Ecological site R015XF016CA
Very Shallow Steep Foothills

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General information

Approved. An approved ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model, enough information to identify the ecological site, and full documentation for all ecosystem states contained in the state and transition model.

MLRA notes

Major Land Resource Area (MLRA): 015X–Central California Coast Range

Major land Resource Area (MLRA 15): MLRA 15 is an area of gently sloping to steep, low mountains. Precipitation is evenly distributed throughout fall, winter, and spring but is very low in summer. Elevation ranges from sea level to 2,650 feet in most of the area, but up to 4,950 feet in some of the mountains. The soils in the area dominantly have a thermic soil temperature regime, a xeric soil moisture regime, and mixed or smectitic mineralogy. LRU Description: This Land Resource Unit (designated by “15XF”) includes Blue Ridge in the northern California Coast Ranges and steep hills east of Blue Ridge and east of the Stony Creek fault, extending north to the Klamath Mountains down to the southern portion of Napa and Yolo Counties. The LRU is formed mostly from upper and lower Cretaceous sandstone, shale and conglomerate facies of the Great Valley sequence. This area includes north to south trending foothill slopes and alluvial back valleys. Soil temperature regime is mostly thermic, with some high elevation areas that are mesic, and soil moisture regime is xeric. Common vegetation includes introduced annual grasses and forbs, blue oak, chamise, ceanothus, manzanita and California foothill pine. Elevations generally range from 500 to 2,400 feet. Rainfall levels drop quickly from the mountains to the foothills and valley due to the rain shadow effect. Annual precipitation generally averages from 16 to 40 inches. This ecological site is within LRU 15XF and is located within EPA Ecoregion designated as “6f”.

Classification relationships

This site is predominantly located within M261C, the Northern California Interior Coast Ranges Section, (McNab and others, 2007) of the National Hierarchical Framework of Ecological Units (Cleland and others, 1997), 261Ca, the Western Foothills Subsection. Small portions of the following sections are also included: M261A – Klamath Mountain Section and Section M261F - Sierra Nevada Foothills Section. Level III and Level IV ecoregions systems (Omernik, 1987, and EPA, 2011) are: Level III, Central California Foothills and Coastal Mountains and Level IV, Ecoregion 6f, Foothill Ridge and Valleys. This site may include the following Allen-Diaz Classes: 1) Blue Oak-Grass (Allen-Diaz et al., 1989). 2) This site includes the Blue Oak-Foothill Pine (BOFP) of the California Wildlife Habitat Relationships System (Mayer and Laudenslayer, 1988). The Society for Range Management Cover Type for this site is Blue Oak Woodland (Shiflet (ed), 1994). This site includes the Quercus douglasii Alliance from The Manual of California Vegetation (Sawyer et al., (2nd Ed.), 2009).

Ecological site concept

This ecological site is predominately found on south and east facing strath terraces, shale benches and low ridge foothill backslopes at elevations between 900 and 1,700 feet and slopes that average between 20 to 55 percent. Loamy soils are dominantly very shallow to bedrock, creating a root-restricting layer that reduces the water storage capacity within the soil profile. Soils are excessively drained and available water holding capacity is about 1 to 2 inches. This site concept differs from ecological site R015XF003CA primarily due to the higher elevations and steeper slopes, as well as the higher average precipitation that this site receives in comparison to 003 (19-22 inches vs. 24-33 inches). Although the soils are very similar, the increased precipitation and cooler temperatures due to the higher average elevation ranges and steeper slopes, supports a different suite of species potentials. Sparse California foothill pine (Pinus sabiniana) and blue oak (Quercus douglasii) are found on most of this site. Very sparse low shrub cover includes buckbrush (Ceanothus cuneatus) and occasionally common manzanita (Arctostaphylos manzanita). Non-native annual grasses and perennial and annual forbs are found in the understory. Red stem stork's bill (Erodium circutarium), an annual forb, dominates the forb layer and red brome (Bromus rubens) dominates the annual grasses.

Associated sites

R015XF008CA	**Shallow Gravelly Foothills** The Shallow Gravelly Foothills ecological site is found in association with this site, primarily on east to southwest facing slopes. Vegetation is sparse blue oak and foothill pine with a moderate shrub layer of Pacific poison oak and buckbrush, and an understory dominated by perennial and annual grasses and forbs.

Similar sites

R015XF003CA	**Very Shallow Loamy Foothills** The Very Shallow Loamy Foothills ecological site concept is similar primarily due to the very shallow loamy soils both sites can be found on. However, this ecological site is located on lower elevations and gentler slopes (average under 30%), as well as having lower average annual precipitation in comparison to 016 (19-22 inches vs. 24-33 inches). Although the soils are very similar, the lower precipitation and warmer temperatures due to the lower average elevations and gentler slopes, supports a different suite of species potentials.

Table 1. Dominant plant species

Tree	(1) *Quercus douglasii* (2) *Pinus sabiniana*
Shrub	(1) *Ceanothus cuneatus*
Herbaceous	(1) *Erodium cicutarium*

Physiographic features

This ecological site is predominately found on foothill backslopes and ridges at elevations between 900 and 1,700 feet. Slopes average between 20 to 55 percent but range from 5 to 90 percent. This site is dominant on south and southwest-facing slopes, but all aspects are represented. Runoff is medium to high, permeability is moderate.

Figure 1. R015XF016CA -Very Shallow, Steep Foothills

Table 2. Representative physiographic features

Landforms	(1) Ridge
Flooding frequency	None
Ponding frequency	None
Elevation	270 − 520 m
Slope	20 − 60 %
Aspect	E, S, SW

Climatic features

This ecological site has a Mediterranean climate characterized by hot and dry summer temperatures and cool moist winters. The northern part of the California Central Valley receives precipitation from winter storms from the Pacific Northwest primarily as rain, mostly during October through May. The timing, length and intensity of storms are highly variable and unpredictable.

Drought may occur for months or years at a time, depending on the fluctuations of winds and ocean currents in the equatorial region of the Pacific Ocean (Quinn and Keely, 2006). This water deficit in combination with periodic drought results in a period of prolonged low water availability (Stromberg et al., 2007).

The mean annual precipitation ranges from 24 to 33 inches and mean annual air temperature is 46 to 72 degrees F. The frost-free period is 133 to 256 days. The freeze-free period is 241 to 338 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:

46974 - Platina, CA From 1962-1974
46055 - Ono, CA From 1952-1984
46726 - Paskenta, CA From 1937-2001

The climate stations are located in the northern third of the site. The central and southern extent of this site tends to be drier and warmer than the northern area.

