

## Ecological site R015XF008CA Shallow Gravelly Foothills

Accessed: 05/13/2025

### 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.

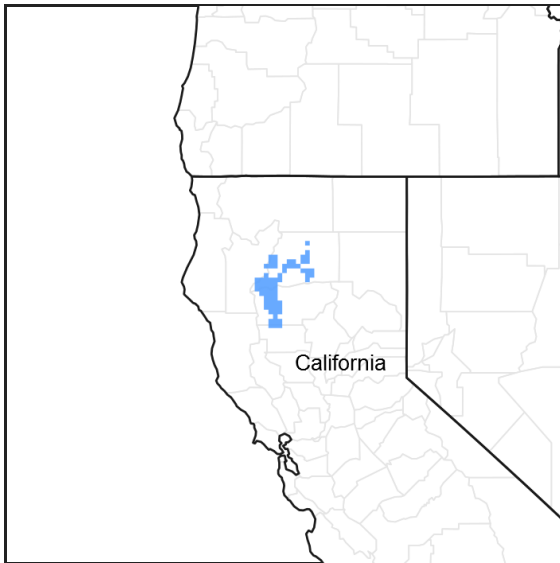


Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

### MLRA notes

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

Major Land Resource Area (MLRA) 15: The MLRA 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 (810 meters) in most of the area, but up to 4,950 feet (1,510 meters) 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.

The Land Resource Unit (LRU) 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 Jurassic and Cretaceous sandstone and shale 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.

Classification relationships

This ecological site is located within Land Resource region (LRR) C, the California Subtropical Fruit, Truck, and Specialty Crop Region, Major Land Resource Area (MLRA) 15, the Central California Coast Range, Land Resource Unit (LRU) XF.

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) 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). Analysis of vegetation was conducted using CALVEG, a provisional classification system of existing vegetation that meets the floristically based level of the National Vegetation Classification Standard hierarchy (USFS).

Ecological site concept

This ecological site is predominately found on east to south-west-facing slopes on foothill backslopes, shoulders and ridges. Slopes average from 20 to 55 percent and average elevations range from 1,100 to 1,700 feet. Gravelly loamy well-drained soils are dominantly shallow to hard bedrock, creating a root-restricting layer that reduces the water storage capacity within the soil profile. Gravelly soils also transfer heat and dry out quickly, reducing soil moisture.

Blue oak (*Quercus douglasii*) and California foothill pine (*Pinus sabiniana*) are found on this ecological site, primarily on east and southeast-facing slopes. Shrub cover is moderate to high and predominantly consists of Pacific poison oak (*Toxicodendron diversiloba*) and buckbrush (*Ceanothus cuneatus*), but other common shrubs include birchleaf mountain mahogany (*Cercocarpus montanus*), whiteleaf manzanita (*Arctostaphylos manzanita*) or sticky whiteleaf manzanita (*Arctostaphylos visida*) and occasionally the shrub form of interior live oak (*Quercus wislizeni* var *frutescens*) or toyon (*Heteromeles arbutifolia*). Native perennial bunchgrasses include Sandberg bluegrass (*Poa secunda*). Annual grasses may include wild oat (*Avena fatua*), red brome (*Bromus rubens*) and desert fescue (*Vulpia microstachys*). A variety of annual and perennial herbs and forbs are also found on this site.

Associated sites

R015XF016CA	<b>Very Shallow Steep Foothills</b> The Very Shallow, Steep Foothills ecological site is found in association with this site, primarily on south and southwest facing slopes. Vegetation is very sparse blue oak and California foothill pine with a sparse shrub layer of buckbrush, and an understory dominated by annual grasses and forbs.
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Table 1. Dominant plant species

Tree	(1) <i>Quercus douglasii</i> (2) <i>Pinus sabiniana</i>
Shrub	(1) <i>Toxicodendron diversilobum</i>
Herbaceous	Not specified

Physiographic features

This ecological site occurs predominantly on steep and very steeply sloping foothill shoulders, backslopes and ridges (See the Physiographic Diagram below) formed in residuum from sedimentary rock. This site is often found in a "mosaic" with ecological site R015XF016CA (Very Shallow, Steep Foothills). Slopes average from 20 to 55

percent, although the full slope range is from 0 to 85 percent. Aspects are dominantly southeast to southwest. Elevations are generally from 1,100 to 1,700 feet, but elevations may range from 690 to 2,660 feet.

Steep east and southeast aspects receive less solar radiation during the day; this factor helps retain moisture for a longer period of time during the spring. The shallow nature of these soils and associated low water holding capacity lead to early seasonal drying of the soil profile. Steep slopes may also generate substantial runoff during storm events.

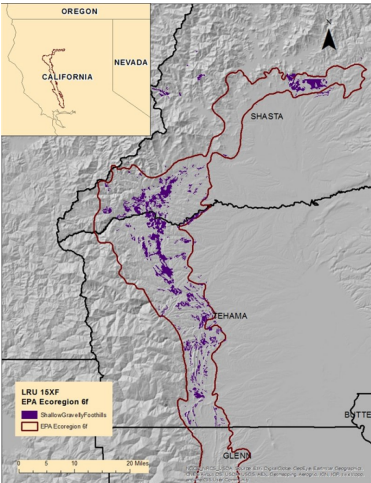


Figure 2. R015XF008CA - Shallow Gravelly Foothills

Table 2. Representative physiographic features

Landforms	(1) Ridge
Flooding frequency	None
Ponding frequency	None
Elevation	335–518 m
Slope	20–55%
Aspect	E, SE, S

Climatic features

This ecological site has a Mediterranean climate characterized by hot 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 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.

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.

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](http://www.nm.nrcs.usda.gov/technical/handbooks/nrph/Climate_Summarizer.xls)) using data from the following climate stations (results are unweighted averages):

Station ID Location Period  
(From : To)

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

**Table 3. Representative climatic features**

Frost-free period (average)	195 days
Freeze-free period (average)	290 days
Precipitation total (average)	889 mm

## Influencing water features

The steep slopes and topographic position of this site affect the rate of infiltration and runoff from this ecological site. Steep sideslopes and backslope positions contribute to medium to very high runoff, and the concave downslope and convex across slope shape favor runoff from this site to lower slope positions. Low levels of organic matter (0-.5 inches) and the amount of bare ground may also contribute to increases in overland flow and soil erosion.

## Soil features

The soils typically associated with this ecological site occur on ridges and steep and very steep upper shoulders and backslopes of foothills formed in residuum weathered from sedimentary and metasedimentary rock (sandstone). These soils are shallow to a hard restrictive layer.

Soils are well drained. Surface textures are clay loam, gravelly loam and subsurface textures are clay loam. Surface gravels < 3 inches on average range from 13 to 28 percent and there are no surface fragments > 3 inches. Subsurface gravels by volume as a whole are variable and may range from 0 to 13 percent, and there are no subsurface fragments > 3 inches. Large rock outcrops are present within some map units. Organic matter is low on this site (1 to 3 percent) and this affects water infiltration, and water and nutrient holding capacity. Available water is very low at 2 to 3 inches. These soils have a moderate resilience with some limited ability to recover when disturbed.

