USDA Natural Resources Conservation Service

Ecological site R015XF016CA
Very Shallow Steep Foothills

Accessed: 04/24/2024

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.

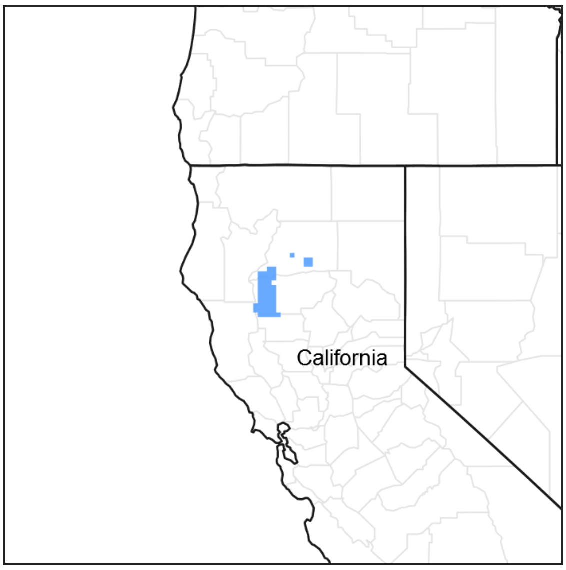

Figure 1. Mapped extent

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): MLRA 15 is an area of gently sloping to steep, low mountains. Precipitation is evenly distributed throughout fall, winter, and spring but is very low in summer. Elevation ranges from sea level to 2,650 feet in most of the area, but up to 4,950 feet in some of the mountains. The soils in the area dominantly have a thermic soil temperature regime, a xeric soil moisture regime, and mixed or smectitic mineralogy.

LRU Description: This Land Resource Unit (designated by “15XF”) includes Blue Ridge in the northern California Coast Ranges and steep hills east of Blue Ridge and east of the Stony Creek fault, extending north to the Klamath Mountains down to the southern portion of Napa and Yolo Counties. The LRU is formed mostly from upper and lower Cretaceous sandstone, shale and conglomerate facies of the Great Valley sequence. This area includes north to south trending foothill slopes and alluvial back valleys. Soil temperature regime is mostly thermic, with some high elevation areas that are mesic, and soil moisture regime is xeric. Common vegetation includes introduced annual grasses and forbs, blue oak, chamise, ceanothus, manzanita and California foothill pine. Elevations generally range from 500 to 2,400 feet. Rainfall levels drop quickly from the mountains to the foothills and valley due to the rain shadow effect. Annual precipitation generally averages from 16 to 40 inches. This ecological site is within LRU 15XF and is located within EPA Ecoregion designated as “6f”.

Classification relationships

This site is predominantly located within M261C, the Northern California Interior Coast Ranges Section, (McNab and others, 2007) of the National Hierarchical Framework of Ecological Units (Cleland and others, 1997), 261Ca, the Western Foothills Subsection. Small portions of the following sections are also included: M261A – Klamath Mountain Section and Section M261F - Sierra Nevada Foothills Section.

Level III and Level IV ecoregions systems (Omernik, 1987, and EPA, 2011) are: Level III, Central California Foothills and Coastal Mountains and Level IV, Ecoregion 6f, Foothill Ridge and Valleys.

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

Ecological site concept

This ecological site is predominately found on south and east facing strath terraces, shale benches and low ridge foothill backslopes at elevations between 900 and 1,700 feet and slopes that average between 20 to 55 percent. Loamy soils are dominantly very shallow to bedrock, creating a root-restricting layer that reduces the water storage capacity within the soil profile. Soils are excessively drained and available water holding capacity is about 1 to 2 inches.

This site concept differs from ecological site R015XF003CA primarily due to the higher elevations and steeper slopes, as well as the higher average precipitation that this site receives in comparison to 003 (19-22 inches vs. 24-33 inches). Although the soils are very similar, the increased precipitation and cooler temperatures due to the higher average elevation ranges and steeper slopes, supports a different suite of species potentials.

Sparse California foothill pine (*Pinus sabiniana*) and blue oak (*Quercus douglasii*) are found on most of this site. Very sparse low shrub cover includes buckbrush (*Ceanothus cuneatus*) and occasionally common manzanita (*Arctostaphylos manzanita*). Non-native annual grasses and perennial and annual forbs are found in the understory. Red stem stork's bill (Erodium circutarium), an annual forb, dominates the forb layer and red brome (*Bromus rubens*) dominates the annual grasses.

