

## Ecological site R015XF006CA Steep Clayey Hills

Accessed: 04/25/2024

### 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(Central California Coast Range): 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.

LRU Description: 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 (78) down to the southern portion of Napa and Yolo Counties. The LRU is formed mostly from Jurassic, 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 range from 1000 to 2400 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. LRU 15XF has several Environmental Protection Agency (EPA) Ecoregions; this ecological site is located in Ecoregion “6f”.

## Classification relationships

This blue oak dominated site may include the following Allen-Diaz Classes: 1) Blue Oak-Foothill Pine/Grass or 2) Blue Oak-Foothill Pine/Whiteleaf Manzanita/Grass (Allen-Diaz et al., 1989). This site includes Blue Oak Woodland (BOW) and Blue Oak-Foothill Pine (BOP) 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* Woodland Alliance from the publication "A Manual of California Vegetation, 2nd Edition", (Sawyer et al., 2009).

## Ecological site concept

This ecological site is found primarily on steep east, southeast, and south facing foothill backslopes and sideslopes. The moderately deep to deep clayey soils associated with this ecological site have an argillic horizon, are slowly permeable, and have moderate to high runoff. Average precipitation ranges from 25 to 34 inches.

Typical vegetation is a low cover of blue oak (*Quercus douglasii*) and California foothill pine (*Pinus sabiniana*), and a sparse cover of shrubs dominated by whiteleaf manzanita (*Arctostaphylos manzanita*) and toyon (*Heteromeles arbutifolia*). Forb cover is high and dominant annual herbs include lthurial's spear (*Triteleia laxa*) and sanicle (*Sanicula* spp.). Dominant non-native annual grasses include wild oat (*Avena fatua*) or slender oat (*Avena barbata*). At the lower elevations this site tends to be oak and grass dominated, with increasing elevation and slope foothill pine and shrub density increases.

## Associated sites

R015XF013CA	<p><b>Shallow Foothills</b></p> <p>This ecological site is predominately found on east to northwest-facing slopes on foothill backslopes, shoulders and ridges. Loamy well-drained soils are dominantly shallow to hard bedrock. Blue oak (<i>Quercus douglasii</i>) is the dominant tree species found on this ecological site. California foothill pine (<i>Pinus sabiniana</i>) is also found at the higher elevations. Shrub cover that includes common manzanita (<i>Arctostaphylos manzanita</i>), poison oak (<i>Toxicodendron diversiloba</i>), and birchleaf mountain mahogany (<i>Cercocarpus montanus</i>) is generally low to moderate. Non-native annual grasses and perennial and annual forbs are a sparse component of the understory. Wild oat (<i>Avena fatua</i>) dominates the understory grasses.</p>
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## Similar sites

R015XF014CA	<p><b>Cool Silty Hills</b></p> <p>This ecological site is found primarily on the southwest and western flank of north to south trending foothill ridges, occurring on steep convex backslopes and footslopes. Vegetation is typically patchy with a low cover of blue oak (<i>Quercus douglasii</i>) and coast live oak (<i>Quercus agrifolia</i>), sparse to moderate cover of shrubs dominated by buckbrush (<i>Ceanothus cuneatus</i>) and scrub oak (<i>Quercus berberidifolia</i>), and occasionally chamise (<i>Adenostoma fasciculatum</i>). Dominant non-native annual grasses include wild oat (<i>Avena fatua</i>) and slender oat (<i>Avena barbata</i>).</p>
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Table 1. Dominant plant species

Tree	(1) <i>Quercus douglasii</i> (2) <i>Pinus sabiniana</i>
Shrub	(1) <i>Arctostaphylos manzanita</i>
Herbaceous	(1) <i>Avena fatua</i>

## Physiographic features

This ecological site is found on the backslope and sideslopes of hills. Generally slopes are greater than 30 percent but overall may range from 5-75 percent. Site elevations average from 500 to 1,300 feet but more broadly range from 492 to 1,673 feet. These steep slopes may generate a very high degree of runoff during storm events. This site occurs predominantly on east, southeast and south facing slopes, but other aspects are represented as well.

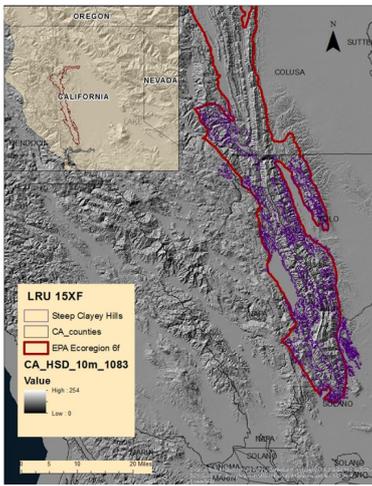


Figure 2. R015XF006CA - Steep Clayey Hills

Table 2. Representative physiographic features

Landforms	(1) Hill
Flooding frequency	None
Ponding frequency	None
Elevation	500–1,300 ft
Slope	20–50%
Aspect	E, SE, S

### Climatic features

This ecological site has a Mediterranean climate characterized by hot summer temperatures and cool moist winters. The driest time of the year is June, July and August. Precipitation falls primarily as rain during October through May. The northern part of the California Central Valley receives precipitation from winter storms from the Pacific Northwest. The timing length and intensity of storms are highly variable and unpredictable. Periodic 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 Keeley, 2006).

Precipitation falls as rain during November through March. Mean annual precipitation is 25 to 34 inches and mean annual air temperature is 47 to 74 degrees. The frost free period averages 256 days, and the freeze free period averages 322 days. The two climate stations that were utilized, Winters and Markley Cove are located in the southern extent of this ecological site. The southern portion of this ecological site has a marine influence that results in cooler temperatures and moister conditions.

