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Natural Resource Stewardship and Science

Forest Structure in Muir Woods National Monument

Survey of the Redwood Canyon Old-Growth Forest

Natural Resource Technical Report NPS/SFAN/NRTR—2014/878

ON THE COVER
The Main Trail through Redwood Canyon in Muir Woods National Monument.
Photograph by: Jessica Weinberg, NPS

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May 2014

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Please cite this publication as:

Steers, R. J., H. L. Spaulding, and E. C. Wrubel. 2014. Forest structure in Muir Woods National Monument: Survey of the redwood canyon old-growth forest. Natural Resource Technical Report NPS/SFAN/NRTR—2014/878. National Park Service, Fort Collins, Colorado.

NPS 112/124788, May 2014

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Abstract

The old-growth coastal redwood forest found in Redwood Canyon, Muir Woods National Monument was sampled in June of 2011. Woody plant density and basal area were collected in nine 0.10122 ha (0.25 acre) sample plots. The purpose of this vegetation sampling effort was to refine methodologies that will be utilized to measure a number of forested vegetation types in the San Francisco Bay Area National Parks following the plant community vital sign monitoring protocol. The secondary goal was to document woody plant structure in the Monument since limited information on forest structure exists here. Our vegetation sampling revealed that live tree density per hectare is 430 ± 31 individuals and dead tree density per hectare is 48 ± 12 individuals. *Sequoia sempervirens* was the most abundant tree species in terms of density and basal area. *Notholithocarpus densiflorus* exhibited the highest amount of tree mortality, which was due primarily to sudden oak death. Our analyses of different woody plant sampling methods revealed that trees <20 cm diameter at breast height did not need to be sampled in the entire plot but could be scaled-up from a subplot to accurately portray tree density and basal area metrics. Applying these results to future sampling efforts in forested vegetation types will greatly improve time efficiency and allow field crews to sample a higher number of plots.

Acknowledgments

This study was funded by the National Park Service, San Francisco Bay Area Network, Inventory and Monitoring Program. Alison Forrestel, Dawn Adams, Benjamin Ramage, and Daniel George provided comments that greatly improved this manuscript.

Introduction

Muir Woods National Monument, hereafter referred to as Muir Woods, is an old-growth coastal redwood forest that was protected by the federal government in 1908. Muir Woods is primarily bound by Redwood Canyon, which is covered in forest, including massive and ancient redwood (*Sequoia sempervirens*) trees that fill the banks of Redwood Creek and upland areas of the valley bottom. Several natural resources studies have been conducted in Muir Woods related to vegetation. Notably, McBride and Jacobs (1978) surveyed the age of trees, fuel hazards, soil compaction, and created a vegetation map, among other management-related investigations. Also, the National Park Service, San Francisco Bay Area Fire Effects Monitoring Program has measured forest structure in Muir Woods along Redwood Creek (NPS unpublished data).

In developing a vegetation monitoring protocol for the San Francisco Bay Area Network (SFAN), Inventory and Monitoring Program, Muir Woods was identified as an ideal site to test vegetation sampling methodology. Primarily, we were interested in understanding if tree basal area and diameter could be accurately extrapolated from a smaller subplot to a larger encompassing macroplot that was being considered for use by the protocol. Based on previous vegetation sampling in a bay laurel (*Umbellularia californica*) woodland, we found that it was not necessary to measure every tree within the macroplot and that only sampling smaller-sized trees within the subplot would suffice and save a nontrivial amount of time. However, this realization was based on only one forest type that appeared fairly even-aged with a relatively low range in tree basal area; basically, a forest with homogenous structure where one would not expect problems arising from scaling-up tree structural data. Therefore, the old-growth forests of Muir Woods plus an open, savanna-like valley oak (*Quercus lobata*) woodland in John Muir Historic Site (Martinez, California) were sampled to compare methodologies since they both exhibit non-uniform tree structure with densities and/or basal areas that more or less represent the extremes found in the San Francisco Bay Area. Our assumption in choosing these vegetation types is that they would reveal the differences between vegetation sampling methods more-so than a uniformly structured forest. This report contains only information for the vegetation analysis from Muir Woods because no past studies on its forest structure have been synthesized and reported to date, and it is the focal resource of the monument. The report outlines the methods and results of this sampling effort and discusses their implications in choosing an appropriate vegetation sampling method for the SFAN plant community monitoring protocol.

Methods

Study Area

Muir Woods is 223.5 ha of mostly forested land located on the southern slope of Mt. Tamalpais in southwestern Marin County, California. Redwood Canyon is the primary land formation within the monument with Redwood Creek meandering through the valley floor. Mean precipitation is about 95.1 cm per year (WRCC 2013), although an unquantified but significant amount of water input is also derived from fog (Ewing et al. 2009). Soils in the monument are mainly classified as Centissima-Barnabe complex (NRCS 2013) derived from the Franciscan complex mélange. Elevation in the monument ranges from about 36 to 417 m.

Redwood stands with the largest trees occur in the valley floor of Redwood Canyon where this study took place. Tan oaks (*Notholithocarpus densiflorus*) and bay laurel are found as infrequent to abundant trees in the canyon. Along Redwood Creek, red alder (*Alnus rubra*) and big leaf maple (*Acer macrophyllum*) are also components of the redwood forest. Redwood forests, Douglas-fir (*Pseudotsuga menziesii*) forests, and mixed redwood – Douglas-fir forests are common on slopes above the valley floor. In the lower reaches of Redwood Creek near the southern border of the monument, red alder riparian forests occur. Other trees such as California buckeye *(Aesculus californica*), Pacific madrone (*Arbutus menziesii*), giant chinquapin (*Chrysolepis chrysophylla* var. *chrysophylla*), California nutmeg (*Torreya californica*), and coast live oak (*Q. agrifolia*) are uncommon, occasional, or locally common. Other vegetation types in the vicinity of Muir Woods include grasslands, chaparral, coastal scrub, and bay laurel woodlands.