Table 3 Representative climatic features

Frost-free period (average)	200 days
Freeze-free period (average)	290 days
Precipitation total (average)	740 mm

Influencing water features

Loamy soil texture, very shallow soil depth, and low soil cover dramatically affect infiltration and overland flow on this ecological site. The sandstone and shale parent material are often tilted and fragtured, allowing water to penetrate and pass through the soil profile quickly. This site’s landscape position on backslopes and ridges that are generally steep (>30 percent slope) contribute to rapid runoff and subsequently weathered material is more easily removed by erosion.

Typically the very sparse distribution of trees and shrubs intermixed with open areas with light forb and/or grass cover do not contribute much to water retention on this site. Some infiltration occurs, but much is transported offsite via overland flow.

Soil features

The loamy soils typically associated with this ecological site occur on strath terraces, shale benches and low ridges in foothill back valleys formed in residuum primarily from shale sources. They are very shallow over a soft or hard bedrock contact at 5-10 inches and are well drained. Available water holding capacity is about 1 to 2 inches.

Soils have rapid permeability. Surface gravels 3 inches on average 18 percent but as a whole range from 0-18 percent. Surface fragments greater than 3 inches are 3 percent. Subsurface fragments > 3 inches are absent.

Soil characteristics are the over-riding factor that controls the production and species composition on this ecological site. A very shallow soil depth reduces the water storage capacity of the soil profile, and rapid permeability with excessive drainage and low soil cover favor non-native annual forbs and grasses. The relative lack of cover and steep slopes lend to increased erosive potential on this site.

The associated soil series that are 15 percent or greater of any one map unit are:
Lodo (Loamy, mixed, superactive, thermic Lithic Haploxerolls).

CA607 – Shasta County, California
Lbe: Lodo shaly loam, 10 to 50 percent slopes

LbF3: Lodo shaly loam, 50 to 70 percent slopes, severely eroded

CA645 – Tehama County, CA
LbEsh: Lodo shaly loam, 10 to 50 percent slopes
LbF3sh: Lodo shaly loam, 50 to 75 percent slopes, severely eroded
LdD2: Lodo and Maymen shaly loams, 10 to 30 percent slopes, eroded
LdE2: Lodo and Maymen shaly loams, 30 to 65 percent slopes, eroded
MbgE: Maymen and Lodo gravelly loams, 30 to 65 percent slopes

Table 4. Representative soil features

Parent material	(1) Residuum – shale
Surface texture	(1) Clay loam (2) Sandy loam
Drainage class	Somewhat excessively drained
Permeability class	Rapid to very rapid
Soil depth	0 – 30 cm
Surface fragment cover <=3"	20 %
Surface fragment cover >3"	Not specified
Available water capacity (0-101.6cm)	2.54 – 5.08 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)	5.6 – 7.3

Subsurface fragment volume <=3" (Depth not specified)	Not specified
Subsurface fragment volume >3" (Depth not specified)	Not specified

Ecological dynamics

Disturbance is defined as “any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resource pools, substrate availability, or the physical environment” (Pickett and White,1985); it may be natural or anthropogenic in origin.

Historic Influences:
Historically, the foothill pine - blue oak woodlands burned at 15 to 30-year intervals, and were of light or moderate severity (Howard, 1992). Native Americans regularly used fire to manage vegetation communities to provide food and fiber (McCleary 2004; Anderson, 2005) and to reduce brush surrounding oaks and foothill pine, a rich source of acorns and pine nuts, making trees accessible and reducing fire risk. Fire frequency was around 25 years prior to settlement in the mid-1800s. After settlement by Europeans, the use of fire to remove brush and trees changed the fire frequency to approximately 7 year intervals. Ranchers continued the extensive use of prescribed burning until the 1950s.

This ecological site is primarily located within the Cottonwood Creek and Tehama West Watersheds in Shasta and Tehama Counties. The Cottonwood Creek Watershed Assessment (USDA Forest Service, 1999) reports that the dominant influences in the watershed during the early 1800’s were gold mining and farming. According to that report, one of the greatest impacts resulting from gold mining was the associated population growth and housing development. Later, copper and other ore mining activities surpassed gold mining. In the southern extent of the ecological site, cattle ranching, sheep herding and dryland farming were the activities that dominated the foothill areas (Tehama County Resource Conservation District, 2006).

The large scale livestock operations established in the 1800’s throughout the Cottonwood Creek and the Tehama West Watersheds were described as having sheep, cattle and hogs. Intensive year-round grazing impacted many soils, resulting in reduced vegetative cover and compaction in some areas (Tehama County Resource Conservation District, 2006). A series of droughts and floods in the 1860’s devastated many cattle herds, and when recovery occurred in the 1870s, sheep-raising had largely replaced cattle-ranching. High densities of sheep grazing that occurred during that period reduced litter and plant cover. This was likely due to intense grazing over a longer season. The grazing effects were worsened by burning practices that were more frequent and intense and resulted in permanent soil loss.

Widespread conversion of blue oak to grassland and dryland agriculture occurred after World War II, when both pine and oak were cleared to improve grazing, especially during the 1950s and 1960s. One estimate suggests that up to 60 percent of the oak woodland in the Cottonwood Creek watershed has been converted to other uses (State of California, DWR, 1992). Other influences that impacted oak woodlands included fire, grazing and drought.

Blue oak (Quercus douglasii) and California foothill pine (Pinus sabiniana) are tree species found on this site. Oaks are relatively long-lived, but foothill pine tends to grow faster. Young blue oaks sprout well and are more likely to replace themselves after fires than mature oaks (McCreary, 2004, Fryer, 2007). Shrub species such as buckbrush (Ceanothus cuneatus) and whiteleaf manzanita (Arctostaphylos manzanita) have seed stored in the soil, having abundant germination following fire (Abrahamson, 2014). Other shrubs that may be present in lesser amounts include birchleaf mountain mahogany (Cercocarpus montanus var glaber) and hollyleaf redberry (Rhamnus ilicifolila) that sprout from the root crown following cutting or fire.

At lower elevations on this ecological site, the blue oak and foothill pine vegetation type intergrades with blue oak woodlands, and at higher elevations, with dense mixed chaparral shrub cover (USDA Forest Service, 1999). Within the Lower Montane Mixed Chaparral Alliance (CALVEG 2008) the shrub mixture may include chamise (Adenostoma fasiculatum), whiteleaf and sticky whiteleaf manzanita (Arctostaphylos visida), buckbrush, and birchleaf mountain mahogany. There may be isolated areas with small populations of California juniper (Juniperus californica) and chamise (Adenostoma fasciculatum) within this ecological site.