The associated soils components that are 15 percent or greater of any one map unit are:  
Millsholm, (Loamy, thermic Lithic Haploxerept).

### CA607 - Shasta County, CA

MeE: Millsholm gravelly loam, 30 to 50 percent slopes

MeG: Millsholm gravelly loam, 50 to 75 percent slopes

MfE2: Millsholm very rocky loam, 30 to 50 percent slopes, eroded

MfF2: Millsholm very rocky loam, 50 to 70 percent slopes, eroded

### CA645 - Tehama County CA

MeEsh: Millsholm gravelly loam, 30 to 50 percent slopes

MeGsh: Millsholm gravelly loam 50 to 70 percent slopes

MtE : Millsholm loam, 15 to 50 percent slopes

MtF: Millsholm clay loam, 50 to 65 percent slopes



Figure 7. Millsholm Soil Pit. J. Welles, 2013.

Table 4. Representative soil features

Parent material	(1) Residuum—sandstone
Surface texture	(1) Gravelly clay loam (2) Clay loam
Family particle size	(1) Clayey
Drainage class	Well drained
Permeability class	Moderate
Soil depth	25–51 cm
Surface fragment cover <=3"	13–28%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	5.08–7.62 cm
Soil reaction (1:1 water) (0-101.6cm)	5.1–7.3
Subsurface fragment volume <=3" (Depth not specified)	0–13%
Subsurface fragment volume >3" (Depth not specified)	0%

### 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:

Native Americans regularly used fire to manage vegetation communities to provide food and fiber (McCleary 2004). Fire was utilized to reduce brush surrounding oaks and foothill pine, a rich source of acorns and pine nuts, making trees accessible and reducing fire risk (Anderson, 2006). Generally the foothill pine-blue oak woodlands burned at 15 to 30-year intervals, and were of light or moderate severity (Howard, 1992). Fire frequency in these foothill oak forests was around 25 years prior to settlement in the mid-1800s, and after settlement by Europeans, the use of fire to remove brush and trees changed to a 7 to 8 year fire return intervals (Skinner and Chang, 1996). Ranchers continued the extensive use of prescribed burning until the 1950s.

This ecological site is located within the Cottonwood Creek and Tehama West Watersheds in Shasta and Tehama Counties. The Cottonwood Creek Watershed Assessment (USDA Forest Service, 1999) indicates the dominant influences in the watershed during the early 1800’s were gold mining and farming. 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, within the Tehama West Watershed, cattle ranching, sheep herding and dryland farming 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 and were described as having sheep, cattle and hogs. The 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. The grazing effects were worsened by burning practices that were more frequent and intense and resulted in soil loss.

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

#### Current Influences:

**Fire:** Several large fires burned through the landscape of this ecological site in the 1940s through the 1970s. Large fires, such as the Skinner Mill fire in 1976, reportedly had large 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). Pine is increasing in blue oak-California foothill pine communities due to fire suppression and lack of blue oak regeneration. There is an increase of chaparral brush invading grassy understories of blue oak-California foothill pine woodlands, also because of fire suppression. Shrub recruitment has increased in the absence of periodic fire or grazing in some foothill environments (Powers, 1990).

Blue oak and California foothill pine are the dominant tree species on this site, with lesser amounts of interior live oak (*Quercus wislizeni*). 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). Interior live oak, an evergreen found at lower elevations, most commonly reproduces via sprouting from the root crown. Some authors suggest that the occurrence of shrub form of this species, scrub interior live oak (*Quercus wislizeni* var *frutescens*), may be related to either the droughty nature of the soils or fire history (Fryer, 2012). Shrub species such as buckbrush and whiteleaf manzanita that have seed stored in the soil have abundant germination following fire (Stuart et al., 2001, Abrahamson, 2014). Other shrubs that sprout from the root crown following cutting or fire include Pacific poison oak, birchleaf mountain mahogany and toyon (*Heteromeles arbutifolia*).

At lower elevations of this ecological site, the blue oak and foothill pine vegetation types intergrade with blue oak woodlands and at higher elevations intergrade with dense mixed chaparral shrub cover (USDA Forest Service, 1999). Within the Lower Montane Mixed Chaparral Alliance (CALVEG 2008) a shrub mixture may include chamise (*Adenostoma fasciculatum*), whiteleaf and sticky whiteleaf manzanita, buckbrush, birchleaf mountain mahogany, and various scrub oaks. California foothill pine and blue oak may be present, but in minor amounts.

**Grazing:** Production is low on this shallow ecological site, and forage dries out early 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 (*Periderium harknessii*) and dwarf-mistletoe (*Arceuthobium occidentale* and *A. campylopodum* forma *campylopodum*), and the insect *Ips spinifer* is a bark beetle

that attacks susceptible foothill pine trees (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 and 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). The combination of steep slopes, shallow rooting depth, and low water availability (1 to 3 inches) influence the vegetation community potential on this site. Drought conditions may also impact blue oak seedlings, affecting their growth and survival (Grünzweig et al., 2008).

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). 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). 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. 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). Extended periods of drought could limit photosynthesis and affect carbon intake, hindering reproductive processes, leading to a reduction in oak seedling establishment.

Predictions project an increase in the blue oak-foothill pine type with increased temperature and precipitation (Kueppers et al, 2005). 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**

