

RESTORING REDWOOD FORESTS

Coast redwood forests were among the most spectacular forests in North America, and members of Portolá's Spanish expedition from 1769-1770 were the first Europeans to see them. These forests wound their way 450 miles up the foggy coast of northern California in a narrow band, from 5 to 35 miles in width. They began in southern Monterey County and extended into the southwest corner of Oregon, covering an area just under 2 million acres. Therefore, coast redwoods were one of the smallest of America's historic forests.

Open grasslands also dotted the ridges above historic redwood forests. "Prairies of rich grass lie on their southern slopes, and especially on their tops," wrote the chronicler of Colonel M'Kee's 1851 expedition to the redwoods. Indians used fire to maintain these hunting and gathering places as oases along their trails. Little herds of elk and deer were often seen sprinkled over the grasslands. This must have been a welcome sight to any Indian that emerged from the depths of the forest after a long hike. Surely, they also appreciated the grand views their little prairies provided of the fog drenched redwood forests that blanketed distant mountains. An outer fringe of Oregon white oak and Pacific madrone, an evergreen tree with a twisted red trunk, served as a decorative frame that separated these picturesque openings from the darkness of the redwoods.

The coast redwoods of today are probably among the most ancient forests in North America, partly because the trees live to be 2,200 years old, perhaps older. Furthermore, redwoods, including some of their associates such as Sitka spruce and western hemlock, probably moved outward onto the exposed coastal shelf during the Ice Age when ocean levels dropped. Then they moved landward when the warming climate poured glacial meltwater into the oceans until they reached their present location.

Fire History

At the end of the Ice Age, coast redwood forests must have looked different from the ones the Spanish first saw because fires burned less often. Even today, lightning-fires seldom start in coast redwood forests, although a large lightning fire burned in Humboldt Redwood State Park as recently as 2003.

It was not until Indians came and started more fires that redwood forests took on their modern character and diversity. Indians settled among the redwoods about 12,000 to 11,000 years ago. This was a time when redwoods were moving north and farther inland as the climate warmed and melting glaciers caused ocean levels to rise and submerge the coastal plain.

Fires swept through redwood forests about once in 135 to 350 years before Indians began burning. These had to be mostly mixed severity fires (surface fires intermixed with scattered small crown fires) and crown fires because understory trees and logs had time to accumulate.

After Indians started burning, only about 17 to 82 years passed between each fire. It dropped to eight years in some places. This shift to frequent fires kept the understory of most redwood forests open by thinning understory trees and removing debris. These were mostly light surface fires.

Surface fires left most large redwoods unharmed when they burned through a forest, leaving only a black char on the outside of their thick bark. Mixed fires created scattered openings in the forest by burning patches of trees, top killing some redwoods and stripping branches from others, which grow back slowly, allowing sunlight to reach bare soil. These sunny openings provided the proper conditions for Douglas fir regeneration. Therefore, a flush of Douglas fir seedlings often sprang up along with sprouts from redwoods to form a new patch of trees in the forest.

Tanoak thrived in the understory of the historic forest as well, eventually creating a layer of hardwoods below the redwood and Douglas fir trees. Additional light surface fires kept tanoak under control while also stimulating its growth because tanoak sprouts vigorously when burned.

Since fires burned each part of a forest differently, an ancient redwood forest consisted of a mosaic of patches, each with a different combination of trees and layers, although most had relatively open understories. Redwoods thrived as long as fires kept burning.

Modern Coast Redwood-Douglas fir Forests

Most people don't think of groves of giant coast redwoods as a wildfire threat, but the forest has changed. Indian burning ended over a century ago followed by extensive logging and aggressive fire suppression. The results are predictable. Old growth forests grew thicker as tanoak, a flammable hardwood, and Douglas-fir trees took over the understory. The canopy also closed within second growth forests as the trees grew older and their crowns intermingled. Tanoak and Douglas fir grow thick in these forests as well, and logs and debris piled up on the ground. These conditions exist in many coast redwood-Douglas fir forests. In such an overcrowded forest filled with fuel, all it takes is a single spark on a hot windy day to ignite a raging and potentially unstoppable crown fire.