Table 3. Representative climatic features

Frost-free period (average)	256 days
Freeze-free period (average)	322 days
Precipitation total (average)	28 in

### Climate stations used

- (1) MARKLEY COVE [USC00045360], Napa, CA
- (2) WINTERS [USC00049742], Winters, CA

### Influencing water features

The presence of an Argillic Horizon, steep slopes, and topographic position affect the rate of infiltration and runoff from this ecological site. Steep slopes and the site's location on sideslopes and backslope positions contribute to

medium to very high runoff. The presence of the slowly permeable argillic layer affects water infiltration through subsurface layers and may alter interflow to downslope positions. The linear downslope and across slope shape also favors runoff from this site. Low levels of organic matter (0-.5 inches) and the amount of bare ground may also contribute to increases in overland flow and soil loss.

## Soil features

The soils typically associated with this ecological site occur on steep sideslopes and backslopes formed in residuum from Cretaceous sandstone, shale and siltstone facies of the Great Valley sequence. The soils typically associated with this ecological site predominantly occur on steep slopes. Soils are moderately deep and deep to a soft or hard bedrock contact.

Dominant soils surface textures are loam, clay loam and silty clay loam and subsurface textures are clay. Water availability is moderate to high (4 to 7 inches) on these sites. Surface gravels range from 2 to 5 percent, and subsurface gravels by volume range from 13 to 30 percent.

These soils have some properties that have a high resistance to disturbance (Seybold, 1999); for example they have a high volume (moderate to deep depth) to absorb and buffer compaction. Smectitic clay soils have a very high cation exchange capacity or nutrient retention capacity. These soils have an Argillic (increase in clay with depth) Horizon that indicates that the surface is relatively stable and that the period of stability has been long (USDA, NRCS, 1999). The presence of an argillic layer may slow water movement and fine root penetration. Slow permeability and steep slopes also make this site susceptible to erosion if disturbed. This soil also has a high resilience when dry with some ability to recover following disturbance.

This ecological site is correlated with the following map units and components in MLRA 15:

Skyhigh: Fine, smectitic, thermic Mollic Haploxeralf

Sleeper: Fine, smectitic, thermic Mollic Haploxeralf

Dibble: Fine, smectitic, thermic Typic Haploxeralf

### Soils Map Units:

CA011; Colusa County, California:

280: Skyhigh-Millsholm complex, 15 to 50 percent slopes; Skyhigh

345: Skyhigh-Sleeper-Millsholm association, 1 to 35 percent slopes; Skyhigh and Sleeper

346: Skyhigh-Millsholm-Sleeper association, 30 to 50 percent slopes; Skyhigh and Sleeper

347: Boar-Sleeper complex, 15 to 30 percent slopes; Sleeper

348: Boar-Sleeper complex, 30 to 50 percent slopes; Sleeper

CA033; Lake County, California:

208: Skyhigh-Asbill complex, 15 to 50 percent slopes; Skyhigh

209: Skyhigh-Millsholm loams, 15 to 50 percent slopes; Skyhigh

212: Skyhigh-Sleeper-Millsholm association, 30 to 50 percent slopes Skyhigh and Sleeper

CA055; Napa County, California:

112: Bressa-Dibble complex, 5 to 15 percent slopes; Dibble

113: Bressa-Dibble complex, 15 to 30 percent slopes; Dibble

114: Bressa-Dibble complex, 30 to 50 percent slopes; Dibble

115: Bressa-Dibble complex, 50 to 75 percent slopes; Dibble

DaF2y: Dibble clay loam, 30 to 50 percent slopes, eroded; Dibble

DaG2y: Dibble Clay loam, 50-75 percent slopes, eroded

DIF2so: Dibble-Los Osos clay loams, 30 to 50 percent slopes, eroded; Dibble

CA113; Yolo County, California

114n: Bressa-Dibble complex, 30 to 50 percent slopes; Dibble

115n: Bressa-Dibble complex, 50 to 75 percent slopes; Dibble

280c: Skyhigh-Millsholm complex, 15 to 50 percent slopes; Skyhigh

BdF2: Balcom-Dibble complex, 30 to 50 percent slopes, eroded; Dibble

DaF2: Dibble clay loam, 30 to 50 percent slopes, eroded; Dibble  
 DaG2: Dibble clay loam, 50 to 75 percent slopes, eroded; Dibble  
 DbE2: Dibble-Millsholm complex, 9 to 30 percent slopes, eroded; Dibble  
 DbF2: Dibble-Millsholm complex, 30 to 50 percent slopes, eroded; Dibble  
 DbG2: Dibble-Millsholm complex, 50 to 75 percent slopes, eroded; Dibble

CA095: Solano County, California

114n: Bressa-Dibble complex, 30 to 50 percent slopes; Dibble

D1F2: Dibble-Los Osos clay loams, 30-50 percent slopes, eroded

\*\* Map Units 114 and 114n need to be phased west and south of Lake Berryessa to reflect the vegetation change to the Interior Mixed Hardwood Alliance (CALVEG), due to marine influence.



Figure 7. Dibble Soil Profile. J. Welles, 2015

Table 4. Representative soil features

Parent material	(1) Residuum–sandstone and shale
Surface texture	(1) Loam (2) Clay loam (3) Sandy clay loam
Family particle size	(1) Clayey
Drainage class	Well drained
Permeability class	Slow
Soil depth	20–60 in
Surface fragment cover <=3"	2–5%
Surface fragment cover >3"	0%
Available water capacity (0-40in)	4.75–8 in
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0–2
Soil reaction (1:1 water) (0-40in)	5.6–6.5
Subsurface fragment volume <=3" (Depth not specified)	13–30%
Subsurface fragment volume >3" (Depth not specified)	0%

## Ecological dynamics

### Disturbance 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 interaction of several disturbance agents including fire, clearing, intensive agriculture, invasive species and drought has influenced and shaped the oak woodland environment. In the mid-1800s prior to European settlement fire frequency was approximately every 25 years (McClaran, 1986). Native Americans regularly used fire to manage vegetation communities to provide food and fiber (Blackburn and Anderson 1993; McCleary 2004). The historic vegetation community likely experienced an understory fire regime (Arno and Allison-Burnell, 2002). Frequent low intensity fire likely left widely spaced overstory trees and removed smaller trees and brush (McCleary, 2004) following settlement before and after the gold rush (Pavlik 1991; Mensing 1992; Stephens 1997). Fires were more frequent, every 5 to 15 years, due to the intentional use of fire by ranchers and others to reduce brush. Shrub and oak recruitment increased in the absence of periodic fire or grazing in some environments (Purcell and Stephens, 2005). 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-Burnell, 2002). Blue oak is considered a weak sprouter following fire, and sprouting declines with age (McDonald, 1990).

