# Ecological site R015XF004CA
# Shallow Loamy Foothills

Accessed: 05/07/2024

## 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:
This 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 upper and lower Cretaceous sandstone, shale and conglomerate members 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 1,000 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. The Environmental Protection Agency (EPA)

Ecoregion that this ecological site is located in is designated as 6f.

## Classification relationships

This blue oak site may include the following Allen-Diaz Classes: 1) Blue Oak-Grass (Allen Diaz et al., 1989). This site includes the Blue Oak Woodland (BOW) of the California Wildlife Habitat Relationships System (Mayer and Laudenslayer, 1988). The Society for Range Management Cover Type for this site is Blue Oak Woodland (Shiflet (Ed.), 1994). This site includes the *Quercus douglasii* Alliance from The Manual of California Vegetation, (Sawyer et al.,(2nd Ed.), 2009).

## Ecological site concept

This ecological site is found on south and southwest facing foothill backslopes, shoulders and ridges and the soils are dominantly shallow to soft or hard bedrock, creating a root-restricting layer that reduces the water storage capacity within the soil profile. The combination of steep slopes, shallow rooting depth, and low water availability (1 to 3 inches) lower the vegetation community potential on this site. Annual precipitation averages from 19 to 24 inches.

This ecological site is an annual grass and forb dominated blue oak savanna.

## Associated sites

| | |
|---|---|
| R015XF002CA | **Clayey Foothills**<br>This site is found on north-facing slopes and footslopes. Vegetation is dominated by annual forbs and grasses with a blue oak overstory. |
| R015XF003CA | **Very Shallow Loamy Foothills**<br>This site is found on very shallow benches and strath terraces. Vegetation is primarily annual forbs and grasses, often dominated by stork's bill or filaree species. |
| R015XF005CA | **Steep Loamy Foothills**<br>This site is found on moderately deep loamy foothill shoulders and backslopes. Vegetation is blue oak and California foothill pine with a substantial shrub understory. |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | (1) *Quercus douglasii* |
| Shrub | (1) *Ceanothus cuneatus* |
| Herbaceous | (1) *Avena fatua*<br>(2) *Bromus hordeaceus* |

## Physiographic features

This ecological site occurs predominantly on steep and very steeply sloping shoulders, backslopes and ridges (See the Physiographic Diagram below). This site is often found in a "mosaic" with R015XF002CA, Clayey Foothills, R015XF003CA, Very Shallow Loamy Foothills and/or site R015XF005CA, Steep Loamy Foothills. Slopes average from 30 to 55 percent, although the full slope range is from 10 to 75 percent. Elevations are generally from 600 to 1,400 feet, but elevations may range from 300 to 2,200 feet.

Steep south-facing aspects receive more solar radiation during the day; this factor along with 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.

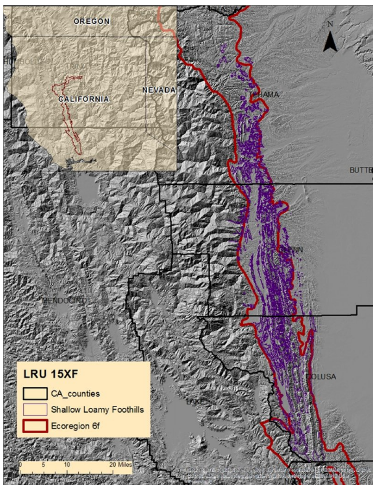


**Figure 2. R015XF004CA - Shallow Loamy Foothills**

**Table 2. Representative physiographic features**

| | |
|---|---|
| Landforms | (1) Ridge<br>(2) Hill |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 183–427 m |
| Slope | 30–55% |
| Aspect | SE, S, SW |

## Climatic features

This ecological site has a Mediterranean climate characterized by hot summer temperatures and cool moist winters. 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).

The mean annual precipitation ranges from 19 to 24 inches and mean annual air temperature is 44 to 74 degrees F. The frost-free period average is 224 days. The freeze-free period average is 279 days.

Two climate stations were utilized for this ecological site: East Park Reservoir and Stony George Reservoir. The northern and southern portions tend to be slightly wetter and cooler than the central area of this site.

**Table 3. Representative climatic features**

| | |
|---|---|
| Frost-free period (average) | 224 days |
| Freeze-free period (average) | 279 days |
| Precipitation total (average) | 610 mm |

## Climate stations used

- (1) EAST PARK RSVR [USC00042640], Stonyford, CA
- (2) STONY GORGE RSVR [USC00048587], Elk Creek, CA

## Influencing water features

Loamy soil texture, shallow soil depth, and low soil cover dramatically affect infiltration and overland flow on this ecological site. The sandstone and shale parent material are often tilted, allowing water to penetrate and pass through the soil profile quickly. This site's landscape position on backslopes and sideslopes that are generally steep (>30 percent slope) contribute to rapid runoff.

## Soil features

The soils typically associated with this ecological site are formed in residuum from Cretaceous sandstone, shale and conglomerate facies of the Great Valley sequence. These soils are shallow to hard bedrock and are well drained. Surface textures are loam, clay loam, very gravelly sandy loam and subsurface textures are loam, clay loam, gravelly loam, and gravelly sandy clay loam. Surface gravels < 3 inches on average range from 5 to 13 percent but as a whole range from 0-35 percent. Surface fragments > 3 inches range from 0 to 5 percent. Subsurface gravels by volume as a whole are variable and may range from 0 to 30 percent; larger fragments by volume range from 0 to 3 percent. Large rock outcrops may be present. 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 1 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).