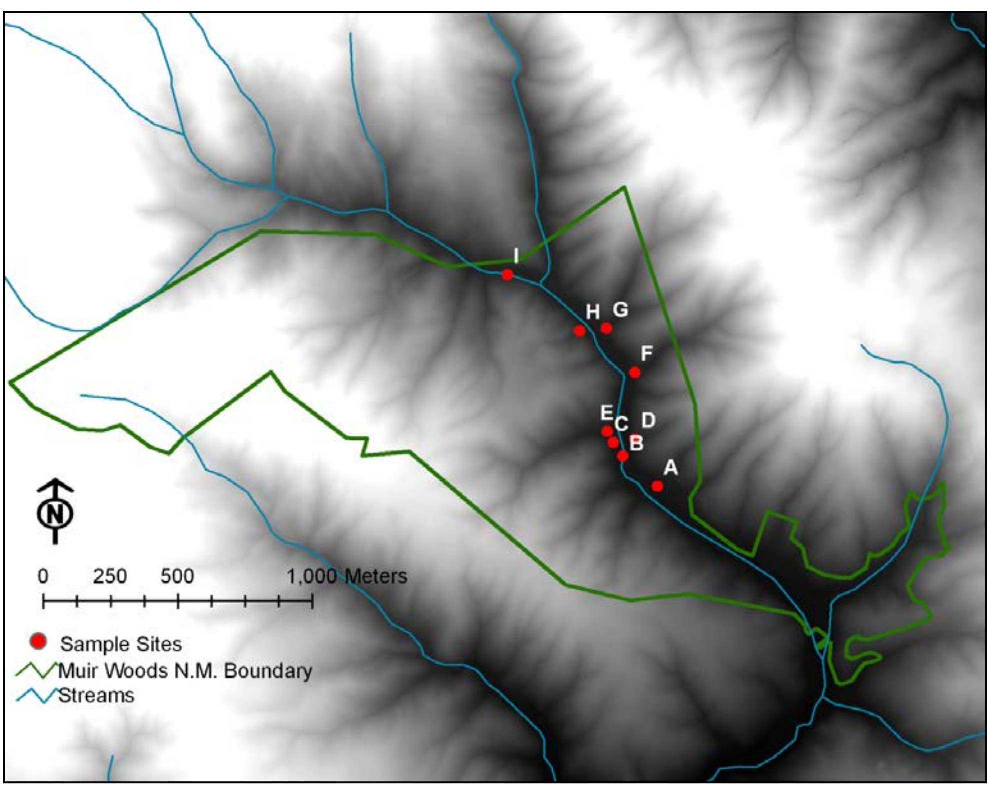

Figure 1. Map of Muir Woods showing the location of sample sites used in this study.

Vegetation Sampling

Nine vegetation sampling plots were randomly placed within the original monument tract in old-growth redwood forested vegetation found in the valley floor of Redwood Canyon (Figure 1). Redwood forests outside of the valley floor (i.e., on hillslopes surrounding the valley floor) were excluded. Plot placement consisted of randomly selecting a point from all areas of the valley floor that were large enough to accommodate a sampling plot without overlapping the Main Trail or other highly modified areas.

The sampling plot was a 17.95 m-radius circle (macroplot) that encompassed a smaller, 7.32 m-radius circle (subplot) (Figure 2). This plot design was based on a USDA Forest Service long-term forest monitoring sampling plot (USFS 2011). To sample tree density and basal area, all stems in the entire sampling plot were measured and recorded as growing either inside the subplot or outside. If the middle of a stem was growing exactly 7.32 m away from plot center, it was counted as inside the subplot. Also, any stem whose middle was exactly 17.95 m away from plot center was counted as inside the macroplot. A stem was classified as a tree if its diameter at breast height (DBH) was ≥5 cm. All stems <5 cm DBH and ≥1.4 m heights were classified as saplings.

For any tree whose bole forked below 1.37 m height, the two or more resulting stems were each counted individually and the DBH of each stem was recorded as close to the 1.37 m mark as possible. There were several *U. californica* boles that grew horizontally along the ground. In these cases, if the main bole ever surpassed 1.4 m height, then the DBH was recorded 1.37 m along the stem from where it left the ground surface. If the main bole never surpassed 1.4 m height, then vertical branches or stems growing out of the bole that exceeded 1.4 m height were recorded as trees or saplings depending on their dimensions, and their DBH was recorded 1.37 m from the ground surface.

Many of the largest *S. sempervirens* stems contained large basal burls with a profusion of suckers, sometimes with a thick litter layer, that covered the 1.37 m mark. Instead of removing the piles of litter, trying to weave through multitudes of suckers with DBH tape, and measuring a large distorted burl at 1.37 m from the ground surface, DBH measurements were taken at 1.37 m height above the top of the burl.

Tree seedling and shrub density were sampled from three, 3 x 3 m quadrats per macroplot. These three quadrats were oriented on the clockwise side of a straight line that started at plot center and emanated outward at 30, 150, and 270 degrees. The edge of each quadrat was placed along each of the three lines, from the 2.57 m to the 5.57 m mark. A seedling was any stem <1.4 m height. However, seedling-sized suckers or basal sprouts were not counted at all if growing from a live tree. Only seedling-sized suckers growing from the base of dead trees were recorded. Furthermore, if there were multiple seedling-sized sucker stems growing out of the base of a dead tree, all of the suckers were just counted as one seedling (plus the dead tree stem would be counted as a dead tree).

To precisely measure overstory canopy closure, densiometer readings were taken in the center and 10 m off-center at 30, 150, and 270 degrees. This resulted in four densiometer sampling locations per subplot. At each of the four locations, densiometer readings were recorded facing north, south, east, and west. All vegetation sampling was performed during June, 2011.