Clearing of oaks occurred throughout the 1880's for agriculture and livestock purposes (McCleary, 2004). Increased settlement also resulted in the loss of oaks in the support of fuels for railroads, mines and steamships. After the Second World War, there was extensive conversion of woodland to pasture, and the inventory of hardwood forest types in California has decreased with widespread conversion from residential and commercial development. Within the State of California about 1.9 million acres of hardwoods and chaparral were reported to have been cleared in rangeland improvement projects (Bolsinger, 1988). Chaining of oaks occurred during the 1960's in an attempt to provide more for grassland production. The increase in grass production was short-lived (less than 10-20 years) following oak removal and oak representation on some landscapes was altogether eliminated. Some 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), and indicates that oaks help retain more water on site and enhance soil quality through nutrient cycling, organic matter deposition and reduced bulk density. Firewood cutting for fuel and residential and commercial development continue to contribute to the loss of oak woodlands, though at a much slower rate. The lack of natural regeneration in some oak woodlands has been attributed to many factors including herbivory, acorn predation, competition from annual grasses, and altered fire regimes (Fryer 2007; UC 2007; Sweitzer and Van Vuren 2002).

During the late 1800's a combination of extensive agriculture and an influx of exotic species are thought to have influenced a species conversion from native perennial grasses to that of annual grasses and forbs in a relative short time period (Burcham 1957; Bartolome 1987; Baker 1989; Stromberg et al., 2007). Deep tilling for crop agriculture also eventually eliminated many native grass species and continuous grazing is believed to have promoted native forb dominance. 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.

Intensive year-round grazing by cattle impacted many soils during the late 1800's, resulting in reduced vegetative cover and soil compaction in some areas. Compaction from moderate to heavy grazing or grazing during wet periods may result in reduced water infiltration, and increased surface run-off causing soil erosion (Daniel et al., 2002).

**Fire:** A significant area of this ecological site has burned in the last fifty years, mostly due to arson along travel routes. Blue oak can withstand low-intensity ground fires but is very susceptible to moderate to severe fire (Pavlik et al., 1992). Blue oak is considered a weak sprouter following fire, and sprouting declines with age (McDonald, 1990). Small oaks are more likely to sprout than larger oaks and sprouting is better on moist sites than drier sites (McCreary, 2004). Oak sprouting following fire or cutting has been noted on the deep soils found in this ecological site. Moderate to severe fire kills a significant number of California foothill pine (Howard, 1992), however large trees

can survive fires. Whiteleaf manzanita lacks burls and reproduces primarily by seed (Stuart and Sawyer, 2001) that requires fire to break the hard seed coat. Viable manzanita seed may remain "banked" in the soil from 10 to 40 years (Abrahamson, 2014). Both toyon (*Heteromeles arbutifolia*) and birchleaf mountain mahogany (*Cercocarpus montanus* var *glaber*) are capable of resprouting following fire.

**Disease and Insects:** Some diseases of blue oak damage the heartwood of the trunk and large limbs (McDonald, 1990; Hickman et al., 2011). A white pocket called *Inonotus dryophilus* causes rot in the heartwood of living oaks. 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.

**Drought:** California grasslands experience an annual summer water deficit (Barbour and Major, 1977) as a result of the Mediterranean-influenced climate. This water deficit in combination with periodic drought can lead to changes in grassland species composition and production as a result of prolonged low water availability (Stromberg et al., 2007). Currently species composition and productivity of the annual dominated grassland and understory grasses and forbs vary greatly within and between years and is greatly influenced by the timing and amount of precipitation and the amount of residual dry matter (George et al., 2001a). The most recent drought period, now in its fourth year is unprecedented 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, lowering oak seedling survival (Grünzweig et al., 2008) and lessening overall range production. 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., 2007). Oak leaves may brown and drop prematurely during a drought year and fully recover the following year, potentially affecting the acorn crop, however, prolonged severe drought can result in mortality in oaks, especially on south facing slopes (Harper et al, 1991). Foothill pine has the ability to grow on the droughtiest sites by photosynthesizing during winter and spring and through low transpiration rates (Burns and Honkala (Eds.) 1990).

#### **Climate:**

In California's Mediterranean climate evaporative demand and rainfall are out of synch 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 slow recovery and affect carbon uptake, hindering reproductive processes, leading to a reduction in oak seedling establishment.

The influence of climate change on vegetation has been widely debated. Some climate models indicate that decreasing precipitation and increasing temperature could result in a potential shift in the blue oak type to the north and shrinking of the overall range of the species. This change in range is thought to be a potential result of increasing moisture stress with changing climate (Kueppers, et al., 2005). 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**