CA011-Colusa County, California:

280; Skyhigh-Millsholm Complex, 15 to 50 percent slopes; Millsholm
320; Millsholm loam, 5 to 30 percent slopes, Millsholm
330; Millsholm-Contra Costa Complex, 15 to 30 percent slopes; Millsholm
331; Sehorn-Millsholm-Rock outcrop Complex, 30 to 50 percent slopes; Millsholm
334; Millsholm-Contra Costa Association, 30 to 75 percent slopes; Millsholm
337; Millsholm-Salt Canyon Association, 5 to 15 percent slopes; Millsholm
345; Skyhigh-Sleeper-Millsholm Association, 15 to 30 percent slopes; Millsholm
346: Skyhigh-Sleeper-Millsholm Association, 30 to 50 percent slopes; Millsholm
350; Haploxererts, 30 to 50 percent slopes
371; Buttes-Millsholm Complex, 30 to 50 percent slopes; Millsholm

CA021- Glenn County, California:

CvE; Contra Costa-Millsholm clay loam, 30 to 65 percent slopes; Millsholm
MnD; Millsholm clay loam, 10 to 30 percent slopes; Millsholm
MnE; Millsholm clay loam, 30 to 50 percent slopes; Millsholm
MnE2; Millsholm clay loam, 30 to 50 percent slopes, eroded; Millsholm
MngD; Millsholm clay loam, gullied land complex, 10 to 30 percent slopes; Millsholm
MrE; Millsholm rocky sandy loam, 30 to 50 percent slopes; Millsholm
MrE2; Millsholm rocky sandy loam, 30 to 50 percent slopes, eroded; Millsholm
MuE; Millsholm very rocky sandy loam, 30 to 65 percent slopes; Millsholm
MvE; Millsholm soils, 30 to 50 percent slopes; Millsholm
MxE; Millsholm-Contra Costa complex, 30 to 50 percent slopes; Millsholm
SdE; Sehorn-Millsholm association, 30 to 65 percent slopes; Millsholm

CA645- Tehama County, California:

LfE: Lodo-Millsholm complex, 50 to 65 percent slopes: Millsholm
MuE; Millsholm rocky sandy loam, 30 to 50 percent slopes; Millsholm
MuF; Millsholm rocky sandy loam, 50 to 65 percent slopes; Millsholm
MvD: Millsholm-Millsap complex, 10 to 30 percent slope; Millsholm
MvE; Millsholm-Millsap complex, 30 to 50 percent slope; Millsholm
MvF: Millsholm-Millsap complex, 50 to 65 percent slope; Millsholm
SmD; Sehorn-Millsholm complex, 10 to 30 percent slopes: Millsholm

SmE: Sehorn-Millsholm complex, 30 to 50 percent slopes: Millsholm

**Figure 7. Soil profile Millsholm. Welles 2012**

**Table 4. Representative soil features**

| | |
|---|---|
| Parent material | (1) Residuum–sandstone and shale |
| Surface texture | (1) Loam |
| Family particle size | (1) Loamy |
| Drainage class | Well drained |
| Permeability class | Moderate |
| Soil depth | 25–51 cm |
| Surface fragment cover <=3" | 5–13% |
| Surface fragment cover >3" | 0–5% |
| Available water capacity (0-101.6cm) | 2.54–7.62 cm |
| Electrical conductivity (0-101.6cm) | 0–2 mmhos/cm |
| Sodium adsorption ratio (0-101.6cm) | 0–2 |
| Soil reaction (1:1 water) (0-101.6cm) | 6–8 |
| Subsurface fragment volume <=3" (Depth not specified) | 0–30% |
| Subsurface fragment volume >3" (Depth not specified) | 0–3% |

## 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:
The interaction of several disturbance agents including fire, clearing, invasive species, grazing and drought have influenced and shaped the oak savanna 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.

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 decreased with widespread conversion from residential and commercial development. Chaining of oaks occurred during the 1960's in an attempt to increase grassland production, though studies show the growth response was short-lived (less than 10-20 years) and oak representation on some landscapes was altogether eliminated. 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). Firewood cutting for fuelwood continues to contribute to the loss of oak woodlands, though at a much slower rate. The lack of natural regeneration in some oak woodland has been attributed to many factors including herbivory, acorn predation, competition from annual grasses, and altered fire regimes (Fryer 2007; UC 2007; Sweitzer 2002). According to locals familiar with this area, California foothill pine suffered a similar fate to blue oak, and is absent from some areas due to harvesting.

During the late 1800's an influx of exotic species are thought to have influenced a species conversion from native perennials grasses to that of annual grasses and forbs in a relatively short time period (Burcham 1957; Bartolome 1987; Baker 1989; Stromberg et al., 2007). 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). 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 compaction in some areas. 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 (Seibert, 2003). High densities of sheep grazing that occurred during that period reduced litter and plant cover, leaving some areas barren. This was likely due to a higher number of concentrated animals over a longer season. The grazing effects were worsened by burning practices that were more frequent and intense and resulted in permanent soil loss (Tehama County Watershed Assessment, 2010).