Associated sites

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

Similar sites

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

Table 1. Dominant plant species

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

Herbaceous	(1) *Erodium cicutarium*

Physiographic features

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

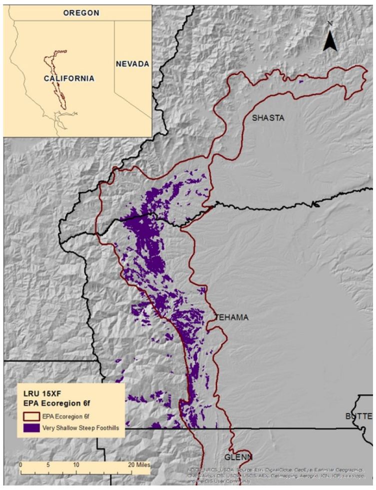

Figure 2. R015XF016CA -Very Shallow, Steep Foothills

Table 2. Representative physiographic features

Landforms	(1) Ridge
Flooding frequency	None
Ponding frequency	None
Elevation	900–1,700 ft
Slope	20–55%
Aspect	E, S, SW

Climatic features

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

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

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

Maximum and minimum monthly climate data for this ESD were generated by the Climate Summarizer (http://www.nm.nrcs.usda.gov/technical/handbooks/nrph/Climate_Summarizer.xls) using data from the following climate stations:

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

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

Table 3. Representative climatic features

Frost-free period (average)	195 days
Freeze-free period (average)	290 days
Precipitation total (average)	29 in

Influencing water features

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

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

Soil features

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

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

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

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

CA607 – Shasta County, California
Lbe: Lodo shaly loam, 10 to 50 percent slopes
LbF3: Lodo shaly loam, 50 to 70 percent slopes, severely eroded

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

Table 4. Representative soil features

Parent material	(1) Residuum–shale
Surface texture	(1) Clay loam (2) Sandy loam

Drainage class	Somewhat excessively drained
Permeability class	Rapid to very rapid
Soil depth	0–10 in
Surface fragment cover <=3"	18%
Surface fragment cover >3"	3%
Available water capacity (0-40in)	1–2 in
Calcium carbonate equivalent (0-40in)	0%
Electrical conductivity (0-40in)	0 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	5.6–7.3
Subsurface fragment volume <=3" (Depth not specified)	0%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

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

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

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

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

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

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

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

Current Influences:

Fire: Several large fires burned through the landscape of this ecological site in the 1940s through the 1970s. The Skinner Mill fire in 1976, had significant impacts on soil erosion and associated soil productivity (DWR, 1992). Many of these fires were either a result of human-caused ignition or equipment use (Tehama County Resource Conservation District, 2006). Active fire suppression during the last century has allowed for the accumulation of fuels and a trend towards larger more devastating fires (McCleary 2004, Arno and Allison-Bunnell, 2002). Fire suppression during the last 100 years has influenced and shaped the environment of this ecological site. Pine is increasing in blue oak-California foothill pine communities, contributing to a lack of blue oak regeneration and adding to ladder fuels. There is an increase of chaparral shrubs invading grassy understories of blue oak-California foothill pine woodlands, with a rise in shrub recruitment in the absence of periodic fire or grazing in some foothill environments (Powers, 1990).

