Ecological site R030XD014CA
Hyperthermic Sandy Plains

Accessed: 08/18/2026

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): 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 Land Resource Unit (designated by ‘XD’) is found on the eastern side of California. Elevations range from 400 to 2200 feet on average, but may be found up to 3600 feet on southern exposures. Precipitation ranges from 1 to 6 inches per year, but averages between 2-4 inches. This LRU is characterized primarily by the extreme aridity, hot temperatures, hyperthermic soil temperatures and low stature of widely spaced vegetation. Temperatures can reach over 110 degrees Fahrenheit for several weeks in July and August. Summer precipitation falls between July and September, ranging from 20-33% in the form of rain, and winter precipitation falls starting in November and ends between February and March, ranging from 56-70%, also mostly in the form of rain. Vegetation is primarily small, widely-spaced, low-producing creosote bush (Larrea tridentata), burrobush (Ambrosia dumosa), and brittlebush (Encelia farinosa). Ecological Site Concept – This ecological site is found on semi-stabilized sandsheets at elevations ranging from 1150 to 2200 feet, and slopes of 2 to 15 percent. Dominant soils are very deep fine sands that formed from eolian deposits and exhibit no soil development. Soils may have an alluvial influence, but eolian processes dominate. The reference community is dominated by big galleta (Pleuraphis rigida), and creosote bush (Larrea tidentata) is the dominant shrub. Production reference value (RV) is 470 pounds per acre, and depending on precipitation and resulting annual forb production, ranges from 280 to 625 pounds per acre. Annual forbs are abundant during years of average to above average precipitation. Semi-stabilized, deep fine sands are optimum habitat for big galleta, which colonizes and stabilizes these eolian habitats with rhizomatous growth. The data in the following sections is from major (15% of mapunit or greater) components only.

Classification relationships

This ecological site is found within the Pleuraphis rigida Herbaceous Alliance (Sawyer et al. 2009), and includes the Pleuraphis rigida/Larrea tridentata Association.

Associated sites

R030XD001CA	**Hyperthermic Dry Hills** R030XD001CA is found on adjacent hillslopes. Creosote bush (Larrea tridentata) and burrobush (Ambrosia dumosa) are dominant.
R030XD003CA	**Hyperthermic Steep South Slopes** R030XD003CA is found on adjacent mountain slopes. Brittlebush (Encelia farinosa) and creosote bush (Larrea tridentata) are dominant.

R030XD004CA	**Low-Production Hyperthermic Hills** R030XD004CA is found on adjacent mountain slopes. Creosote bush (Larrea tridentata) is dominant.
R030XD006CA	**Abandoned Fan** R030XD006CA is found on adjacent fan aprons. Creosote bush (Larrea tridentata) is dominant.
R030XD008CA	**Hyperthermic Sandhill** R030XD008CA is found on adjacent steep sandsheets with slopes greater than 8 percent. Creosote bush (Larrea tridentata) and big galleta (Pleuraphis rigida) are dominant species.
R030XD015CA	**Hyper-Arid Fans** R030XD015CA is found on adjacent fan aprons. Creosote bush (Larrea tridentata) and burrobush (Ambrosia dumosa) are dominant.
R030XD025CA	**Hyperthermic Sandsheets** R030XD025CA is found on adjacent more stable sandsheets with higher cover of surface gravels. Creosote bush (Larrea tridentata) is dominant and big galleta (Pleuraphis rigida) and Emory's dyebush (Psorothamnus emoryi) are important species.
R030XY001CA	**Occasionally Flooded, Hyperthermic, Diffuse Ephemeral Stream** R030XY001CA is found on adjacent small, occasionally flooded ephemeral drainageways. Creosote bush (Larrea tridentata) and Schott's dalea (Psorothamnus schottii) are dominant species.
R030XY092NV	**DESERT PATINA** This ecological site is found on adjacent fan remnants covered with desert pavement. Very sparse vegetation is dominated by creosote bush (Larrea tridentata).