Even so, redwood forest fires are rare, but they do occur and they can be destructive and dangerous. For example, in September 2003 numerous lightning strikes hit Humboldt County, igniting over 60 wildfires. Firefighters quickly extinguished most of these fires, but two fires burned for over a month. When it was over, the Honeydew Creek fire burned 11,861 acres and the Canoe Fire burned 13,774 acres, becoming the largest fire in the region since 1950.

Even if a redwood forest escapes burning in a crown fire, it will still decline. They need prescribed fire or a mechanical substitute not only to keep them safe from crown fires, but also to clear openings where redwood and Douglas fir can grow. Redwood sprouts

do not grow well in dense shade and seeds cannot germinate and survive without bare soil and abundant sunlight. Other more shade tolerant trees such as California bay and tanoak will gradually increase as redwood decreases.

Goal for Forest Restoration

This desired future condition is an old growth redwood-Douglas fir forest that averages 32 redwood trees per acre (about 10 trees per acre over 40 inches in diameter, 2 trees per acre over 50 inches in diameter, and 1 tree per acre over 90 inches in diameter). This desired future condition may not be feasible to create in specific locations because of the need to generate revenue from wood products to cover the cost of forest management.

Silvicultural System

Clearcutting is not used for restoring coast redwood-Douglas fir forests, although it is a cost-effective and scientifically sound way to regenerate commercial forests. Even so, creating large openings is essential for regenerating coast redwood.

Furthermore, individual tree selection that concentrates on crown thinning or thinning larger trees from above rather than smaller trees from below, is not appropriate for restoring coast redwood-Douglas fir forests. Understory or overtopped trees are not thinned and most intermediate trees are not harvested in individual tree selection. These trees substantially add to crown bulk density, which already is high enough in this forest to carry a crown fire. Ladder fuels also are abundant and the post-harvest debris adds to an already high surface fuel load. Opening the overstory by thinning from above further exacerbates understory growth and ladder fuels by providing more sunlight below the canopy and encouraging tree growth. This increases the fire hazard.

Instead, the silvicultural system should be a combination of individual tree selection, group selection (harvesting trees in small groups), and thinning from below (thinning understory trees), with an emphasis on the latter in the short term.

In one major study, redwoods in a single cohort (age group) without competition from understory trees (e.g., even-aged management) had diameters three times as large and heights twice that of multi-storied forests that grew during the same period (19 years in this study), compared to a individual tree selection system. Similar, but less dramatic increases occur with group selection (removing and regenerating trees within small groups).

Crown thinning should focus on removing poor quality and diseased trees, reducing competition among closely spaced dominant and co-dominant trees, releasing the best intermediate trees with a bias toward redwood, and generating revenue from wood products to help cover the cost of forest management.

Thinning from below, which can be both commercial and pre-commercial, involves selectively removing poor quality intermediate trees and most of the overtopped trees. This method mimics mortality caused by surface fires, which historically was the most common type of fire in coast redwood-Douglas fir forests. It also concentrates growth on dominant and co-dominant trees.

More importantly, thinning from below in combination with some crown thinning will significantly reduce ladder fuels, crown base height, and crown bulk density. This, together with reducing surface fuels, can dramatically lower crown fire potential, which is the primary goal.

In addition, if practiced properly this silvicultural regime can accelerate restoration of the forest to a more natural, diverse, aesthetically pleasing, and healthier condition. Instead of thinning trees to a uniform spacing, it should favor some clumping while keeping tree spacing within clumps wide enough to encourage growth and sustain tree health. Tree spacing should vary based on the size of adjacent trees. Larger trees should be more widely spaced than smaller trees. This will create various stand structures across the landscape while minimizing both the vertical and horizontal continuity of aerial fuel.

Standards

Check with a professional forester or a Registered Professional Forester (RPF) before acting on these guidelines.

Surface fuel: Remove surface fuel by piling and burning, lopping, crushing or other methods over the entire area as appropriate to meet a four-foot flame length goal under severe fire weather conditions.