Current Influences:

Fire: 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). Most of the extent of this ecological site has not burned in the last century. Moderate grazing may act to reduce fine fuels and lengthen the fire return interval on some sites (Davies et al., 2010). Shrub recruitment has increased in the absence of periodic fire or grazing in some foothill environments (Duncan, 1987), however, on this ecological site natural regeneration of shrubs is largely fire-dependent and the lack of fire has resulted in shrub decadence and low recruitment. Buckbrush and whiteleaf manzanita are obligate seeders, requiring fire for seed germination that is enhanced by scarification and charate (League, 2005; Abrahamson, 2014). Blue oak's sprouting ability varies based on the severity of fire, site, precipitation post-fire and sprouting declines with age (Burns and Honkala 1990; McDonald 1990, Fryer, 2007).

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). 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. The fruit tree leaf roller (Archips argyrospila) can cause significant defoliation and when combined with a multi-year drought may increase oak tree mortality rates (USDA, 2006).

Drought: Though droughts of varying lengths are common occurrences in a Mediterranean ecosystem, the most recent drought period, now in its fourth year, is unparalleled in California's climate record (Griffin and Anchukaitis, 2014). Increased temperature and evaporation will likely have a significant effect on species composition and productivity on this site, favoring more droughty species and lessening overall production.

Climate Change: 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 lead to a drop in ground water levels and eventual tree and shrub mortality (Miller et al., 2010).