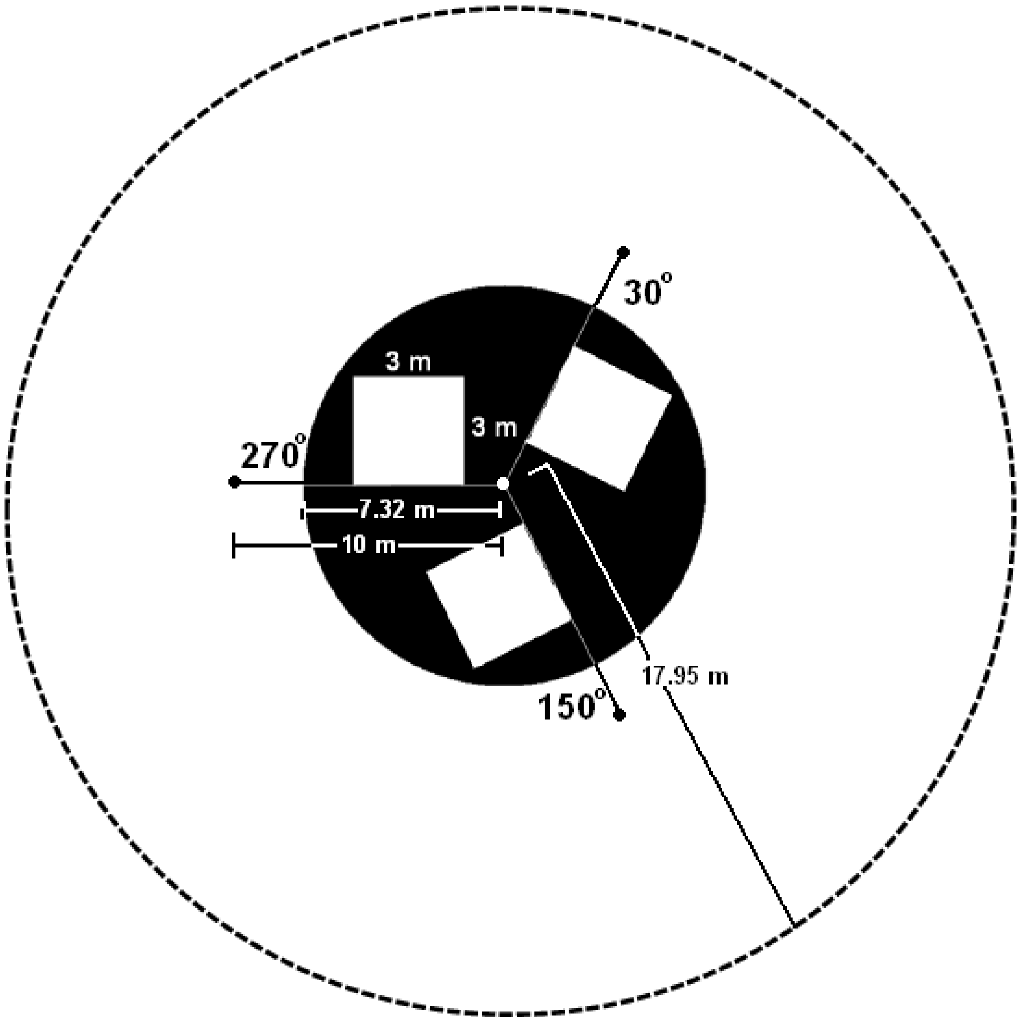

Figure 2. Sampling plot showing all of the components used to measure forest structure and composition in this study. The macroplot consists of the entire area within the 17.95 m-radius circle while the subplot includes the entire area within the 7.32 m-radius circle.

Statistical Analyses

Nine sampling plots were utilized in this study. For parameters measured in subplots (i.e. 3 x 3 m quadrats) or at multiple sampling points per plot (i.e. densiometer locations) data were averaged within-plot (or within sampling location and then within-plot in the case of densiometer readings) so that $n = 9$ for every mean and standard error reported herein.

To compare stem density per hectare between what was measured in the macroplot (entire 17.95 m radius circle) versus what was measured just in the subplot (7.32 m radius circle), paired t-tests compared stem densities for 15 different size-classes of trees, for all trees collectively, and for all saplings. Paired t-tests were also used to compare tree basal area per hectare between the macroplot versus the subplot data.

Based on the results of comparing tree density per hectare between the macroplot and subplot, we found that trees <20 cm DBH do not need to be sampled in the portion of the plot that forms the outer ring between the 7.32 m radius subplot and the 17.95 m radius macroplot. Instead, trees <20 cm can just be sampled from the subplot and then scaled up to the macroplot before calculating tree density per hectare or basal area per hectare. Thus, our final analyses compared mean tree basal area per hectare from the macroplot versus mean tree basal area per hectare when all trees ≥20 cm DBH are not sampled beyond the edge of the subplot but are scaled up from the subplot.

For all tree density statistical analyses, Log10(0.5+*x*) transformations were used on size class data that had non-normal distributions based on Shapiro-Wilk normality tests. All basal area data were normally distributed so no transformations were necessary. R version 2.13.1 (© 2011 The R Foundation for Statistical Computing) was used for all statistical analyses at $\alpha = 0.05$. All original data on the geographical coordinates of sample plots, untransformed tree plus sapling density and DBH measures, seedling density, and canopy coverage are provided as Appendices A through D.

Results

Tree Composition

Old growth redwood forests in this study consisted of five tree species. Mean richness of tree species, based on tree- and sapling-sized individuals, was 3.6 ± 0.3 species in the macroplot. Mean tree plus sapling Shannon Diversity (*H'*) within the macroplot was 0.74 ± 0.12. *Sequoia sempervirens* trees are the most frequent species while other tree-sized species found in sampling plots included *N. densiflorus*, *U. californica*, and *A. macrophyllum*. *Corylus cornuta*, which can exhibit a tree or shrub grow-form, but was considered as a tree species for the purposes of this study, was also found in sampling plots but only as sapling-sized specimens.

Tree Structure

Diameter at Breast Height and Basal Area

Again, only stems with a DBH ≥5 cm were recorded as trees. The largest live tree documented in the monument was a 444.5 cm DBH *S. sempervirens* (Figure 3), found in sampling plot B. *Sequoia sempervirens* trees were more numerous and larger than any other tree species (Figure 3).

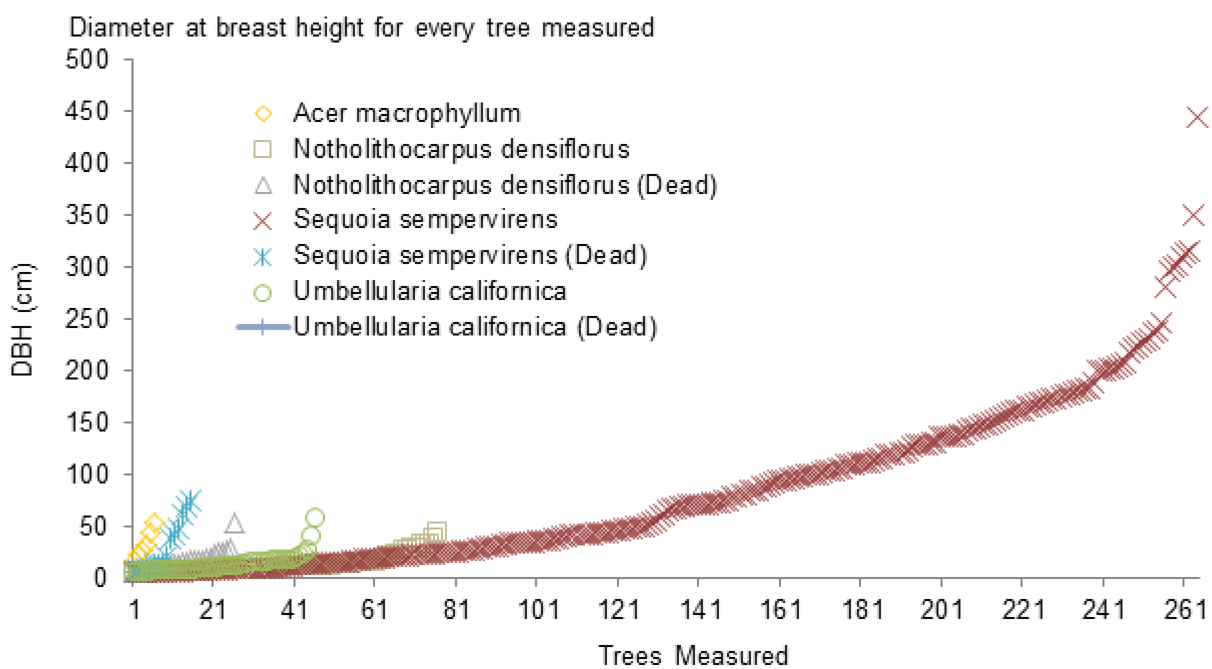

Figure 3. Graph of all trees measured and their diameter at breast height (DBH). Live and dead trees are reported separately.