Similar sites

R030XD025CA	**Hyperthermic Sandsheets** R030XD025CA is found on more stable sandsheets with higher cover of surface gravels. Production is lower and creosote bush (Larrea tridentata) is dominant.
R030XD045CA	**Hyperthermic Stable Sand Dunes And Sandsheets** R030XD045CA is found on less stable sandsheets. Production is much higher, and big galleta (Pleuraphis rigida) is very strongly dominant.
R030XD008CA	**Hyperthermic Sandhill** R030XD008CA is found on dunes and steeper sandsheets, with slopes of 8 to 30 percent. Production is lower and creosote bush (Larrea tridentata) and big galleta (Pleuraphis rigida) are codominant.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Larrea tridentata*
Herbaceous	(1) *Pleuraphis rigida*

Physiographic features

This ecological site occurs on sandsheets and fan aprons that are influenced by eolian surface deposits. Elevations range from 1150 to 2200 feet, and slopes range from 2 to 15 percent. Runoff class is very low to low.

Table 2. Representative physiographic features

Landforms	(1) Sand sheet (2) Alluvial fan
Flooding frequency	None
Ponding frequency	None
Elevation	350 – 670 m
Slope	0 – 20 %
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 65 percent falling in winter between November and March. The mean annual precipitation is 3 to 5 inches and mean annual air temperature is 68 to 73 degrees F. The frost free period is 300 to 340 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 unweighted averages; numbers in square brackets represent relative weights):

42598, Eagle Mountain, CA (Period of record = 1933 to 2011) [1]

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

049099, Twentynine Palms, California (Period of record = 1935 to 2011) [1]

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

Table 3 Representative climatic features

Frost-free period (average)	340 days
Freeze-free period (average)	0 days
Precipitation total (average)	130 mm

Influencing water features

Soil features

The dominant soils associated with this ecological site are very deep sands that formed from eolian deposits derived from granitoid and igneous parent material. Less commonly, this site is associated with soils that formed in alluvium from igneous and granitoid sources that are overlain with a sandy surface. Surface textures are fine sand with fine sand subsurface textures. Gravel sized (3 inch diameter) surface rock fragments range from 5 to 10 percent, with larger fragments typically absent. Subsurface gravel sized fragments by volume range from 1 to 25 percent, and larger fragments range from 0 to 35 percent (for a depth of 0 to 59 inches).

The associated soil series that are 15 percent or greater of any one map unit are: Dalelake (mixed, hyperthermic Typic Torripsamments); and Sheephole (sandy, mixed, hyperthermic Typic Torriorthents). This site is also associated with a four percent component of the Joetree series (mixed, hyperthermic Typic Torripsamments).

The Dalelake soils, which this ecological site is predominately associated with, occur on dunes and sand sheets overlying fan remnants, fan aprons, and alluvial fans. These soils typically have few rock fragments within the soil horizons. The Sheephole soils occur on the same landforms, but include an alluvial influenced soil horizon with 25 percent gravel-sized and 35 percent larger fragments in the middle of the soil profile. Joetree soils are an alluvial soil with deep sands to 100 centimeters which overlie an argillic horizon.

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

2715;Dalelake-Sheephole-Pintobasin complex, 2 to 8 percent slopes;Sheephole;;30
2067;Aquapeak-Buzzard Springs-Dalelake complex, 2 to 30 percent slopes;Dalelake;thick sandy surface;20
1220;Jadestorm-Blackeagle-Rock outcrop complex, 15 to 50 percent slopes;Dalelake;thick sandy surface;3
1410;Missionwell-Rock outcrop complex, 15 to 50 percent slopes;Dalelake;thick sandy surface;2
1522;Pintobasin sand, 1 to 3 percent slopes, rarely flooded;Dalelake;thick sandy surface;1
1531;Dalelake-Pintobasin complex, 0 to 4 percent slopes;Joetree;overblown;4

Table 4. Representative soil features

Parent material	(1) Eolian deposits – granite
Surface texture	(1) Fine sand
Family particle size	(1) Sandy
Drainage class	Somewhat excessively drained
Permeability class	Rapid
Soil depth	150 cm