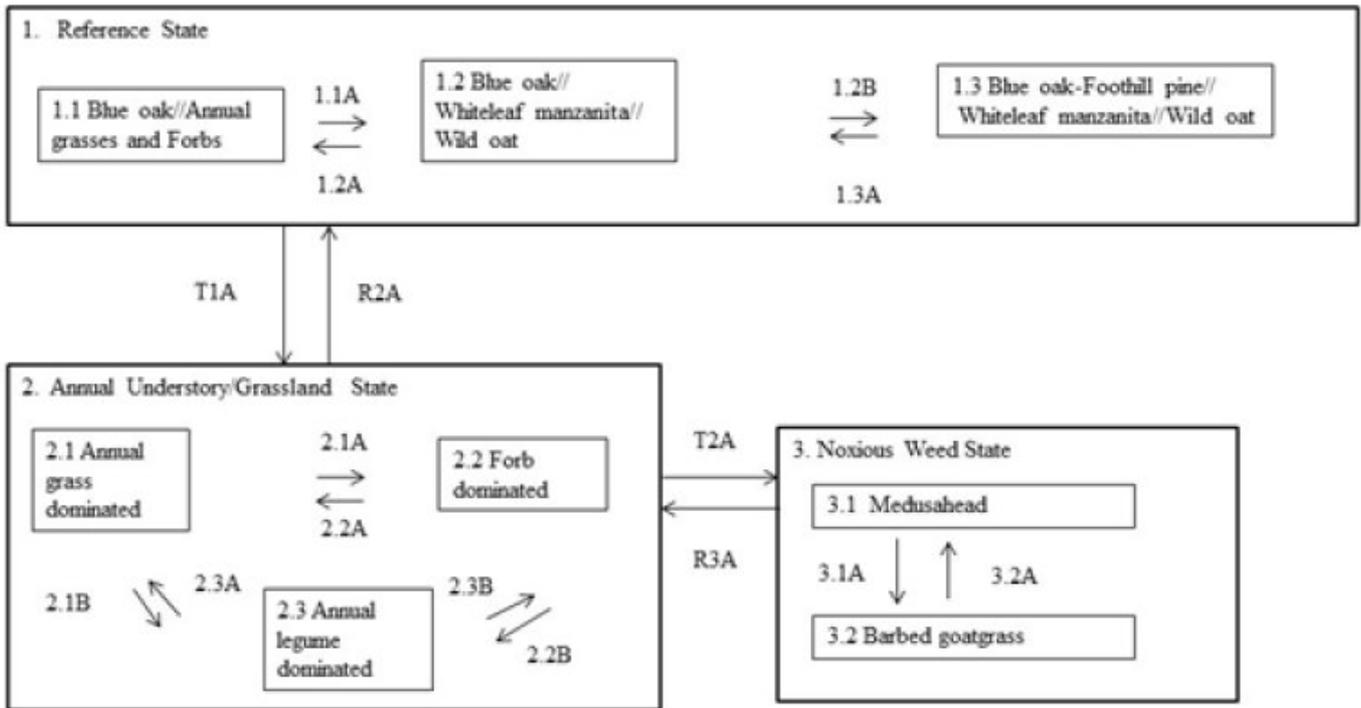


Figure 8. R015XF006CA - Steep Clayey Hills

## State 1 Reference State

The Reference State displays the natural range of variability and ecological potential for this ecological site. States and Community Phases included in this document include those previously recognized by Fire and Resource Assessment Program (FRAP, State of California, 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). The reference state has three community phases: 1) Blue oak//Annual Grasses and Forbs Phase: the lower elevations of this site tend to be grass and blue oak dominated. 2) Blue oak//Birchleaf mountain mahogany//Annual Grasses and Forbs Phase: at mid-elevations this phase is common; with increasing elevation and slope, tree and shrub density increases. 3) Blue oak-Foothill pine//Whiteleaf manzanita//Wild oat: east-facing slopes with favorable moisture conditions support increased biomass. The southern extent of the Dibble soils (Map unit 114) are subject to a marine influence that results in cooler temperatures and moister conditions, creating a cooler phase that supports a mixed oak vegetation community. This cool phase is part of another ESD, Cool Silty Hills. The reference community phase is oak savanna with an understory dominated by non-native annual grasses including wild oat (*Avena fatua*) or slender oat (*Avena barbata*), a low to moderate cover of blue oak (*Quercus douglasii*) and California foothill pine (*Pinus sabiniana*). Most sites have shrub cover that includes whiteleaf amanzanita (*Arctostaphylos manzanita*). Other shrubs found on lower slopes positions include birchleaf mountain mahogany (*Cercocarpus montanus* var *glaber*), and occasionally toyon (*Heteromeles arbutifolia*). Shrub density is low to moderate, with greater cover as elevation increases. This state is relatively stable unless tree removal occurs. Blue oak contributes to soil productivity through increased soil nutrition 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). This recycling of nutrients provides an energy source to microbes, insects and other plants

present on the site, increasing its productivity. As a result, soil and herbaceous vegetation under oak canopies have higher nitrogen and carbon resources than adjacent grasslands and appear to increase rates of soil nitrogen turnover, as well as increased rates of microbial activity (Herman et al, 2003). Soils under oaks retain water into the early summer months as ground temperatures are moderated by shading. Trees increase the soil water holding capacity of savanna soils (Baldocchi et al, 2004). Findings from this study also indicated that oak savannas retain and store more energy than grasslands, due to lower reflectance and surface temperatures. 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 Blue oak - Foothill pine habitat type provides important breeding habitat for a large variety of wildlife and acorns are an important food source for a variety of birds and mammals. Animal communities associated with this reference state are provided with a variety of vegetation stages and habitats. Following secondary succession annual grassland gives way to shrubs in 2-5 years; mature shrubs develop in 10 to 15 years and mature foothill pine 30 to 40 years (Verner, 1988). Most stands of blue oak range from 80 to 100 years of age (Kertis et al., 1993), however, remnant older blue oak specimens may range to over 450 years of age (Stahle et al., 2013) in more remote or steep locations. The lack of oak regeneration and the increase in foothill pine in the understory, are of concern in the long-term existence of this habitat (Mayer and Laudenslayer, 1988).

## Community 1.1

### Blue oak// Annual Grasses and Forbs



Figure 9. Community Phase 1.1 on Dibble Soil. J. Welles, 2013

This community phase is the representative community phase or the phase most represented on the landscape. It is dominated by non-native annual grasses primarily wild oat (*Avena fatua*) or slender oat (*Avena barbata*), with a small amount of soft brome (*Bromus hordeaceus*) and desert fescue (*Vulpia microstachys*). Non-native invasives such as medusahead (*Taeniatherum caput-medusae*) and barbed goatgrass (*Aegilops triuncialis*) are sometimes found in the open patches of grassland intermixed with blue oak. Other forbs and herbs including common yarrow (*Achillea* spp.), stork's bill (*Erodium* spp.), bluedicks (*Dichelostemma capitatum*), and knotted hedgeparsley (*Torilis nodosa*). The overstory is dominated by blue oak. Occasionally a few isolated interior live oak (*Quercus wislizeni*) may be present. This community phase is typically found at the lower elevational range of this ecological site on lower slope positions.