The only species that had a greater mean DBH represented by dead individuals instead of live individuals was *N. densiflorus* (Table 1). However, there were still many more live *N. densiflorus* trees than dead ones and the basal area per hectare of live *N. densiflorus* was greater than for dead individuals. The total basal area of all live trees and dead trees was 307.65 ± 55.72 m^2 (ha^{-1}) and 3.28 ± 2.17 m^2 (ha^{-1}), respectively (Table 1). Live basal area ranged from 157.2 m^2 (ha^{-1}) to 404.9 m^2 (ha^{-1}) in the plots sampled (Figure 4).

Table 1. Mean diameter at breast height (DBH) per tree by species, and mean basal area per hectare by species. Standard errors are also shown. Live and dead trees are reported separately.

	Mean DBH (cm)	**Basal Area (m²/ha)**
Acer macrophyllum	31.52 ± 4.16	0.64 ± 0.39
Notholithocarpus densiflorus	14.21 ± 2.59	1.56 ± 0.55
Notholithocarpus densiflorus (Dead)	19.25 ± 2.12	0.83 ± 0.42
Sequoia sempervirens	93.19 ± 8.78	304.39 ± 26.27
Sequoia sempervirens (Dead)	24.48 ± 6.82	2.44 ± 1.03
Umbellularia californica	14.91 ± 1.35	1.06 ± 0.5
Umbellularia californica (Dead)	6.05 ± 0.3	0.01 ± 0.01
Total Live	62.73 ± 4.16	307.65 ± 26.27
Total Dead	18.46 ± 2.74	3.28 ± 1.02

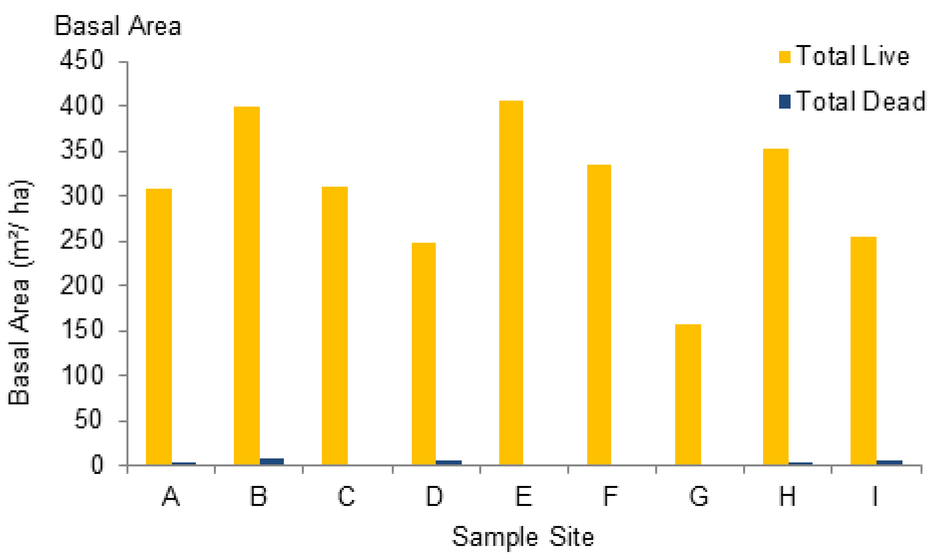

Figure 4. Basal area per hectare by sample site. Note that sites A through I are ordered from south to north.

Canopy Closure

Canopy closure ranged from 90.8 to 96.1% per sample site. Mean canopy closure for all sites combined was 94.4 ± 0.6%.

Density

Sequoia sempervirens exhibited the greatest mean stem density of live trees and saplings compared to all other species (Table 2). *Notholithocarpus densiflorus* had the greatest mean stem density of dead trees and dead saplings compared to all other species (Table 2).

Table 2. Mean tree and sapling density per hectare by species. Standard errors are also shown. Live and dead trees are reported separately. Only dead trees are indicated, all other trees are live.

	Tree Density/ha	Sapling Density / ha
Acer macrophyllum	6.59 ± 3.68	
Corylus cornuta		26.34 ± 20.37
Corylus cornuta (Dead)		2.2 ± 2.2
Notholithocarpus densiflorus	83.42 ± 24.98	180.02 ± 49.44
Notholithocarpus densiflorus (Dead)	28.54 ± 11.81	37.32 ± 15.77
Sequoia sempervirens	289.79 ± 44.12	461.03 ± 292.68
Sequoia sempervirens (Dead)	15.37 ± 4.69	12.07 ± 4.59
Umbellularia californica	50.49 ± 21.62	60.37 ± 30.25
Umbellularia californica (Dead)	4.39 ± 2.9	13.17 ± 10.8
Total Live	430.29 ± 31.07	727.77 ± 264.77
Total Dead	48.3 ± 12.37	64.76 ± 19.97

Seedling data revealed that *N. densiflorus* had the highest live seedling density of any other tree species, followed by *S. sempervirens* and lastly, by *U. californica* (Figure 5).