Surface fragment cover <=3"	10 %
Surface fragment cover >3"	Not specified
Available water capacity (0-101.6cm)	4.32 – 7.87 cm
Calcium carbonate equivalent (0-101.6cm)	Not specified
Electrical conductivity (0-101.6cm)	Not specified
Sodium adsorption ratio (0-101.6cm)	Not specified
Soil reaction (1:1 water) (0-101.6cm)	10 – 8.4
Subsurface fragment volume <=3" (Depth not specified)	0 – 30 %
Subsurface fragment volume >3" (Depth not specified)	0 – 40 %

Ecological dynamics

Abiotic Factors

The abiotic drivers of this ecological site are an semi-stabilized eolian landscape with hyperthermic soil temperatures. This ecological site occurs on semi-stabilized sandsheets on soils with a hyperthermic soil temperature regime. Sandsheets are extensive, low relief accumulations of eolian sand deposits (Laity 2008). Stable, or dormant sandsheets are those where perennial vegetation cover is well-developed, and current rates of sand movement and deposition are low or absent, but may become active as a result of minor climate change or disturbance (Lancaster 1994). The stability of these landforms means that factors such as burial or abrasion by blowing sand does not restrict vegetation to psammophiles (plants restricted to active eolian environments).

The plant community is strongly dominated by big galleta, a highly drought-tolerant C4 grass that occurs on a range of soil types, but is dominant only on sandy soils where soil moisture is most readily available (McAuliffe 1994, Austin et al. 2004). Big galleta colonizes and stabilizes semi-stabilized eolian habitats with rhizomatous growth (Matthews 2000), and dominance by big galleta on these habitats is an indicator of eolian stability. However, there is a threshold of stability where creosote bush becomes dominant over big galleta. Big galleta exhibits rapid growth and high productivity in response to temporal high moisture availability in these deep sands (Austin et al. 2004). In arid regions, sand textured soils have greater water availability because water quickly infiltrates through sand to depths where it is not lost to evaporation, and because sandy surfaces form a physical crust that further reduces evaporation (Noy-Meir 1973, Hamerlynk et al. 2002). Thus, in desert regions, where the availability of soil water is the critical resource shaping plant communities in arid environments, productivity is higher on sandy soils (Noy-Meir 1973, McAuliffe 1994, Martre et al. 2002, Hamerlynk and McAuliffe 2002, Austin et al. 2004).

Creosote bush is a long-lived, deep-rooted evergreen shrub dominant across vast areas of the North American warm deserts. Creosote bush maintains its evergreen status by using water held in deep soil layers, and once established in this ecological site, individuals are large and productive. Creosote remains a secondary species in this site however, because of soil moisture restrictions and seedling sand abrasion during the establishment phase. Creosote bush establishes in response to warm season moisture; given limited warm season rain in this ecological site, the rapid infiltration of water and rapidly drying soil surfaces during the warm season, and increased erosion and abrasion during the summer, opportunities for successful establishment of creosote seedlings are rare. However, multiple years with conditions favorable for creosote bush establishment, especially if coupled with a decrease in deposition or wind activity, can cause a transition to an alternative stable state where creosote bush is dominant.

Disturbance dynamics
Drought, invasion by nonnative species, and fluctuations in sand erosion and deposition are the primary disturbance affecting this ecological site.

Drought is an important shaping force in desert plant communities (Webb et al. 2003, Bowers 2005, Hereford et al. 2006, Miriti et al. 2007, Hamerlynk and McAuliffe 2008). The effects of drought may be particularly severe in deep sandy soils with little horizon development. High availability of soil moisture during normal to high precipitation conditions can lead to high growth rates and large individuals whose size cannot be sustained when water is no longer available (Hamerlynk and McAuliffe 2008). Short-lived shrubs and perennial grasses demonstrate the highest rates of drought-induced 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, 1974, 1976). Long-lived species are more likely to exhibit branch-pruning with limited recruitment during drought (Hereford et al. 2006, Miriti et al. 2007).