Current Influences:

Fire: Several large fires burned through the landscape of this ecological site in the 1940s through the 1970s. The Skinner Mill fire in 1976, had significant impacts on soil erosion and associated soil productivity (DWR, 1992). Many of these fires were either a result of human-caused ignition or equipment use (Tehama County Resource Conservation District, 2006). Active fire suppression during the last century has allowed for the accumulation of fuels and a trend towards larger more devastating fires (McCleary 2004, Arno and Allison-Bunnell, 2002). Fire suppression during the last 100 years has influenced and shaped the environment of this ecological site. Pine is increasing in

blue oak-California foothill pine communities, contributing to a lack of blue oak regeneration and adding to ladder fuels. There is an increase of chaparral shrubs invading grassy understories of blue oak-California foothill pine woodlands, with a rise in shrub recruitment in the absence of periodic fire or grazing in some foothill environments (Powers, 1990).

Grazing: Production is low on this very shallow ecological site, and forage dries out quickly in the season. Forage on these sites appears to be lightly utilized during most years, due to steep slopes, the lack of water, and the concentration of animals in more productive low lying areas.

Disease and Pathogens: Some diseases of blue oak damage the heartwood of the trunk and large limbs (McDonald, 1990). Several fungi cause wood decay in the limbs and trunks of oaks (Hickman et al., 2011). The sulphur conk, (Laetiporus sulphureus), causes a brown cubical rot also of the heartwood of living oaks. The hedgehog fungus (Hydnum erinaceum) and the artist's fungus (Ganoderma applanatum) are also capable of destroying the heartwood of living oaks. A disease of blue oak roots, the shoestring fungus rot (Armillaria mellea) gradually weakens trees at the base until they fall. A white root rot (Inonotus dryadeus) also has been reported on blue oak. Diseases of California foothill pine include western gall rust (Peridermium harknessii) and dwarf-mistletoe (Arceuthobium occidentale and A. campylopodum forma campylopodum) (Howard, 1992).

Drought: Oaks are efficient water users; they are adapted to very low moisture conditions by virtue of their small leaf size, the regulation of water loss through the leaf stomata and by tapping into water below fractured rock (Baldocchi et al., 2006). California foothill pine is drought tolerant, however, increases in mortality have been noted during the most recent drought period, due to a combination of weakening, subsequent attack of the bark beetle (Ips spp.), and severe dwarf mistletoe infections. Both buckbrush and whiteleaf manzanita are very drought tolerant (League, 2005, Abrahamson, 2014).

Though droughts of varying lengths are common occurrences in a Mediterranean ecosystem, the most recent drought period, beginning in 2012 and now in its fourth year, is unparalleled in California's climate record (Griffin and Anchukaitis, 2014). Increased temperature and evaporation will likely have a significant effect on species composition and productivity on this site, favoring more droughty species and lessening overall production. While most oaks have adapted to withstand prolonged drought (Harper et al., 1991, Fryer, 2007), under the particularly harsh site conditions on this ecological site, natural regeneration may be severely restricted. Extended periods of drought could slow recovery by limiting photosynthesis and affect carbon intake, hindering reproductive processes, leading to a reduction in oak seedling establishment (Miller et al., 2010). Others predict large scale shifts in forest structure and function with an increase in smaller trees, a loss of large trees and a shift of increased dominance of oaks over pines, due largely to an increase in warming and declines in available water (McIntyre et al., 2014).

Climate: In California's Mediterranean climate evaporative demand and rainfall are out of sync with one another (Miller et al., 2012). During peak demand in the spring, water is quickly depleted from the soil profile and grasses senesce. After that period the only moisture available to woody plants is through root access to groundwater. Groundwater has been shown to be a critical link to blue oak survival over the prolonged summer drought period (Miller et al., 2010).

Climate predictions project an increase in the blue oak foothill pine type with increased temperature and precipitation. The amount of area burned in fires is also expected to increase due to the effects of climate change. Although there are many other factors that influence plant communities, climate related effects include the potential for a changed fire regime and more favorable conditions for species invasions (Stromberg et al., 2007).

State and transition model

Figure 6. R015XF016CA - Very Shallow, Steep Foothills

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
Grass/Grasslike					
1	**Annual grasses**			146-230	
	red brome	BRRU2	*Bromus rubens*	135-168	1-5
	wild oat	AVFA	*Avena fatua*	22-34	1-2
	desert fescue	VUMIM	*Vulpia microstachys var. microstachys*	2-8	1-2
	soft brome	BRHO2	*Bromus hordeaceus*	2-6	1-2
2	**Perennial grasses**			2-6	
	Sandberg bluegrass	POSE	*Poa secunda*	2-6	1-2
Forb					

3	**Annual forbs**			135-572	
	redstem stork's bill	ERCI6	*Erodium cicutarium*	168-516	5-20
	narrowleaf cottonrose	LOGA2	*Logfia gallica*	6-11	2-3
	dotseed plantain	PLER3	*Plantago erecta*	6-11	1-3
	q-tips	MICAC2	*Micropus californicus var. californicus*	6-11	1-2
	chia	SACO6	*Salvia columbariae*	2-6	1-3
	agoseris	AGOSE	*Agoseris*	1-6	1-2
	trefoil	LOTUS	*Lotus*	1-3	1-2
	whiskerbrush	LECI18	*Leptosiphon ciliatus*	2-3	1-2
4	**Perennial forbs**			11-22	
	bluedicks	DICA14	*Dichelostemma capitatum*	11-22	2-3
Shrub/Vine					
5	**Shrubs**			50-185	
	buckbrush	CECU	*Ceanothus cuneatus*	45-106	3-7
	interior live oak	QUWIF	*Quercus wislizeni var. frutescens*	0-22	0-3
	whiteleaf manzanita	ARMA	*Arctostaphylos manzanita*	6-17	1-5
	birchleaf mountain mahogany	CEMOG	*Cercocarpus montanus var. glaber*	3-6	1-3
	hollyleaf redberry	RHIL	*Rhamnus ilicifolia*	1-2	1-2
Tree					
6	**Trees**			202-370	
	blue oak	QUDO	*Quercus douglasii*	191-280	1-4
	California foothill pine	PISA2	*Pinus sabiniana*	22-45	1-5