The future 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

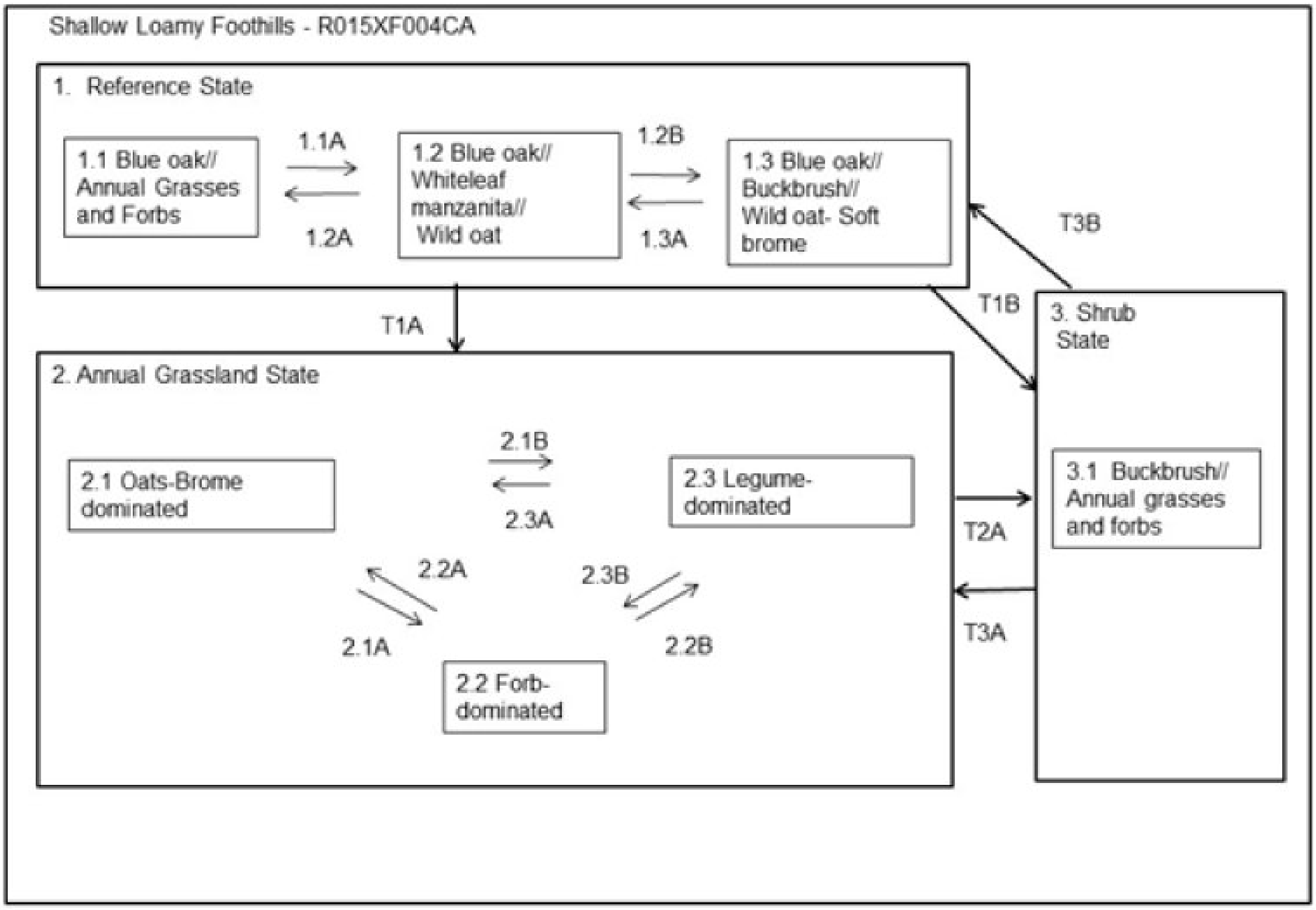


**Figure 8. R015XF004CA - Shallow Loamy Foothills**

## State 1
## Reference State

State 1 is the Reference State that represents the natural range of variability for this ecological site. Periodic drought, grazing and fire exclusion are the most dominant disturbances influencing this site. States and Community Phases included in this document include those previously recognized by Fire Resource Assessment Program (State of California, FRAP, 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 for this ecological site has three community phases; landscape position, slope and aspect influence the vegetation dynamic between the phases. Each Community Phase has a blue oak overstory, however, the drier south and southwest-facing backslopes and ridgetops (Community phase 1.1) are primarily composed of a grass and forb understory, and on the cooler north and east-facing shoulders and backslopes (Community Phases 1.2 and 1.3) shrub cover increases where moisture conditions are more favorable for regeneration and survival. Long fire-free periods have resulted in a shrub component that is often mature and even decadent, with low natural regeneration. While it has been demonstrated that buckbrush and whiteleaf manzanita can regenerate at low levels in the absence of fire (League, 2005; Abrahamson, 2014), long-term fire suppression or exclusion has led to eventual decadence and a decline in shrub abundance. 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). Both buckbrush and whiteleaf manzanita are also very drought tolerant (League, 2005; Abrahamson, 2014). Oaks and annual herbaceous production rely on the organic matter and nitrogen to retain more water on site and they enhance soil quality through nutrient cycling, organic matter deposition and reduced bulk density (Dahlgren et al., 2003). 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 as opposed to just grasses alone (Gill and Burke, 1999). Increased shrub cover slows water runoff rates, improving water storage. 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. As development of the shrub community progresses, inter-shrub native and non-native herbaceous vegetation decreases, and less understory vegetation is remaining. The duration of vegetation successional stages varies greatly, and lacks sufficient research to gain better estimates. It has been estimated by some that it may take at least 50 years (Mayer and Laudenslayer, 1988) for development. Blue oak growth is slow and variable. Most stands of blue oak range from 80 to 100 years of age (Kertis et al., 1993), however, 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. This reference state is relatively stable unless tree removal occurs.

### Community 1.1
### Blue oak//Annual Grasses and Forbs

**Figure 9. Blue oak//Annual grasses and Forbs. J. Welles, 2015**

**Figure 10. Community Phase 1.1 on Millsholm soil. Welles 2012**

This community phase is an annual grass and forb dominated blue oak savanna. Non-native annual grasses including wild oat (*Avena fatua*), soft brome ( *Bromus hordeaceus*), and red brome (*Bromus rubens*) are the dominant grass species and blue oak (*Quercus douglasii*) is the dominant tree species found in this community phase. This phase may have a poor stocking or patchy distribution of blue oak, due to low moisture conditions. Annual herbaceous species that may be present include pincushionplant (Navarretia spp.), dotseed plantain (*Plantago erecta*), bluedicks (*Dichelostemma capitatum*), and redstem or longbeak stork's bill (*Erodium cicutarium* or *Erodium botrys*).

## Community 1.2
## Blue oak//Whiteleaf manzanita//Wild Oat

**Figure 11. Community Phase 1.2 - Blue oak//Whiteleaf manzanita. J. Welles, 2014**

The representative community phase most widely seen on the landscape is an annual grass and forb dominated blue oak savanna, with a sparse whiteleaf manzanita shrub layer. Non-native annual grasses that dominate the understory include wild oat (*Avena fatua*) and poverty brome (*Bromus sterilis*), however, red brome ( *Bromus rubens*), soft brome ( *Bromus hordeaceus*) and bristly dogstail grass ( *Cynosurus echinatus*) may also be present. Annual and perennial forbs and herbs may include straightbeak buttercup (*Ranunculus orthorhynchus*), pincushionplant (Navarretia spp.), knotted hedgeparsley (*Torilis nodosa*), common yarrow ( *Achillea millefolium*), dovefoot geranium (*Geranium molle*) and bedstraw (Galium spp.). In drier years, in some isolated areas, a perennial grass, California melicgrass (Melic californica) can dominate over wild oat by utilizing moisture at greater soil depths. The shrub layer is dominated by whiteleaf manzanita (*Arctostaphylos manzanita*), that averages 2 to 3 percent cover. Occasionally birchleaf mountain mahogany (*Cercocarpus montanus*) may be found as well. Blue oak (*Quercus douglasii*) is the dominant overstory tree species found on this ecological site with canopy cover averaging from 15 to 30 percent. Average production during a 80 percent of normal year was approximately 1,000 lbs./acre.

**Table 5. Annual production by plant type**

| Plant Type | Low (Kg/Hectare) | Representative Value (Kg/Hectare) | High (Kg/Hectare) |
|---|---|---|---|
| Tree | 287 | 382 | 460 |
| Grass/Grasslike | 229 | 381 | 457 |
| Forb | 33 | 323 | 355 |
| Shrub/Vine | 40 | 68 | 82 |
| **Total** | **589** | **1154** | **1354** |

**Table 6. Ground cover**

| | |
|---|---|
| Tree foliar cover | 0-1% |
| Shrub/vine/liana foliar cover | 0-1% |
| Grass/grasslike foliar cover | 0-1% |
| Forb foliar cover | 0-1% |
| Non-vascular plants | 0% |
| Biological crusts | 0-1% |
| Litter | 60-70% |
| Surface fragments >0.25" and <=3" | 0-2% |
| Surface fragments >3" | 0-2% |
| Bedrock | 0-1% |
| Water | 0% |
| Bare ground | 10-20% |