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

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

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

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

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

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

State and transition model

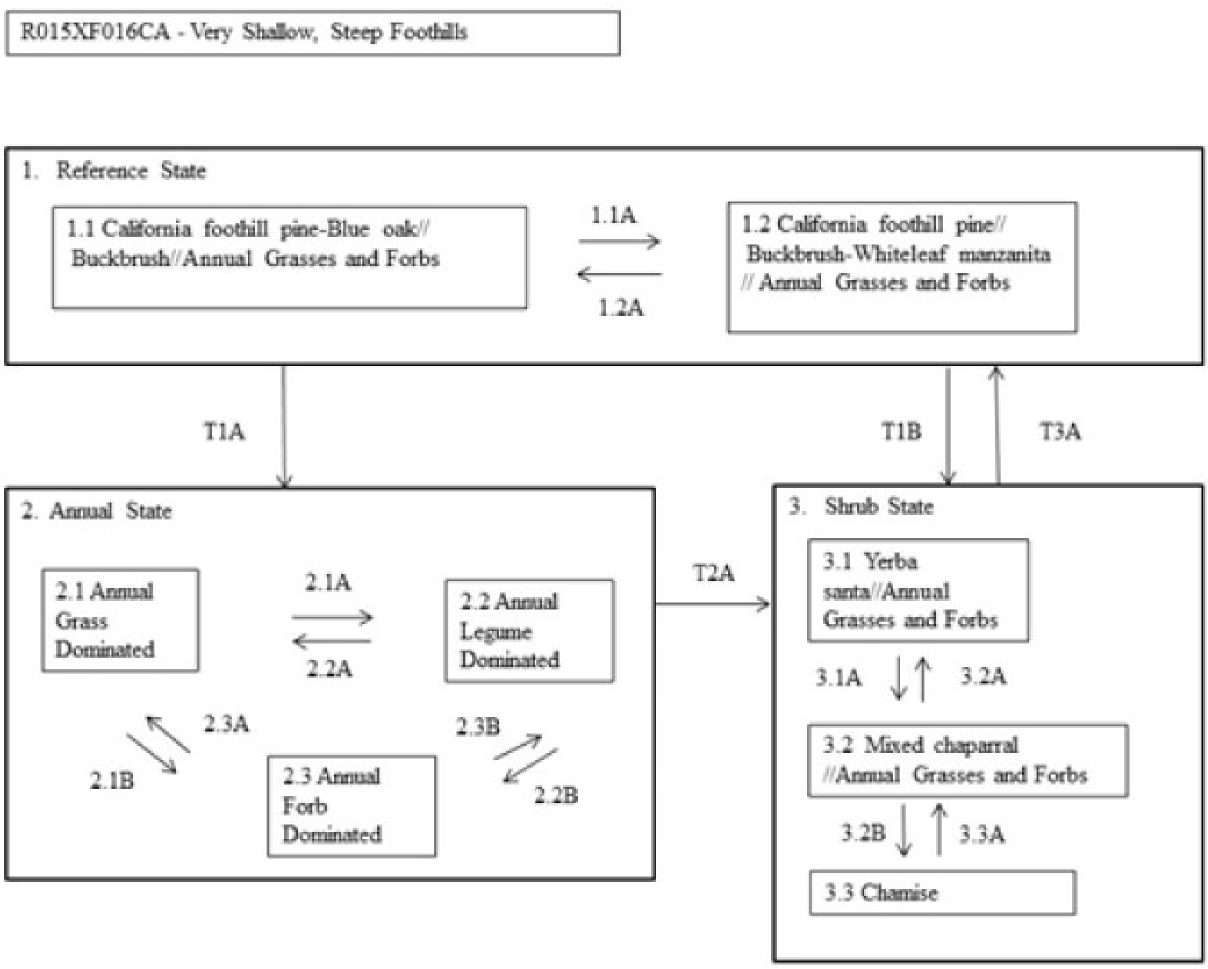

Figure 7. R015XF016CA - Very Shallow, Steep Foothills

State 1
Reference State

State 1 is the Reference State that represents the natural range of variability for this ecological site. States and Community Phases included in this document include those previously recognized by Fire Resource Assessment Program (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, Sawyer et al., 2009, Vayssieres and Plant, 1998 and George et al., 1993). Drought, fire, and grazing are the primary drivers of the natural disturbance regime. The reference state for this ecological site has two community phases, with elevation, slope, aspect and past disturbance influencing the vegetation dynamic between the phases. Community Phase 1.1, the Representative Community Phase, has blue oak and California foothill pine with a sparse shrub understory, and Community Phase 1.2 is dominated by California foothill pine and a buckbrush understory. Blue oak is rarely present. Shrub cover most commonly includes buckbrush (*Ceanothus cuneatus*) but some areas also include hollyleaf redberry (*Rhamnus ilicifolia*) and whiteleaf manzanita (*Arctostaphylos manzanita*). Non-native annual grasses and perennial and annual forbs are generally a moderate component of the understory. Red brome (*Bromus rubens*) commonly dominates the annual understory grasses. A variety of annual forbs and herbs are also present, dominantly redstem stork's bill (*Erodium cicutarium*). This state is relatively stable unless tree removal occurs. Blue oak contributes to soil productivity through increased soil nutrition and health under trees, and removal of trees causes changes to soil cover, water and nutrient status. Research indicates that oak removal results in a rapid decline in soil quality, including a loss in soil organic matter and nitrogen (Dalgren et al., 2003). Oaks help retain more water on site and enhance soil quality through nutrient cycling, organic matter deposition and reduced bulk density (O'Geen et al., 2010). Some deeply rooted trees and shrubs may also induce hydraulic lift, transporting water to the upper soil layers (Richards and Cadewell, 1987, Caldwell et al., 1998, Ishikawa and Bledsoe, 2000, Liste and White, 2008), supporting the development of neighboring plants. Nutrients are also concentrated around shrub bases from litter fall and from sediment capture via movement of soil particles. As community phases change over time within the Reference State, shrubs and trees become a greater component of the community. Fire regimes may shift from low intensity fires towards more mixed severity and replacement fires due to the presence of ladder fuels and several missed fire cycles. Fuel load, season of burn, fire frequency and duration all interact to affect the amount of damage and mortality response (Swiecki et al., 1997, Neary et al., 1999). The duration of vegetation successional stages varies greatly, and lacks sufficient research to gain better estimates. Annual grasslands give way to shrubs within 2 to 5 years with mature shrub development taking approximately 10 to 15 years (Mayer and Laudenslayer, 1988). Some research estimates that for this ecological site and other similar ecological sites, conifers may take 30 to 40 years to develop, and blue oak may take at least 50 years (Mayer and Laudenslayer, 1988). Blue oak growth is slow and variable. Most stands of blue oak range from 80 to 100 years of age (Kertis et al., 1993) 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. California foothill pine may range to over 200 years in age (Howard, 1992). The California foothill pine - blue oak type provides important breeding and foraging habitat during winter and spring and a vital food source for birds and mammals.