Table 6. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height M	Canopy Cover (%)	Diameter Cm	Basal Area (square M/hectare)
Tree							
California foothill pine	PISA2	*Pinus sabiniana*	Native	3-19.8	1-3	25.4-55.9	2.3-4.6
blue oak	QUDO	*Quercus douglasii*	Native	1.5-7.6	1-2	10.2-38.1	2.3-4.6

Table 7. Community 1.2 plant community composition

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

Table 8. Community 2.1 plant community composition

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

Table 9. Community 2.2 plant community composition

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

Table 10. Community 2.3 plant community composition

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

Table 11. Community 3.1 plant community composition

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

Table 12. Community 3.2 plant community composition

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

Table 13. Community 3.3 plant community composition

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

Animal community

This ecological site provides a mixture of sparse tree, shrub and grassland cover, with some areas transitioning to more chaparral and others more to grassland, depending on the elevation, aspect, and fire frequency. There is very limited forage and cover available for birds and other animals due to very shallow soils, low soil moisture and low site productivity. This ecological site has scattered overstory trees, primarily blue oak and California foothill pine, that are described as “keystone structures” in that their contribution to ecosystem structure and function is substantial compared to the space they occupy (Manning et al., 2006). Some key ecological functions they provide include tree cover, connectivity for other trees and animals, nesting and roosting sites for birds and bats and restoration “centers”. All of these functions serve to enhance ecosystem function and biodiversity. One study demonstrated that even scattered trees made a significant difference to bird and bat populations as opposed to no trees at all (Fischer et al., 2010). Bird species have essential habitat elements met in savannas that include some large oak trees with associated cavities and acorns and grasses and forbs (Zack, 2002). Many species of raptors and owls, such as red-tailed hawks (Buteo jamaicensis), Western screech owl (Megascops kennicotti) and golden eagles (Aquila chrysaetos) use oak savannas for the abundance of easily accessible small mammal prey found on the landscape. Even though reduced cover supports less animal diversity, these areas provide corridors to other important surrounding habitats. Surrounding intermixed oak savannas provide a food resource for both herbivores and carnivores (Pavlik et al., 1992). Acorns are a critical food source for deer, which migrate from high-elevation dry summer ranges to blue oak woodland for fall and winter forage (Burns and Honkala 1990). Acorns are eaten by at least a dozen species of songbirds, several upland game birds, rodents, black-tailed deer, feral and domestic pig, and all other classes of livestock (Adams et al., 1992, Duncan and Clawson 1980, Sampson and Jespersen 1963). Overgrazing by livestock or removing wildlife trees (granary trees and/or snags) would dramatically reduce the quality of this habitat. This community is susceptible to degradation from feral pigs (Sus scrofa). The blue oak-foothill pine community is preferred habitat for Columbian black-tailed deer (Odocoileus hemionus columbianus), California quail (Callipepla californica), and mourning dove (Zenaida macroura). Acorns and the seeds of foothill pine are important diet items for various birds and rodents; Western scrub jay (Aphelocoma californica), acorn woodpecker (Melanerpes formicivorus), and California gray squirrel (Otospermophilus beecheyi) are major seed consumers (Howard, 1992). Western scrub jays cache thousands of acorns each year to use as winter forage, and thus are very important for blue oak regeneration. Acorn woodpeckers also cache acorns in granary trees, which become an important food source for other birds and rodents. Shrubs provide important hiding cover and food for a variety of birds and deer that use them to escape from predation and fawning. Manzanita berries provide food for rodents and birds and nesting cover for passerines. Long term fire suppression can lead to declines in deer, small mammals and birds in this habitat (Mayer and Laudenslayer, 1988). Of the 632 terrestrial vertebrates (amphibians, reptiles, birds, and mammals) native to California, over 300 species use oak woodlands for food, cover and reproduction, including at least 22 species of mammals, 79 species of birds and approximately 29 species of amphibians and reptiles (Mayer and Laudenslayer, 1988). Bobcats, foxes and coyotes spend time searching for prey in oak savannas (Pavlik, et al., 1992). The rich rodent and rabbit population is an important food source for common predators including: bobcat (Lynx rufus californicus), coyote (Canis latrans) and the Pacific rattlesnake (Crotalus viridis oreganus). Other common predators include the mountain lion (Puma concolor) and black bear (Ursus americanus californiensis). Important game animals include the Columbian black-tailed deer, California quail and the "re-introduced" wild turkey (Meleagris gallopavo) that contribute to the economy of California through revenues from recreational hunting (Garrison and Standiford, 1997). Grazing and Browsing The main problems for livestock production on this site is the early seasonal drying of the soil profile causing forage quality to decline rapidly in early spring. Filaree is important forage for cattle, horses, and domestic sheep; yields vary depending upon soil moisture (Howard, 1992). The forage value of red brome is relatively low and is only palatable during its short green period when it is young (Sampson, 1951).

Hydrological functions

The watersheds associated with these sites are drained by intermittent streams that only flow during the wet season. In dry years these intermittent streams may not flow at all. Runoff on these soils is high and soil erosion hazard is high.

Recreational uses

Hunting, horseback riding, all-terrain vehicle riding are common recreational pursuits.

Wood products

This site offers no wood products, with the exception of occasional firewood.

Other products

Native Americans historically used and managed the blue oak savannas for food and fiber. The gathering of native plants such as bulbs and corms, grasses and brush for food, medicine and crafts is still practiced today (Anderson, 2005). These gathering methods sustained local plant populations and promoted plant diversity.

Other information

The soils in the ecological site have a low resistance to disturbance and have a very limited volume to absorb and buffer compaction. In one study that examined long term grazing (Daniel et al., 2002), high livestock stocking densities resulted in compaction in the top 4 inches (0-4 cm) of the soil profile. Disturbance on shallow soils is often significant as erosion causes losses in organic matter and root-restricting layers are closer to the surface.

Inventory data references

Information utilized to develop the Ecological Site Concept and plant communities includes the following: ES Inventory Plot Data: 6 line intercept transects, 7 production (double sampling) plots

Type locality

Location 1: Shasta County, CA	
Township/Range/Section	T30N R8W S33
UTM zone	N
UTM northing	40.413781
UTM easting	-122.76382
General legal description	Southeast ¼ of the SE ¼ Section 33, T.30N., R.8W., off Highway 36.

