

# Structural Characteristics of an Old-Growth Coast Redwood Stand in Mendocino County, California<sup>1</sup>

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## Abstract

This paper compares stand characteristics of Old Growth coastal redwood stand densities and forest structure found throughout the northern tier of the range of coast redwood (*Sequoia sempervirens*). Tree densities are relatively low compared to commercially managed stands of coast redwood. Tree size classes distributions vary from <5cm to >254cm (2" dbh to >100"). Dominant tree species include tanoak (*Lithocarpus multiflora*), Douglas-fir (*Pseudotsuga menziesii*) and Coast Redwood (*Sequoia sempervirens*). Snag densities are given for a stand of old-growth redwoods in Mendocino County.

## Introduction

Forestry practices have historically tended to simplify the structural components of coast redwood forests (O'Dell 1996). However, recruitment of the structural elements commonly found in older forests is increasingly recognized as an important management objective in younger forest stands to address issues of biological diversity and forest integrity (Mladenoff 1993, Spies 2003). Obviously, old forest features develop as a function of time; as such they often include stand characteristics not associated with younger stands. Old forest characteristics are often the result of stochastic disturbance events—for example, storms, fire, and landslides, whose legacies shape forest structure and composition and which may be difficult to mimic.

The management for old forest characteristics in coastal redwood forests is a topic of concern and often-heated debate among managers and policy leaders in California. Unfortunately, there exists a limited knowledge base regarding the structure and composition of older forests from which to make sound management decisions. This has led to the reliance on data sources from other forests in the Pacific Northwest to help guide management decisions across the redwood region. Much of the scientific inquiry investigating the characteristics of redwood forests is relatively new and promises to provide useful and enlightening information in the years to come.

## Study Site

Many of the sites that are now redwood parks along the north coast were recognized for their splendor even during a time when old growth forests were still relatively common. Montgomery Woods State Reserve is no different in this regard from the other impressive stands in the California State Park system.

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The site is located in a narrow canyon in the headwaters of Big River. It represents one of the few stands of uncut redwoods remaining in Mendocino County. The Reserve is 456 ha (1,142 acres) located on the Comptche-Ukiah road about 24 Km (15 miles) west of Ukiah and 48 Km (30 miles) east of the town of Mendocino. The Reserve was originally acquired in the 1940s through the efforts of the Save-the-Redwoods League. From an original gift of 9 acres, donated by the landowner Robert Orr in 1945, the grove has grown to its present size. The uniqueness of this particular site is the fact that beyond the original nine acre gift the surrounding acreage could be described as “common ground” that was the mainstay of the logging industry in Mendocino county. Most of the Reserve is very steep, inaccessible to the public and sparsely covered by trees. It represents an example of the type of redwood stands that would have extensively covered this part of the coast redwood range. The fact that this site was spared the loggers ax makes it unique.

Montgomery Woods, has the expected assemblage of associated flora including tanoak (*Lithocarpus densiflora*), big-leaf maple (*Acer macrophyllum*), California bay or laurel (*Umbellularia californica*), red alder (*Alnus rubra*), sword fern (*Polystichum munitum*), redwood sorrel (*Oxalis oregana*), rhododendron (*Rhododendron macrophyllum*), huckleberry (*Vaccinium ovatum*), salal (*Gaultheria shallon*), and azalea (*Rhododendron occidentale*). Sholars (in Sawyer and others 2000) has cataloged 47 species of lichens as part of the Bryophytic component for Montgomery Woods.

The study site is adjacent to the Big River. The sites parallel to the river are relatively flat. Transects that are perpendicular to the river vary from 0° to 45° slope. The average slope across the study area is 31.5°.

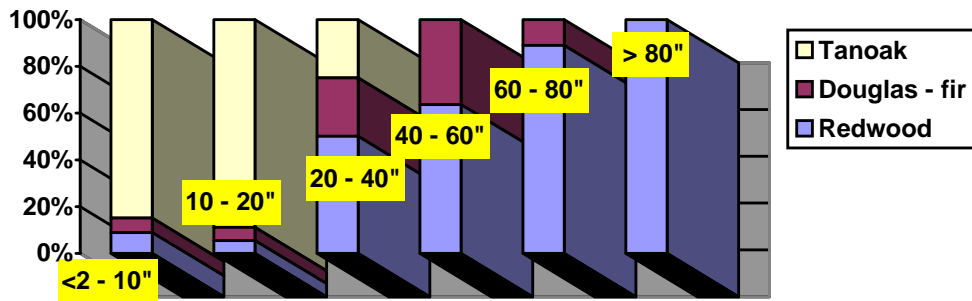
## Methods

Currently, the study site includes 14 parallel transects spaced at 35 m intervals perpendicular to the river. Plot spacing is 30 m, with an average of four plots/transect. The sampled area is 5.46 ha (13 acres). By design, each transect includes sites in the alluvial plain and the adjacent upland. A total of 46, permanent, 0.04 ha (1/10 acre), circular plots have been established. Each plot is surveyed for slope, tree species, tree size, and habitat elements. Habitat elements include snags, down wood, rock outcroppings, leaf litter, and ground cover.