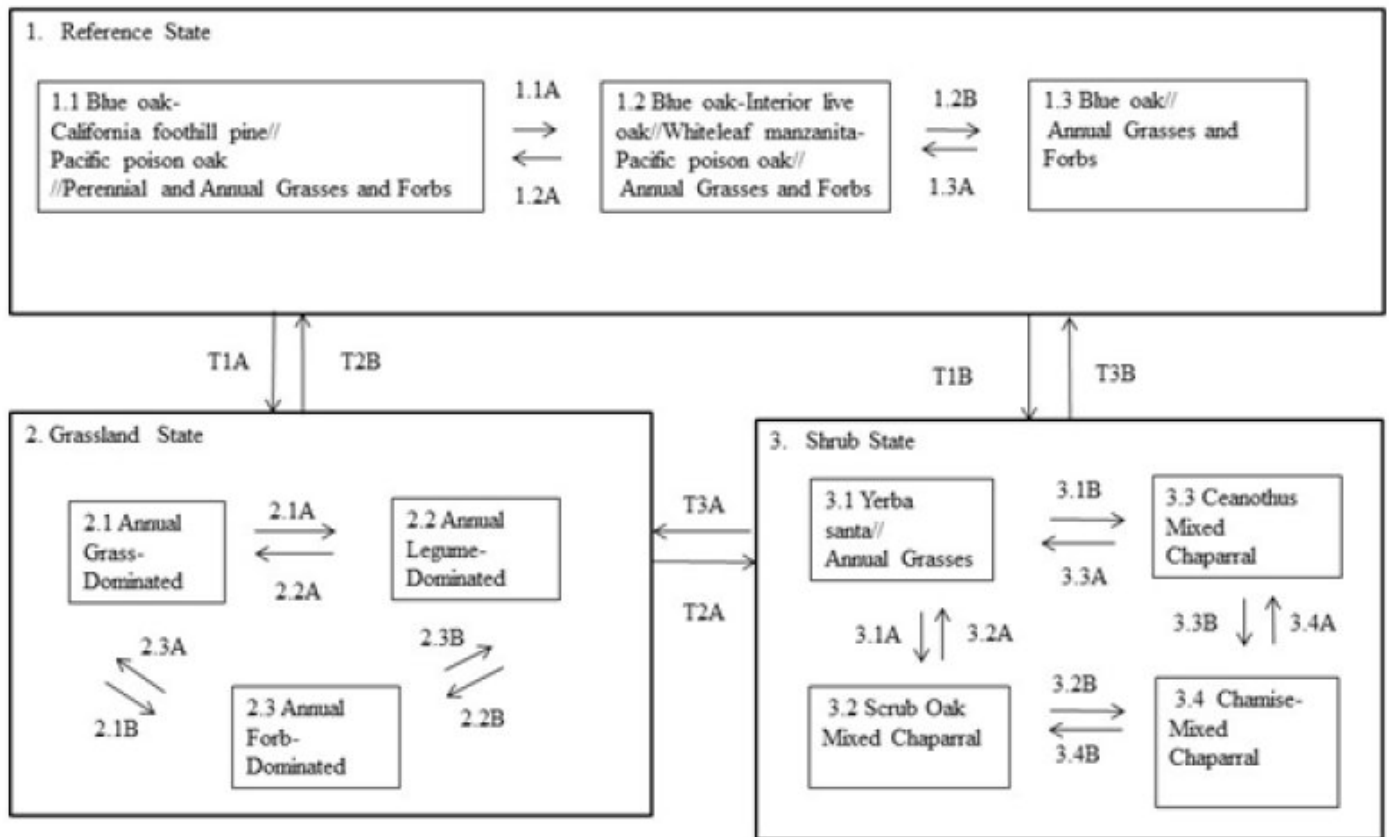


Figure 8. R015XF008CA - Shallow Gravelly Foothills

## State 1 Reference State

State 1 is the Reference State that represents the natural range of variability for this ecological site. States and Community Phases included in this document include those previously recognized by Fire Resource Assessment Program (FRAP) (State of California, CALFIRE, 1998) and other entities, as a result of the use of ordination software and professional consensus (Allen-Diaz et al., 1989, Vayssieres and Plant, 1998 and George et al., 1993). Drought, fire, and grazing are the primary drivers of the natural disturbance regime. The reference state for this ecological site has three community phases; landscape position, slope, aspect and past disturbance influence the vegetation dynamic between the phases. All Community Phases have some degree of blue oak overstory, however, the higher elevation, steep slopes and north and east facing sites favor California Foothill Pine and heavier shrub development (Reference and Representative Community Phase 1.1), the cooler east-facing slopes where moisture conditions are more favorable for survival of young shrub have blue oak and interior live oak with a more developed shrub understory species (Community Phase 1.2) and the drier south and southwest-facing backslopes and sideslopes (Community Phase 1.3) are primarily composed of blue oak with an annual grass and forb understory. In Phase 1.1, California foothill pine is dominant, with much less blue oak in the overstory; lack of frequent fire allows foothill pine to proliferate, and as blue oak is shade intolerant, it does not grow well under dense canopy of shrubs and foothill pine (McDonald, 1990, ucanr.edu, 2015). As community phases change over time within the Reference State, shrubs and trees become a greater component of the community. Fire regimes may shift from low intensity fires towards more mixed severity and replacement fires due to the presence of ladder fuels and several missed fire cycles. Fuel load, season of burn, fire frequency and duration all interact to affect the amount of damage and mortality response (Swiecki et al., 1997, Neary et al., 1999). Blue oak and California foothill pine are the dominant tree species found on this ecological site and to a limited extent, interior live oak. At lower elevations the blue oak and foothill pine vegetation type intergrades with blue oak savanna. At higher elevations this type transitions to dense mixed chaparral shrub cover (USDA, 1999). Small isolated populations of California juniper (*Juniperus*



*californica*) may also be found on this ecological site. Moderate shrub cover most commonly includes buckbrush, whiteleaf manzanita and/or sticky whiteleaf manzanita, Pacific poison oak, and birchleaf mountain mahogany (*Cercocarpus montanus* var *glaber*). Some areas also include hollyleaf redberry (*Rhamnus ilicifolia*), and the shrub form of interior live oak. Non-native annual grasses and native perennial grasses are generally a moderate component of the understory. Wild oat commonly dominates the annual understory grasses in the lower elevation community phases and the perennial grasses Sandberg bluegrass is common in small openings at the higher elevations. A variety of annual and perennial forbs and herbs are also present. This state is relatively stable unless tree removal occurs. Blue oak contributes to soil productivity through increased soil nutrition and health under trees, and removal of trees causes changes to soil cover, water and nutrient status. Research indicates that oak removal results in a rapid decline in soil quality, including a loss in soil organic matter and nitrogen (Dahlgren et al., 2003). Oaks help retain more water on site and enhance soil quality through nutrient cycling, organic matter deposition and reduced bulk density (O'Geen et al., 2010). Some deeply rooted trees and shrubs may also induce hydraulic lift, transporting water to the upper soil layers (Richards and Cadewell, 1987; Caldwell et al., 1998; Ishikawa and Bledsoe, 2000; Liste and White, 2008), supporting the development of neighboring plants. Nutrients are also concentrated around shrub bases from litter fall and from sediment capture via movement of soil particles. The duration of vegetation successional stages varies greatly, and lacks sufficient research to gain better estimates. It has been estimated by some research that for this ecological site and other similar ecological sites, conifer development may take 30-40 years (Verner, 1988). Blue oak growth is slow and variable. Most stands of blue oak range from 80 to 100 years of age (Kertis et al., 1993). There are remnant older blue oak specimens that may range to over 450 years of age (Stahle et al., 2013) in more remote or steep locations. Mature brush development can take 10 to 15 years (Mayer and Laudenslayer, 1988).

## Community 1.1

### Blue oak-California foothill pine//Pacific poison oak//Perennial and Annual Grasses and Forbs



Figure 9. Community Phase 1.1 (MtE), J. Welles, 2016

Community phase 1.1 represents the ecological potential and is considered the representative and reference community phase for this site. This phase is comprised of a low to moderate cover of blue oak and California foothill pine. Shrub cover predominately consists of Pacific poison oak and buckbrush. Birchleaf mountain mahogany is commonly present and to a lesser degree whiteleaf and sticky whiteleaf manzanita and the shrub form of interior live oak and toyon. Perennial grasses found in the understory include the native Sandberg bluegrass. Annual non-native grasses found in understory openings include red brome, soft brome (*Bromus hordeaceus*), desert fescue and wild oat. Annual forbs and herbs include delicate buttercup, common chickweed, whiskerbrush (*Leptosiphon ciliatus*), q-tips (*Micropus californicus*), dovefoot geranium (*Geranium molle*) and the invasive spreading hedgeparsley (*Torilis avensis*). Other perennial herbs and forbs that may be found on the site include bedstraw (*Gallium* spp.), royal larkspur (*Delphinium variegatum*), blue dicks (*Dichelostemma capitatum*), yarrow (*Archillea*), straightbeak buttercup (*Ranunculus orthorhynchus*), Claytonia spp., Diogene's lantern (*Calochortus amabilis*), purple sanicle (*Sanicula bipinnatifida*), Pacific black snakeroot (*Sanicula crassicaulis*), Ithuria's spear (*Triteleia laxa*) and mosquito bills (*Dodecatheon hendersonii*). Goldback fern (*Pentagramma triangularis*) is also rarely found. Community phase production: Expected production is highly variable based on unfavorable normal or favorable year. Total production ranges from a low of 500 to a high of 1,500 pounds per acre. The drought over the last several years has hampered efforts to sample the full range of site conditions, however rains in the fall of 2015 and winter of 2016 were regular and resulted in a normal to slightly higher productivity.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Forb	202	404	644
Shrub/Vine	123	308	432
Tree	157	258	415
Grass/Grasslike	78	157	191
<b>Total</b>	<b>560</b>	<b>1127</b>	<b>1682</b>