Other references

Abrahamson, I. 2014. Arctostaphylos manzanita. In: Fire Effects Information System, [Online]. U.S. Dep. of Agric., For. Serv., Rocky Mountain Res. Sta., Fire Sci. Lab. (Producer). Available: http://www.fs.fed.us/database/feis/ [2014, July 21].

Adams, Theodore E., P. B. Sands, W.H. Weitkamp, and N. K. McDougald. 1992. Oak seedling establishment on California rangelands. J. Range Manage. 45: 93-98.

Allen-Diaz, Barbara, R. R. Evett, B. A. Holzman, and A. J. Martin. 1989. Report on Rangeland Cover Type Descriptions for California Hardwood Rangelands. Forest and Rangeland Resources Assessment Program, Calif. Dep. of Forestry and Fire Protection, Sacramento, Calif. 318 pgs.

Anderson, M.K. 2005. Tending the Wild, Native American Knowledge and the Management of California's Natural Resources. University of California Press.

Arno, S. H. and S. Allison-Bunnell. 2002. Flames in Our Forest. Island Press. 227 pgs.

Baldocchi, D.D., and L. Xu. 2006. What limits evaporation from Mediterranean oak woodlands – The supply of moisture in the soil, physiological control or the demand by the atmosphere? Elsevier Ltd. Doi:10.1016/j.advwatres.2006.06.013. Advances in Water Resources. 30 (2007) 2113-2122. www.elsevier.com/locate/advwatres

Barbour, M.G., and J. Major. Terrestrial Vegetation of California. 1977. John Wiley and Sons, Inc.

Bernhardt, E., and T. J. Swiecki. "The State of Urban Forestry in California--1992. Prepared for the California Department of Forestry and Fire Protection." Plant Science Consulting and Research, Vacaville, CA (1993).

Bartolome, J.W. 1979. Germination and Seedling Establishment in California Annual Grassland. Journal of Ecology. Vol.67, No. 1, 7 pgs.

Bartolome, J. W. 1987. California grassland and oak savannah. Rangelands 9:122-125.

Bartolome, J.W., W.F. Frost, N.K. McDougald and M. Connor. 2002. California guidelines for residual dry matter (RDM) management on

coastal and foothill annual rangelands. Rangeland Monitoring Series. Publ. 8092, Div. of Agr. and Nat Res., Univ. of Calif. 8pp.

Bernhardt, E., and T.J. Swiecki. 1993. The State of Urban Forestry in California--1992. Prepared for the California Department of Forestry and Fire Protection. Plant Science Consulting and Research, Vacaville, CA (1993).

Blackburn, T.C. and K. Anderson. 1993. Before The Wilderness: Environmental Management By Native Californians. Ballena Press, Menlo Park, CA.

Block, W.M. 1990. Geographic Variations in Foraging Ecologies of Breeding and Non-Breeding Birds in Oak Woodlands. Studies in Avian Biology No. 13. 264-269. 1990.

Bolsinger, C. L. 1988. The hardwoods of California's timberlands, woodlands, and savannas. Res. Bull. PNW-RB-148. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 148 p.

Bonner, F.T., R.P. Karrfalt, and R.G. Nisley. 2008. The woody plant seed manual. USDA. For. Serv., Agr. Handbk. 727, Washington, DC. 1223 p.

Briske, D.D., Fulendorf, S.D., and F.E. Smiens. 2006. A Unified Framework for Assessment and Application of Ecological Thresholds. Rangeland Ecolgy and Management 59(3) May 2006. Pp. 225-236.

Burcham, L. T. 1957. California Rangeland. Div. Forestry, Sacramento, Calif. 261 pgs.
Burns, Russell M. and B. H. Honkala. 1990. Silvics of North America (Vol. 2): Hardwoods. Agric. Handbook 654. USDA Forest. Service, Washington D.C. 877 p.

Caldwell, M.M., Dawson, T.E., and J.R. Richards Hydraulic lift: consequences of water efflux from the roots of plants. 1998. Oecologia 113:151-161.

Conner, M. 1991. http://ucanr.edu/sites/oak_range/Oak_Articles_On_Line/Factors Affecting Annual Forage Yield in Oak Woodlands.

Corbin, J. D. and C. M. D'Antonio. 2004. Competition between native perennial and exotic annual grasses: Implications for an historical invasion. Ecology 85:1273-1283.
Dahlgren R., Horwath W., Tate K., Camping T. 2003. Blue oak enhance soil quality in California oak woodlands. Calif. Agr. 57(2):42-47. DOI: 10.3733/ca.v057n02p42

Dahlgren, R.A., K.W. Tate, D. Lewis, D.R. Atwill, J.M. Harper, and B. Allen-Diaz. 2001. Watershed research examines rangeland management effects on water quality. CALIFORNIA AGRICULTURE, VOL. 55, No. 6.
Dahlgren, R.A., Singer, M. J., and X. Huang. 1997. Oak tree and grazing impacts on soil properties and nutrients in a California oak woodland. In: Biogeochemistry 39:45-64. Kluwer Academic Publishers.

Daniel, J.A., K. Potter, W. Altom, H. Aljoe, and R. Stevens. 2002. Long-Term Grazing Density Impacts on Soil Compaction. Transactions of the ASAE, 45:1911-1915.
Daryanto, S. and D.J. Eldridge. 2010. Shrub removal and grazing alter the spatial distribution of infiltrability in a shrub-encroached woodland. In: Proceedings of the 16th Biennial Conference of the Australian Rangeland Society, Bourke (Eds. D.J. Eldridge and C. Waters) (Australian Rangeland Society:Perth)

D'Antonio, C.D, S. Bainbridge, C. Kennedy, J. Bartolome, S. Reynold. 2006. Ecology and Restoration of California Grasslands with special emphasis on the influence of fire and grazing on native grassland species. University of California, Berkeley. Department of Integrative Biology.

DeBano, L.F., 2000. The role of fire and soil heating on water repellency in wildland environments: a review. Elsevier Science PII: S0022-1694 (00)00194-3 Journal of Hydrology 231-232 (2000) 195-206.

Duncan, Don A.; McDougald, Neil K.; Westfall, Stanley E. 1987. Long-term changes from different uses of foothill hardwood rangelands. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep.
PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 367-372.

Duncan, D. A. and W.J. Clawson. 1980. Livestock utilization of California's oak woodlands. In: Plumb, Timothy R., (technical coordinator). Proceedings of the symposium on the ecology, management, and utilization of California oaks. Gen. Tech. Rep. PSW-44. U.S. Dep. of Agr., For. Serv. Pacific Southwest Forest and Range Exp. Sta., Berkeley, CA. Pgs. 306-313.