Community 1.1
Blue oak-California foothill pine//Buckbrush//Annual Grasses and Forbs

Figure 8. Community Phase 1.1 Landscape (LbE). J. Welles, 2015

Figure 9. Community Phase 1.1 on Lodo (LbE). J. Welles, 2015

The Representative Community Phase has California foothill pine and blue oak in the overstory, with predominantly buckbrush in the shrub layer, but also lesser amounts of whiteleaf manzanita, hollyleaf redberry, and occasionally the shrub form of interior live oak (Quercus wislenzii var frutencens) or yerba santa (*Eriodictyon californicum*). On some north facing slopes, birchleaf mountain mahogany (*Cercocarpus montanus*) may also be present. Annual forbs are dominanted by redstem stork's bill (*Erodium cicutarium*), but also include dotseed plantain (*Plantago erecta*), trefoil (Lotus spp.), q-tips (*Micropus californicus*), chia (*Salvia columbariae*), whiskerbrush (*Leptosiphon ciliatus*), narrowleaf cottonrose (*Logfia gallica*) and other forbs that may be present in minor amounts include naked buckwheat (*Eriogonum nudum*) and dove weed (Croton setigeris). Perennial forbs include blue dicks (*Dichelostemma capitatum*). Non-native annual grasses include red brome, desert fescue (*Vulpia microstachys* var microstachys) and wild oat. Rarely very small populations of perennial native grasses may include Sandburgs bluegrass (*Poa secunda*). Buckbrush regenerates from seed following fire which is required to break the hard seed coat. An extremely drought tolerant shrub, increased buckbrush may occur following fire when there is a source of stored seed "banked" in the soil. Mechanical disturbance occasionally may scarify seed and facilitate germination (Bonner, 2008). The roots of brush seedlings penetrate more deeply into the soil than their herbaceous competitors. As development of the shrub community progresses after fire, native and non-native herbaceous vegetation decreases, and less understory vegetation is remaining. This community phase could be considered "at risk" if tree cover of blue oak is diminished to a very low level; continued fire suppression acts to increase levels of foothill pine over blue oak. Natural regeneration of oak is very low and shrub and grass cover dominate the site. Fire dynamics change when the grassland continuity is altered (D'Odorioc et al., 2012). Shrubs may act as 'ladder fuels' allowing fire to spread into the canopy (Arno and Allison-Bunnel, 2002). Community phase production: Expected production is highly variable based on unfavorable normal or favorable year. The drought over the last several years has hampered efforts to sample the full range of site conditions however, rains in the fall of 2016 and winter of 2016 were regular and resulted in a normal to slightly higher productivity. Annual production in pounds per acre during an unfavorable, average and favorable year are 350, 805 and 1,140.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Forb	130	325	460
Tree	80	200	280
Grass/Grasslike	100	170	270
Shrub/Vine	40	110	130
Total	**350**	**805**	**1140**

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	0-15%
Biological crusts	0%
Litter	10-27%
Surface fragments >0.25" and <=3"	0-1%
Surface fragments >3"	0%
Bedrock	0-1%
Water	0%
Bare ground	70-85%

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

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

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

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

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

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

Community 1.2
California foothill pine//Buckbrush-Whiteleaf manzanita//Annual Grasses and Forbs

Figure 14. Community Phase 1.2 on LdE2 in midground. J. Welles, 2016

Community phase 1.2 has California foothill pine with buckbrush, scrub interior live oak and whiteleaf manzanita in the shrub layer, and occasionally, hollyleaf redberry (Rhamnus illicifolia) or yerba santa (*Eriodictyon californicum*). Isolated blue oak may be present on some sites, though rare. Buckbrush regenerates from seed following fire which is required to break the hard seed coat. An extremely drought tolerant shrub, increased buckbrush may occur following fire when there is a source of stored seed "banked" in the soil. Mechanical disturbance occasionally may scarify seed and facilitate germination (Bonner, 2008). Annual forbs are dominated by redstem stork's bill (*Erodium cicutarium*), dotseed plantain (*Plantago erecta*), q-tips (*Micropus californicus*), and bluedicks (*Dichelostemma capitatum*) and non-native annual grasses include red brome (*Bromus rubens*) or compact brome (*Bromus madritensis*). Other forbs that may be present in minor amounts include naked buckwheat (*Eriogonum nudum*), and dove weed (Croton setigeris).

Pathway 1.1A
Community 1.1 to 1.2

Blue oak-California foothill pine//Buckbrush//Annual Grasses and Forbs

California foothill pine//Buckbrush-Whiteleaf manzanita//Annual Grasses and Forbs

Oak removal or severe fire in combination with prolonged drought may cause mortality or unfavorable conditions for oak sprouting, resulting in a loss of blue oak on this site. Intensive grazing and frequent fire are not likely to favor blue oak recruitment (Swiecki and Bernhardt, 1993). Grazing following fire also reduces new seedling vigor and may lower or eliminate seed production prior to the next fire (League, 2005).

Pathway 1.2A
Community 1.2 to 1.1

California foothill pine//Buckbrush-Whiteleaf manzanita//Annual Grasses and Forbs

Blue oak-California foothill pine//Buckbrush//Annual Grasses and Forbs

Favorable climate conditions for blue oak regeneration could result in oak establishment if a seed source remains in the area. Ground squirrels may transport and cache acorns over large distances. A reduction or elimination of grazing activity would help protect any blue oak that become established.

