Ecological site group F004BI103CA
Fog-influenced, Cool, Wet, Low Elevation Mountain Slopes and Terraces

Last updated: 03/07/2025
Accessed: 05/10/2025

Key Characteristics

- Heavy coastal fog dominates the landscapes below 1500 ft.
- Soil moisture is udic – LRU I
- Fog-influenced mountain slopes
- Fog influences the site most of the year, typically under 2000 ft elevation

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

The ESG occurs on mostly well-drained mountain slopes, however there are small areas that are found on stabilized debris flows that have a seasonally high water table and redox features. This ESG covers the mountains within close proximity to the coast in LRU I. It occurs on uniform to slightly convex summits and shoulders of broad ridges; and slightly concave to convex positions of mountain slopes. These mountain slopes are gently sloping to very steep. Slopes are gently sloping to very steep reaching elevations just under 2000 ft, and the site is limited to areas of high annual precipitation and a cool, maritime climate that provides fog drip and sufficient summer moisture to mollify evapotranspiration rates in the summers.

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, and 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. Nighttime 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 (10 to 15 degrees C).

The low mountains of the Northern Franciscan Redwood Forest LRU I, lie entirely within the coastal fog zone and are characteristically covered by fog-dependent coast redwoods and Douglas-fir. Historically, unbroken redwood forests occurred and moderated local climate by trapping coastal fog and producing shade. The combination of shade, root competition, young soils with a deep organic debris layer on the soil surface, occasional fire, and silting by floods limits the number of plant species that occur here. The region extends north only about 10 miles into Oregon near Brookings. Dominated by conifers, the region also includes Sitka spruce, western hemlock, western redcedar, Port Orford cedar, and grand fir. Hardwoods such as red alder, Pacific rhododendron, and tanoak commonly occur. This LRU also includes the areas known as the Bald Hills that have been maintained for over 100 years as prairies and oak woodlands through prescribed fire. These hills are dominated by Oregon white oak and perennial and annual native and non-native grasses and forbs but are actively encroached by Douglas-fir and redwood. Fine and fine-loamy, udic, isomesic, Ultisols and Alfisols are typical. In some factors, this region has more similarities to the temperate rain forests of the Oregon and Washington Coast Ranges, however since it does not receive winter snow and colder temperatures and still maintains the distinct presence and dominance of coast redwood make this LRU unique to MLRA 4B.

Soil features

Although coast redwood can grow on a variety of soils, the soils most associated with this concept are primarily found on colluvium and residuum materials derived from weakly consolidated sandstone, conglomerate and mudstone, with very deep soils that are primarily well-drained, and are strongly to very strongly acidic at 40 inches. They have a dominantly loamy subsurface rock content ranging from non-gravelly to extremely gravelly.

Vegetation dynamics

This provisional ecological site concept attempts to describe the coast redwood dominated mountain slopes that can be found within this LRU. This concept is primarily supported through literature and available information from the Redwood National and State Park Soil Survey. 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.

Sequoia sempervirens (coast redwood) forests are unique in this MLRA in their ability to dominate the low hills and mountains of LRU I that are solidly within the coastal fog belt, 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 (Sawyer et. al., 2009).

This ecological site is dominated by a multi-tiered canopy of conifers, with coast redwood making up 90% of the stands basal area and hardwoods accounting for only about 4%. Western hemlock readily establishes on rotting fallen logs rather than the surface due in part to the thick litter layer. 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, however, the historical origin of fires and flooding regimes within the Northern Redwood Region remains enigmatic (Varner and Jules, 2016). Lightning-ignited fires would likely spread due to the winds that are frequent within this LRU. However, Native American burning is thought to have played a major role by burning fires from the interior into the redwood zone (Veirs, 1996). Natural fire intervals were frequent as the northern range of redwoods evolved within a low to moderate natural disturbance regime (Veirs, 1996). Overall, the fire history studies conducted in redwood forests consistently show frequent fires that contrast sharply with the notion of a rainforest ecosystem (Varner and Jules, 2016). Fire scars are abundant throughout old-growth stands. Previous harvesting and the use of fire to treat logging slash in this area has also changed species composition on many formerly redwood-dominated sites (Noss, 2000). Within many areas of the park, aerial seeding of Douglas-fir has led to a 10:1 ratio of Douglas-fir to redwood (Noss, 2000).

Coast redwood has the ability to sprout if damaged from trunks, branches, stumps, and roots. The aboveground portions of trees can be killed outright by ground fire, but they sprout. The ability to survive fire increases with age, as tree bark thickens and becomes protective with age. In addition, young stands have more litter that is flammable on the ground, and their microclimate is drier than under are older forests (Olson et al. 1990, Stuart and Stephens 2006). The mean fire interval is quite variable, depending on environmental site conditions. Old-growth stands show evidence of three or more severe fires each century, and the distribution of fires appears as a natural pattern of several short intervals between fires followed by one or more long interval (Stuart 1987, Jacobs et al. 1985).