Elliot, W.J., Page-Dumroese, D.S., and P.R. Robichaud. 1998. The effect of forest management on erosion and soil productivity. In: Lal, R., Soil quality and erosion. Boca Raton, FL: St. Lucie Press, 195-209.

England, S.A. In: Mayer K. E., and W. F. Laudenslayer. (Eds.) 1988. A guide to wildlife habitats of California. California Dept. of Forestry and Fire Protection, Sacramento.

Evangilista, D., S. Hutton, J. Dumais. 2011. The mechanics of explosive dispersal and self-burial in the seeds of filaree in Erodium cicutarium (Geraniaceae). The Journal of Experimental Biology 214, 521-529 . Published by The Company of Biologists Ltd. doi:10.1242/jeb.050567

Eviner, V.T. and F.S. Chapin III, 2001. Plant species provide vital ecosystem functions for sustainable agriculture, rangeland management and restoration. California Agriculture, Volume 55, Number 6. Pgs. 54-59.

Fischer, J., Stott, J., and B.S. Law. 2010. The disproportionate value of scattered trees. In Biological Conservation 143 (2010) 1564-1567. WWW.ELSEVIER.BIOCON

Freudenberger, D.O., Fish, B.E., and J. Keeley. 1987. Distribution and stability of grasslands in the Los Angeles Basin. Bulletin of the Southern California Academy of Sciences. 86:13-26

Fryer, J. L. 2007. Quercus douglasii. 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/ [2013, February 19].

Garrison, B.A., and R.B. Standiford, 1997. A Post-Hoc Assessment of the Impacts to Wildlife Habitat from Wood Cutting in Blue Oak Woodlands in the Northern Sacramento Valley. USDA Forest Service Gen. Tech. Rep. PSW-GTR-160.

George. M., Roche, L.M., and D.J. Eastburn. Ecology. Annual Rangeland Ecology. http://californiarangeland.ucdavis.edu/Annual_Rangeland_Handbook/Ecology/ Accessed June 2015.

George, M., Harper, J., Davy, J., and T. Bechetti. Livestock Production. http://californiarangeland.ucdavis.edu/Livestock_Production/ accessed May 1, 2015.

George, M., J. Clawson, J. Menke, and J. Bartolome. 1985. Annual Grassland Forage Productivity. 1985. In: Rangelands 7(1), 3 pgs.

George, M., J. Bartolome, N. McDougald, M. Connor, C. Vaughn and G. Markegard. 2001a. Annual Range Forage Production. ANR Publ. 8018, Div. of Agric. And Nat. Res., Univ. of Calif., Oakland, Calif. 9 pgs.

George, M., G. Nader, N. McDougald, M. Connor, and B. Frost. 2001b. Annual Rangeland Forage Quality. ANR Publ. 8022, Div. of Agric. And Nat. Res., Univ. of Calif., Oakland, Calif. 13 pgs.

George, M.R., J.R. Brown and W.J. Clawson. 1992. Application of non-equilibrium ecology to management of Mediterranean grasslands. J. Range Manage. 45: 436-440.

George, M. 1993. ESDs https://esis.sc.egov.usda.gov/

Griffin, D., and K. J. Anchukaitis (2014), How unusual is the 2012–2014 California drought? Geophys. Res. Lett., 41, 9017–9023, doi:10.1002/2014GL062433.

Gill, R. A., and I.C. Burke. 1999. Ecosystem consequences of plant life form changes at three sites in the semi-arid United States. Oecologia (1999) 121:551-563

Grünzweig, J.M., Carmel, Y., Riov, J., Sever, N., McCreary, D.D., and C.H. Flather, 2008. Growth, resource storage, and adaptation to drought in California and eastern Mediterranean oak seedlings. Can. J. For. 38: 331-342 (2008) doi:10.1139/X07-152

Harper, J.M., Standiford, R.B., and J.
Leblanc. 1991. http://ucanr.edu/sites/oak-range/Oak_Articles_On_Line/Oaks Climatic Factors/The Effect of Drought on California Oaks. Accessed June 2015.

Heady, H. F. 1956. Changes in a California Annual Plant Community Induced by Manipulation of Natural Mulch. In Ecology, Vol.7, No.4. pgs. 798-812.

Hickman, G.W., E.J. Perry, and R.M. Davis. 2011. Wood Decay Fungi in Landscape Trees. University of California. Integrated Pest Management Program. Agriculture and Natural Resources. Pest Notes 74109.

Howard, Janet L. 1992. Pinus sabiniana. In: Fire Effects Information System, [Online].
U.S. Dep. of Agric., For. Ser., Rocky Mountain Res. Sta., Fire Sciences Lab. (Producer). Available: http://www.fs.fed.us/database/feis/ [2015, April 30].

Ishikawa, C.M. and C.S. Bledsoe. 2000. Seasonal and diurnal patterns of soil water potential in the rhizosphere of blue oaks: evidence of

hydraulic lift. Oecologia 125:459-465. DOI 10.1007/s004420000470

Johnson W.H. and E.L. Fitzhugh, 1990. Grazing helps maintain brush growth on cleared land. California Agriculture September- October, 1990. Pg. 31-32.

Keeley, J.E. 2002. Native American impacts on fire regimes of the California coastal ranges. Jor. of Biogeography, 29, 303-320.

Kertis, J.A., R. Gross, D.L. Peterson, M.J. Arbaugh, R.B. Standiford, D.D. McCreary.1993. Growth trends of Blue oak (Quercus douglasii in California. Can. Jor. For. Res. 23:1720-1724.

League, Kevin R. 2005. Ceanothus cuneatus. 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/ [2015, June 10].

Liste, H-H., and J.C. White, 2008. Plant hydraulic lift of soil water- implications for crop production and land restoration. Plant Soil (2008) 313:1-17 DOI 10.1007/s11104-008-9696z

Mayer K. E., and W. F. Laudenslayer. (Eds.) 1988. A guide to wildlife habitats of California. California Dept. of Forestry and Fire Protection, Sacramento.

McCreary, D.D., Tietje, W., and W. Frost. 2008. Stump Sprouting 19 Years after Harvest. Gen. Tech. Rep. PSW-GTR-217.