State 2
Annual State

Non-native grasses and forbs 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. Very low production and low vegetative cover, result in high amounts of exposed soil in this State. This very shallow exposed soil dries out quickly and is subjected to a high degree of erosion, especially on steep slopes. 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 that study. Nutrient turnover is rapid in grassland systems and is lost via leaching, gaseous exchange and soil erosion (Stromberg et al., 2007); most of the nitrate that accumulates during the summer and fall is moved to seeds at senescence and the remainder is removed via rains prior to initiation of growth, little is available for later absorption by growing plants. Although nutrient leaching from grassland systems is variable, nutrients that are moved beyond the shallow root systems of the annual grasses are lost to leaching. Annuals use available water primarily in the top 1 foot of soil (George et al., 2001); their shallow root structures dry out quickly during rapid spring growth and evapotranspiration quickly depletes soil moisture.

Community 2.1
Annual Grass Dominated

This is considered a provisional community, and no data has been collected for this phase. Red brome comprises most of the annual grass species composition. Soft brome and desert fescue may also be present. Red brome has a shallow root system and is shade intolerant, making it an effective competitor on shallow soils. This invasive non-native annual is prolific seeder, but has a low seedling survival rate (Wu and Jain, 1979). Burning and grazing may increase the amount of red brome as it is adapted to and competitive in disturbed areas. Sufficient litter or residue is required for good germination of grass species (Young et al., 1981) and leaving greater amounts may favor grass dominance (George et al., 1985). Minimum residual dry matter (RDM) guidelines for dry annual grassland suggest retention of 300 to 600 pounds per acre, with greater retention as slope increases (Bartolome et al., 2002) to provide for soil and nutrient retention. This site has very low litter and thus germination of many grass seeds is hindered. Grasses have positive effects on soils by enhancing water percolation, aeration and carbon storage (Eviner and Chapin, 2001).

Community 2.2
Annual Legume Dominated

Community Phase 2.2 is considered a provisional community, and no data has been collected for this phase. 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). Minature lupine (*Lupinus bicolor*) are commonly found in this community phase.

Community 2.3
Annual Forb Dominated

Community Phase is considered a provisional community, and no data has been collected for this phase. This community phase may be dominated by “filaree”, either *Erodium botrys* or Erodium circutarium, more commonly known as stork’s bill and redstem stork's bill. Non-native annual grasses such as wild oats and soft brome may also be present. Filaree provides forage early in the growing season but rapidly disintegrates after maturity (Pitt and Heady, 1978). Filaree is an exotic forb that has become naturalized in California, but provides good early forage for livestock (Howard, 1992). Filaree seed dispersal mechanisms include the ability to drill into the ground or to disperse up to a half meter away via the twisting awns serve to enhance its invasive capacity (Evangilista, Hotton and Dumais, 2011). In one study, nitrogen and phosphorus availability was found to be low in filaree dominated areas (Eviner and Chapin, 2001). The taprooted filaree contributes to a very low and low soil surface and subsurface cohesion or structure, presumably due to a lack of a root mat (Eviner and Chapin, 2001).

Pathway 2.1A
Community 2.1 to 2.2

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

Pathway 2.1B
Community 2.1 to 2.3

Filaree years are triggered in low rainfall years or when residual dry matter (Bartolome et al., 2002, George et al, 1985) is low. Often when a dry period follows the first rains, drought-tolerant self-burial seed species, like filaree, are favored (Young et al., 1981) and the deep taproot of filaree supplies water to the plant (Pitt and Heady 1978). Filaree presence may be reduced if rains come early and are followed by severe drought stress (Bartolome, 1979). 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 2.2A

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). Litter is extremely low on this ecological site, and production low, making the retention of sufficient litter difficult. Retention of 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).

Pathway 2.2B
Community 2.2 to 2.3

Filaree years are triggered in low rainfall years or when residual dry matter (Bartolome et al., 2002, George et al., 1985) is low. Often when a dry period follows the first rains, drought-tolerant self-burial seed species, like filaree, are favored (Young et al., 1981) and the deep taproot of filaree supplies water to the plant (Pitt and Heady 1978). Filaree presence may be reduced if rains come early and are followed by severe drought stress (Bartolome, 1979). Filaree 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. Increases in runoff and soil erosion from low residual dry matter may act as a feedback that reduces available water and increases the amount of exposed ground (Briske et al., 2006).

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

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

State 3
Shrub State

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

Community 3.1
Yerba santa//Annual Grasses and Forbs

Figure 15. Community Phase 3.1 Yerba santa (LbE). J. Welles, 2013

Community Phase 3.1 is considered a provisional community, and no data has been collected for this phase. Yerba santa (*Eriodictyon californicum*), a native shrub is both a residual colonizer and a survivor in disturbed communities, establishing either from seed or by sprouting from rhizomes (Howard, 1992). This shrub may become dominant on some rangelands, especially in areas converted from brushland to grassland (Howard, 1992). This species forms a soil seed bank that may last for decades, and germinates following disturbance that scarifies the seed surface. This phase may last up to 10 years as it is sensitive to competition and may endure in areas with repeated fire (Sawyer et al., 2009).