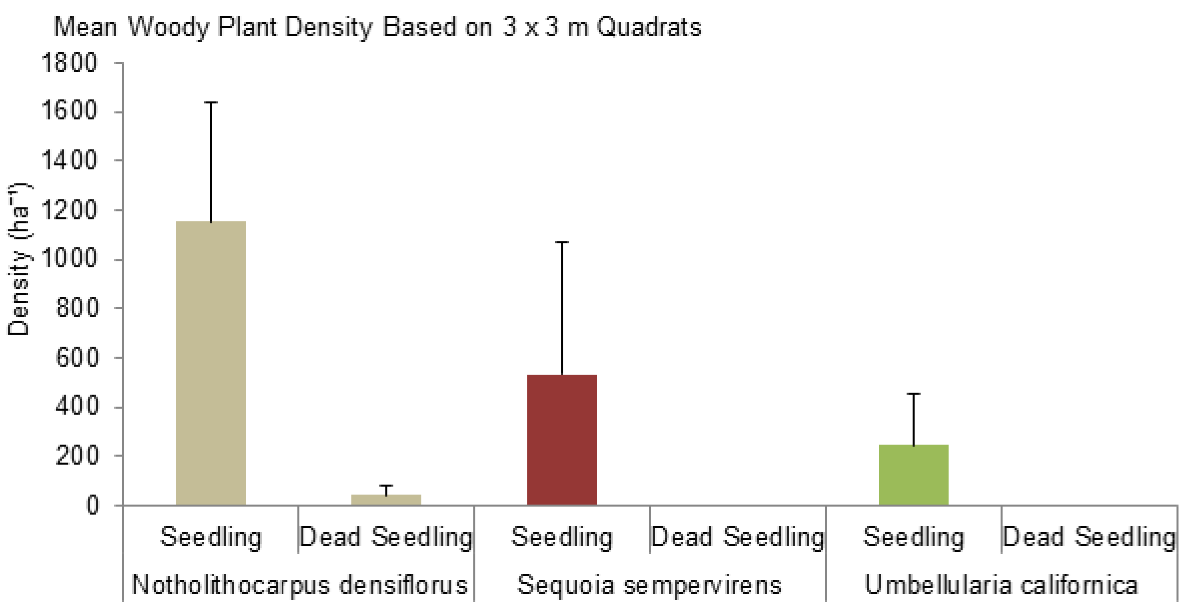

Figure 5. Mean density of woody plant life forms per hectare based on data from 3 x3 m quadrats. Standard errors are also shown. Live and dead trees are reported separately.

Density by Sample Site

Of the three tree species, *U. californica* exhibited the lowest live tree density over the entire study area. The majority of *U. californica* trees were found in the southern part of the canyon, associated with sample sites A through E (Figure 6). In contrast, sample sites found in the north portion of the canyon (sites F through I) contained relatively more live *N. densiflorus* tree stems (Figure 6); although, based on the density of dead tree stems (Figure 7), this species appears to have formerly been more prevalent in southern portion of the canyon. *S. sempervirens* exhibited higher tree stem density in the southern part of the canyon compared to the north (Figure 6).

Data of live sapling density also showed that *U. californica* is less abundant in the study area than both *S. sempervirens* and *N. densiflorus*, and is also relatively more prevalent in the southern part of the canyon compared to the north (Figure 8). Mean dead sapling density was lower than live sapling density (Table 2); although, more dead saplings were represented by *N. densiflorus* than any other species, with an unusually high amount in sample site D (Figure 9). *Notholithocarpus densiflorus* seedlings were more abundant than seedlings of any other species (Figure 5) and were found somewhat evenly throughout the entire study area (Figure 10). Seedlings of *S. sempervirens* and *U. californica* were only found in the most southern sample sites (Figure 10).

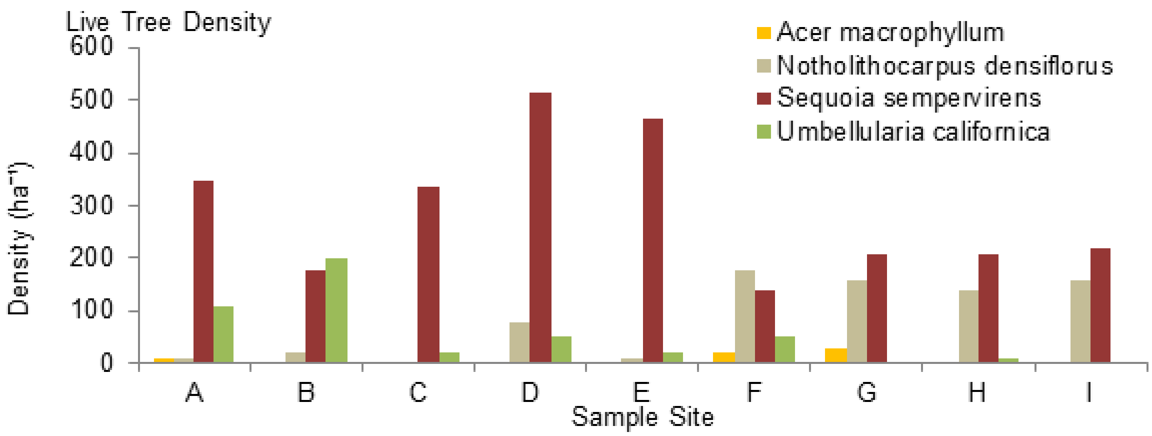

Figure 6. Live tree density per hectare by species by sampling site. Note that sites A through I are ordered from south to north.

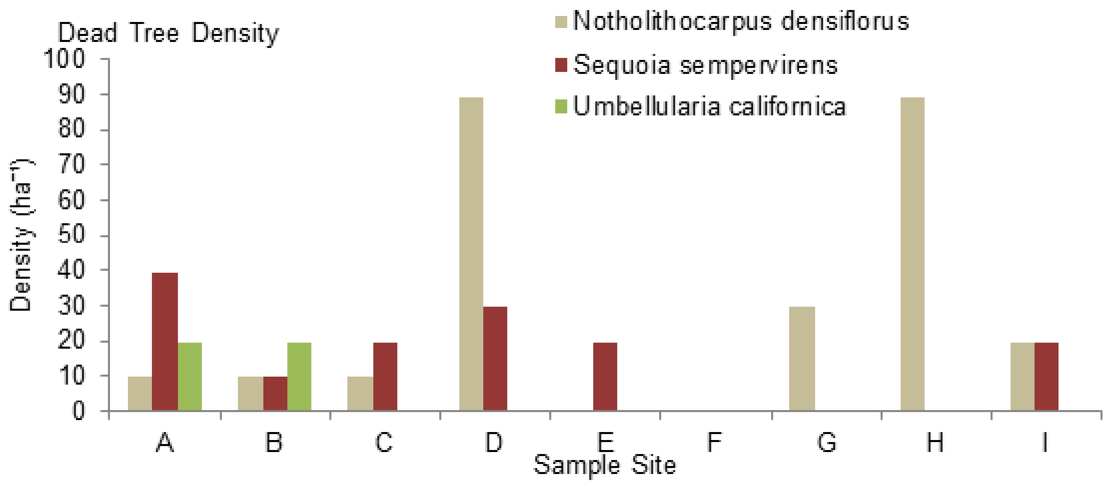

Figure 7. Dead tree density per hectare by species and by sampling site. Note that sites A through I are ordered from south to north.