## Community 1.2

### Blue oak//Whiteleaf manzanita//Wild oat



Figure 10. Community Phase 1.2 on Dibble Soil. J.Welles, 201

This community phase predominantly consists of a low to moderate cover of blue oak (*Quercus douglasii*) and low to moderate cover of whiteleaf manzanita (*Arctostaphylos manzanita*) and occasionally birchleaf mountain mahogany (*Cercocarpus montanus* var *glaber*). Annual grasses are dominated by wild oat (*Avena fatua*) or slender oat (*Avena barbata*), soft brome (*Bromus hordeaceus*) and red brome (*Bromus rubens*) and annual forbs include longbeak or red stem stork's bill (*Erodium botrys* or *Erodium cicutarium*). Improved water storage under shrubs and trees makes for plant available water later in the growing season due to decreased evaporation and shading, maintaining water longer (Gill and Burke, 1999). Although more shallow rooted than trees, shrubs may also induce hydraulic lift, transporting water to the upper soil layers (Richards and Cadewell, 1987). Nutrients are concentrated around shrub bases from litter fall and movement of soil particles. The increase in shrub cover causes a reduction in the amount of grass and forb cover as compared to community phase 1.1.

### Community 1.3

#### Blue oak-California foothill pine/Whiteleaf manzanita/Wild oat



Figure 11. Community Phase 1.3 on Dibble Soil. Welles, 2015



Figure 12. Community Phase 1.3 on Skyhigh Soil. J. Welles, 2013



Figure 13. Community Phase 1.3 Landscape, Midground. Welles, 2013

Community phase 1.3 represents the ecological potential and is considered the reference community phase for this site. This phase (1.3) consists of an understory mostly dominated by perennial forbs such as lathyrus' spear (*Triteleia laxa*) and sanicle (*Sanicula* spp.). Other common annual forbs include clover (*Trifolium* spp.), q-tips (*Micropus californicus*), and both spreading and knotted hedgeparsley (*Torilis avensis* and *nodosa*). Spreading hedgeparsley is considered an invasive species. Annual grasses are dominated by wild oat (*Avena fatua*) or slender oat (*Avena barbata*) with lesser amounts of desert fescue (*Vulpia microstachys*). A low to moderate overstory of blue oak (*Quercus douglasii*) averages 20 percent canopy and a low cover of California foothill pine (*Pinus sabiniana*), averages 2 to 10 percent canopy. Whiteleaf manzanita (*Arctostaphylos manzanita*) is a common shrub on the higher elevations of this site. Other shrubs that may be found on the site include birchleaf mountain mahogany and toyon (*Heteromeles arbutifolia*). Small stands of perennial native grasses found in some locations on this ecological site include Sandberg's bluegrass (*Poa secunda*) or blue wildrye (*Elymus glaucus*). California foothill pine is regenerating in the understory and is represented in the seedling and sapling stages. In the absence of fire, foothill pine composition and cover will continue to increase at the expense of blue oak. Reference community phase production: Expected production is highly variable based on unfavorable normal or favorable year. Total production in an 80 percent of normal year ranges from a low of 500 to a high of 1700 pounds per acre. The drought over the last several years has hampered efforts to sample the full range of site conditions.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Forb	323	538	861
Tree	97	242	339
Grass/Grasslike	23	230	322
Shrub/Vine	47	117	140
<b>Total</b>	<b>490</b>	<b>1127</b>	<b>1662</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	0-5%
Biological crusts	0%
Litter	29-59%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	15-60%

**Figure 15. 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 16. 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 17. 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

**Pathway 1.1A  
Community 1.1 to 1.2**



Blue oak// Annual Grasses and Forbs



Blue oak//Whiteleaf manzanita//Wild oat

Whiteleaf manzanita maintains viable seed in the soil for extended periods of time, and primarily regenerates following fire when temperatures crack the hard seed coating (Stuart and Sawyer, 2001); its abundance increases after fire when there is a source of stored seed “banked” in the soil. This shrub species may also establish in shrub openings without fire naturally or via mechanical disturbance (League, 2005, Bonner, 2008). Seed is spread by mammals that consume the fruit or berries of this shrub (Abrahamson, 2014). Scarification or abrasion of the seed

coat allows for moisture intake and aids seed germination. Low grazing pressure and long fire-free intervals allow for establishment of Birchleaf mountain mahogany on the low to mid-elevations of this site. Birchleaf mountain mahogany seed is spread by wind and animals, though a great deal of the seed is not viable.

### Pathway 1.2A Community 1.2 to 1.1



Blue oak//Whiteleaf manzanita//Wild oat



Blue oak// Annual Grasses and Forbs

Grazing and/or browsing or repeated fire in the early stages of brush growth could slow further brush invasion and reduce fuel loads, reducing the seed source needed for brush re-establishment and favoring grasses (Stromberg, 2007). Shrub redevelopment may take 10 to 20 years.

### Pathway 1.2B Community 1.2 to 1.3



Blue oak//Whiteleaf manzanita//Wild oat



Blue oak-California foothill pine//Whiteleaf manzanita//Wild oat

The prolonged absence of fire (20-30 years) triggers a shift in species composition as California foothill pine seedlings become established. Protection from fire and grazing results in a gradual increase in foothill pine and shrubs and contributes to increased ladder fuels and higher fuel loads.

### Pathway 1.3A Community 1.3 to 1.2



Blue oak-California foothill pine//Whiteleaf manzanita//Wild oat



Blue oak//Whiteleaf manzanita//Wild oat

The presence of shrubs and young pine seedlings provide ladder fuels, increasing the potential for severe fire effects to vegetation should a fire occur. Young regeneration of foothill pine is susceptible to fire by virtue of its thin bark (Howard, 1992). California foothill pine is killed by fire and blue oak may sprout. Tree removal or conversion of foothill pine may result in a blue oak dominated community phase.