Community 3.2
Mixed Chaparral//Annual Grasses and Forbs

Figure 16. Mixed Chaparral/Annual Grasses and Forbs (LdE2). J. Welles, 2015

Buckbrush (*Ceanothus cuneatus*) and whiteleaf manzanita are the most common species found in this state. Shrub "sprouters" that may be found in combination with these species include scrub oak, scrub interior live oak (Quercus wislenzii var frutenscens) and birchleaf mountain mahogany. Whiteleaf manzanita and buckbrush are extremely drought-tolerant shrubs whose germination is commonly dependent on fire. Increased shrubs may occur with moderate to severe fire when there is a source of stored seed "banked" in the soil. First year survival of buckbrush seedlings may be very low (League, 2005) due to drought conditions. Seedlings 4 to 8 inches in height may have roots that extend greater than 2 feet into the soil (Schultz et al., 1955). Mechanical disturbance also may also occasionally act to scarify seed and facilitate germination, though to a much lesser degree (Bonner et al., 2008). These shrubs fix nitrogen and may also improve local soil fertility immediately surrounding plants (League, 2005).

Community 3.3

Chamise

Figure 17. Community Phase 3.3 on Lodo (LdE2). J. Welles, 2016

The chamise community phase 3.3 may be found in disturbed areas. These areas provide an ideal substrate for establishment of chamise seedlings should an adjacent seed source in present. Feral pigs may contribute to seed dispersement and establishment via rooting behavior and their use of shrub areas as bedding and resting areas.

Pathway 3.1A
Community 3.1 to 3.2

Yerba santa//Annual Grasses and Forbs

Mixed Chaparral//Annual Grasses and Forbs

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

Pathway 3.2A
Community 3.2 to 3.1

Mixed Chaparral//Annual Grasses and Forbs

Yerba santa//Annual Grasses and Forbs

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

Pathway 3.3A
Community 3.3 to 3.2

Chamise

Mixed Chaparral//Annual Grasses and Forbs

Community pathway 3.3A may occur with repeated fire or mechanical treatments that remove chamise and it there is a shrub seed source "banked" in the soil. Season of burning, fire intensity and fire frequency are important determinants in mortality of chamise. Late spring and summer fires may sustain greater mortality as plants may have utilized most of the starch reserves in the lignotuber (McMurray, 1990). Repeated fire kills many young chamise plants that are susceptible to fire due their small lignotubers. Frequent fire intervals may completely eliminate new chamise seedlings and if the sufficient seed is not present in the soil (McMurray, 1990).

Transition T1A
State 1 to 2

Loss of blue oak and foothill pine could result in a Community Phase 1.1 transition to grassland. Indicators of a change in structure and function on this site would include a lack of reproduction in shrubs and trees and a reduction in cover. Triggers such as severe fire, mechanical removal and intensive prolonged grazing or prolonged drought may result in the community reaching a Threshold (T1A) causing tree mortality or unfavorable conditions for sprouting. Drought conditions may also affect blue oak seedlings, affecting their growth and survival (Grünzweig et al., 2008). Intensive grazing and frequent fire are not likely to favor blue oak recruitment (Swiecki and Bernhardt, 1993). 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 (McCreary, 2001). Frequent fire return intervals kill new shrub seedlings and may eventually deplete the shrub seed bank (League, 2005). Grazing following fire also reduces new seedling vigor and may lower or eliminate seed production prior to the next fire (League, 2005). Mechanical treatments such as cutting or removal in combination with grazing may also achieve this result. Removal of blue oaks has been found to reduce soil productivity due to decreased soil nutrition from tree litter (Dalgren et al., 2003) and increase the potential for erosion due to a decline in soil porosity and increased bulk density from organic matter losses (Dalgren 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). Insect predators and high temperatures resulted in significant buckbrush seed mortality and reduction of the seedbank in one study (O’Neil and Parker, 2005). Seed of buckbrush is also highly preferred by small mammals (League, 2005).