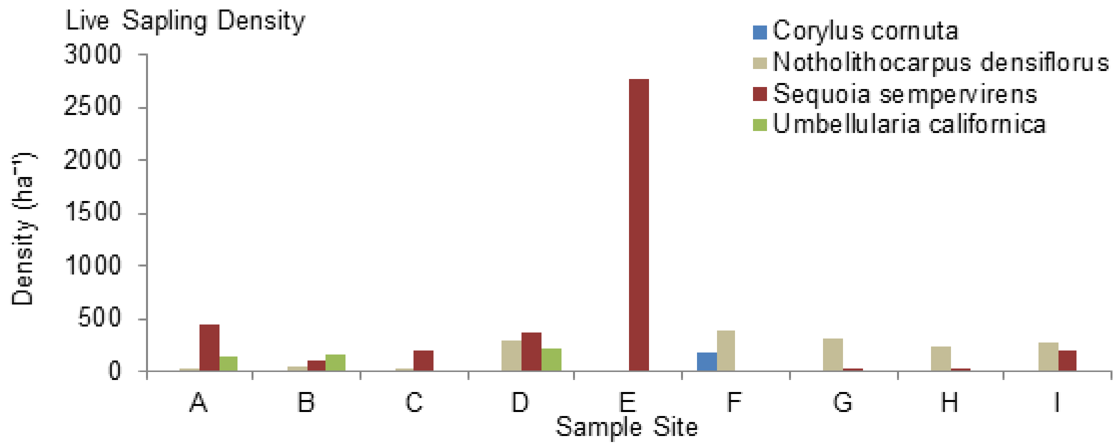

Figure 8. Sapling density of live trees per hectare by sample site. Note that sites A through I are ordered from south to north.

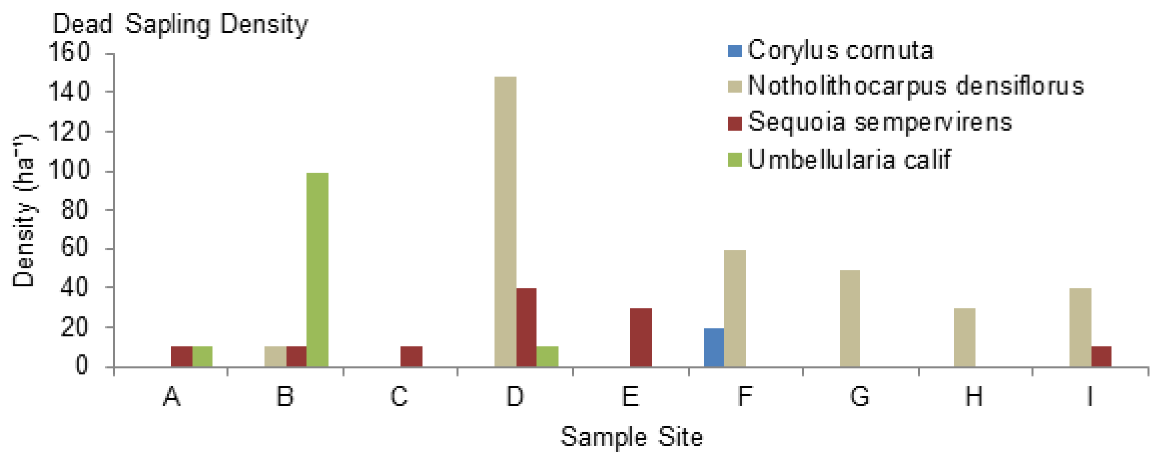

Figure 9. Sapling density of dead trees per hectare by sample site. Note that sites A through I are ordered from south to north.

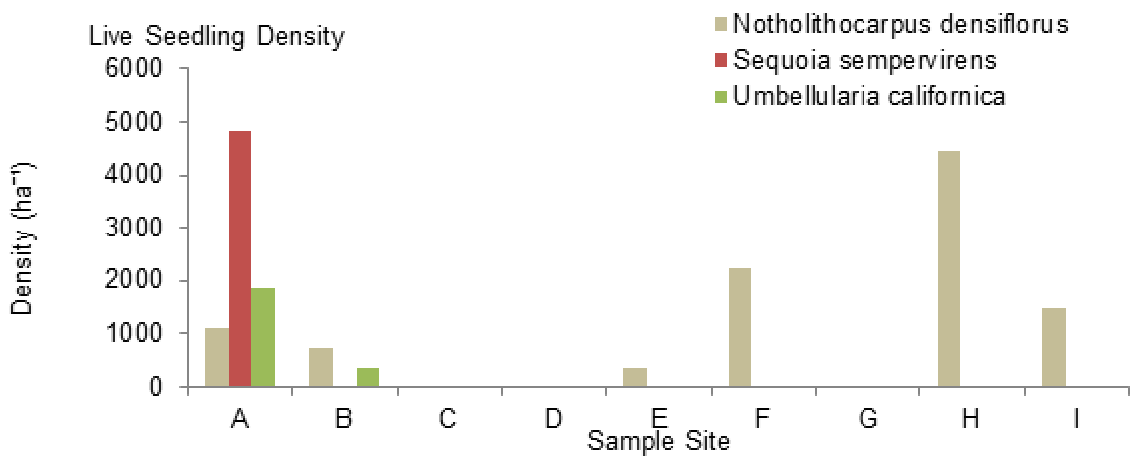

Figure 10. Seedling density per hectare by species by sample site. Note that sites A through I are ordered from south to north.

Comparisons in Forest Structure between the Macroplot and Subplot

Density per Hectare

For a range of tree size classes, we found no difference between their respective densities per hectare when measured from the entire macroplot versus when only sampled from the subplot (Table 3). The only exception was for trees in the 20–25 cm DBH size class (Table 3 and Figure 11); although, the number of sampling sites that had zero trees in the 20–25 cm DBH size class was high (6) for the subplot data.

Table 3. Comparison of mean live tree density per hectare for different size classes of trees between all stems found in the entire macroplot (17.95 m radius) versus all trees found just within the subplot (7.32 m radius).