## Community 1.3
## Blue oak//Buckbrush//Wild oat-Soft brome

**Figure 13. Reference Community Phase 1.3 on Millsholm soil. J. Welles, 2014.**

This phase is the reference community phase most commonly found on north and east facing slopes at the higher elevations of this ecological site. This phase is primarily an annual grass and forb dominated blue oak savanna, with a light to moderate shrub understory. Non-native annual grasses and annual forbs that dominate the understory include wild oat (*Avena fatua*) and redstem and/or longbeak stork's bill ( *Erodium botrys* or cicutarium). Other common annual grasses present include soft brome (*Bromus hordeaceus*) and red brome (*Bromus rubens*). Common forbs and herbs include pincushionplant (Navarretia spp.), dotseed plantain (*Plantago erecta*), blue dicks (*Dichelostemma capitatum*), American wild carrot ( *Daucus pusillus*), miniature lupine ( *Lupinus bicolor*), Douglas' fiddleneck (Amsinkia douglasiana), trefoil (Lotus spp.), whiskerbrush (Leptosiphon ciliates) and clover (Trifolium spp.). The shrub layer is dominated by buckbrush (*Ceanothus cuneatus*) with cover averaging from 1 to 5 percent.

Occasionally birchleaf mountain mahogany (*Cercocarpus montanus*) or whiteleaf manzanita (*Arctostaphylos manzanita*) may be found as well. Blue oak (*Quercus douglasii*) is the dominant overstory tree species found on this ecological site with canopy cover averaging from 5 to 15 percent. California foothill pine (*Pinus sabiniana*) may be found at the higher elevations but is sparse or absent over most of this site. Buckbrush regenerates from seed following fire which is required to break the hard seed coat. Increased buckbrush may occur with fire when there is a source of stored seed “banked” in the soil. Very low shrub recruitment occurs without fire. Mechanical disturbance occasionally may scarify seed and facilitate germination. This community phase could be considered "at risk" if tree cover is diminished to a very low level, as natural regeneration of oak is very low and shrub cover could eventually dominate the site. Fire dynamics may change when the grassland continuity is altered with increasing shrub cover (D’Odorioc et al., 2011); shrubs may act as ‘ladder fuels’ allowing fire to spread into the canopy (Arno and Allison-Bunnel, 2002). Fires may increase runoff and erosion from the steep slopes Production estimates for a Unfavorable, RV and Favorable years are approximately 540, 1,100, and 1300 lbs./acre.

**Table 7. Annual production by plant type**

| Plant Type | Low (Kg/Hectare) | Representative Value (Kg/Hectare) | High (Kg/Hectare) |
|---|---|---|---|
| Grass/Grasslike | 428 | 714 | 856 |
| Forb | 31 | 312 | 343 |
| Shrub/Vine | 73 | 122 | 147 |
| Tree | 77 | 103 | 123 |
| **Total** | **609** | **1251** | **1469** |

**Table 8. Ground cover**

| | |
|---|---|
| Tree foliar cover | 0-1% |
| Shrub/vine/liana foliar cover | 0-1% |
| Grass/grasslike foliar cover | 0-1% |
| Forb foliar cover | 0-1% |
| Non-vascular plants | 0% |
| Biological crusts | 1-3% |
| Litter | 55-60% |
| Surface fragments >0.25" and <=3" | 1% |
| Surface fragments >3" | 1% |
| Bedrock | 1% |
| Water | 0% |
| Bare ground | 25-30% |

**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 establish in shrub openings without fire naturally or via mechanical disturbance (League, 2005; Bonner, 2008). Scarification or abrasion of the seed coat allows for moisture intake and aids seed germination. Seed is also spread by mammals that consume the fruit or berries of this shrub (Abrahamson, 2014).

## Pathway 1.2A
## Community 1.2 to 1.1

**Blue oak//Whiteleaf manzanita//Wild Oat**

**Blue oak//Annual Grasses and Forbs**

Whiteleaf manzanita is a "fire recruiter" (Abrahamson, 2014; Keeley, 1992). Lack of fire may result in decadent shrubs with low seed production; without fire to stimulate seed germination, shrub populations would decline. Grazing and trampling by cattle may eliminate or reduce whiteleaf manzanita seedlings, and competition for moisture from grasses reduces early shrub survival rates.

## Pathway 1.2B
## Community 1.2 to 1.3

**Blue oak//Whiteleaf manzanita//Wild Oat**

**Blue oak//Buckbrush//Wild oat-Soft brome**

Buckbrush has a tap root that extends deep into the soil profile (League, 2005). This shrub increases on dry higher elevation sites with a more frequent fire regime.

## Pathway 1.3A
## Community 1.3 to 1.2

**Blue oak//Buckbrush//Wild oat-Soft brome** → **Blue oak//Whiteleaf manzanita//Wild Oat**

Buckbrush seedlings are very susceptible to drought and competition from grasses and forbs (League, 2005). Browsing by deer and seed predation by rodents has been shown to cause a reduction in ceanothus seed production (Deveny and Fox, 2006).

### State 2
### Annual Grassland State

The annual dominated Grassland State is greatly influenced by the timing and amount of precipitation and the amount of residual dry matter (George et al., 2001a). Currently species composition and productivity of the annual-dominated grassland and understory grasses and forbs vary greatly within and between years. 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. There is a higher nutrient loss from annual systems as opposed to shrub-dominated systems (Michaelides et al., 2012) and a higher percentage of “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. Water infiltration may be more rapid in grasslands than in shrub-dominated landscapes.