Surface fires likely modified the tree species composition by favoring the thicker-barked redwood and killing western hemlock (*Tsuga heterophylla*), tanoak (*Notholithocarpus densiflorus*) and grand fir (*Abies grandis*) (Veirs, 1996). Western hemlock's shallow roots and thin bark make it susceptible to fire damage (Tesky, 1992). The establishment of a western hemlock understory is increased by surface fires. This is due to the exposure of mineral-rich soil and the reduction of other plant competition (Veirs, 1996, Williamson, 1976). 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 more of a mosaic in regeneration patterns. Patches of trees would be killed leaving others slightly damaged or unharmed. Douglas-fir (*Pseudotsuga menziesii*) 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, 1996). 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, 1996).

Other potential disturbances in the redwood zone include winter storms that can cause top breakage. 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., 2009). 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

MLRA 004B
Coastal Redwood Belt

Stage

Provisional

Contributors

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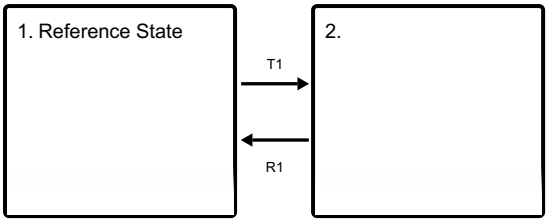
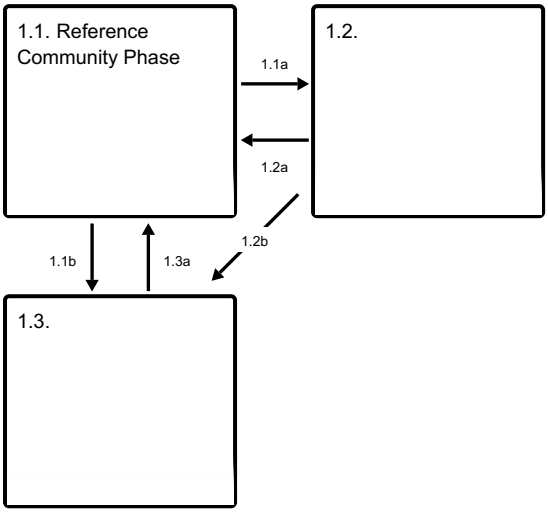
State and transition model

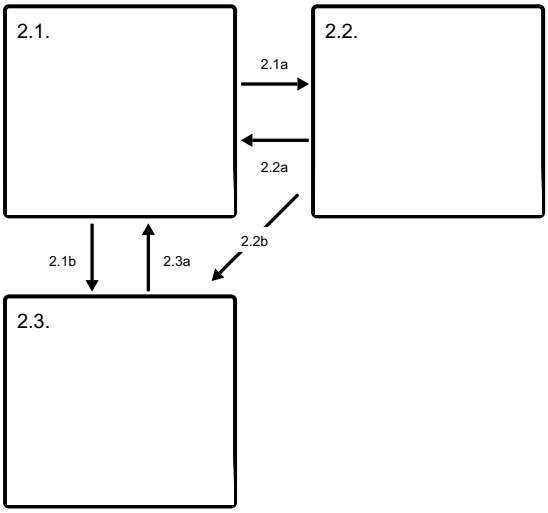
Ecosystem states



State 1 submodel, plant communities



State 2 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) – 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.

Dominant plant species

- redwood (*Sequoia sempervirens*), tree
- western hemlock (*Tsuga heterophylla*), tree
- tanoak (*Notholithocarpus densiflorus*), tree
- California huckleberry (*Vaccinium ovatum*), shrub
- salal (*Gaultheria shallon*), shrub
- redwood-sorrel (*Oxalis oregana*), other herbaceous
- western swordfern (*Polystichum munitum*), other herbaceous

Community 1.1
Reference Community Phase

The reference plant community for this site dominated by *Sequoia sempervirens* (redwood), with *Tsuga heterophylla* (western hemlock) as a significant associate. The estimated tree age for this site ranges from 75 to 200+ years. *Abies grandis* (grand fir), Pseudotsuga menzeisii (Douglas-fir) and red alder may also occur in lower densities in the lower tiers of the overstory canopy. The understory is dominated by *Polystichum munitum* (western swordfern) and *Vaccinium ovatum* (California huckleberry) with openings commonly filled in by *Oxalis oregana* (redwood-sorrel). Western hemlock and redwood seedlings are also commonly found in the understory, mostly on fallen, decaying logs. Windthrow from winter storms or small partial cuts can create small gaps which will maintain the redwood dominance and increase the red alder and swordfern cover and potentially increase the cover of shrubs as well.

