

COAST REDWOOD FOREST

Sequoia sempervirens

OLD-GROWTH REDWOOD FOREST (MUIR WOODS)



Condition: Good
Trend: Improving
Confidence: High

SECOND-GROWTH REDWOOD FOREST



Condition: Caution
Trend: Declining
Confidence: Moderate



WHY IS THIS RESOURCE INCLUDED?

Coast redwoods are the definition of resiliency. Among the tallest trees in the world, individual redwoods may live as long as 2,000 years. Thick bark and an ability to resprout enables established adult trees to survive most wildfires, and their seedlings thrive in the mineral-rich soil left behind by fires and floods. High levels of tannins make them resistant to insect and fungal infestations. Acidic soil conditions, thick duff layers, and dense shade also make redwood-dominated stands relatively resistant to non-native plant invasions. Despite their overall resiliency, historic logging practices have diminished the extent and density of old-growth redwood stands and have also altered forest conditions. As a result, coast redwood forests are on the International Union for Conservation of Nature and Natural Resources red list as “endangered”.

Redwood growth rates have increased significantly in recent decades, but their future growth trajectory is unknown as California becomes functionally more arid with climate change. Redwood forest communities are also being impacted by Sudden Oak Death (SOD), which rapidly kills tanoak (*Notholithocarpus densiflorus*) trees and other coast redwood forest understory species.

Mt. Tam's coast redwood forests provide important habitat for a number of mammals and birds, including the state and federally threatened Northern Spotted Owl (*Strix occidentalis caurina*). Endangered coho salmon (*Oncorhynchus kisutch*) and threatened steelhead trout (*O. mykiss*) also live in the Redwood Creek Watershed.

Redwood forest communities are good indicators of forest management practices, wildfire regimes, and disease processes. Coast redwood trees sprout prolifically from stumps, and many of Mt. Tam's second-growth stands have higher redwood tree densities than old-growth areas as a result of turn-of-the-century logging. In the absence of wildfire or active management, fast growing species such as Douglas-fir (*Pseudotsuga menziesii*) and tanoak have

become more abundant in Mt. Tam's redwood forests. High densities of tanoak in second-growth redwood stands in the moister regions of the One Tam area of focus reflect a history of logging, followed by fire suppression and a lack of any action designed to favor redwood recruitment. Sudden Oak Death has caused wide-spread cycle of tanoak dieback and resprouting in One Tam area of focus redwood forests, as well as in mixed hardwood forests across Mt. Tam and the Coast Range.

OVERALL CONDITION

Less than 5% of the original old-growth redwood forests remain, although second-growth forests have persisted over much of the historic range. Within the One Tam area of focus, coast redwood forests may be found in Muir Woods on National Park Service (NPS) lands, as well as in stands on Marin Municipal Water District (MMWD), California State Parks (State Parks), and Marin County Parks (MCP) lands.

The vast majority of redwood forests on Mt. Tam have a varied history of commercial logging prior to gaining protections within the current network of public lands. Of the 6,220 acres of coast redwood forest in the One Tam area of focus, less than 15% was protected from logging and can be considered "old-growth," including Muir Woods and Steep Ravine. In general, old-growth conditions represent a desirable state for redwood stands on Mt. Tam given their complex habitat structure and other ecological conditions that are resilient to wildfire and other stressors.

The majority of redwood stands on Mt. Tam are considered second-growth. These stands exhibit greatly simplified structure, with an absence of larger trees in the canopy, simplified understory, and high densities of small diameter trees.

DESIRED CONDITIONS

The desired condition for old-growth redwood forests is to sustain complex species composition and stand structure including multi-aged, multi-storied stand structure, coarse woody debris, tree cavities, and nesting structures.

In second-growth forests, the desired condition is evidence that a stand is on a trajectory towards development of old-growth characteristics. This includes a reduction in the total stem density over time as well as the development of large diameter trees and a multi-storied stand structure. Maintenance of the existing extent of redwoods in the One Tam area of focus is considered highly desirable because of their habitat value for Northern Spotted Owls and coho salmon, their ability to store carbon and other greenhouse gases, and their iconic value.

STRESSORS

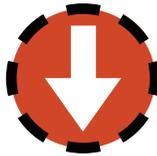
Sudden Oak Death: Since its onset in 1995, this disease has heavily impacted tanoaks within the One Tam area of focus and elsewhere on the central California coast, altering the structure of redwood stands that have a high tanoak component. Tanoaks are among the most shade tolerant hardwood in coastal California, and one of the few species that thrives in the dense shade of the redwood overstory. In addition to the extensive canopy gaps left by dead trees, SOD damages the structural integrity of diseased trees, and infected tanoaks collapse and decay rapidly.

Climate Change: Models generally forecast warmer temperatures and normal precipitation patterns for coastal California over the next 15 years, with the southern extent of the redwood range experiencing more warming than the northern extent. How these predicted climate changes will impact the health of the redwood forest is complex, given redwoods have shown increased growth with climate changes so far. The loss of fog, particularly in the summer, could lower redwood forests' ability to thrive if precipitation also declines in the future. Fog has decreased by approximately one-third over the past century.

Non-native, Invasive Species Encroachment: The deep shade created by the redwood overstory protects these forests from invasion by many invasive plant species. However, some species, most notably panic veldt grass (*Ehrharta erecta*), are able to persist in the redwood understory and displace native understory biodiversity.

Soil Compaction: Recreational use of redwood forests both on and off trails leads to soil compaction and disruption of understory biodiversity and abundance.

METRICS USED TO MEASURE HEALTH

Metric	Condition Goal	Status - Old-growth forest (Muir Woods)	Status - Second-growth stands
<p>Metric 1 Forest structure and demography with old-growth characteristics or moving towards old-growth characteristics</p>	<p>Tree density at or moving towards southern redwood forest reference conditions of 460 ± 70 trees per hectare with approximately 18% of trees > 100 cm in</p>		
<p>Metric 2 Mid-canopy structure</p>	<p>Persistence of a multi-layered stand structure, dominated by native tree species</p>		
<p>Metric 3 Targeted invasive non-native species cover</p>	<p>Maintain 6,220 acres at or below maintenance levels for target weed species</p>		

INFORMATION GAPS

Presence of Complex/Old-growth Habitat Structure: Quantification of habitat structure including measuring and mapping coarse woody debris, tree cavities, and nesting platforms is needed to inform Metric 1.