McCreary, D.D. and M. George. 2005. Managed Grazing and Seedling Shelters Enhance oak Regeneration on Rangelands. http://californiaagriculture.ucop.edu/

McCreary, D.D. Fire in California's Oak Woodlands. 2004. http://danr.ucop.edu/ihrmp

McCreary, D. D. 2001. Regenerating rangeland oaks in California. ANR Publ. 21601, Div. of Agric. And Nat. Res., Univ. of Calif., Oakland, Calif. 62 pgs.

McCreary, D.D., Tietje, W.D., and W. Frost. 2002. Stump sprouting of Blue Oaks Ten Years after Harvest. USDA For. Serv., Gen.Tech.Rep. PSW-GTR-184. 8 pgs.

McCreary, D.D., Tieje, W., and W. Frost. 2008. Stump Sprouting 19 Years after Harvest. Gen. Tech. Rep. PSW-GTR-217.

McDougald, N.K. W.E. Frost, and W.J. Clawson. 1991. Estimating the cost of replacing forage losses on annual rangeland. Leaflet 21494. Division of Agric. and Nat. Res., Univ. of Calif., Oakland, Calif.

McDonald, P. M. 1990. Quercus douglasii Hook & Arn. Blue oak. In: Burns, Russell M.; Honkala, Barbara H., tech. coords. Silvics of North America. Vol.2. Hardwoods. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service: 631-639.

Michaelides, K., Lister, D., Wainwright, J., and A.J. Parsons. 2012. Linking runoff and erosion dynamics to nutrient fluxes in a degrading dryland landscape. Journal of Geophysical Research, VOL. 117, G00N15,doi:10.1029/2012JG002071, 2012

Miller, G.R., Cable, J.M., McDonald, A.K., Bond, B., Franz, T.E., Wang, L., Gou, S., Tyler, A.P., Zou, C.B., and R.L. Scott. 2012. Understanding ecological connectivity in savannas; a system dynamics modelling approach. Ecohydrology 5 200-220 (2012) Published online Juley 7 2011 Wiley Online Library DOI 10.1002/eco245

Miller, G.R., Cable, J.M., McDonald, A.K., Bond, B., Franz, T.E., Wang, L., Gou, S., Tyler, A.P., Zou, Z.P., and R.L. Scott. 2012. Understanding ecohydrological connectivity in savannas: a systems dynamics modelling approach. Ecohydrol. 5 (200-220) Published online 7 July 2011 in Wiley online dictionary (wileyonlinedictionary.com) DOI: 10.1002/eco245.

Miller, G.R., Chen, X., Rubin, Y., Ma, S., and D.D. Baldocchi. 2010. Ground water uptake by woody plants in a semi-arid oak savanna. Water Resources Research, Vol. 46, W10503, http://dx.doi.org/10.1029/2009WR008902

Neary, D.G., Klopatek, C.C., DeBano, L.F., and P.F. Folliott, 1999. Fire effects on belowground sustainability: a review and synthesis. Forest Ecology and Management 122 (1999) 51-71. Published by Elsevier Science. PII:S0378-1127(99)00032-8

O'Geen, A.T., Dalgren, R.A., Swarowsky, A., Tate, K.W., Lewis, D.J., and M.J. Singer. 2010. Research connects soil hydrology and stream water chemistry in California oak woodlands. CA. Agric. Vol. 64. No.2. HTTP://ESCHOLARSHIP.ORG/UC/ITEM/34X9M71J

O'Neil, S.E., and T. Parker. 2005. Factors contributing to the soil seed bank size of two obligate seeding ceanothus species in northern California. Madrono. Vol.52, No. 3, pp.182-190, 2005.

Parsons, D.J and T.K. Stohlgren. 1989. Effects of varying fire regimes on annual grasslands in the southern Sierra Nevada of California.

Madroño, 36:154-168.

Pavlik, B.M., P.C. Muick, S. Johnson, and M. Popper. 1991. Oaks of California. Cachuma Press, Inc. Los Olivos, Calif. 184 pgs.

Pickett, S.T.A., and P.S. White. 1985. The Ecology of Natural Disturbance and Patch Dynamics. Academic Press. 472 Pgs.

Pitt, M. D. and H. F., Heady. 1978. Responses of Annual Vegetation to Temperature and Rainfall Patterns in Northern California. Ecology, Vol.59, No.2, pgs. 336-350.

Powers, R., 1990. Pinus sabiniana In: Burns, Russell M., and Barbara H. Honkala, tech. coords. 1990. Silvics of North America: 1. Conifers; 2. Hardwoods. Agriculture Handbook 654. U.S. Dep. Of Agric., For. Serv., Washington, DC. vol.2, 877 p.

Purcell, K.L., Stephens, S.L., 2005. Changing fire regimes and the avifauna of
California oak woodlands. Studies in Avian Biology 30, 33–45.

Quinn, R.D. and S.C. Keeley. 2006. Introduction to California Chapparal. University of California Press. 322 pgs.
Richards, J. H., and M.M. Cadewell, 1987. Hydraulic lift: Substantial nocturnal water transport between soil layers by Artemesia tridentada roots. Oecologia (Berlin) (1987) 73:486-489.

Sampson, A. W. and B. S. Jespersen. 1963. California range brushlands and browse plants. Univ. of Calif. Div. of Agr. Sci., Berkeley, CA. 162 pgs.

Sawyer, J. O., Keeler-Wolf, T., and J. M. Evens. 2009. A Manual of California Vegetation, Second Edition. California Native Plant Society Press. Sacramento, CA.

Shiflet, T.N., (ed.) 1994. Rangeland Cover Types of the United States.

Schultz, A.M., Launchbaugh, J.L., and H. H. Biswell 1955. Relationship Between Grass Density and Brush Seedling Survival. Ecology 36:226–238. http://dx.doi.org/10.2307/1933228

Stahle D.W., R.D. Griffin, D.M. Meko, M.D. Therrel, J.R. Edmondson, M.K. Cleaveland, L.N. Stahle, D.J. Burnette, J.T. Abatzoglou , K.T. Redmond, M.D. Dettinger, and D.R Cayan. 2013. The Ancient Blue Oak Woodlands of California: Longevity and Hydroclimatic History. Earth Interactions Volume 17. Paper No. 12.

Standiford, R.B., McCreary, D.D., Barry, S.J., Forero, L.C., 2011. Blue oak stump sprouting evaluated after firewood harvest in northern Sacramento Valley. Ca. Agric. Vol. 65, No. 3. http:/scholarship.org/us/item/5pv6j50d
State of California, Cal. Dep. For. and Fire Protection (CALFIRE) FRAP Publication: State and Transition Models for California's Rangelands. HTTP://FRAP.FIRE.CA.GOV/PROJECTS/HARDWOOD_EXPERT/BUILDING_STATE/OVERVIEW2.HTM

State of California Department of Water Resources 1992. Sacramento Valley Westside Tributaries Water Erosion Study, Executive Summary.