Transition T1B
State 1 to 3

Removal of tree cover via conversion or severe fire, in combination with prolonged drought are triggers that causes mortality or unfavorable conditions for oak sprouting. 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. A moderate to severe fire that kills blue oak and California foothill pine is a trigger that could result in reaching a Threshold (T1B) causing an irreversible transition to Shrub State. Fire stimulates buckbrush seed to germinate by scarifying the seed “banked” in the soil (League, 2005). While buckbrush may have very limited natural regeneration without fire, fire-stimulated regeneration is more abundant. The “feedback” of sediment transport of fines from grasslands to shrub lands may eventually contribute to limited expansion of shrub communities (Briske et al., 2006). Low levels of browsing or complete protection from herbivory would also favor shrubs. Shrub species have several mechanisms for regenerating post-fire via sprouting or through seed. Shrub species such as buckbrush (*Ceanothus cuneatus*) and whiteleaf manzanita that have seed stored in the soil have abundant germination following fire (Abrahamson, 2014, League, 2005). Hollyleaf redberry (*Rhamnus ilicifolia*) reproduces via seed also. Birchleaf mountain mahogany (*Cercocarpus montanus* var glaber) sprouts from the root crown following cutting or fire. Moderate to severe fire can result in a loss of nutrients and microbial processes and lead to accelerated erosion and leaching; high heat transfer to soils may give rise to a loss of soil organisms, destroy tree and shrub roots, and lead to changes in physical soil properties resulting in reduced water infiltration and increased surface runoff (Neary et al., 1999). In some cases severe fire heating may create a water repellant layer lasting from one year to several years (DeBano, 2000), and the resulting increases in raindrop splash and rill formation can dramatically increase erosion rates. Early post-fire plant communities commonly have a native shrub, California yerba santa (*Eriodictyon californicum*), that reproduces via rhizomes as a component. This shrub slowly diminishes in abundance as the plant community progresses.

Transition T2A
State 2 to 3

Browsing pressure is low and the protection from or elimination of grazing may allow brush to expand into grasslands over a period of time (Freudenburger et al., 1987). The “feedback” of sediment transport of fines from grasslands to shrub lands may eventually contribute to limited expansion of shrub communities (Briske et al., 2006). Moderate to severe fire is the trigger that stimulates buckbrush (and other shrubs) seed to germinate by scarifying the seed “banked” in the soil (League, 2005). While buckbrush may have very limited natural regeneration without fire, fire-stimulated regeneration is more abundant; historic photos of the area indicate that shrub patches were previously of greater extent with more frequent fire than under current conditions. The seed of other shrub species may be transported via birds or mammals. Though expansion of shrubs into grassland is limited, disturbance creates the opportunity when a seed source is present.

Transition T3A
State 3 to 1

The prolonged absence of fire (>20-30 years) causes a shift in species composition as scattered blue oak and /or California foothill pine seedlings become established (Duncan et al., 1987). Protection from fire and grazing results in a gradual increase in trees and shrubs and contributes to increased ladder fuels and higher fuel loads. Seeds are spread by animals, gravity and water (Howard, 1992). Shrub canopies may facilitate oak re-establishment by providing protective canopy from herbivores (Stromberg et al., 2007) and by providing shade. Birds may also disperse acorns in shrub areas.

Additional community tables

Table 7. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Annual grasses**			130–205	
	red brome	BRRU2	*Bromus rubens*	120–150	1–5
	wild oat	AVFA	*Avena fatua*	20–30	1–2
	desert fescue	VUMIM	*Vulpia microstachys var. microstachys*	2–7	1–2
	soft brome	BRHO2	*Bromus hordeaceus*	2–5	1–2
2	**Perennial grasses**			2–5	
	Sandberg bluegrass	POSE	*Poa secunda*	2–5	1–2
Forb					
3	**Annual forbs**			120–510	
	redstem stork's bill	ERCI6	*Erodium cicutarium*	150–460	5–20
	narrowleaf cottonrose	LOGA2	*Logfia gallica*	5–10	2–3
	dotseed plantain	PLER3	*Plantago erecta*	5–10	1–3
	q-tips	MICAC2	*Micropus californicus var. californicus*	5–10	1–2
	chia	SACO6	*Salvia columbariae*	2–5	1–3
	agoseris	AGOSE	*Agoseris*	1–5	1–2
	trefoil	LOTUS	*Lotus*	1–3	1–2
	whiskerbrush	LECI18	*Leptosiphon ciliatus*	2–3	1–2
4	**Perennial forbs**			10–20	
	bluedicks	DICA14	*Dichelostemma capitatum*	10–20	2–3
Shrub/Vine					
5	**Shrubs**			45–165	
	buckbrush	CECU	*Ceanothus cuneatus*	40–95	3–7
	interior live oak	QUWIF	*Quercus wislizeni var. frutescens*	0–20	0–3
	whiteleaf manzanita	ARMA	*Arctostaphylos manzanita*	5–15	1–5
	birchleaf mountain mahogany	CEMOG	*Cercocarpus montanus var. glaber*	3–5	1–3
	hollyleaf redberry	RHIL	*Rhamnus ilicifolia*	1–2	1–2
Tree					
6	**Trees**			180–330	
	blue oak	QUDO	*Quercus douglasii*	170–250	1–4
	California foothill pine	PISA2	*Pinus sabiniana*	20–40	1–5

Table 8. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
California foothill pine	PISA2	*Pinus sabiniana*	Native	10–65	1–3	10–22	–
blue oak	QUDO	*Quercus douglasii*	Native	5–25	1–2	4–15	–

Animal community

This ecological site provides a mixture of sparse tree, shrub and grassland cover, with some areas transitioning to more chaparral and others more to grassland, depending on the elevation, aspect, and fire frequency. There is very limited forage and cover available for birds and other animals due to very shallow soils, low soil moisture and low site productivity.