### Community 2.1
### Oats-Brome dominated

Both wild and slender oats (*Avena fatua* and *Avena barbata*) comprise most of the annual grass species composition with lesser amounts of soft brome and red brome. Some very scattered blue oak or California foothill pine may be found, though they are not common. Wild oat is very successful as an exotic due to its capability for rapid development, early maturity, high production of seed, and staggered germination (USGS, 2003). Red brome is common on south slopes that are dry; it’s shallow root system and intolerance to shade limits its ability to compete with other established plants. Soft brome requires mulch or residue for germination and is commonly found in areas that have not been disturbed from fire or grazing (Howard, 1998). 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, and by leaving more moisture in the soil profile (Heady, 1956).

### Community 2.2
### Forb-dominated

**Figure 18. Filaree dominated plant community on Millsholm Soil. Welles 2013**

This community phase may be dominated by filaree species, also known as longbeak or redstem storksbill (*Erodium botrys* or Erodium circutarium). Annual grasses such as wild oat and soft brome may also be present, though to a lesser degree. 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.

### 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). Clovers (Trifolium spp.) or minature lupine (*Lupinus bicolor*), and trefoil (Lotus spp.) may commonly be found in this community phase.

### Pathway 2.1A
### Community 2.1 to 2.2

Fire and heavy grazing are triggers that can affect post-fire presence of grasses by eliminating mulch needed for good seed germination. A reduction in cover in many instances also increases potential for erosion. 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.

### 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

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). 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 2.3

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). 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.

## State 3
## Shrub State

Conversion, severe fire or poor oak regeneration and senescence of mature oaks are triggers that could lead to a shrub-dominated community. Shrub species such as buckbrush (*Ceanothus cuneatus*) and whiteleaf manzanita require moderate to severe fire to scarify the seed coat and produce abundant regeneration. Small patches of the shrub yerba santa (*Eriodictyon californicum*) may also be present. As development of the shrub community progresses after fire, inter-shrub native and non-native herbaceous vegetation decreases, and less understory vegetation is remaining. 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). 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. As development of the shrub community progresses, inter-shrub native and non-native herbaceous vegetation decreases, and less understory vegetation is remaining.

## Community 3.1
## Buckbrush//Annual Grasses and Forbs

**Figure 19. Community Phase 3.1 on Millsholm soil. Welles, 2015**

**Figure 20. Community Phase 3.1 South slope. Welles, 2015**

Buckbrush (*Ceanothus cuneatus*) is an extremely drought-tolerant shrub. These shrubs may improve local soil fertility immediately surrounding plants through its ability to fix nitrogen (League, 2005). Buckbrush is an obligate seeder whose germination is enhanced by fire, especially when there is a source of stored seed “banked” in the soil. The native shrub yerba santa (*Eriodictyon californicum*) may also be found in this community phase. Buckbrush may also establish in the absence of fire in shrub openings (League, 2005), though the amount of regeneration is limited. Seed casting occurs during summer months, with most seed falling beneath the mature shrub, although some seed may be cast up to 35 feet away (League, 2005). Mechanical disturbance also may also occasionally act to scarify seed and facilitate germination, though to a much lesser degree (Bonner et al., 2008). First year survival of buckbrush seedlings may be very low (League, 2005) due to drought conditions. Following establishment, seedlings 4 to 8 inches in height may have roots that extend greater than 2 feet into the soil (Schultz et al, 1955). Substantial mortality of buckbrush can occur after age 50 (League, 2005) adding fuel loading or ladder fuels to this ecological site.

### Transition T1A
### State 1 to 2

Transition 1A occurs following a trigger such as tree removal or clearing (Type Conversion), moderate or stand-replacing fire. Thinning oaks too heavily on this site can also have negative effects on the amount of natural regeneration, as natural regeneration seldom occurs further away than 100 feet from an existing tree canopy (FRAP, 1998). Additionally, stump sprouting in mature trees is not likely in a low rainfall area. If young seedlings and saplings are not recruited into the next age class as older trees die or before they are removed, oak populations may decline and areas converted to grassland (State 2) (McCreary, 2001). Natural regeneration of oaks is low on this dry site. Research indicates that oak removal results in a decline in soil quality, including a loss in soil organic matter and nitrogen (Dalgren et al., 2003). Potential feedbacks from tree removal are the loss of organic matter, increased erosion and higher soil bulk density (Dalgren, et al., 2003).

### Transition T1B
### State 1 to 3

Loss of blue oak through conversion, moderate to severe fire or poor oak regeneration and senescence of mature oaks could lead to a buckbrush shrub and grass dominated community (State 3). Buckbrush is a nitrogen fixing shrub, giving it a competitive advantage over grasses and forbs (League, 2005). 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.

### Transition 2A
### State 2 to 3

Buckbrush primarily regenerates following fire when temperatures crack the hard seed coating (Stuart and Sawyer, 2001) although it may occasionally become established in shrub openings without fire via mechanical disturbance (League, 2005). If there is stored seed in the soil, fire could stimulate buckbrush seed to germinate.

## Transition 3A
## State 3 to 2

Transition to an Annual Grassland State is triggered when frequent fire return intervals kill new shrub seedlings and eventually deplete the seed bank (League, 2005). In one study (Keeley, 1975) a second burn of young buckbrush caused an occurrence called “shock stagnation”, where buckbrush was completely eliminated, allowing grasses and forbs to dominate. Grazing following fire reduces new seedling vigor and may lower or eliminate seed production prior to the next fire (League, 2005). Brush treatments such as cutting or removal in combination with grazing may also result in buckbrush elimination.