Severe drought, especially if coupled with additional disturbance such as off-road vehicle use, increases the susceptibility of soils to wind erosion due to loss of stabilizing plant cover, and increased erodibility of dry soils (Cooke et al. 1993, Lancaster 1994). This may trigger a transition to an altered state where stabilized sand surface become active. Similarly, semi-stabilized sand surfaces may alternatively become more stable with changes environmental changes resulting in increased vegetation cover, changes in wind environment or decreased deposition (Cooke et al. 1993, Lancaster 1994. Increases in vegetation cover and decreases in deposition are generally due to a wetter climate (Cooke et al. 1993, Lancaster 1994).

Non-native annual species such as red brome (Bromus rubens), Mediterranean grass (Schismus barbatus), redstem stork's bill (Erodium cicutarium) and Asian mustard (Brassica tournefortii) 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). In lower elevations, where soil temperature regimes are hyperthermic and soil moisture is more limiting, Mediterranean grass is the dominant non-native grass (Brooks and Berry 2006). Like native annuals, non-native annual cover and production is directly related to winter precipitation (Beatley 1969, Brooks and Berry 2006, Barrows et al. 2009). Asian mustard and Russian thistle (Salsola tragus) are significant threats in eolian habitats, with Russian thistle potentially abundant on disturbed areas or more active sand. Asian mustard may become dominant on stabilized sandsheets during years of above average precipitation, during which time is has detrimental affects on the abundance and fecundity of native annuals (Barrows et al. 2009). Asian mustard is less dominant on semi-stabilized sand (Barrows et al. 2009); probably because of increased seed burial depths in these habitats from which seedlings cannot emerge (Abella et al. 2011).

State and transition model

Figure 3. R030XD014CA

Additional community tables

Table 5. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
Grass/Grasslike					
1	**Native perennial grasses**			241-482	
	big galleta	PLRI3	*Pleuraphis rigida*	241-481	15-30
4	**Non-native annual grasses**			0-3	
	common Mediterranean grass	SCBA	*Schismus barbatus*	0-3	0-6
Shrub/Vine					
2	**Native shrubs**			71-141	
	creosote bush	LATR2	*Larrea tridentata*	71-141	1-6
	dyebush	PSEM	*Psorothamnus emoryi*	0-17	0-2

	burrobush	AMDU2	*Ambrosia dumosa*	0-2	0-1
Forb					
3	**Native forbs**			0-78	
	small wirelettuce	STEX	*Stephanomeria exigua*	0-56	0-2
	cryptantha	CRYPT	*Cryptantha*	0-18	0-8
	birdcage evening primrose	OEDE2	*Oenothera deltoides*	0-11	0-2
	pincushion flower	CHFR	*Chaenactis fremontii*	0-6	0-4
	smooth desertdandelion	MAGL3	*Malacothrix glabrata*	0-1	0-1
5	**Non-native annual forbs**			0-56	
	Asian mustard	BRTO	*Brassica tournefortii*	0-56	0-5