Dominant plant species

- redwood (*Sequoia sempervirens*), tree
- western hemlock (*Tsuga heterophylla*), tree
- tanoak (*Notholithocarpus densiflorus*), tree
- California huckleberry (*Vaccinium ovatum*), shrub
- western swordfern (*Polystichum munitum*), other herbaceous
- redwood-sorrel (*Oxalis oregana*), other herbaceous

Community 1.2

This community phase represents the portions of this ecological site that have gone a significant amount of time without disturbance, especially fire. It is dominated by coast redwoods, with a significant understory of western hemlock. Western hemlock is extremely fire sensitive and any low intensity fires will remove them while maintaining redwoods, moving the community back to Community Phase 1.1.

Dominant plant species

- redwood (*Sequoia sempervirens*), tree
- western hemlock (*Tsuga heterophylla*), tree
- California huckleberry (*Vaccinium ovatum*), shrub

- western swordfern (*Polystichum munitum*), other herbaceous
- brackenfern (*Pteridium*), other herbaceous

Community 1.3

Red alder, salmonberry, and western swordfern may rapidly establish the site after a disturbance with redwood seedlings present. Redwood-sorrel may also increase in cover. 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. Remnants of salmonberry remain until the canopy has completely closed and California huckleberry, western swordfern and redwood-sorrel begin to regain dominance.

Dominant plant species

- red alder (*Alnus rubra*), tree
- salmonberry (*Rubus spectabilis*), other herbaceous
- redwood-sorrel (*Oxalis oregana*), other herbaceous
- brackenfern (*Pteridium*), other herbaceous

Pathway 1.1a
Community 1.1 to 1.2

The reference state may transition to Community Phase 1.2 following a significant amount of time without disturbance, such as fire or logging.

Pathway 1.1b
Community 1.1 to 1.3

A significant, stand-replacing fire or block harvest timber practice would remove all the overstory conifers, opening the site to red alder to germinate and dominate.

Pathway 1.2a
Community 1.2 to 1.1

Following a low-intensity fire or tree removal event that removes most of the fire-sensitive western hemlocks and younger redwood trees that are still sensitive to fire, returning the site to a redwood dominated community phase with western swordfern understory.

Pathway 1.2b
Community 1.2 to 1.3

Following a significant stand removal event such as a large, hot fire or timber harvest practice that removes most of the conifers, red alder rapidly establishes the bare mineral soil where the canopy has opened and litter layer has been removed, transitioning to Community Phase 1.3. Western swordfern will also dominate the understory.

Pathway 1.3a
Community 1.3 to 1.1

With continued growth and no significant disturbance over several hundred years, this community phase could be expected to return to the multi-storied redwood reference community seen in Community Phase 1.1.

State 2

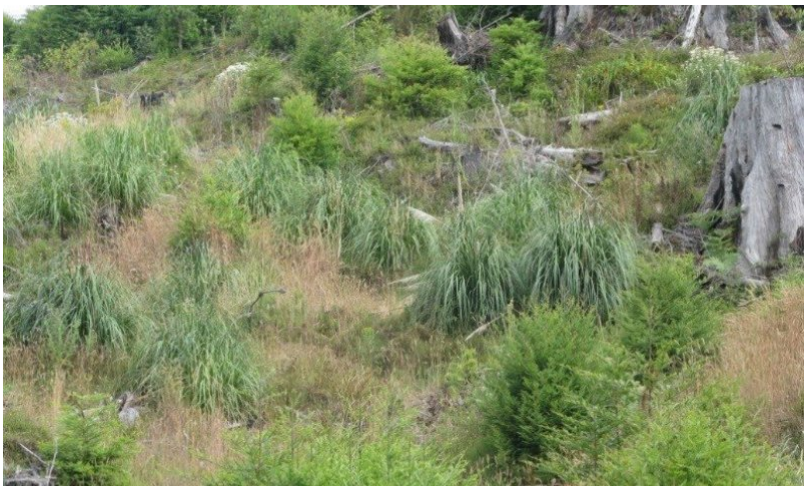


Figure . Jubata grass (Cortaderia jubata)

This state represents the coast redwood stands that have been invaded by jubatagrass, a native grass to Argentina that aggressively dominates and crowds out conifer and red alder seedlings, significantly slowing the recovery after disturbance. More information about this state is needed to flesh out the various impacts and dynamics, however current literature describes the impacts by this invasive species as primarily altering the recovery time/re-establishment of the coast redwoods after disturbance by suppressing seedling establishment. It also creates a fire hazard with excessive buildup of dry leaves, leaf bases, and flowering stalks. Because it is such a large plant, it can make fire management activities more difficult by blocking vehicle and human access. The leaves are toothed along the edge like a saw and can cause injury to humans. Exercise caution with when removing larger plants. Seedlings can be easily removed with hand pulling.