Table 6. Ground cover

Tree foliar cover	1%
Shrub/vine/liana foliar cover	1%
Grass/grasslike foliar cover	1%
Forb foliar cover	1%
Non-vascular plants	1%
Biological crusts	0%
Litter	50-65%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%
Bedrock	1-2%
Water	0%
Bare ground	10-20%

Figure 11. Plant community growth curve (percent production by month). CA1501, Annual rangeland (Normal Production Year). Growth curve for a normal (average) production year resulting from the production year starting in November and extending into early May. Growth curve is for oak-woodlands and associated annual grasslands..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	10	25	40	5	0	0	0	0	0	10	10

Figure 12. Plant community growth curve (percent production by month). CA1502, Annual rangeland (Favorable Production Year). Growth curve for a favorable production year resulting from the production year starting in October and extending through May. Growth curve is for oak-woodlands and associated annual grasslands..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	10	20	30	25	0	0	0	0	5	5	5

Figure 13. Plant community growth curve (percent production by month). CA1503, Annual rangeland (Unfavorable Production Year). Growth curve for an unfavorable production year resulting from the production year starting in October and extending through May. Growth curve is for oak-woodlands and associated annual grasslands..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	15	70	5	0	0	0	0	0	0	5	5

## Community 1.2

Blue oak-Interior live oak//Whiteleaf manzanita-Pacific poison oak//Annual Grasses and Forbs



Figure 14. Community Phase 1.2 (MtE). J. Welles, 2016



Figure 15. Community Phase 1.2 (MeE). J. Welles, 2013

This community phase is dominated by the annual grass wild oat (*Avena fatua*) and annual forbs including filaree (*Erodium* spp.) and pincushionplant (*Navarretia* spp.), with an overstory of blue oak and to lesser degree interior live oak, and a low to moderate shrub cover of whiteleaf and/or sticky whiteleaf manzanita (*Arctostaphylos visida*) and Pacific poison oak. On some north-facing slopes, birchleaf mountain mahogany may also be present. Interior live oak, while very drought tolerant, is more common on moist north to east facing slopes (Fryer, 2012). This is considered a provisional community, and no data has been collected for this phase.

### Community 1.3 Blue oak//Annual Grasses and Forbs



Figure 16. Community Phase 1.3 (MeE). J. Welles, 2013

Community phase 1.3 is considered a provisional community, and no data has been collected for this phase. An annual grass and forb dominated blue oak savanna, this community is typically found on the more gentle slopes of



this ecological site. Non-native annual grasses including wild oat (*Avena fatua*), soft brome (*Bromus hordeaceus*), dogtail (*Cynosurus echinatus*), fescues (*Vulpia* spp.), and ripgut brome (*Bromus diandrus*) are the dominant, naturalized species found in this community. Medusahead (*Taeniatherum caput-medusae*), a non-native invasive is common in the mix of grasses at the lower elevations. Blue oak (*Quercus douglasii*) is the dominant overstory tree species found in this community phase, and though an occasional California foothill pine may be found, this is not common. Herbaceous species that may be present include pincushion plant (*Navarretia* spp.), spreading hedgeparsely (*Torilis arvensis*), and rose clover (*Trifolium hirtum*).

### Pathway 1.1A Community 1.1 to 1.2



Blue oak-California foothill pine//Pacific poison oak//Perennial and Annual Grasses and Forbs



Blue oak-Interior live oak//Whiteleaf manzanita-Pacific poison oak//Annual Grasses and Forbs

Prolonged drought weakens trees and a subsequent increase in bark beetle activity causes mortality of many California foothill pine. Foothill pine also decreases under a frequent fire regime, and rapidly growing blue oak sprouts interfere with pine seedling growth (Howard, 1992).

### Pathway 1.2A Community 1.2 to 1.1



Blue oak-Interior live oak//Whiteleaf manzanita-Pacific poison oak//Annual Grasses and Forbs



Blue oak-California foothill pine//Pacific poison oak//Perennial and Annual Grasses and Forbs

In many instances with the absence of fire, foothill pine composition and cover will continue to increase. Interior live oak tends to be lost from the species composition as elevation increases, perhaps due to its poor adaptation to cold and snow (Fryer, 2012). Foothill pine and blue oak are regenerating in the understory and are represented in the seedling and sapling stages.

### Pathway 1.2B Community 1.2 to 1.3



Blue oak-Interior live oak//Whiteleaf manzanita-Pacific poison oak//Annual Grasses and Forbs



Blue oak//Annual Grasses and Forbs

Interior live oak generally is eliminated from the species composition at the lower elevations. A higher fire frequency can also deplete the seed bank of buckbrush and manzanita and eliminate or greatly reduce these species from the site.

### Pathway 1.3A Community 1.3 to 1.2



Blue oak//Annual Grasses and Forbs



Blue oak-Interior live oak//Whiteleaf manzanita-Pacific poison oak//Annual Grasses and Forbs

Browsing pressure is low and the protection from or elimination of grazing may allow brush to expand into grasslands over a period of time (Freudenberger et al., 1987). Fire suppression may also lead to brush expansion into grasslands increasing fire hazard (Johnson and Fitzhugh, 1990).

## State 2

### Annual Grassland State

Non-native grasses now have become naturalized in much of California. Introduced annual forbs and grasses have unique adaptations that give them a competitive advantage over native species. Some of these plant adaptations include high seed production, fast early season growth and the ability to set seed in drought years (Stromberg et al., 2007). Soil disturbance from burrowing animals and feral pigs continue to create new opportunities for exotic species invasion. Nutrient turnover is rapid in grassland systems and is lost via leaching, gaseous exchange and soil erosion (Stromberg et al., 2007). Because most of the nitrate that accumulates during the summer and fall is moved to seeds at senescence and the remainder is removed via rains prior to initiation of growth, little is available for later absorption by growing plants. There is a higher nutrient loss from annual systems as opposed to shrub-dominated systems (Michaelides et al., 2012) and a higher percentage of soil “fines” transported offsite despite similar erosion rates, according to one study. Although nutrient leaching from grassland systems is variable, nutrients that are moved beyond the shallow root systems of the annual grasses are lost to leaching. Annuals use available water primarily in the top 1 foot of soil (George et al., 2001); their shallow root structures dry out quickly during rapid spring growth and evapotranspiration quickly depletes soil moisture. Water infiltration may be more rapid in grasslands than in shrub-dominated landscapes.