## Results

### ***Stand Density Characteristics***

Tree density is relatively low with relatively few; very large individuals occupying the stand. A total of 1,313 trees were tallied within the plots. Of these 13 percent are coast redwood, seven percent Douglas-fir and 80 percent tanoak. The dominance of tanoak, in the smaller size classes is obvious in *figure 1*. Nearly 80 percent of all stems under 25.4 cm (10") dbh are tanoaks. Conversely, all of the stems >203 cm (80") dbh are redwood with the dominant Douglas-fir cohorts found between 101 to 152 cm (40 to 60") dbh.



**Figure 1**—Size class distribution of old-growth coastal redwood stand (Montgomery Woods State Park, Mendocino County).

Trees diameters varied from <5.0cm to 254 cm (<2" to >100") dbh (fig. 1). Tanoaks dominated the smaller sizes between 5 to 25.4cm (2 to 10") with dominance inversely proportion to size class. The largest tanoak measured 91.4cm (36") dbh. Douglas-fir was represented in the small and moderate sizes from <5.0 to 167.6cm (<2" to 66" dbh) and redwood was present in all sizes from <5.0 to 269.25cm (<2" to 106" dbh).

**Size Class Distribution Characteristics**

Redwood densities by size class varied from 62 trees/ha <25.4 cm (26 tpa <10") to 2.4 trees/ha >203 cm (1 tpa >80") (table 1). Overall, redwood averaged 105 trees/ha (44 tpa) when all size classes are considered. DF density on the site, averaged 74 trees/ha (31 tpa) and varied between 43 trees/ha (18 tpa <10") to 12 trees/ha (5 tpa) for the largest cohorts. Tanoak was both heavily dominant and limited in its size distribution being skewed toward the smaller size classes. Tanoak stems varied between 595 stems/ha (248 stems/acre) for trees <25.4 cm dbh (10") to approximately 5 trees/ha (2 tpa) of those >51 cm (20"). Tanoak densities averaged 677/ha (282 tpa). The largest tanoak measured 91.44 cm (36 inches).

**Table 1**—Distribution of trees size classes by species per acre, Montgomery Woods State Reserve.

Species	<25.4 cm	27.9-51 cm	53-101 cm	101-104cm (41-60")	154-203cm (61-80")	>203cm (80")	Total/ac
<b>redwood</b>	62 t/ha (26 tpa)	5 t/ha (2 tpa)	9 t/ha (4 tpa)	17 t/ha (7 tpa)	9 t/ha (4 tpa)	2.4t/ha (1 tpa)	105 t/ha (44 tpa)
<b>Douglas-fir</b>	43t/ha (18 tpa)	5t/ha (2 tpa)	5t/ha (2 tpa)	9t/ha (4 tpa)	12t/ha (5 tpa)	0	74t/ha (31 tpa)
<b>tanoak</b>	595t/ha (248 tpa)	77t/ha (32 tpa)	5t/ha (2 tpa)	0	0	0	677t/ha (282 tpa)

This data illustrates a relatively flat inverse “J” curve suggesting that tree

recruitment is limited on the site (fig. 2). Many of the smallest seedlings of all three species have very little live crown and are showing outward signs of senescence. Some of the redwood stems in the intermediate size classes (<51 cm (20") appear to be the sprouts from the “fairy ring” from a nearby maternal tree unique to coast redwood regeneration.