## State 2 Annual Understory/Grassland State

Today species composition and productivity of the annual dominated understory grasses and forbs vary greatly within and between years and is greatly influenced by the timing and amount of precipitation and the amount of residual dry matter (George et al., 2001a). Residual mulch influences and impacts germination and organic matter (George et al., 1985). Nutrient turnover is rapid in grassland systems and is lost via leaching, gaseous exchange and soil erosion (Stromberg et al., 2007). Much of the nitrate that accumulates during the summer and fall is moved to seeds at senescence and the remainder is removed via rains before growth begins, little is available for later absorption by plants (Stromberg et al., 2007).

## Community 2.1 Annual Grass Dominated



Figure 18. Community Phase 2.1 in foreground. J. Welles, 2013.

Common annual grasses are dominated by wild oat (*Avena fatua*) and slender oat (*Avena barbata*) with lesser amounts of medusahead and barbed goatgrass common in the mixture. Soft brome (*Bromus hordeaceus*) and the forb rose clover (*Trifolium hirtum*) are also present. 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). Mulch also improves soil fertility and increases infiltration as well (Heady, 1956). 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. Medusahead, high in silica, produces a litter buildup that is detrimental to germination of other grasses and forbs.

## Community 2.2 Forb Dominated

Common forb species found are longbeak stork's bill (*Erodium botrys*) and redstem stork's bill (*Erodium cicutarium*). Filaree years occur in low rainfall years or when residual dry matter (Bartolome et al., 2002, George et al., 1985) is low. Drought, heavy grazing and fire may all result in filaree-dominated understory. Often when a dry period follows the first rains, drought tolerant self-burial seed species are favored (Young et al., 1981). Filaree presence may be reduced if rains come early and are followed by severe drought stress (Bartolome, 1979).

## Community 2.3 Legume Dominated

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). Rose clover (*Trifolium hirtum*) or minature lupine (*Lupinus bicolor*) are commonly found in this community phase. Legumes enhance nitrogen availability, but may increase leaching and gopher activity (Eviner and Chapin, 2001).

## Pathway 2.1A Community 2.1 to 2.2

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).

Filaree provides forage early in the growing season but rapidly disintegrates after maturity and often leaves a lot of exposed soil (Pitt and Heady, 1978). Successive droughts could lead to erosion especially after a filaree year.

### **Pathway 2.1B** **Community 2.1 to 2.3**

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).

### **Pathway 2.2A** **Community 2.2 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).

### **Pathway 2.2B** **Community 2.2 to 2.1**

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).

### **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). Litter also 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).

### **Pathway 2.3B** **Community 2.3 to 2.2**

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).

## **State 3** **Noxious Weed State**

The two dominant invasive species that occur in this state include medusahead (*Taeniatherum caput-medusae*) (Cal-IPC List 1A) and barbed goatgrass (*Aegilops triuncialis*) (CFDA B). These plants are commonly found in greater abundance in the lower slope positions due to the clayey nature of the soils; they are also found on backslopes but are not nearly as common. Italian plumeless thistle (*Carduus pycnocephalus*, Cal-IPC list 2C) may also be found in limited populations but is not as extensive as the other above-mentioned species. The California Invasive Plant Council (Cal IPC <http://www.cal-ipc.org/>) maintains an invasive plant inventory that rates invasive plants based on their ecological impacts to native flora and fauna. The California Department of Food and Agriculture (CDFA) also maintain a list of "noxious weeds" that are subject to regulation or quarantine by county agricultural departments. Some experts have suggested that medusahead and other invasive species may gradually adapt to new sites (Rice et al., 2006). These weed species have a potentially high ecological impact on this ecological site. These weed species are active later into the growing season than other non-native forage species and may significantly reduce livestock productivity due to their effect on forage quality and quantity (Eviner et al., 2009; DiTomaso et al., 2006). The slow breakdown of plant litter of both medusahead and goatgrass may shift nutrient cycling dynamics.

## **Community 3.1**

### **Medusahead**

Medusahead can reduce grazing capacity by 75 to 80 percent (Kyser et al., 2014). Due to the clayey nature of the soils on this ecological site, invasion is likely to dominate the lower slope positions. A prolific seeder, most medusahead seed falls near the plant but is also spread via animals and human activity. Medusahead competes successfully with other plants by going to seed in late spring, avoiding competition for remaining soil moisture (Kyser et al., 2014). The plant's high silica content creates a dense litter that ties up nutrient cycling, slows soil warming in spring and prevents seed penetration of other grass species (DiTomaso et al., 2007). Heavy thatch suppresses most other herbaceous species and poses a fire hazard in summer months. Medusahead seeds are adapted to germinate in and under its own litter (DiTomaso et al., 2006). Late maturity of medusahead in relation to other annual grasses and its subsequent requirements for high water-holding capacity clay soils determines its abundance. Medusahead acquire soil nutrients more easily than other grasses, accelerating its growth rate and making soils with high nutrient levels more susceptible to invasion (Kyser et al., 2014).

## **Community 3.2**

### **Barbed goatgrass**



**Figure 19. Barbed goatgrass and medusahead on DibbleSoil. Welles, 2014**

Barbed goatgrass germinates with fall rains but matures later than most other annual grasses (DiTomaso, 2007). Each plant has several seeds; the larger seeds germinate first and the smaller seeds may remain dormant for 2 to 5 years. Shifts to species that grow later in the growing season such as these may affect nitrogen cycling and fluxes, with peak nitrogen cycling occurring later in the season and at different depths with these deep rooted species that have access to water later in the season (Stromberg et al., 2007).

## **Pathway 3.1A**

### **Community 3.1 to 3.2**

Spread of goatgrass occurs with animal movement and handling activities. In a study of goatgrass and other annual grasses such as medusahead, it was found that goatgrass had an advantage over other grasses due to its rapid growth, deep root system and greater average height giving it a competitive advantage for site occupation and the capture of water and nutrients (Peters, 1994). Heavy grazing or high intensity grazing for a short duration appear to increase barbed goatgrass (CDFA, 2015), as animals concentrate on other more desirable forbs and grasses that are present.

