Ecological site group F004BN100CA
Fog-influenced, low elevation mountain slopes

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Key Characteristics

- Santa Cruz Mountains – LRU N
- Fog-influenced, low elevation mountain slopes

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

Physiography

It occurs commonly on the uniform to slightly concave of mountain slopes where soil moisture is likely slightly higher than the more convex positions on the mountain slopes of LRU N.

Climate

The average annual precipitation in this MLRA is 23 to 98 inches (585 to 2,490 millimeters), increasing with elevation inland. Most of the rainfall occurs as low-intensity, Pacific frontal storms. Precipitation is evenly distributed throughout fall, winter, and spring, but summers are dry. Snowfall is rare along the coast, but snow accumulates at the higher elevations directly inland. Fog is a significant variable that defines this MLRA from other similar MLRAs. Summer fog frequency values of greater than 35% are strongly correlated to the extent of coast redwood distribution, which is a primary indicator species in this MLRA. Nightime fog is approximately twice as common as daytime fog and seasonally, it reaches its peak frequency in early August, with the greatest occurrence of fog from June through September (Johnstone and Dawson 2010). The average annual temperature is 49 to 59 degrees F (1C to 15 degrees C). The freeze-free period averages 300 days and ranges from 230 to 365 days, decreasing inland as elevation increases.

Climate varies from the west to the east in LRU N, the Santa Cruz Mountains, as the high mountain ridges reduce the penetration of maritime air. Winters are cool and wet with the occasional snow storms at the highest elevations and in narrow, north-facing drainages, leading to some white and red fir in limited locations. Heavy rains are also known to cause mudslides throughout this LRU, and on the west side, summers are cooler, and fog or low overcast skies are only around for the mornings and carry through the low slopes and stream terraces.

Soil features

Although coast redwood and Douglas-fir can grow on a variety of soils, the soils most associated with this concept are primarily found on colluvium and residuum materials derived from sandstone, conglomerate and mudstone, with soils that are loamy textured and can be skeletal. Soil depth ranges but most all of the soils have a lithic or paralithic contact within 60 inches. Slopes are generally over 30%, but can be gentler in some areas and elevations are generally under 2500 ft.

Vegetation dynamics

This provisional ecological site concept attempts to describe the coast redwood-Douglas-fir dominated mountain slopes that can be found within this LRU. This concept is primarily supported through literature and available information from the Santa Cruz County Survey. This provisional ecological site concept covers the mountains within proximity to the coast and at the lower elevations that spend longer periods within the summer coastal fog. Future work will need to be done to better understand the soil and site characteristics that drive the vegetation expression for this provisional ecological site concept.

Abiotic Factors

Sequoia sempervirens (coast redwood) and Pseudotsuga menzeisii (Douglas-fir) forests are unique in this MLRA in their ability to dominate the low elevations of the mountains of LRU K that are solidly within the coastal fog influence, especially during the summer months.

Coast redwood attains a height of 395 ft (~120 m), and an age of at least 2200 years. Roots are shallow without a taproot. Trees begin bearing cones by 5 to 15 years of age and seed production is generally high, however seed viability is low. Wind and gravity disperse the seeds, with most falling within 395-400 ft of the parent tree. Seedling establishment is best on moist soil lacking litter but can occur on duff or logs. Plants are moderately shade tolerant, but they grow faster in higher light levels if soil moisture is present (MCV 2018).

Douglas-fir is a large, coniferous, evergreen tree. Adapted to a moist, mild climate, it grows bigger and more rapidly than the inland variety. Trees 5 to 6 feet (150-180 cm) in diameter (150-180 cm) and 250 feet (76 m) or more in height are common in old-growth stands. These trees commonly live more than 500 years and occasionally more than 1,000 years. Old individuals typically have a narrow, cylindric crown beginning 65 to 130 feet (20-40 m) above a branch-free bole. It often takes 77 years for the bole to be clear to a height of 17 feet (5 m) and 107 years to be clear to a height of 33 feet (10 m). In wet coastal forests, nearly every surface of old-growth Douglas-fir in this ecological site is often covered by epiphytic mosses and lichens (Uchytil, 1991). This tree's rooting habit is not particularly deep. The roots of young Douglas-fir tend to be shallower than roots of many of the same aged conifers like ponderosa pine, sugar pine, or incense-cedar. Some roots are commonly found in organic soil layers or near the mineral soil surface.

This ecological site is dominated by a multi-tiered canopy of conifers, with coast redwood making up more than 50% of the stands basal area and Douglas-fir and other hardwoods accounting for between 30-50%. Pacific rhododendron and tanolk readily establish after disturbance and may dominate the overstory for several years post-disturbance. Fallen logs are an essential part of this ecological site, providing significant habitat for wildlife species and conifer recruits. Conifer recruitment on the bare mineral soil is rare, due to the thick litter layer and organic surface soil and is therefore relegated only to areas of surface soil disturbance from mass wasting, logging practices, wind throw, and recreation trails.