Ladder fuel: Retain 10 to 20 percent of conifer regeneration, hardwoods, and shrubs dispersed within the forest. This includes individual trees and shrubs or clumps provided there is horizontal separation among them of at least 2-3 times their height. The distance of these ladder fuels to the base of the live co-dominant trees (height to live crown base HTLCB) should be at least 8 feet.

Openings: In addition to individual tree selection harvesting, openings should be created periodically by group selection harvesting according to a sustained yield plan. Most regeneration should be in scattered openings. This will produce revenue from wood products, regenerate desired conifers and hardwoods, reduce the continuity of crown fuels, and create an age class distribution of trees that will sustain the forest indefinitely.

Openings should be no more than twice the height of surrounding overstory trees, although some may be larger. However, most openings should be less than one acre and no opening should exceed 2 acres. Trees within these openings should be located outside the drip lines of adjacent overstory trees. In addition, regeneration should be thinned to

ensure it doesn't touch the crowns of adjacent overstory trees as it matures. Also thin shrubs if they begin overtopping tree seedlings. This occurs in about three years.

The edges of an opening should be feathered (i.e., irregular or jagged) rather than linear. That is, blended into the adjacent forest so that the opening looks like fire or some other natural disturbance created it. These openings should vary in size as well. Similarly, fires rarely destroyed all of the trees in an opening. Some dead trees remained standing after the fire and others lay in heaps on the ground. During fires that created larger openings, wind often drove flames along narrow paths, leaving behind stringers or rows of scorched live trees, as well as scorched trees around the edge of the opening. Occasionally the flames would leap over, or skip around, protected areas and leave groups of trees untouched. As a result, snags, fallen logs and patches of live trees usually remained on the site after the fire passed. These remnants of the former forest provided habitat for wildlife and the foundation for a new forest. Therefore, group selection openings should include some of these features.

Crown fuel: Canopy cover should be 50-60 percent between regeneration openings with few crowns touching until measurements are available to determine crown bulk density, which should not exceed the critical threshold of 0.0062 lb/ft³ to prevent crown fire. Retain some natural clumps of canopy trees in isolated patches.

Planting and retention: Interplant trees as necessary to maintain the historic species composition of the forest, and retain the largest and healthiest hardwoods. This will improve wildlife habitat and aesthetics without diminishing crown fire resistance.

Snags and logs: The Forest Service and the California State Board of Forestry and Fire Protection have different standards for snags and logs in the general forest. Even so, they are trying to achieve a similar objective by providing adequate wildlife habitat.

Therefore, in general retain 2-6 of the largest snags over 16 inches dbh and 20 feet tall per acre, and 5-10 of the largest down logs over 16 inches dbh and 20 feet long per acre, as well as den and nesting trees to enhance wildlife habitat, biodiversity, and aesthetics. Use the upper end of these ranges for area restoration.

Marking rules: Restoration requires developing marking and harvest rules (rules that guide decisions on which individual trees and other plants to remove) tailored to local conditions.

Additional Considerations

Redwood should occupy a minimum of 60 percent of the canopy and Douglas fir should occupy no more than 25 percent of the canopy. Canopy cover of redwood should be lowest on upper slopes (without going below the minimum) and higher, perhaps 70 percent, on lower slopes and in valley bottoms. Tanoak and other hardwoods should not exceed 15 percent of the canopy cover.

The largest and healthiest hardwoods, such as tanoak, madrone, black oak, live oak, bay, and big-leaf maple should be chosen for hardwood retention within coast redwood-Douglas fir forests. This will improve wildlife habitat and aesthetics without diminishing crown fire resistance.

Hardwoods

The hardwood type, usually tanoak, which is largely a scattered remnant of historical timber harvesting, is the only exception to the general recommendations for this forest. Hardwoods should be converted to conifers where it is consistent with historical conditions. Do this by thinning hardwoods to reduce them to no more than 15 percent of the area. Leave residual hardwoods dispersed over the landscape in scattered groups composed of the largest and healthiest trees.

Thinning hardwoods should concentrate on releasing suppressed Douglas fir and redwood. In addition, use local seed sources to plant areas cleared of hardwoods to redwood and Douglas fir. Retain scattered Douglas fir and clumps of redwood and thin them as necessary to promote the growth and health of the trees.