull 1997 and references therein). Ground water drawdown from household wells (Nishikawa et al. 2004) or the diversion of surface flow in the upper watershed can deplete the water source for deep rooted species such as desert lavender, smoketree, blue paloverde, and desert ironwood.

Transition 2A
State 2 to 3

Triggers that can cause a transition to State 3 include surface flow alterations and prolonged drought. Any of the community phases from this state can cross the threshold to State 3, but community phase 2.3 and the later stages of 2.2 are especially vulnerable because decreases in vegetation density (and upland vegetation density) leave soils more susceptible to erosion (Bull 1997).

Transition T3a
State 3 to 2

Restoration from State 3 back to State 2 would be an intensive task. Individual site assessments would be required to determine proper restoration methods. Some hydrological modifications are not feasible restored, such as ground water depletion. However, impervious pavement, road diversions, and channel armoring can be redesigned to allow proper infiltration and channel flow. Entrenched channels can be built up with check dams, stones, or woody debris to increase the frequency of overflow on to the alluvial fan. Seeds or plants of appropriate species may need to be reintroduced to the restored channels, and associated sheet-flow areas.

Additional community tables

Table 7. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Tree					
1	**Trees**			78–530	
	desert ironwood	OLTE	*Olneya tesota*	67–508	1–10
	smoketree	PSSP3	*Psorothamnus spinosus*	1–112	1–15
	blue paloverde	PAFL6	*Parkinsonia florida*	11–112	1–10
Shrub/Vine					
2	**Shrubs**			28–224	
	burrobrush	HYSA	*Hymenoclea salsola*	8–133	1–8
	brittlebush	ENFA	*Encelia farinosa*	0–112	0–18
	desert lavender	HYEM	*Hyptis emoryi*	8–43	1–10
	sweetbush	BEJU	*Bebbia juncea*	1–36	1–4
	Schott's dalea	PSSC5	*Psorothamnus schottii*	0–28	0–10
	creosote bush	LATR2	*Larrea tridentata*	0–11	0–1
	catclaw acacia	ACGR	*Acacia greggii*	0–7	0–1
	bladderpod spiderflower	CLIS	*Cleome isomeris*	0–7	0–1
	burrobush	AMDU2	*Ambrosia dumosa*	0–6	0–1
	beavertail pricklypear	OPBA2	*Opuntia basilaris*	0–1	0–1
	Wiggins' cholla	CYEC3	*Cylindropuntia echinocarpa*	0–1	0–1
	branched pencil cholla	CYRA9	*Cylindropuntia ramosissima*	0–1	0–1
Forb					
3	**Forbs**			17–112	
	pygmy poppy	ESMI	*Eschscholzia minutiflora*	0–101	0–2
	phacelia	PHACE	*Phacelia*	0–45	0–2
	bristly fiddleneck	AMTE3	*Amsinckia tessellata*	0–22	0–1
	smooth desertdandelion	MAGL3	*Malacothrix glabrata*	0–7	0–1
	whitemargin sandmat	CHAL11	*Chamaesyce albomarginata*	0–6	0–1
	brownplume wirelettuce	STPA4	*Stephanomeria pauciflora*	0–3	0–1
	chia	SACO6	*Salvia columbariae*	0–2	0–1
	Western Mojave buckwheat	ERMO3	*Eriogonum mohavense*	0–1	0–3
	cryptantha	CRYPT	*Cryptantha*	0–1	0–1
	Abrams' sandmat	CHAB2	*Chamaesyce abramsiana*	0–1	0–1
4	**Non-native forbs**			0–1	
	Asian mustard	BRTO	*Brassica tournefortii*	0–1	0–1
	Asian mustard	BRTO	*Brassica tournefortii*	0–1	0–1
Grass/Grasslike					
5	**Non-native grasses**			0–1	
	red brome	BRRU2	*Bromus rubens*	0–1	0–1
	Mediterranean grass	SCHIS	*Schismus*	0–1	0–1

Animal community

Small animals live in this ecological site. Animal diversity in this ecological site may be greater than in other areas due to the heterogeneity of the site. Large shrubs and trees, such as desert ironwood, blue paloverde, catclaw acacia, and smoketree, provide structural diversity and additional food sources that may support a higher diversity of fauna. Ephemeral drainages are important wildlife migration corridors.

Hydrological functions

Ephemeral drainages provide some similar hydrologic functions as perennial streams. A properly functioning system will maintain water quality by allowing energy dissipation during high water flow. These systems transport nutrients and sediments, and store sediments and nutrients in deposition zones. Ephemeral drainages provide temporary storage of surface water, and longer duration storage of subsurface water (Levick et al. 2008).

Recreational uses

This site provides open access along the for hiking with trees to provide shade. Wildflowers and wildlife may be more abundant in the wash than in the surrounding areas.

Wood products

Desert ironwood wood is very dense, and has been used for firewood and wood carvings, but due to its slow growth rate and low recruitment it is unsustainable and illegal to collect in some areas (Phillips et al., 2000). Blue paloverde wood is used for fire wood, but is not very strong (Pavek 1994). Catclaw acacia wood is strong, durable and has unique coloration. It has been used to make cabinets, souvenirs, and fencing (Gucker 2005).

Other products

Blue paloverde and desert ironwood seeds are edible after being prepared and cooked properly (Pavek 1994, Phillips and Wentworth 2000). Desert lavender is used in landscaping, because it has a pleasant aroma and it attracts bees and hummingbirds.

Other information

Wild burros are present in the eastern range of this ecological site (close to Lake Havasu). The burros may have caused a decline in understory diversity in this area, especially since the original data plot is within a mile of a permanent water source (Lake Havasu).

Inventory data references

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

CC1
1250015103 (Type location)
18

CC2
6811-31-7LL (CA803-Colorado Desert Area Survey, UTMS NAD83 7504331 3808611, Near lake Havasu)
Hasp-02b
I5-G

CC3
18B
1248617416

CC4
Vipa-12

CC5
Vipa-11

Type locality

Location 1: Riverside County, CA	
UTM zone	N
UTM northing	3728830
UTM easting	610630
General legal description	The type location is about .25 miles west of Cottonwood Springs Road, about 1.5 miles north of the Bajada Nature Trail, in Joshua Tree National Park.

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Approval

Scott Woodall, 2/08/2019

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:**