## Additional community tables

**Table 9. Community 1.2 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Kg/Hectare) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Forb** | | | | | |
| 1 | **Forbs** | | | 139–528 | |
| | knotted hedgeparsley | TONO | *Torilis nodosa* | 0–216 | 0–5 |
| | bedstraw | GALIU | *Galium* | 0–202 | 0–2 |
| | yarrow | ACHIL | *Achillea* | 0–43 | 0–1 |
| | pincushionplant | NAVAR | *Navarretia* | 0–17 | 3–5 |
| | western buttercup | RAOC | *Ranunculus occidentalis* | 0–17 | 0–5 |
| | dovefoot geranium | GEMO | *Geranium molle* | 0–17 | 0–1 |
| | clover | TRIFO | *Trifolium* | 0–17 | 0–1 |
| **Grass/Grasslike** | | | | | |
| 2 | **Annual and Native Grasses** | | | 247–1027 | |
| | wild oat | AVFA | *Avena fatua* | 100–1027 | 20–45 |
| | California melicgrass | MECA2 | *Melica californica* | 0–146 | 3–5 |
| | poverty brome | BRST2 | *Bromus sterilis* | 0–136 | 1–5 |
| **Shrub/Vine** | | | | | |
| 3 | **Shrub** | | | 10–126 | |
| | whiteleaf manzanita | ARMA | *Arctostaphylos manzanita* | 10–126 | 2–3 |
| **Tree** | | | | | |
| 4 | **Trees** | | | 124–545 | |
| | blue oak | QUDO | *Quercus douglasii* | 124–545 | 2–25 |
| | California foothill pine | PISA2 | *Pinus sabiniana* | 0–105 | 0–5 |

**Table 10. Community 1.3 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Kg/Hectare) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Forb** | | | | | |
| 1 | **Forbs** | | | 238–389 | |
| | American wild carrot | DAPU3 | *Daucus pusillus* | 0–114 | 0–3 |
| | redstem stork's bill | ERCI6 | *Erodium cicutarium* | 0–105 | 0–1 |
| | bluedicks | DICA14 | *Dichelostemma capitatum* | 0–102 | 0–2 |
| | Douglas' fiddleneck | AMDO | *Amsinckia douglasiana* | 0–102 | 0–1 |
| | miniature lupine | LUBI | *Lupinus bicolor* | 0–65 | 0–1 |
| | pincushionplant | NAVAR | *Navarretia* | 0–47 | 1–2 |
| | longbeak stork's bill | ERBO | *Erodium botrys* | 0–44 | 0–2 |
| | Hoover's desertparsley | LOTU | *Lomatium tuberosum* | 0–36 | 0–2 |
| | trefoil | LOTUS | *Lotus* | 0–36 | 0–2 |
| | clover | TRIFO | *Trifolium* | 0–17 | 1–2 |
| | dotseed plantain | PLER3 | *Plantago erecta* | 0–15 | 0–1 |
| | whiskerbrush | LECI18 | *Leptosiphon ciliatus* | 0–7 | 0–1 |
| **Grass/Grasslike** | | | | | |
| 2 | **Grasses** | | | 452–736 | |
| | wild oat | AVFA | *Avena fatua* | 375–618 | 10–15 |
| | soft brome | BRHO2 | *Bromus hordeaceus* | 36–59 | 1–5 |
| | red brome | BRRU2 | *Bromus rubens* | 40–59 | 1–2 |
| **Shrub/Vine** | | | | | |
| 3 | **Shrubs** | | | 91–122 | |
| | buckbrush | CECU | *Ceanothus cuneatus* | 91–114 | 1–5 |
| | whiteleaf manzanita | ARMA | *Arctostaphylos manzanita* | 0–8 | 0–1 |
| **Tree** | | | | | |
| 4 | **Trees** | | | 58–202 | |
| | blue oak | QUDO | *Quercus douglasii* | 58–202 | 15–35 |
| | California foothill pine | PISA2 | *Pinus sabiniana* | 0–105 | 0–1 |

## Animal community

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 et al., 1997).

Of the 632 terrestrial vertebrates (amphibians, reptiles, birds, and mammals) native to California, over 300 species use oak savannas and 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). A rich rodent and rabbit population is an important food source for common predators including: bobcat (Lynx rufus californicus), coyote (Canis latrans) and the Pacific rattlesnake (Crotalus viridis oreganus).

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

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 (Zack, 2002, Garrison and Standiford, 1997). Community Phases 1.2 and 1.3 provide some of the important habitat elements necessary for birds and deer, including shrubs and large oak trees.

Oak woodlands are important over-wintering environments for large numbers of Neotropical migratory birds such as flycatchers, vireos, and warblers. Oak woodlands also provide important breeding habitat for a variety of birds. Acorn woodpeckers (Melanerpes formicivoris) 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 kites, hawks, eagles and owls use oak savannas for the abundance of prey found on the landscape.

Grazing and Browsing

The main problems for livestock production on this site are steep slopes, sparse understory production and the lack of natural water sources during most of the year. Blue oak shade helps ameliorate hot temperatures for grazing cattle, especially during late spring and summer. Range forage is optimal for livestock growth and production for only a short period of the year.

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). Oak leaves provide an important source of protein and phosphorus in the spring and fall (ucanr.edu). Deer, rodents and rabbits browsing of blue oak contribute to poor regeneration and survival.