Size Class (DBH in cm)	Mean with Standard Error		t	p value
	Macroplot	Subplot		
sapling	73.7 ± 26.8	79.5 ± 31.9	-0.442	0.6702
5 to 10	9.8 ± 1.7	11.4 ± 4.2	-1.542	0.1615
10 to 15	5.2 ± 1	4.7 ± 2.2	-0.36,	0.7282
15 to 20	3.6 ± 0.7	3.3 ± 1.5	-1.793	0.1107
20 to 25	2.6 ± 0.4	2 ± 1	-2.308	0.0498
25 to 30	1.7 ± 0.4	2.7 ± 1.5	-0.962	0.3641
30 to 35	1.7 ± 0.3	2 ± 1	-1.277	0.2374
35 to 40	1.2 ± 0.4	0.7 ± 0.7	-2.079	0.0712
40 to 45	1.4 ± 0.4	2 ± 1	-1.031	0.3325
45 to 50	0.8 ± 0.3	1.3 ± 1.3	-0.892	0.3982
50 to 75	2.6 ± 0.6	3.3 ± 1.8	-1.336	0.2183
75 to 100	2.6 ± 0.9	4.7 ± 1.9	0.3072	0.7666
100 to 150	5.1 ± 1.1	8 ± 3.2	-0.488	0.6383
150 to 200	2.8 ± 0.9	4 ± 1.7	-0.721	0.4915
> 200	2.8 ± 0.5	2.7 ± 1.5	-1.838	0.1033
Total trees*	43.7 ± 3.1	52.8 ± 6.2	1.8747	0.0977

* Total trees does not include saplings

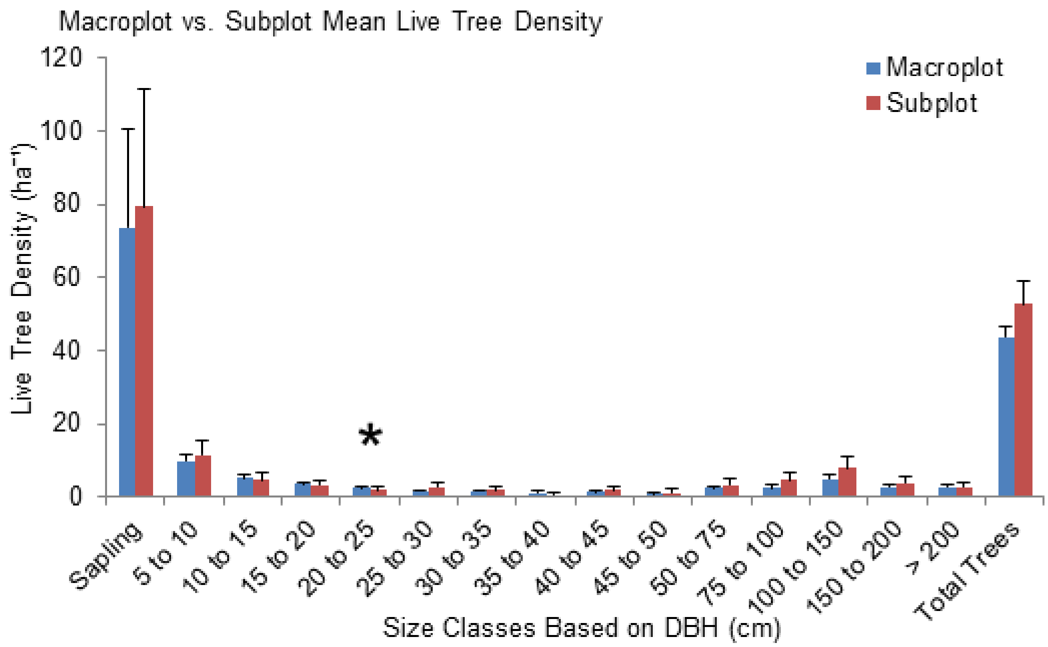

Figure 11. Comparison of mean live tree density per hectare between all trees using a 17.95 m radius plot (macroplot) versus all trees using a 7.32 m radius plot (subplot) for various size classes. Asterisks above paired bars indicate significant differences (α = 0.05).

Basal Area

Mean basal area per hectare of all live trees did not exhibit any difference when calculated from the entire macroplot (307.7 ± 26.2) versus using trees solely within the subplot (378.2 ± 88.6) (t = 0.8739, df = 8, *p* value = 0.4076). Also, when comparing mean basal area per hectare of all live trees in the macroplot (307.7 ± 26.2) versus all live trees in the macroplot with trees <20 cm scaled-up from the subplot (307.7 ± 26.3), the values were very similar and no significant difference was found (t = 0.2639, df = 8, *p* value = 0.7985).

Discussion

Tree Composition

Tree species richness and diversity were low in the valley floor of Redwood Canyon; however, this is not atypical of redwood forests, since tall, dense redwoods can preclude the establishment of shade intolerant tree species (Hunter 1997). While the herbaceous layer was not sampled in this study, additional surveys to establish the baseline of non-woody plant abundance and composition would greatly improve our understanding of how this old-growth forest may change in the future and also in comparison with other redwood forest stands being monitored locally by the SFAN Inventory and Monitoring Program, the San Francisco Bay Area Fire Effects Monitoring Program, and by other organizations elsewhere in coastal California.

Tree Structure

Per hectare, there are more than 1000 tree plus sapling stems in Redwood Canyon. *Sequoia sempervirens* exhibits the greatest mean stem density compared to all other species, with some of the highest density sites near the southern section of the canyon. *Umbellularia californica* exhibits the lowest tree stem density, with most of its stems also found in the southern part of the canyon. In contrast, *N. densiflorus* tree density is lower in the southern part of the canyon compared to the northern part, but dead tree stems, dead and live saplings, and seedlings were found more or less evenly throughout the entire canyon. Overall, the southern part of the canyon has higher tree density and contains the largest trees. This may be because the canyon is wider here and is less resource limited (e.g., water) as other tributaries have joined Redwood Creek by the time it flows through this section of the canyon.

Notholithocarpus densiflorus was the only species that had a greater mean DBH represented by dead individuals instead of live individuals. Symptoms of sudden oak death were observed on the majority of *N. densiflorus* measured during the study. Many downed *N. densiflorus* trees were also encountered during sampling but were never documented since this study only focused on standing stems. Furthermore, the density of dead trees, saplings, and seedlings were much higher for *N. densiflorus* than any other tree species. Clearly, sudden oak death is altering forests in Muir Woods just as it has elsewhere in Marin County (Ramage et al. 2012) and other portions of coastal California (Cobb et al. 2012). It appears that larger and older trees have been disproportionately impacted thus far. Also, it appears that trees and saplings in the southern part of Redwood Canyon seem to have been disproportionately impacted, possibly because a well-known sudden oak death host, *U. californica*, is more prevalent here; although it is difficult to speculate without measuring dead and downed trees or conducting additional studies.

In this study, we counted all free-living seedlings encountered but did not count seedling-sized basal sprouts or suckers growing out of live boles. Also, we only counted one seedling per dead bole if there were one or more live sprouts on its base. These seedling counting methods may have biased against *S. sempervirens* regeneration since that species can produce hundreds of basal sprouts per tree. Had every sucker been counted, both *S. sempervirens* and *N. lithocarpus* seedling numbers would have been much higher with the former having the highest numbers. However, the sampling was done to maximize time efficiency. In addition, because the vast majority of basal sprouts will not mature into tree stems, this was an acceptable trade-off. Lastly, we think that this method of limiting counts of basal sprouts will also result in less variance and have more statistical power for tracking changes in seedling density over time.