Table 6. Community 2.2 plant community composition

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

Table 7. Community 2.3 plant community composition

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

Table 8. Community 2.4 plant community composition

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

Animal community

This ecological site is preferred habitat for the threatened desert tortoise (Gopherus agassizii agassizii). Creosote bush shrublands provides a home for an abundance of specialist insect species, for example, creosote bush flowers provide nutrition for over twenty species of bees, and the creosote bush grasshopper (Bootettix argentatus) feeds solely on creosote leaves (Pavlik 2008). A diverse assemblage of reptiles and mammals are likely to be found in this site. These may include (based on habitat preferences): Lizards: Mojave Desert tortoise (Gopherus agassizii agassizii) Desert banded Gecko (Coleonyx variegatus variegatus) Northern desert iguana (Dipsosaurus dorsalis dorsalis) Long-nosed leapard lizard (Gambelia wislizenii wislizenii) Western chuckwalla (Sauromalus ater obesus) Mojave zebra-tailed lizard (Callisaurus draconoides rhodostictus) Southern desert horned lizard (Phrynosoma platyrhinos calidiarum) Western brush lizard (Urosaurus graciosus graciosus) Desert side-blotched lizard (Uta stansburiana stejnegeri) Great basin whiptail (Aspidoscelis tigris tigris) Snakes: 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) Sonoran gopher snake (Pituophis catenifer affinis) Western long-nosed snake (Rhinocheilus lecontei lecontei) Desert patch-nosed snake (Salvadora hexalepis hexalepis) Smith's black-headed snake (Tantilla hobartsmithi) Western diamondback snake (Crotalus atrox) Mojave Desert sidewinder (Crotalus cerastes cerastes) Colorado Desert sidewinder (Crotalus cerastes laterorepens) The following mammals are likely to occur in this ecological site: American badger (Taxidea taxus berlandieri) 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) Desert kit fox (Vulpes macrotis arsipus) Southern Desert cottontail (Sylvilagus audobonii arizonae) Desert blacktail jackrabbit (Lepus californicus deserticola) Whitetail antelope squirrel (Ammospermphilus leucurus leucurus) Mojave roundtail ground squirrel (Spermophilus tereticaudus tereticaudus) Mojave pocket gopher (Thomomys bottae mojavensis) Coachella pocket gopher (Thomomys bottae rupestris) Eastern spiny pocket mouse (Peroganthus spinatus spinatus) Pallid (San Diego) pocket mouse (Chaetodipus fallax pallidus) Mojave little pocket mouse (Perognathus longimembris longimembris) Merriam's kangaroo rat (Dipodomys merriami merriami) Desert kangaroo rat (Dipodomys deserti) Desert wood rat (Neotoma fuscipes simplex) 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, wildflower viewing, and aesthetic enjoyment.

Other products

Creosote bush is an important medicinal plant for Native Americans. It has a very wide range of uses from treatment for bowl complaints, menstrual cramps, to induce vomiting, relief for arthritis, rheumatism, aching bones and sprains, congestion and cold, as an antiseptic and disinfectant, dandruff, antispasmodic, to induce urination, gonorrhea, and to cancer treatment. (This list is not exhaustive). http://herb.umd.umich.edu/herb/search.pl?searchstring=Larrea+tridentata. Creosote bush stems are used to make weapons, digging tools, and basket handles, and creosote gum is used for knife and awl handles. Creosote bush branches are used as thatch in dwelling construction. http://herb.umd.umich.edu/herb/search.pl?searchstring=Larrea+tridentata.

Inventory data references

Community Phase 2.1: 11CA795223 (Type location) 11CA795224

Type locality

Location 1: San Bernardino County, CA	
UTM zone	N
UTM northing	3870466
UTM easting	610724
General legal description	The type location is in the Devil's Playground area of the Mojave National Preserve, approximately 7.8 miles west of the intersection of Kelbaker and Kelso-Cima Road.

Other references

Abella, S. R., A. C. Lee, and A. A. Suazo. 2011. Effects of burial depth and substrate on the emergence of Bromus rubens and Brassica tournefortii. Bulletin of the Southern California Academy of Science 110:17-24.

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.

Barrows, C. W., E. B. Allen, M. L. Brooks, and M. F. Allen. 2009. Effects of an invasive plant on a desert sand dune landscape. Biological Invasions 11:673-686.

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.

Cooke, R. U., A. Warren, and A. S. Goudie. 1993. Desert Geomorphology. UCL Press, London.

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.

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.

Laity, J. 2008. Deserts and desert environments. John Wiley & Sons.

Lancaster, N. 1994. Controls on aeolian activity: some new perspectives from the Kelso Dunes, Mojave Desert, California. Journal of Arid Environments 27:113-125.

Matthews, Robin F. 2000. Pleuraphis rigida. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2012, April 4].

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.

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. and A. C. Sanders. 2000. Brassica tournefortii (Gouan.) Sahara mustard. Pages 68-72 in C. Bossard, M. Hoshovsky, and J. Randall, editors. Noxious wildland weeds of California. University of California Press, Berkeley, CA.

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.

Okin, G. S., B. Murray, and W. H. Schlesinger. 2001. Degradation of sandy arid shrubland environments: observations, process modelling, and management implications. Journal of Arid Environments 47:123-144.

Pavlik, B. M. 2008. The California Deserts: an ecological rediscovery. University of California Press, Ltd., Berkeley and Los Angeles, California.

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.

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

Contributors

Alice Lee Miller
P. Novak-Echenique / H. McAllister

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:**