### Community 2.1

#### Annual Grass-Dominated

Community phase 2.1 is considered a provisional community, and no data has been collected for this phase. Common annual grasses found include wild oat and slender oat (*Avena barbata*), soft brome (*Bromus hordeaceus*), fescue (*Festuca* spp.) and red brome. Sufficient litter or residue is required for good germination of grass species (Young et al., 1981) and leaving greater amounts may favor grass dominance (George et al., 1985). Minimum residual dry matter (RDM) guidelines for dry annual grassland suggest retention of 300 to 600 pounds per acre, with greater retention as slope increases (Bartolome et al., 2002) to provide for soil and nutrient retention. Litter improves soil fertility and increases infiltration as well by providing cover during the hot summers, reducing evapotranspiration rates, leaving more moisture in the soil profile (Heady, 1956). Grasses have positive effects on soils by enhancing water percolation, aeration and carbon storage (Eviner and Chapin, 2001). Certain grasses that produce high amounts of litter such as wild oat and soft brome may attract voles and mice.

### Community 2.2

#### Annual Legume-Dominated

Community phase 2.2 is considered a provisional community, and no data has been collected for this phase. Rose clover (*Trifolium hirtum*) or minature lupine (*Lupinus bicolor*) are commonly found in this community phase. Legumes enhance nitrogen availability, but may increase gopher activity (Eviner and Chapin, 2001), and lower cover provides less protection from leaching and gopher activity.

### Community 2.3

#### Annual Forb-Dominated

Community phase 2.3 is considered a provisional community, as no data has been collected for this phase. Common forb species found are longbeak stork's bill (*Erodium botrys*) and redstem stork's bill (*Erodium*

circutarium). Filaree is an exotic forb that has become naturalized in California (Howard, 1992) and it provides forage early in the growing season but rapidly disintegrates after maturity (Pitt and Heady, 1978). Filaree can withstand heavy grazing but when early fruits are eaten, growth is modified to a more prostrate form, making it more difficult for grazing animals to consume (Howard, 1992). Filaree seed dispersal mechanisms which include the ability to drill into the ground or to disperse up to a half meter away via the twisting awns serve to enhance its invasive capacity (Evangilista, Hotton and Dumais, 2011). In one study, nitrogen and phosphorus availability was found to be low in filaree dominated areas (Eviner and Chapin, 2001). Successive droughts could lead to erosion especially after a filaree year as it quickly disintegrates and often leaves a lot of exposed soil (Pitt and Heady, 1978).

### **Pathway 2.1A**

#### **Community 2.1 to 2.2**

Legume or clover years may be favored with early rains and regularly distributed rainfall throughout the growing season from November through April (George et al., 1985). Dry autumn weather followed by precipitation in late fall or early winter may contribute to legume domination or clover plant community over grasses (Pitt and Heady, 1978).

### **Pathway 2.1B**

#### **Community 2.1 to 2.3**

Filaree years are triggered in low rainfall years or when residual dry matter (Bartolome et al., 2002, George et al., 1985) is low. Often when a dry period follows the first rains, drought-tolerant self-burial seed species, like filaree, are favored (Young et al., 1981) and the deep taproot of filaree supplies water to the plant (Pitt and Heady 1978). Filaree presence may be reduced if rains come early and are followed by severe drought stress (Bartolome, 1979).

### **Pathway 2.2A**

#### **Community 2.2 to 2.1**

Filaree years are triggered in low rainfall years or when residual dry matter (Bartolome et al., 2002, George et al., 1985) is low. Often when a dry period follows the first rains, drought-tolerant self-burial seed species, like filaree, are favored (Young et al., 1981) and the deep taproot of filaree supplies water to the plant (Pitt and Heady 1978). Filaree presence may be reduced if rains come early and are followed by severe drought stress (Bartolome, 1979).

### **Pathway 2.2B**

#### **Community 2.2 to 2.3**

Filaree years are triggered in low rainfall years or when residual dry matter (Bartolome et al., 2002, George et al., 1985) is low. Often when a dry period follows the first rains, drought-tolerant self-burial seed species, like filaree, are favored (Young et al., 1981) and the deep taproot of filaree supplies water to the plant (Pitt and Heady 1978). Filaree presence may be reduced if rains come early and are followed by severe drought stress (Bartolome, 1979). Successive droughts could lead to erosion especially after a filaree year. The taprooted filaree contributes to a very low and low soil surface and subsurface cohesion or structure, presumably due to a lack of a root mat (Eviner and Chapin, 2001).

### **Pathway 2.3A**

#### **Community 2.3 to 2.1**

Annual grass years occur when precipitation is high or with late spring rains (George et al., 1985). Annual grasses are shallow-rooted species that require a continual supply of moisture for growth (Barbour and Major, 1977). Sufficient litter or residue is required for good germination of grass species (Young et al., 1981) and leaving greater amounts may favor grass dominance (George et al, 1985).

### **Pathway 2.3B**

#### **Community 2.3 to 2.2**

Legume domination or clover years may be favored with early rains and adequately spaced rainfall thereafter (George et al., 1985). Low mulch cover may allow for increased development of legumes (Heady, 1956).

## State 3

### Shrub State

The Shrub State has four Community Phases: 1) the Yerba santa Community Phase, 2) the Scrub Oak Mixed Chaparral Community Phase, 3) Ceanothus Mixed Chaparral Community Phase and 4) the Chamise Mixed Chaparral Community Phase. Many factors may influence the pathways between community phases; the degree of fire severity and frequency, species composition “pre-fire”, topography, slope and weather as it influences fire behavior (Fried et al., 2004). Much of the information that exists for chaparral in northern California is from the work of Biswell (1952) and Sampson (1944), however there has been extensive research in the chaparral of central and southern California by Keeley and many others. Subshrubs, annuals and perennial herbs sometimes dominate the early stages following fire (1 to 3 years), with shrub seedlings and sprouts (England, 1988). Most shrub species that are present following fire are either obligate seeders or sprouters. From 3 to 15 years shrub canopy continues to close until at age 35 to 50 years, when shrub canopy may be up to 80 percent of total cover. As development of the shrub community progresses after fire, inter-shrub native and non-native herbaceous vegetation decreases, and less understory vegetation is remaining. In a shrub state available water may be present later in the growing season due to decreased evaporation and shading, maintaining moisture longer than under just grasses alone (Gill and Burke, 1999). Deeply rooted shrubs may also induce hydraulic lift, transporting water to the upper soil layers (Richards and Cadewell, 1987). Nutrients are also concentrated around shrub bases from litter fall and from sediment capture via movement of soil particles. In grazed areas, shrub interspaces have increased potential for erosion. Native and non-native herbaceous vegetation is decreased, and less understory grass and forbs are remaining. Periodic or reoccurring fire will maintain this state. Shrub species composition changes depending on aspect and slope position.