## 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 and near developed reservoirs are common recreational pursuits.

## Wood products

Firewood cutting of blue oak, once prevalent, has decreased with increased public awareness of poor blue oak regeneration. Oak regeneration is especially poor on these soils.

## 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). Historically these gathering methods sustained local plant populations and promoted plant diversity.

## Other information

Natural regeneration of blue oaks may be limited on some dry sites and because of a number of factors that limit seed germination, seedling establishment and survival to the tree stage. Competition for soil moisture from the understory annual plants, acorn and seedling damage by rodents, livestock grazing and changed fire regimes are important factors that can reduce blue oak regeneration.

Oak restoration is not likely to be successful on this site. Regeneration studies conducted at the University of California Sierra Foothill Research and Extension Center (SFREC) were successful on similar soils, however, average rainfall is lower on this ecological site (19-22 inches) than in the study area (28 inches), and the supplemental irrigation that would be required (McCreary, 2001) and cost would likely be prohibitive.

McCreary (2001) provides an extensive review of oak regeneration problems and practices on California's oak woodlands. Young oak seedlings are especially susceptible to mortality during the early years. One study indicates blue oak seedlings that reach 10 years of age are more likely to survive compared to newly germinated seedlings (Philips et al., 2007). Protection of saplings from grazing pressure utilizing tree shelters (McCreary and George, 2005) or exclosures (Philips et al., 2007) has been shown to be an effective management technique to aid survival and accelerate growth of young seedlings.

Restoration of Native Grasses: Native grass restoration is subject to a variety of constraints including the persistence of invasive non-native species, plant viruses, and the use of fire and grazing (Stromberg et al., 2007). The use of grazing to restore or maintain native grasses is both controversial and subject to debate; varying grazing intensity has been shown to have mixed results.

Poisonous Plants: There are potentially poisonous plants on this ecological site. Pyrrolizidine alkaloids in fiddleneck (Amsinkia spp.) can cause liver damage in livestock. Acorns and oak leaves taken in excess may be toxic. Livestock poisoning is a result of hungry animals being concentrated on toxic plants (George, 1993).

Plant Preference by Animal Kind: The browse associated with the buckbrush is palatable to deer. The buckbrush shrub provides cover for small birds and mammals including rabbits, quail, mourning doves and mice. It may also provide good cover for deer (League, 2005). Twigs, leaves and seed of buckbrush are eaten by deer, birds and insects. (League, 2005). Whiteleaf manzanita berries are eaten by birds, rodents and deer and black bear (Abrahamson, 2014).

Soils: "Dynamic properties include organic matter, soil structure, infiltration rate, bulk density, and water and nutrient holding capacity" (Soil Quality.Org, 2012). Soil resistance is defined as: "the capacity of a soil to continue to function without change throughout a disturbance" and soil resilience is defined as "the capacity of a soil to recover its functional and structural integrity after a disturbance" (Seybold et al. 1999). "Changes in those properties depend both on land management practices and the inherent properties of the soil" (Soil Quality.Org, 2012).

The soils for this ecological site have a moderate resistance to disturbance with a limited volume (generally shallow depth, 10 to 20 inches) to absorb and buffer compaction.

## Inventory data references

Existing Data:
- 4 Range 417s; Glenn and Colusa Counties
- Woodland Site Blue oak-grass-forb

12 ESI Vegetation Plots with soil pits:

- 6 line intercept transects
- 6 step point traverses
- 6 plots with double sampling production data

## Type locality

| Location 1: Glenn County, CA | |
|---|---|
| Township/Range/Section | TT21N RR6W S32 |
| UTM zone | N |

| | |
|---|---|
| UTM northing | 4387672.13 |
| UTM easting | 537085.73 |
| General legal description | Approximately 2.3 miles from Road 306. |

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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.

| | |
|---|---|
| Author(s)/participant(s) | Judy Welles, Ryan Miebach |
| Contact for lead author | Chico Soil Survey Office, Chico, CA |
| Date | 09/25/2013 |
| Approved by | |
| Approval date | |
| Composition (Indicators 10 and 12) based on | Biomass |

### Indicators

1. **Number and extent of rills:** No rilling has been noted.

2. **Presence of water flow patterns:** Water flow patterns are typically downslope for 200-400 feet.

3. **Number and height of erosional pedestals or terracettes:** None.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 10-20% bare ground

5. **Number of gullies and erosion associated with gullies:** No gullies noted.

6. **Extent of wind scoured, blowouts and/or depositional areas:** None.

7. **Amount of litter movement (describe size and distance expected to travel):** Steep to very steep slope gradient. Not alot of litter movement noted.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil structure is weak and platy in the uppermost 1 inch. Soil is well drained, permeability is moderate, runoff is medium and erosion hazard is moderate.

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)

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Grass is approximately 57 percent, forbs 24 percent, shrubs 7 percent and trees 10 percent.

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

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: Annual Grasses. AVFA>BRDI3>BRHO2>BRRU2
    Forbs: NAVAR>TONO>DAPU3>DICA14

    Sub-dominant: Trees. QUDO>PISA3

    Other: Shrubs. ARMA>CECU3

Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Plant mortality highest in grasses and forbs after May through June drought conditions.

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

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** From Range sites: Low = 500
Moderate = 850
High= 1200

    Total production for an unfavorable, normal and favorable year are 540, 1,100 and 1,300 pounds per acre per year, respectively for data collected in a 80 percent of normal precipitation year.

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.

17. **Perennial plant reproductive capability:** Small stands of California melic or purple needlegrass may be found on this site.