Primary Disturbances

Fire is the principal disturbance agent in both young-growth and old-growth stands. Lightning-ignited fires do occur (Van Wagtendonk and Cayan, 2008), though Native American burning played a major role when fires ignited in nearby grasslands and oak woodlands and would burn into the redwood zone (Greenlee and Langenheim, 1990, Veirs, 1996). Fire intervals in the pre-Euro American settlement period were on the order of several decades in redwood forests of the Santa Cruz Mountains and Monterey Bay area, and perhaps more frequent since analyses from fire scarred trees are generally an underestimate of fire frequency (Greenlee and Langenheim, 1980, Jones and Russell, 2015). The co-dominance of Douglas-fir and hardwoods in this provisional ecological site concept indicates a regular occurrence of fires and disturbance since Douglas-fir would only persist in this type of forest if there were adequate openings and mineral soils periodically exposed to facilitate regeneration and canopy recruitment. Fire scars are abundant throughout old-growth stands and are also strong evidence of this fire history. Previous harvesting and the use of fire to treat logging slash has also changed species composition on many formerly redwood-dominated sites (Noss et al, 2000).

Redwood, tanoak and other hardwoods can re-sprout following fire. After fire, redwood may sprout from the root crown or from dormant buds located under the bark of the bole and branches (Veirs, 1996, Noss, 2000), while tanoak and other hardwoods sprout from the root crown, root collar, lower part of the stem and underground burls (McDonald and Tappeiner 1986). The sprouting ability of redwood is most vigorous in younger stands and decreases with age, while the ability to survive fire increases with age as its fibrous bark thickens. Frequent fire reduces tanoak’s sprouting ability and tends to keep understories open (Arno, 2002). Fire exclusion would allow for the gradual increase of tanoak in the understory (McMurray, 1989). Surface fires likely modified the tree species composition by favoring the thicker-barked redwood and killing young tanoak. Fires also expose the mineral-rich soil and reduce competition from other plants, thereby increasing the establishment of Douglas-fir (Veirs, 1980, Agee, 1993). Tanoak seedlings and sapling-sized stems are often top-killed by surface fire, though larger stems may survive with only basal wounding (Fryer, 2008).

A moderate fire could lead towards a mosaic in regeneration patterns and uneven-aged structure. Patches of trees would be killed leaving others slightly damaged or unharmed. Douglas-fir regeneration would be favored in the large gaps that are created following a moderate fire, potentially leading to a larger proportion of Douglas-fir to redwood for several centuries (Agee, 1993). Without these gaps caused by fire, Douglas-fir regeneration is unsuccessful, and with continued lack of disturbance it may slowly be replaced by redwood as the dominant canopy species (Veirs, 1980, 1996).

Fires also alter the composition of shrubs and forbs in the understory community. *Vaccinium ovatum* (evergreen huckleberry) is a common species in both moist and dry Douglas-fir and redwood environments. It is normally a fire-dependent shrub species, but little is known concerning it's adaptation to fire under low to moderate fire return intervals (Tirmenstein, 1990). Following a fire, evergreen huckleberry will often re-sprout and recover rapidly. *Rhododendron macrophyllum* (Pacific rhododendron) is considered sensitive to fire. Following a surface fire, it may reestablish seedlings by sprouting from the root crown or stem base (Crane, 1990). After a disturbance such as fire, a decrease in plant cover is common, and will be followed by a gradual increase in cover over time.

Another important disturbance for this redwood ecological site is damage from winter storms that can cause top breakage and blowdowns. This breakage may kill individual or groups of trees and create small openings from windfall (Noss, 2000). This would likely favor the establishment of redwood and other shade tolerant conifers.

Coast redwood is one of the signature trees of California, with 95% of its range existing within the state. Years of logging have left significantly lower amounts of the original forest (Sawyer et al. 2000b). Old-growth stands exist mainly in protected areas including parks, experimental forests, and private reserves. Asexual regeneration is prolific and many stands of younger trees exist, but many areas are on the third cycle of regeneration with collateral impacts of erosion, streambed siltation, and alteration to watershed and wildlife values. Residential development is an increasing concern.

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Major Land Resource Area

Stage

Provisional

Contributors

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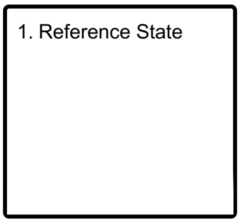
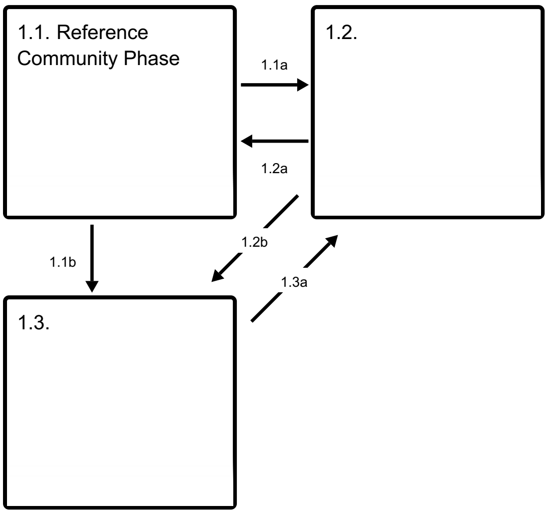
State and transition model