Dominant plant species

- redwood (*Sequoia sempervirens*), tree
- western hemlock (*Tsuga heterophylla*), tree
- tanoak (*Notholithocarpus densiflorus*), tree
- California huckleberry (*Vaccinium ovatum*), shrub
- purple pampas grass (*Cortaderia jubata*), grass
- brackenfern (*Pteridium*), other herbaceous
- western swordfern (*Polystichum munitum*), other herbaceous

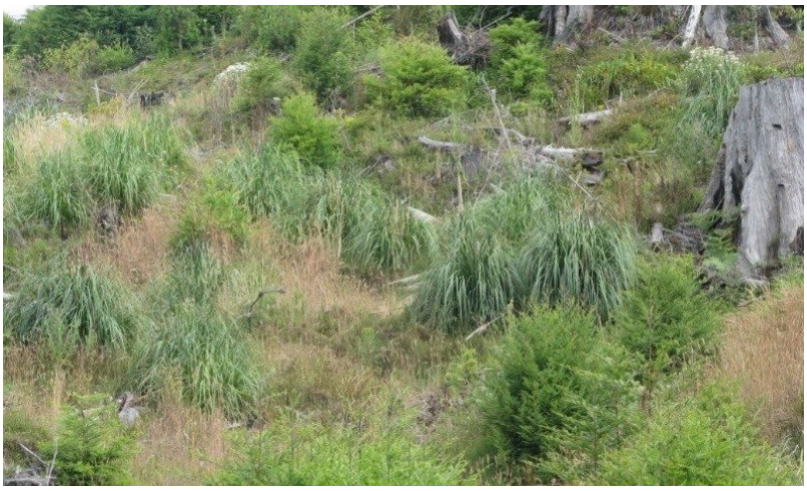
Community 2.1

Resilience management. This community phase is similar to Community Phase 1.1, however it contains jubatagrass in the understory. This is significant, as it maintains a seed source that can quickly spread after a disturbance. There is little impact to the community otherwise, due to the dominance of redwoods once they become the established overstory.

Community 2.2

This community phase may eventually shade out the jubatagrass, effectively removing it from the ecological site and assisting in a natural transition back to the reference state—however if the seed source is not removed either within the stand or nearby, any disturbance would bring jubatagrass back to the ecological site.

Community 2.3



This community phase is dominated by jubatagrass with some red alder and western swordfern. Germination generally requires open mineral soils (most aggressive on sandy soils), ample moisture and light. After germination has occurred, initial growth is slow, but increases rapidly once seedlings become established. Seedling growth and establishment is most rapid on bare sandy soil and exposed road cuts, but requires cool foggy climate and moist soil. Seedling survival is low in shaded areas or in competition with grasses or sedges. Jubatagrass does not tolerate winter frost, warmer summer temperatures, more intense sunlight, and moderate drought. This may account for its inability to become established in the drier associated ecological sites in this LRU.

Pathway 2.1a
Community 2.1 to 2.2

With enough time without disturbance, western hemlock will become a significant dominant conifer in the overstory canopy.

Pathway 2.1b
Community 2.1 to 2.3

A significant, stand-replacing fire or block harvest timber practice would remove all the overstory conifers, opening the site to red alder and jubatagrass seed to germinate and dominate.

Pathway 2.2a
Community 2.2 to 2.1

A low- to moderate-intensity fire or selective timber harvest would return this community phase to CP 1.1

Pathway 2.2b
Community 2.2 to 2.3

A significant, stand-replacing fire or block harvest timber practice would remove all the overstory conifers, opening the site to red alder and jubatagrass seed to germinate and dominate.

Pathway 2.3a
Community 2.3 to 2.1

With time and no disturbance, redwood will eventually re-establish and dominate the ecological site, reducing jubatagrass cover slowly as it is shaded out. This pathway could take several years if not more, depending on the site conditions and disturbance pressures that would help maintain jubatagrass dominance.

Transition T1
State 1 to 2

Reference State

This transition is caused by a significant disturbance like fire or large-scale timber harvest practice and the introduction of invasive species, primarily *Cortaderia jubata* (Jubatagrass) that force this ecological site over a threshold and change the function and structure of this site in extensive ways. If given enough time (500-800 years) the redwoods and hemlocks may eventually shade out and kill the Jubatagrass from this ecological site, however since this will not happen within the lifetime of most humans and current management a State 2 was recognized to discuss the significant impacts that this invasive species has on the ecological site function and disturbance dynamics.

Restoration pathway R1
State 2 to 1

Reference State

This restoration pathway occurs only when significant time and money inputs are focused on removing the invasive species from the system.

Citations