This ecological site has scattered overstory trees, primarily blue oak and California foothill pine, that are described as “keystone structures” in that their contribution to ecosystem structure and function is substantial compared to the space they occupy (Manning et al., 2006). Some key ecological functions they provide include tree cover, connectivity for other trees and animals, nesting and roosting sites for birds and bats and restoration “centers”. All of these functions serve to enhance ecosystem function and biodiversity. One study demonstrated that even scattered trees made a significant difference to bird and bat populations as opposed to no trees at all (Fischer et al., 2010). Bird species have essential habitat elements met in savannas that include some large oak trees with associated cavities and acorns and grasses and forbs (Zack, 2002). Many species of raptors and owls, such as red-tailed hawks (Buteo jamaicensis), Western screech owl (Megascops kennicotti) and golden eagles (Aquila chrysaetos) use oak savannas for the abundance of easily accessible small mammal prey found on the landscape.

Even though reduced cover supports less animal diversity, these areas provide corridors to other important surrounding habitats. Surrounding intermixed oak savannas provide a food resource for both herbivores and carnivores (Pavlik et al., 1992). Acorns are a critical food source for deer, which migrate from high-elevation dry summer ranges to blue oak woodland for fall and winter forage (Burns and Honkala 1990). Acorns are eaten by at least a dozen species of songbirds, several upland game birds, rodents, black-tailed deer, feral and domestic pig, and all other classes of livestock (Adams et al., 1992, Duncan and Clawson 1980, Sampson and Jespersen 1963). Overgrazing by livestock or removing wildlife trees (granary trees and/or snags) would dramatically reduce the quality of this habitat. This community is susceptible to degradation from feral pigs (Sus scrofa).

The blue oak-foothill pine community is preferred habitat for Columbian black-tailed deer (Odocoileus hemionus columbianus), California quail (Callipepla californica), and mourning dove (Zenaida macroura). Acorns and the seeds of foothill pine are important diet items for various birds and rodents; Western scrub jay (Aphelocoma californica), acorn woodpecker (Melanerpes formicivorus), and California gray squirrel (Otospermophilus beecheyi) are major seed consumers (Howard, 1992). Western scrub jays cache thousands of acorns each year to use as winter forage, and thus are very important for blue oak regeneration. Acorn woodpeckers also cache acorns in granary trees, which become an important food source for other birds and rodents. Shrubs provide important hiding cover and food for a variety of birds and deer that use them to escape from predation and fawning. Manzanita berries provide food for rodents and birds and nesting cover for passerines. Long term fire suppression can lead to declines in deer, small mammals and birds in this habitat (Mayer and Laudenslayer, 1988).

Of the 632 terrestrial vertebrates (amphibians, reptiles, birds, and mammals) native to California, over 300 species use oak woodlands for food, cover and reproduction, including at least 22 species of mammals, 79 species of birds and approximately 29 species of amphibians and reptiles (Mayer and Laudenslayer, 1988). Bobcats, foxes and coyotes spend time searching for prey in oak savannas (Pavlik, et al., 1992). The rich rodent and rabbit population is an important food source for common predators including: bobcat (Lynx rufus californicus), coyote (Canis latrans) and the Pacific rattlesnake (Crotalus viridis oreganus). Other common predators include the mountain lion (Puma concolor) and black bear (Ursus americanus californiensis).

Important game animals include the Columbian black-tailed deer, California quail and the "re-introduced" wild turkey (Meleagris gallopavo) that contribute to the economy of California through revenues from recreational hunting (Garrison and Standiford, 1997).

Grazing and Browsing

The main problems for livestock production on this site is the early seasonal drying of the soil profile causing forage quality to decline rapidly in early spring.

Filaree is important forage for cattle, horses, and domestic sheep; yields vary depending upon soil moisture (Howard, 1992). The forage value of red brome is relatively low and is only palatable during its short green period when it is young (Sampson, 1951).

Hydrological functions

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

Recreational uses

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

Wood products

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

Other products

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

Other information

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

Inventory data references

Information utilized to develop the Ecological Site Concept and plant communities includes the following:

ES Inventory Plot Data:
6 line intercept transects, 7 production (double sampling) plots

Type locality

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

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

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Date	05/30/2015
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

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

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** A1--0 to 0.5 inches; pale brown (10YR 6/3) light clay loam, brown (10YR 4/3) moist; weak medium platy structure; slightly hard, friable, nonsticky and nonplastic; common fine roots; common fine pores; slightly acid; abrupt s A2--0.5 to 6 inches;

brown (10YR 5/3) clay loam, brown (10YR 4/3) moist; moderate coarse subangular blocky structure; hard, friable, moderately sticky and nonplastic; common fine roots; common fine pores; few shale fragments; neutral; clear smooth boundary. (4 to 10 inches thick)

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

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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 soil structure may be confused with effects of compaction.

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

    Dominant: Forbs

    Sub-dominant: Grass

    Other: Shrubs>>Trees

    Additional:

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

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

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

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:** Invasives such as medusahead and yellow star-thistle do not have the potential to become

dominant on this site.

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