Ecosystem states



State 1 submodel, plant communities



State 1
Reference State

The dynamics described below are general to the level that the site concept has been developed for provisional ecological site concept identification and further investigation purposes only. It is meant to give a general overview of the ecological dynamics of the system and should not be viewed as a model for a specific ecological site level management. It is supported by the current available literature that was reviewed for a general understanding of the system and basic understanding of the abiotic and biotic drivers. Further investigations and soil-site data collection and analysis should be conducted before specific land management can be applied at the ecological site specific scale. This STM only serves to explain the general ecology and dynamics. No alternative states were found during the literature review, however that does not mean they do not exist and more time should be spent determining whether or not this model captures all the dynamics of this system, especially once more is known about the soil-site characteristics of this LRU and ecological site concept. Reference State (State 1) – The reference state for this provisional ecological site concept is dominated by *Sequoia sempervirens* (coast redwood) and Pseudotsuga menzeisii (Douglas-fir), with a significant component of *Notholithocarpus densiflorus* (tanoak) and Arbutus menzeisii (Pacific madrone) in the lower canopy. The ecological dynamics represented in the reference state are driven primarily by periodic fires that create the complex dynamics and plant expressions reflected by the community phases described. Depending on the intensity, severity, timing, and weather conditions associated with each fire and which community phase is impacted by the fire, this ecological site will respond to varying degrees. At this very general scale, this reference state only really captures the generalities related to the functional groups that are most dominant and does not capture the more specific dynamics and patterns that would be found at the more detailed and refined ecological site scale that focuses on specific abiotic factors that drive some of these various complex plant expressions. More data and refinement is needed to capture the information needed in order to make specific land management decisions at the ecological site-component scale.

Community 1.1
Reference Community Phase

The reference community for this site is a redwood and Douglas-fir forest. Coast redwood dominates in the overstory, with Douglas-fir and tanoak and Pacific rhododendron found as associates in the subcanopy. The understory is shrub-dominated with *Vaccinium ovatum* (California huckleberry), Arbutus menzeisii (Pacific madrone), and *Gaultheria shallon* (salal). Occasionally *Polystichum munitum* (western swordfern) may be found in the understory layer, but forb cover is generally low. The estimated age for this community is 200 years or more. Windthrow from winter storms or small partial cuts can create small gaps which will provide openings for Douglas-fir and hardwoods to maintain their subcanopy dominance and potentially increase the cover of shrubs as well.

Community 1.2

This community phase represents a stand primarily dominated by Douglas-fir with redwoods as a sub-dominant with a higher cover of tanoak and/or Pacific rhododendron in the subcanopy and heavier cover of a variety of shrubs. This community phase will look very similar to the provisional ecological site concept that is dominated by Douglas-fir as the reference condition, so it will be important to understand the abiotic factors and influences of the site in order to distinguish this community phase from another provisional ecological site concept.

Community 1.3

Tanoak and/or Pacific madrone, shrubs, and western swordfern will rapidly establish the site after a disturbance with Douglas-fir and redwood seedlings present. The red alder/redwood plant community evolves after the initial red alder invasion. Redwood sprouts may be dominated by alder for a period of 75 years or more. Over time, redwood continues to grow and responds by filling in canopy gaps.

Pathway 1.1a
Community 1.1 to 1.2

The reference community may transition to Community Phase 1.2 following a temporary change in weather patterns that reduces the fog influence and summer moisture required for redwoods, opening the canopy as redwood mortality occurs providing more niche space for the more shade intolerant Douglas-fir. This community pathway could also occur if the timing of a moderate-intensity fire that removed many of the conifers occurred in combination with a short-term weather change that limited the moisture availability for redwoods to re-establish, giving significant edge to the Douglas-fir to establish and dominate. A selective timber harvest for redwoods would produce a similar result, albeit different in the impacts associated.

Pathway 1.1b
Community 1.1 to 1.3

The reference community may transition to Community Phase 1.3 following a significant fire that removes the conifers and hardwoods from the canopy and allows the understory shrubs to dominate for a short time as the conifers and hardwoods attempt to re-establish.

Pathway 1.2a
Community 1.2 to 1.1

With time, redwoods should gradually re-establish and will eventually take over dominance once again in the upper most canopy layer returning the site to Community Phase 1.1.

Pathway 1.2b
Community 1.2 to 1.3

This community phase may transition to Community Phase 1.3 following a significant fire that removes the conifers and hardwoods from the canopy and allows the understory shrubs to dominate for a short time as the conifers and hardwoods attempt to re-establish.

Pathway 1.3a
Community 1.3 to 1.2

With time, the conifers will re-establish dominance and overtop the shrubs. Douglas-fir will likely be the dominant conifer in the overstory for several years, since it more shade intolerant, requires less moisture to establish and grows quickly. Redwoods will regain dominance over time and thin out the Douglas-fir as it develops enough canopy to begin shading out the Douglas-fir.

Citations