Stromberg, M.R., J.D. Corbin, C.M. D'Antonio. 2007. California Grasslands: Ecology and Management. University of California Press, Berkeley and Los Angeles, CA. 390 pgs.

Stuart, J.D. and J.O. Sawyer, 2001. Trees and Shrubs of California. University of California Press. 467 pgs.

Swiecki, T.J., and E. Bernhardt. 1998. Understanding Blue Oak Regeneration. Fremontia 26 (1):19-26

Swiecki, T.J., and E. Bernhardt, 1997. Factors Influencing Blue oak Sapling Recruitment and Regeneration. Report prepared for Strategic Planning Program, California Department of Forestry and Fire Protection. 142 pages.

Swiecki, T.J., Bernhardt, E.A., and C. Drake. 1997. Stand-level Status of Blue Oak Sapling Recruitment and Regeneration. Proceedings, Symposium on Oak Woodlands: Ecology, Management, and Urban Interface Issues. USDA For. Serv. Gen. Tech. Rep. PSW-GTR-160. 147-156

Sweitzer, Rick A. and Dirk H. Van Vuren. 2002. Rooting and Foraging Effects of Wild Pigs on Tree Regeneration and Oak Survival in California's Oak Woodland Ecosystems. USDA Forest Service Gen. Tech. Rep. PSW-GTR-184.

Tehama County Resource Conservation District. 2006. Tehama West Watershed Assessment. Prepared by Vestra Resources, Inc. 386 pages.

Tietje, W.D., J.K. Vreeland, N.R. Siepal, and J.L. Dockter. 1997. Relative Abundance and Habitat Associations of Vertebrates in Oak Woodlands in Coastal Central California. USDA Forest Service Gen. Tech. Rep. PSW-GTR-160. 1997.

Tietje, W., K. Purcell and S. Drill. Oak woodlands as wildlife habitat. In: Giusti, Gregory A., Douglas D. McCreary, and Richard B. Standiford (Ed). 2005. A Planner's Guide for Oak Woodlands, 2nd Ed. ANR Publ. 3491, Div. of Agric. and Nat. Res., Univ. of Calif., Oakland, Calif. pp 15-31.

USDA Forest Service, 1999. Cottonwood Creek Watershed Assessment. Prepared by CH2MHill.
U.S. Dep. Agric., Nat. Res. Cons. Serv., 1999. Soil taxonomy. A Basic System of Soil Classification for Making and Interpreting Soil Surveys. Agric. Handbook 436.

University of California Agriculture ~ California Agriculture ~ January-March 2007 http://calag.ucop.edu/0701JFM/resup02.html
University of California. UC Davis. California rangelands. http://californiarangeland.ucdavis.edu/Weeds/Weeds.htm

University of California Agriculture ~ California Agriculture ~ January-March 2007. Oaks Research Update. http://calag.ucop.edu/0701JFM/resup02.html
University of California. 2010. Sudden Oak Death. UC Statewide Integrated Pest Management Program. Agriculture and Natural Resources. http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74151.html

Vayssieres M.P. and R.E. Plant. 1998. Identification of vegetation state-and-transition domains in California's hardwood rangelands. FRAP Publication, California Department of Forestry and Fire Protection. Sacramento, CA.

Wu, K.K., and S.K. Jain, 1979. Population Regulation in Bromus rubens and B. mollis: Life Cycle Components and Competition. Oecologia (Berl.)39.337-357(1979)

Young, J.A., Evans, R.A., Raguse, C.A., and J. R. Larson, 1981. Germinable seeds and periodicity of germination in annual grasslands. Hilgardia 49:1-37.

Zack, S. 2002. Oak Woodland Bird Conservation Plan, A Strategy for Protecting and Managing Oak Woodland Habitats and Associated Birds in California. California Partners in Flight. V.2.0

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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.

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Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** **A few rills were noted, associated with bare ground and steep slopes, spaced 3 to 4 feet apart across a 200 foot distance.**

2. **Presence of water flow patterns:** **Water commonly flows downslope for a length of 200-500 feet.**

3. **Number and height of erosional pedestals or terracettes:** **Small areas with erosion pedestals were noted, perhaps 2-3 inches in height, perhaps 4 per 500 feet. Not extensive on reference site.**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** **Bare ground ranges from 40 to 70 percent.**

5. **Number of gullies and erosion associated with gullies:** **Gullies were noted on deeper soils found in conjunction with this site.**

6. **Extent of wind scoured, blowouts and/or depositional areas:** **No wind scour or blowouts were noted.**

7. **Amount of litter movement (describe size and distance expected to travel):** **Very little if any litter movement was noted. Typically Erodium spp. litter is 1-2 inches by .25 inches and annual grasses 3-6 inches by .10 inches.**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** **Not available.**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** **A1--0 to 0.5 inches; pale brown (10YR 6/3) light clay loam, brown (10YR 4/3) moist; weak medium platy structure; slightly hard, friable, nonsticky and nonplastic; common fine roots; common fine pores; slightly acid; abrupt s A2--0.5 to 6 inches; brown (10YR 5/3) clay loam, brown (10YR 4/3) moist; moderate coarse subangular blocky structure; hard, friable, moderately sticky and nonplastic; common fine roots; common fine pores; few shale fragments; neutral; clear smooth boundary. (4 to 10 inches thick)**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** **Trees: 3 percent Shrubs: 4 percent Forbs: 55 percent Grass: 38 percent Typically very patchy distribution of sparse trees and shrubs intermixed with open areas with very light forb and grass cover do not contribute much to water retention on this site. Some infiltration occurs, but it would appear that much is transported offsite.**

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

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

    Dominant: Forbs

    Sub-dominant: Grass

    Other: Shrubs>>Trees

    Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Forbs begin to show mortality in March to April. Grasses will show mortality and decadence beginning in late April. Shrub and tree mortality is minimal.

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

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Expected production is highly variable based on unfavorable normal or favorable year. Total production ranges from a low of 350 to a high of 1,140 pounds per acre.

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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:** Invasives such as medusahead and yellow star-thistle do not have the potential to become dominant on this site.

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17. **Perennial plant reproductive capability:** No known capability for perennial grasses due to very shallow soil depth.