### Community 3.1

#### Yerba santa//Annual Grasses



Figure 17. Community Phase 3.1 (MeE). J. Welles, 2013

Yerba santa (*Eriodictyon californicum*), a native shrub is both a residual colonizer and a survivor in disturbed communities, establishing either from seed or by sprouting from rhizomes (Howard, 1992). This shrub may become dominant on some rangelands, especially in areas converted from brushland to grassland (Howard, 1992). This community phase is considered a provisional, and no data has been collected. Yerba santa forms a soil seed bank that may last for decades, and germinates following disturbance that scarifies the seed surface. This phase may last up to 10 years as it is sensitive to competition and may endure in areas with repeated fire (Sawyer et al., 2009).

### Community 3.2

#### Scrub Oak Mixed Chaparral





**Figure 18. Scrub Oak Mixed Chaparral (MeE). J. Welles, 2013.**

Scrub oak tends to be more common on the higher elevations and cooler north or east facing aspects of this site. Species composition is highly variable depending on a number of factors including aspect, slope, and elevation. This community phase may consist of a mixture of scrub oaks and the shrub form of interior live oak (*Quercus dumosa* and *Quercus wislizenii* var *frutescens*), birchleaf mountain mahogany, Pacific poison oak, whiteleaf and/or sticky whiteleaf manzanita, hollyleaf redberry (*Rhamnus ilicifolia*) and chamise (*Adenostoma fasciculatum*).

### **Community 3.3**

#### **Ceanothus Mixed Chaparral**



**Figure 19. Community Phase 3.3 (MeE). J. Welles, 2013**

Community phase 3.3 is primarily dominated by ceanothus species but may have manzanita or scrub oak species present also and is more common in mesic locations. This is considered a provisional community, as no data has been collected for this phase.

### **Community 3.4**

#### **Chamise Mixed Chaparral**

This community is usually associated with warmer south and southwest drier slopes and ridges. In this community phase chamise is the dominant shrub, and other associated species include manzanita (*Arctostaphylos* spp.), various ceanothus (*Ceanothus* spp.), scrub oak and birchleaf mountain mahogany. Chamise reproduces sexually and vegetatively (Mc Murray, 1990) or is known as a facultative resprouter. Other shrubs that have persistent soil seed banks are referred to as “obligate seeders”, including some species of manzanita and ceanothus (buckbrush) that are stimulated by heat or combustion products (Keeley, 2007). This phase is considered a provisional community, as no data has been collected.

### **Pathway 3.1A**

#### **Community 3.1 to 3.2**





Yerba santa//Annual Grasses



Scrub Oak Mixed Chaparral

The foliage of yerba santa is resinous and very flammable, and severe fire kills the plant (Howard, 1992). In the absence of fire yerba santa is shade-intolerant, and plants are gradually shaded out as other shrubs become established and the shrub community matures. Yerba santa is succeeded by buckbrush and manzanita species (Howard, 1992).

### Pathway 3.1B Community 3.1 to 3.3



Yerba santa//Annual Grasses



Ceanothus Mixed Chaparral

Buckbrush and manzanita species often succeed Yerba santa (Howard, 1992). Seeds of buckbrush are dispersed via seed casting and by ants, and manzanita by birds and mammals.

### Pathway 3.2A Community 3.2 to 3.1



Scrub Oak Mixed Chaparral



Yerba santa//Annual Grasses

Yerba santa sprouts from rhizomes or through germination of seed stored in the soil. Repeated fires have increased the amount of yerba santa on rangelands (Howard, 1992) and it may become dominant in areas converted from brushland to grassland (Howard, 1992).

### Pathway 3.2B Community 3.2 to 3.4

Severe fire will cause sprouting from the root crown of scrub oak, and recovery is generally rapid, in less than 10 years. Chamise has a limited ability to colonize disturbed areas; it is capable of invading areas where cover is sparse (Mc Murray, 1990) and may be more successful on steep dry slopes where scrub oak is less successful.

### Pathway 3.3A Community 3.3 to 3.1



Ceanothus Mixed Chaparral



Yerba santa//Annual Grasses

Repeated fires have increased the amount of yerba santa on rangelands (Howard, 1992). Yerba santa sprouts from rhizomes or through germination of seed stored in the soil.

### Pathway 3.3B

## **Community 3.3 to 3.4**

Community shifts to chamise occur with varying topography, slope and aspect. Short or very long fire intervals may have negative effects on obligate seeders and favor resprouters such as chamise (Franklin et al, 2004). Short interval fires may cause a decline in some shrub populations; ceanothus species require almost a decade to replace the seed bank and are eliminated when fire intervals are short (Keeley 2012; Burcham, 1955; Sampson 1944). Over very long fire intervals ceanothus may be replaced by chamise (League, 2005).

### **Pathway 3.4B**

#### **Community 3.4 to 3.2**

Late spring and summer fires may sustain greater mortality of chamise as plants may have utilized most of the starch reserves in the lignotuber (McMurray, 1990). Community shifts to scrub oak may occur with varying topography, slope and aspect. Scrub oak is more common on north-facing slopes.

### **Pathway 3.4A**

#### **Community 3.4 to 3.3**

Season of burning, fire intensity and fire frequency are important determinants in mortality of chamise. Late spring and summer fires may sustain greater mortality as plants may have utilized most of the starch reserves in the lignotuber (McMurray, 1990). Repeated fire kills many young chamise plants that are susceptible to fire due their small lignotubers. Frequent fire intervals may completely eliminate new chamise seedlings and if the sufficient seed is not present in the soil (McMurray, 1990). If there is a ceanothus seedbank present in the soil, thousands of seedlings may be produced following fire (League, 2005).

## **Transition T1A**

### **State 1 to 2**

Triggers that limit blue oak reproduction and/or survival such as intensive prolonged grazing, severe fire, mechanical removal (conversion) and prolonged drought may result in the State reaching a Threshold (T1A) leading to a potential for Community Phases 1.2 or 1.3 to transition to a Grassland State (2). Severe and more frequent fire may result in the potential loss of blue oak on some sites, especially in areas near the limits of blue oak distribution, and where competition from moderate shrub and grass cover could reduce favorable conditions for oak establishment and survival. Frequent fires and intensive grazing have been shown to have a negative effect on recruitment of blue oak saplings (Swiecki and Bernhardt, 1997). As community phases change over time within the Reference State, fire regimes may shift from low intensity fires towards more mixed severity and replacement fires due to the presence of ladder fuels and several missed fire cycles. Fuel load, season of burn and fire frequency and duration interact to affect the amount of damage and mortality response (Swiecki et al., 1997, Neary et al., 1999). Removal of blue oaks has been found to reduce soil productivity due to decreased soil nutrition from tree litter (Dahlgren et al., 2003). Removal also increases the potential for erosion due to a decline in soil porosity and increased bulk density from organic matter losses (Dahlgren et al., 1997). Erosion losses also may reduce productivity by changing the water-holding capacity of the soil and the thickness of the root zone (Elliot, Page-Dumroese, Robichard 1998).