## **Pathway 3.2A**

### **Community 3.2 to 3.1**

Medusahead seed had long awns with silica scales (Kyser et al., 2014) that easily attach to animals, clothing, vehicles and machinery, and long distance dispersal has been connected to travel routes.

## **Transition 1A**

### **State 1 to 2**

Triggers that limit blue oak reproduction and/or survival (intensive prolonged grazing) in combination with (fire or mechanical removal and prolonged drought) causing mortality or unfavorable conditions for sprouting result in a Threshold (T1A). 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 interact to affect the amount of damage and mortality response (Swiecki et al., 1997). This ecological site has showed evidence of sprouting following harvest; oaks are likely to sprout following severe fire. Competition from shrubs for moisture and growing space may limit or slow re-establishment of blue oak. Shrub species such as whiteleaf manzanita that have seed stored in the soil have abundant germination following fire (Abrahamson, 2014). Under drought conditions blue oak seedlings may be less adapted, affecting their growth and survival (Grünzweig et al., 2008). One study (McCreary et al., 2006) found sprout survival 19 years following harvest was 28 percent and noted that sprouting ability would be expected to decline with any subsequent harvest. Removal of blue oaks has been found to reduce soil productivity due to decreased soil nutrition from tree litter (Dahlgren et al., 2003), and increase 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).

## **Restoration pathway 2A**

### **State 2 to 1**

Removal of oak trees and subsequent soil erosion may change infiltration and runoff rates making restoration efforts difficult without significant inputs. Restoration might be achieved, especially on the low elevation sites through planting acorns or seedlings and tending young trees using tested methods (McCreary, 2001, McCreary, 2004) and by protecting young oaks from grazing by utilizing fencing (Philips et al., 2007, McCreary 2005). Blue oak saplings take approximately 10 to 30 years to reach a height of about 4.5 feet (Swiecki, 1998). Tree heights greater than 6.5 feet positively affect seedling survival and growth (Philips, et al., 2007) in light to moderate grazing environments.

## **Transition 2A**

### **State 2 to 3**

This state may cross a threshold, especially on the lower footslope positions with a deeper soil profile and higher clay accumulations. Various triggers (disturbances) that reduce the site resilience and lead to an increased potential for medusahead and barbed goatgrass invasion and expansion could include a lack of grazing and an absence of fire. Either of these situations could result in this community phase reaching a threshold (T2A) where it becomes a noxious weed-dominated state. Areas with reduced plant cover and an increase in bare ground provide opportunities for invasion of noxious weeds like barbed goatgrass, and in areas where production potential is moderate to high, lack of grazing sets the stage for eventual medusahead dominance. Soil disturbance from burrowing animals and feral pigs continue to create new opportunities for exotic species invasion. A nearly continuous canopy of medusahead or barbed goatgrass and a build-up of litter will exclude most other herbaceous species.

## **Restoration pathway 3A**

### **State 3 to 2**

Restoration methods include tilling and mowing, herbicides, and planting of desirable species. Planting of both native and introduced perennial grasses and use of herbicides has shown to be one effective method to control invasive species such as medusahead and barbed goatgrass, although there are no known restorations efforts completed on this ecological site. Restoration is expensive to implement and is generally reserved for the most productive sites. Timing of grazing and targeting the treatment to the plant life stage are important factors in the reduction of invasive species (D'Tomaso and Smith, 2009). Multiple years of intense grazing may reduce the amount of seed of invasive annuals such as medusahead. Treatments that result in thatch reduction are critical for medusahead and barbed goatgrass control or restoration. Medusahead density may be controlled through a variety of measures, including grazing, mowing, burning, disking and chemical treatments. Increasing the density of competing grasses or legumes through planting in combination with fertilization could aid in the control of this species (California Rangelands, UCD). Careful timing of prescribed burning is essential for reduction of medusahead dominance since burning following seed dispersal is largely ineffectual (DiTomaso et al., 2005).

Burning for two consecutive years is also recommended for control of barbed goatgrass. Other methods of control for barbed goatgrass include chemical control and mowing before seedhead production (Davy et al., 2008).

## Additional community tables

Table 7. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
<b>Grass/Grasslike</b>					
1	<b>Grasses</b>			139–779	
	wild oat	AVFA	<i>Avena fatua</i>	104–779	5–15
	desert fescue	VUMIM	<i>Vulpia microstachys var. microstachys</i>	0–20	0–1
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	0–15	0–1
<b>Forb</b>					
2	<b>Forbs</b>			189–780	
	Ithuriel's spear	TRLA16	<i>Triteleia laxa</i>	189–561	5–20
	bedstraw	GALIU	<i>Galium</i>	0–96	0–2
	knotted hedgeparsley	TONO	<i>Torilis nodosa</i>	0–53	0–3
	sanicle	SANIC	<i>Sanicula</i>	0–42	0–1
	spreading hedgeparsley	TOAR	<i>Torilis arvensis</i>	0–33	0–1
	clover	TRIFO	<i>Trifolium</i>	0–27	0–1
	spinster's blue eyed Mary	COSPS	<i>Collinsia sparsiflora var. sparsiflora</i>	0–20	0–1
	q-tips	MICA	<i>Micropus californicus</i>	0–12	0–5
<b>Shrub/Vine</b>					
3	<b>Shrub</b>			117–162	
	whiteleaf manzanita	ARMA	<i>Arctostaphylos manzanita</i>	117–155	10–25
	toyon	HEAR5	<i>Heteromeles arbutifolia</i>	0–40	0–3
	birchleaf mountain mahogany	CEMOG	<i>Cercocarpus montanus var. glaber</i>	0–7	0–1
<b>Tree</b>					
4	<b>Trees</b>			136–477	
	blue oak	QUDO	<i>Quercus douglasii</i>	117–283	15–25
	California foothill pine	PISA2	<i>Pinus sabiniana</i>	19–194	2–10

## Animal community

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 120 species of mammals, 147 species of birds and approximately 60 species of amphibians and reptiles (Tietje et al., 2005). Common 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 rabbit population is an important food source for common predators including: bobcat (*Lynx rufus californicus*), coyote (*Canis latrans*) and the Pacific rattlesnake (*Crotalus viridis oregonus*).