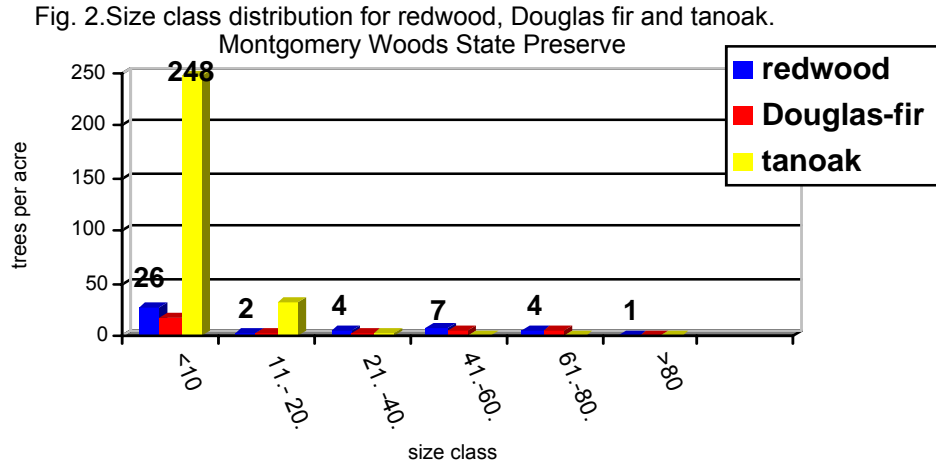
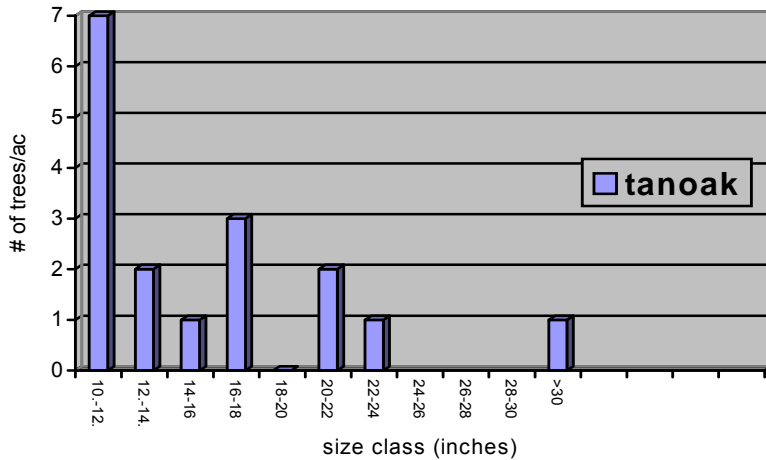


Figure 2—Size class distribution for redwood, Douglas fir and tanoak.

### Snags

Snags, though present are relatively scarce. Because of the high density of tanoak stems, they represent the highest density of snags present (this site is not known to be infected with *Phytophthora ramorum*, the causative agent for Sudden Oak Death disease). Of tanoak snags, 18 percent of stems >25.4 cm (n = 115) exhibit characteristics commonly associated with age including: broken branches, tops, trunk hollows, fire scarring, and standing dead trees. Within this sample, 15 percent are true snags (fig. 3), while three percent have trunk hollows potentially suitable for cavity use by several species. Snag size class distribution of tanoak is directly proportional to the ratio of stem size class availability with the most snags found in the smaller cohort class. Tanoak snag density of trees >25.4 cm (10") = 21 trees/ha (9 tpa).



**Figure 3**—Size distribution of tanoak stems >10" dbh having old forest characteristics, Montgomery Woods State Reserve.

Douglas-fir snag density is low. Of the 22 stems >51 cm (20") only three snags were found. In all cases, each snag is >76cm (30") dbh. This translates to a density of .5 snag/ha (.2/acre) suggesting a relatively few number of DF stems are readily accessible for snag habitat in older coastal redwood/Douglas-fir forests.

True snags of coast redwood were not observed within the transects. However, unique habitat characteristics often associated with standing snags are prevalent on living trees in the form of fire scars with trunk hollows. Virtually every large redwood on site has evidence of fire scarring visible on the trunk. Of those trees >76 cm (30") dbh, 31 percent have trunk hollows of various sizes and shapes. Of those trees >101 cm (40") nearly 29 percent have trunk hollows and 35 percent of those trees >152 cm (60") have hollows. Coast redwood trees with trunk hollows are distributed at densities equaling .4/ha (.16 tpa) for all sizes.

## Discussion

### ***Forest Distribution and Characteristics***

The coast redwood forest, being dispersed along a north-south axis, has characteristics affected by geographic location and localized climate and edaphic conditions (Sawyer and others 2000). Any comparison between redwood stands from differing geographic locations should be viewed as reference points and not as absolute factors. Furthermore, any numerical comparison between stands should also recognize that differences exist in structural attributes between trees growing on upland sites vs. trees growing on alluvial flats with alluvial deposits generally having higher tree densities than those stands on adjacent upland sites. *Table 2* compares stand characteristics of old growth coast redwood stands from the northern tier of its range illustrating the variation in the structural elements of any particular site.

**Table 2**—Stand density comparison between Old Growth coastal redwood stands from different geographic locations with differing climatic and edaphic conditions.