## **Transition T1B**

### **State 1 to 3**

Removal of tree cover via conversion or severe fire in combination with prolonged drought causing mortality or unfavorable conditions for oak sprouting result in a Threshold shift to a Shrub State (3). As community phases change over time within the Reference State, fire regimes may shift from low intensity fires towards more mixed severity and replacement fires due to the presence of ladder fuels and several missed fire cycles. Shrub species have several mechanisms for regenerating post-fire via sprouting or through seed. Pacific poison oak, the shrub form of interior live oak, birchleaf mountain mahogany and toyon (*Heteromeles arbutifolia*) sprout from the root crown following cutting or fire. Fire stimulates buckbrush and manzanita seed to germinate by scarifying the seed "banked" in the soil (Abrahamson, 2014; League, 2005). Early post-fire plant communities commonly have a native shrub, yerba santa (*Eriodictyon* spp.), that reproduces via rhizomes as a component. This shrub slowly diminishes in abundance as the plant community progresses. Severe fire can cause a loss of nutrients and a reduction in microbial processes, and lead to accelerated erosion and leaching. High heat transfer to soils may give rise to a

loss of soil organisms, tree and shrub roots, and changes in physical soil properties resulting in reduced water infiltration and increased surface runoff (Neary et al., 1999). In some cases severe fire heating may create a water repellant layer lasting from one year to several years (DeBano, 2000), and the resulting increases in raindrop splash and rill formation can dramatically increase soil erosion rates.

## Transition T2B

### State 2 to 1

Pioneer establishment of blue oak into treeless areas is uncommon but sometimes occurs in favorable environments (Swiecki and Bernhardt, 1997). Blue oaks are capable of sprouting following harvest or severe fire on this ecological site, especially within this higher precipitation zone, however, competition for moisture and growing space with annual grasses may limit or greatly slow re-establishment. Smaller oaks tend to sprout more vigorously than larger oaks (McCreary et al., 2002). A reduction in grazing duration and pressure or utilizing fencing would help protect young oaks that do get established until they are above the browse line. Blue oak saplings take approximately 10 to 30 years to reach a height of about 4.5 feet (Swiecki, 1998).

## Transition T2A

### State 2 to 3

Browsing pressure is low and the protection from or elimination of grazing may allow brush to expand into grasslands over a period of time (Freudenburger et al., 1987). Fire suppression may also lead to brush expansion into grasslands increasing fire hazard (Johnson and Fitzhugh, 1990). The seed of other shrub species may be transported via birds or mammals. Though expansion of shrubs into grassland is limited, disturbance creates the opportunity when a seed source is present.

## Transition T3B

### State 3 to 1

Shrub canopies may facilitate oak re-establishment by providing protective canopy from herbivores (Stromberg et al., 2006) and by providing shade. Birds may also disperse acorns in shrub areas.

## Transition T3A

### State 3 to 2

High browse pressure and frequent fire may kill many shrubs transitioning back to a Grassland State (2). High fire frequency kills shrubs, reduces the seed bank and allows grasses to become established. Feedbacks that include changes in soil water availability in an annual system may further limit brush re-establishment (Haidinger and Keeley, 1993). Severe fires can cause a degradation in soil function and physical soil properties, nutrition losses and increased erosion (Neary et al., 1999).

## Additional community tables

Table 7. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Forb					
1	Perennial Forbs and Herbs			78–275	
	lthuriel's spear	TRLA16	<i>Triteleia laxa</i>	22–56	3–6
	straightbeak buttercup	RAOR3	<i>Ranunculus orthorhynchus</i>	22–45	3–5
	springbeauty	CLAYT	<i>Claytonia</i>	6–45	1–3
	Pacific blacksnakeroot	SACR2	<i>Sanicula crassicaulis</i>	11–22	2–5
	bluedicks	DICA14	<i>Dichelostemma capitatum</i>	6–22	1–2
	bedstraw	GALI1U	<i>Galium</i>	6–11	1–5
	mosquito bills	DOHE	<i>Dodecatheon hendersonii</i>	4–7	1–2
	swamp larkspur	DEVA	<i>Delphinium variegatum</i>	2–6	1–3

	royal harkspur	DEVA	<i>Delphinium variegatum</i>	3–6	1–3
	Diogenes' lantern	CAAM3	<i>Calochortus amabilis</i>	1–6	1–2
	purple sanicle	SABI3	<i>Sanicula bipinnatifida</i>	2–6	1–2
	yarrow	ACHIL	<i>Achillea</i>	2–3	1–2
2	<b>Annual Forbs and Herbs</b>			67–202	
	spreading hedgeparsley	TOAR	<i>Torilis arvensis</i>	17–56	1–5
	delicate buttercup	RAHE	<i>Ranunculus hebecarpus</i>	22–34	2–5
	dovefoot geranium	GEMO	<i>Geranium molle</i>	6–17	1–4
	false carrot	YAMI	<i>Yabea microcarpa</i>	6–17	1–2
	whiskerbrush	LECI18	<i>Leptosiphon ciliatus</i>	2–6	1–2
	goldback fern	PETRT	<i>Pentagramma triangularis</i> ssp. <i>triangularis</i>	3–6	1–2
	common chickweed	STME2	<i>Stellaria media</i>	2–6	1–2
	agoseris	AGOSE	<i>Agoseris</i>	2–6	1–2
<b>Grass/Grasslike</b>					
3	<b>Perennial grasses</b>			17–50	
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	11–34	5–10
	bulbous bluegrass	POBU	<i>Poa bulbosa</i>	6–17	1–5
4	<b>Annual grasses</b>			56–112	
	wild oat	AVFA	<i>Avena fatua</i>	39–56	3–5
	red brome	BRRU2	<i>Bromus rubens</i>	17–22	1–3
	desert fescue	VUMIM	<i>Vulpia microstachys</i> var. <i>microstachys</i>	11–17	1–2
	soft brome	BRHO2	<i>Bromus hordeaceus</i>	2–6	1–2
<b>Shrub/Vine</b>					
5	<b>Shrubs</b>			84–370	
	buckbrush	CECU	<i>Ceanothus cuneatus</i>	56–140	5–25
	whiteleaf manzanita	ARMA	<i>Arctostaphylos manzanita</i>	34–78	5–30
	birchleaf mountain mahogany	CEMOG	<i>Cercocarpus montanus</i> var. <i>glaber</i>	6–22	5–10
	Pacific poison oak	TODI	<i>Toxicodendron diversilobum</i>	6–17	3–7
	interior live oak	QUWIF	<i>Quercus wislizeni</i> var. <i>frutescens</i>	1–6	1–5
<b>Tree</b>					
6	<b>Trees</b>			179–549	
	blue oak	QUDO	<i>Quercus douglasii</i>	135–404	3–7
	California foothill pine	PISA2	<i>Pinus sabiniana</i>	45–101	1–5

Table 8. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
<b>Tree</b>							
blue oak	QUDO	<i>Quercus douglasii</i>	Native	0.9–9.1	1–15	20.3–30.5	–
California foothill pine	PISA2	<i>Pinus sabiniana</i>	Native	4.6–19.8	1–5	30.5–50.8	–

## Animal community

This ecological site provides a mosaic of tree, shrub and grassland habitat, with some areas transitioning to more chaparral and others more to grassland, depending on the elevation, aspect, and fire frequency. There is somewhat limited forage and cover available for birds and other animals due to shallow soils, low soil moisture and low site productivity. Even though lower cover and hiding areas supports less animal diversity, these areas provide important links to other surrounding habitat.