Other wildlife species found in oak savannas include several important game animals, such as mule deer (*Odocoileus hemionus*), California quail (*Callipepla californica*), and the "re-introduced" wild turkey (*Meleagris gallopavo*) contribute to California's economy through revenues from recreational hunting (Garrison and Standiford, 1997).

Oak savannas and woodlands may provide essential habitat elements for a variety of wildlife species. Due to the natural mosaic of grassland, shrubs and trees, a variety of micro-habitats are provided, meeting some of the reproductive, foraging and/or cover requirements for wildlife. 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 (Tieje, Vreeland, Siepel and Dockter, 1997).

Community phases 1.2 and 1.3 have the important shrub structure required by many birds. Brush provides wildlife habitat in the form of good hiding and fawning cover for deer and forage and hiding places for birds. Habitat use should be a consideration in management alternatives.

Birds can serve as “focal species” in that their requirements define spatial attributes, habitat characteristics and management regimes for a healthy system (Zack, 2002). Bird species have essential habitat elements that include large oak trees with associated cavities and acorns, snags, shrubs, grasses and forbs, brush piles and water. 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. Many types of eagles, kites, hawks and owls use oak savannas for breeding and the abundance of prey found on the landscape. Important habitat elements include snags, granaries, woody debris, shrubs, and brushpiles (Garrison and Standiford, 1997).

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 a new plant (Perry and Elmore, 2006).

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). 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). Deer, rodents and rabbits browse blue oak and contribute to poor survival of oak natural regeneration.

Shade decrease soil temperatures for seedling establishment and the animals that utilize this site. Birds perch in the trees and contribute to shrub dispersal (Block, 1990). Forage and cover available for birds and other animals on these sites is low to moderate.

### Grazing and Browsing

The annual dominated understory of this ecological site is used by domestic livestock and wildlife throughout the year. The primary limitation for livestock production on this site is lack of water sources during most of the year.

The plant communities on this site are suitable for grazing by all classes of livestock at any season (George, 1993), however, forage quality declines below the nutritional needs of many kinds and classes of livestock during the 6 to 8 month dry season. Matching the nutrient demands of livestock with the nutrients supplied by range forage is a balancing act for a considerable portion of each year (George et al., 2001b). The quality of range forage varies with plant species, season, location, and range improvement practices. Range forage is optimal for livestock growth and production for only a short period of the year. Early in the growing season, forage may be of high nutrient content, but high water content in the forage may result in rapid passage through the rumen and incomplete nutrient extraction (George, 1993). The browse value of common oak woodland species is listed in Sampson and Jespersen (1963).

### 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 rapid 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, once prevalent, has decreased with increased public awareness of poor blue oak regeneration.

## Other products

Native Americans historically used and managed the blue oak 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). 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:

2 Range 417s from 1980-1992

Rapid Carbon Assessment 2001, 3 plots

ES Inventory Plot Data:

1 step point transect, 3 line intercept transects, 3 production (double sampling) plots

## Type locality

Location 1: Yolo County, CA	
Township/Range/Section	T8N R2W S23
UTM zone	N
UTM northing	4264985.64
UTM easting	582002.17
General legal description	Approximately 3/4 mile from State Highway 128

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## Contributors

Judy Welles

## 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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Date	07/28/2015
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

## Indicators

- 1. Number and extent of rills:** No rills were noted on any sites.

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

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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 29 to 59 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:** These soils may be found in association with gullies that are 4 to 6 feet deep at 500 to 1000 foot intervals.

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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.

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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):** Soil surface is clay loam and clay with a medium blocky structure. When these soils are wet they are “plastic” or susceptible to deformation under stress and have a low resistance to disturbance (Virmani, Sarawat and Burford, 1982). This soil also has a high resilience when dry with some ability to recover when disturbed. Slow permeability and steep slopes also make this site susceptible to erosion if disturbed. Slumping was noted on steep slopes. Soil erosion hazard is severe to very severe.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Skyhigh: A--O to 2 inches; brown (10YR 4/3) loam, very dark grayish brown (10YR 3/2) moist, weak very fine and fine granular and subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; (2 to 6 inches thick). SOM: 2-5 percent  
Sleeper: A1--0 to 4 inches; brown (7.5YR 5/2) loam, dark brown (7.5YR 3/2) moist; moderate fine, medium and coarse granular and moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; (4 to 8 inches thick.) SOM: 1-2 percent  
Dibble: A1--0 to 2 inches; pale brown (10YR 6/3) silt loam, olive brown (2.5Y 4/4) moist; weak medium platy structure; very hard, friable, slightly sticky and slightly plastic; (1 to 4 inches thick) SOM: 2-5 percent

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Grass - 21%: Low grass cover on foot slopes increases soil loss from rainfall impact and grass cover helps lower runoff.  
Trees - 21%: The presence of trees intercepts rainfall and stem flow and roots aid water infiltration.  
Shrubs - 10 %: While shrubs aid infiltration, their low cover does not significantly contribute to overall infiltration and runoff.  
Forbs – 48 %: Forbs help infiltration and slow 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):** Platy structure may be mistaken for compaction on this site.

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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: TRLA16>>SANIC>MICA2>RAOR3>TRIFO>TOAR>TONO>COSPS

Sub-dominant: Grass: AVFA>VUMIM>POSE

Trees: QUDO>PISA2

Other: Shrubs: ARMA>>HEAR5>CEMOG

Additional:

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

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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 in a 50-60 percent of normal year ranges from 500 to 1700 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:** Medusahead

Barbed goatgrass

Italian thistle

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17. **Perennial plant reproductive capability:** Minor amounts of native and non-native perennial grasses exist on the site including Melic spp. and Stipa spp.. Typically the native perennial grasses face strong competition from non-native grasses and forbs. Wet years with fall and winter rains tend to favor non-native grasses on well drained deep soils (Stromberg et al., 2007).

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