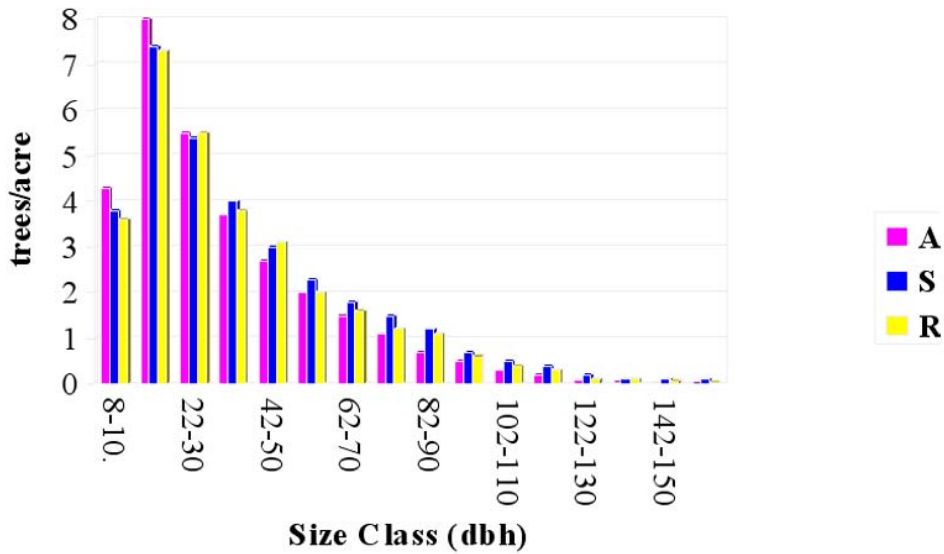
Stand Age	Old Growth	Old Growth	Old Growth	Old Growth
Location	Redwood Creek	Little Lost Man Creek	Bull Creek	Montgomery Woods State Reserve
County	Humboldt	Humboldt	Humboldt	Mendocino
Tree Size	TPA	TPA	TPA	TPA
> 24" dbh	No data	20	40	16
> 32" dbh	No data	15.7	40	—
> 40" dbh	11.3	12	35	15

### Structural Characteristics of Older Forests in the Northern Tier of the Redwood Range

In 1969, the U.S. Department of Interior initiated a project to identify and purchase what is now known as Redwood National Park in the northwestern corner of California. As a result, stand structure data were collected for a number of properties in old growth redwood stands that were being proposed for acquisition (HJW 1969a, 1969b, 1969c, 1969d). The information provides an opportunity to compare size class distributions on un-logged sites from another portion of the northern tier of the redwood region with that obtained at Montgomery Woods.

The resultant data from the approximately 9,000 aggregated acres cruised demonstrates a relatively similar size class distribution of conifers as witnessed in Montgomery Woods, though the northern sites had some larger cohorts. Unfortunately, hardwoods are not part of the data set. Given the acreages of the cruised parcels, one can surmise that both upland and riparian sites were sampled. The average conifer density of the three ownerships for coast redwood was 32 trees/acre, with tree sizes below 50" dbh dominating in each case, trees >50" dbh were common and averaged >2 trees/acre. Similarly, each property averaged approximately one tree >90" dbh per acre. A comparison of the three property cruise reports demonstrates a similarity of size class distribution across each of the ownerships (*fig. 5*).

Comparison between this data and the information obtained from Montgomery Woods (*table 2*) on relative redwood densities suggests that the sites are different. This is consistent with Sawyer (2000, see chapter 3) who suggests that within the central portion of the coast redwood range steep, friable Franciscan formation soils affect both density and composition of the redwood site being evaluated. This characterization is accurate for Montgomery Woods.



**Figure 5**—Size distribution of OG redwood trees ARCO, Simpson and Rellim Timber Companies. Del Norte County. 9,378 acres ≈ 32 trees/acre. (HJW 1969)

### Habitat Relationships

The faunal component of the redwood type is not well studied (Cooperrider and others 2000) and those few examples of redwood–habitat interactions are exhaustively cited (Gellman and Zielinski 1996, Zielinski and Gellman 1999) since so few works exist to guide decision-making.

The alteration of vast acreages of redwood forest, the result of commercial logging, makes it difficult to determine the extent and importance of many of the relationships between various habitat elements and dependent species. The Montgomery Reserve site suggests that the formation of a “true snag” from a redwood may be a rare occurrence with other species providing the necessary elements for snag dependent behaviors. However, those snag-like elements, for example, trunk hollows, found in older stands, are not easily recruited through conventional forestry management practices thereby necessitating the need to maintain those elements when they are found in a managed stand. A need exists to explore managerial alternatives to evaluate strategies to recruit unique habitat elements into redwood stands that have been simplified by past logging.

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