The oak savannas and woodlands may provide essential habitat elements for a variety of wildlife species including key habitat features such as rock outcroppings, cliff faces, and snags. The natural mosaic of grassland, shrubs and trees, provides a variety of micro-habitats suitable for wildlife. The increased shrub cover and structure provided in Communities Phases 1.1 and 1.2 provide additional habitat elements necessary for a variety of birds and animals. Forage and cover available for birds and other animals on these sites is low to moderate. Overgrazing by livestock or removing wildlife trees (snags, granaries and large oaks) would dramatically reduce the quality of this habitat. This community is susceptible to degradation from feral pigs (*Sus scrofa*).

Birds can serve as "focal species" in that their requirements define spatial attributes, habitat characteristics and management regimes for a healthy system (Zack, 2002). Essential habitat elements include large oak trees with associated cavities and acorns, snags, shrubs, grasses and forbs, brush piles and water. The numerous diseases that affect the heartwood of oak boles and limbs create important cavities for a variety of tree dwellers. Mistletoe in oaks (*Phorodendron villosum*) has berries that are attractive to birds that eat and excrete the live seeds which then stick and create new plants (Perry and Elmore, 2006). Other beneficial forage and shelter shrubs include manzanita (*Arctostaphylos* spp.), poison oak (*Toxicodendron diversilobum*), and the occasional western redbud (*Cercis occidentalis*) and California buckeye (*Aesculus californica*). Shade ameliorates soil temperatures for seedling establishment and the animals that utilize this site. In one study in central California, habitat elements that included shrubs, grass and down wood were positively associated with the abundance of small mammals, and shrub cover and litter weight with abundance of birds and reptiles (Tietje et al., 1997). Shrubs provide thermal hiding and escape cover for many birds and mammals, including deer and rabbits (Fryer, 2007). Birds perch in the trees and contribute to shrub dispersal (Block, 1990).

Oak woodlands are important over-wintering environments for large numbers of Neotropical migratory birds such as flycatchers, vireos, and warblers. Acorn woodpeckers (*Melanerpes formicivorus*) and western scrub jays (*Aphelocoma californica*) forage heavily on acorns, and oak titmice (*Baeolophus inornatus*), western bluebirds (*Sialia mexicana*) and tree swallows (*Tachycineta bicolor*) nest in the cavities of oaks. The open grassland areas provide important hunting access for raptors including American kestrels (*Falco sparverius*), red-tailed hawks (*Buteo jamaicensis*), golden eagles (*Aquila chrysaetos*) and owls. Numerous species of bats also roost in tree hollows.

Common prey species on this site include Beechey ground squirrels (*Spermophilus beecheyi*), Botta pocket gopher (*Thomomys bottae mewa*), and Audubon cottontail (*Sylvilagus audubonii vallicola*). The rich rodent and lagomorph population is an important food source for common predators including: gray fox (*Urocyon cinereoargenteus*), bobcat (*Lynx rufus californicus*), coyote (*Canis latrans*) and the Pacific rattlesnake (*Crotalus viridis oreganus*). The apex predators found in this habitat include mountain lion (*Puma concolor*) and the California black bear (*Ursus americanus californiensis*) which place heavy pressure on deer herds.

The blue oak-California foothill pine community is preferred habitat for Columbian black-tailed deer (*Odocoileus hemionus columbianus*), California quail (*Callipepla californica*), the "re-introduced" wild turkey (*Meleagris gallopavo*) and mourning dove (*Zenaidura macroura*). These important game animals and contribute to California's economy through revenues from recreational hunting (Garrison and Standiford, 1997). Feral pigs (*Sus scrofa*) are common throughout the area and are recreationally hunted as well.

Acorns are eaten by birds, upland game birds, rodents, black-tailed deer, feral and domestic pig, and livestock (Adams et al., 1992; Duncan and Clawson 1980; Sampson and Jespersen 1963). 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 (McDonald, 1990). Western scrub jays cache thousands of acorns each year to use as winter forage, and thus are very important for blue and valley oak regeneration. Acorn woodpeckers also cache acorns, but in granary trees, which becomes an important food source for other birds and rodents. Deer, rodents and rabbits browse blue oak seedlings and leaves and contribute to poor survival of oak natural regeneration.

## Grazing and Browsing

The main problems for livestock production on this shallow 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 and wild oats are relatively low and only palatable during its short green period when young (Sampson, 1951). Soft brome is nutritious and edible forage (Howard, 1998).

## 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

Bird watching, hunting, camping, horseback riding, all-terrain vehicle riding, and hiking in spring are common recreational pursuits.

## Wood products

Firewood cutting of blue oak has decreased with increased public awareness of poor blue oak regeneration.

## Other products

Native Americans have historically used and managed the blue oak savanna and woodlands 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, 2006). Acorns and pine nuts, were harvested for food and traded for other items. Historically these gathering methods sustained local plant populations and promoted plant diversity.

## 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, 4 production (double sampling) plots

## Type locality

Location 1: Tehama County, CA	
Township/Range/Section	TT26N RR6W S31
Latitude	40° 3' 50"
Longitude	122° 34' 40"
General legal description	The Type Locality is located in the NE 1/4 of the SE 1/4 approximately .25 miles up Red Bank Road behind a locked gate.

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## **Contributors**

Jud Welles

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This ecological site was reviewed for content by Ryan Miebach, 2-CHI MLRA Soil Survey Leader and Dave Evans, Sonora Ecological Site Specialist.

## **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)	Ryan Miebach, Judy Welles
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Date	03/25/2016
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

## Indicators

1. **Number and extent of rills:** A few rills were noted on steep slopes. Some were associated with heavy traffic on cattle trails, and were not extensive otherwise.  

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2. **Presence of water flow patterns:** Water commonly flows downslope for a length of 200-500 feet. No flow patterns were noted on the reference site.  

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3. **Number and height of erosional pedestals or terracettes:** No erosion pedestals or terracettes were noted.  

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground ranges from 20 to 65 percent with an average of 35 percent. Canopy gaps would be less than 8-10 inches in diameter but would increase in areas with disturbances from rodents or feral pig rooting and bedding activity.  

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

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

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7. **Amount of litter movement (describe size and distance expected to travel):** Very little if any litter movement was noted. Oak leaves (2 by 3 inches) and dead grasses (.15 by 12 inches) are held in place by standing residual dead grasses and forbs with very little if any movement under undisturbed conditions.  

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

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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)

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Trees: 4 percent

Shrubs: 18 percent

Forbs: 40 percent

Grass: 36 percent

Trees and shrubs intercept some precipitation and slow water infiltration. High forb and grass cover aids water infiltration and slows runoff.

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

Sub-dominant: Sub-dominant: Shrubs > or = to Trees

Other:

Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Annual grasses and forbs will show mortality and decadence beginning in late April or early May.

Perennial grasses and forbs may last another month longer than annuals.

Trees: Blue oak shows very little sign of mortality, however, California foothill pine is showing some increase mortality as a result of drought and increased bark beetle activity.

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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 500 to a high of 1,500 pounds per acre over a two year period when data was collected. The first year was considered 80 percent of normal and the 2nd year of data collection was a normal or slightly above normal production year.

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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:** Native perennial grasses that exist on this site including Sandberg bluegrass. Typically the native perennial grasses face strong competition from non-native grasses and forbs.
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