Comparisons between Macro- and Sub-plot Structural Measures

When data representing live tree density per hectare or live tree basal area per hectare were calculated from the macroplot and compared with the subplot, there were no significant differences found. When examining the same comparisons by size class, only density of 20–25 cm DBH trees differed between the macroplot and subplot. In this case, the data from the subplot contained many zeros and was not normal even after transformation. Combined with the low sample size used in the study, this finding alone should not be heavily weighed when designing the methods for SFAN plant community monitoring protocol. However, we also encountered a difference with this same size class based on sampling a valley oak (*Q. lobata*) savanna/woodland at John Muir National Historic Site (R. Steers, unpublished data). The data from the valley oak woodland revealed that mean stem density for trees in the 20–25 cm DBH size class, and greater, could not be accurately estimated using data solely collected at the subplot scale. Thus, in the most current version of the SFAN plant community monitoring protocol, all stems ≥20 cm DBH are sampled throughout the entire macroplot (including the subplot) and tree stem density for trees <20 cm DBH are only measured in the subplot.

Macroplot versus subplot basal area per hectare both yielded similar values. Also, average basal area per tree was almost identical between the macroplot and subplot. Lastly, basal area per hectare by size class was compared between the macroplot and the subplot and our analysis revealed that trees with a DBH less than 20 cm do not need to be sampled from the entire macroplot, similar to the findings based on tree density.

While limiting the outer macroplot (7.32 to 17.95 m radius area) sampling to trees ≥20 cm DBH will save considerable time, it is possible that where trees are highly clumped, this sampling methodology may not be suitable. For example, in recently harvested, second growth redwood forests, tree boles can be relatively thin and highly clumped with large spaces between clumps. Therefore, we recommend conducting a similar study in recently harvested redwood forests before these methods are to be used in that situation. As mentioned previously, the redwood forest measured in the Monument is old growth. The majority of redwood forests in the San Francisco Bay Area Network park units are second growth; however, all were last harvested many decades to a century ago. Thus, they contain large trees (i.e. >100 cm DBH). Vegetation sampling, following the methods outlined herein, have been conducted in many of these second growth forests with no apparent complications (R. Steers, unpublished data).

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Appendix A. Geographic Coordinates of the Sample Sites

Sample Site	Latitude*	Longitude*
A	37.893904°	-122.573828°
B	37.894905°	-122.575281°
C	37.895373°	-122.575689°
D	37.895486°	-122.574766°
E	37.895734°	-122.575950°
F	37.897713°	-122.574762°
G	37.899208°	-122.575961°
H	37.899120°	-122.577097°
I	37.901020°	-122.580133°

* Difficult to acquire coordinates so actual locations may be off by as much as 20 m.

Appendix B. Density and Diameter at Breast Height Data of Trees and Saplings

Sample Site	Species	Dead	DBH (cm)	Density of Sapling-sized Stems	Found within Subplot (7.32 m radius)
A	*Acer macrophyllum*		23.8		
A	*Notholithocarpus densiflorus*			1	X
A	*Notholithocarpus densiflorus*			3	
A	*Notholithocarpus densiflorus*		15.6		
A	*Notholithocarpus densiflorus*	X	27.9		
A	*Sequoia sempervirens*	X		1	
A	*Sequoia sempervirens*			2	X
A	*Sequoia sempervirens*			43	
A	*Sequoia sempervirens*		5.3		
A	*Sequoia sempervirens*		5.9		
A	*Sequoia sempervirens*	X	7		X
A	*Sequoia sempervirens*		9.9		
A	*Sequoia sempervirens*		10.1		
A	*Sequoia sempervirens*	X	12.8		
A	*Sequoia sempervirens*		13.9		
A	*Sequoia sempervirens*		18.8		
A	*Sequoia sempervirens*		21.3		
A	*Sequoia sempervirens*		24.7		
A	*Sequoia sempervirens*		25.9		X
A	*Sequoia sempervirens*		27.8		
A	*Sequoia sempervirens*		28.5		
A	*Sequoia sempervirens*		30.8		
A	*Sequoia sempervirens*		31		X
A	*Sequoia sempervirens*		33.7		
A	*Sequoia sempervirens*		37.2		
A	*Sequoia sempervirens*		37.4		
A	*Sequoia sempervirens*		37.7		
A	*Sequoia sempervirens*		39.8		
A	*Sequoia sempervirens*	X	42.9		
A	*Sequoia sempervirens*	X	47.6		X
A	*Sequoia sempervirens*		50.1		
A	*Sequoia sempervirens*		78.8		
A	*Sequoia sempervirens*		93.1		
A	*Sequoia sempervirens*		97.1		X
A	*Sequoia sempervirens*		103.6		X
A	*Sequoia sempervirens*		109.1		
A	*Sequoia sempervirens*		109.4		X
A	*Sequoia sempervirens*		116.1		X
A	*Sequoia sempervirens*		121.2		X
A	*Sequoia sempervirens*		128.2		
A	*Sequoia sempervirens*		129.1		

Sample Site	Species	Dead	DBH (cm)	Density of Sapling-sized Stems	Found within Subplot (7.32 m radius)
A	*Sequoia sempervirens*		137.7		X
A	*Sequoia sempervirens*		161.6		
A	*Sequoia sempervirens*		165.3		
A	*Sequoia sempervirens*		200.2		
A	*Sequoia sempervirens*		235.7		
A	*Sequoia sempervirens*		302.9		
A	*Umbellularia californica*	X		1	
A	*Umbellularia californica*			3	X
A	*Umbellularia californica*			12	
A	*Umbellularia californica*	X	5.8		
A	*Umbellularia californica*		5.9		
A	*Umbellularia californica*		6.8		
A	*Umbellularia californica*	X	6.9		
A	*Umbellularia californica*		7.7		
A	*Umbellularia californica*		10.6		
A	*Umbellularia californica*		11.5		
A	*Umbellularia californica*		11.9		X
A	*Umbellularia californica*		12.3		
A	*Umbellularia californica*		16.9		
A	*Umbellularia californica*		17.4		X
A	*Umbellularia californica*		17.4		
A	*Umbellularia californica*		22.5		
B	*Notholithocarpus densiflorus*	X		1	
B	*Notholithocarpus densiflorus*			5	
B	*Notholithocarpus densiflorus*		15.5		
B	*Notholithocarpus densiflorus*	X	19		
B	*Notholithocarpus densiflorus*		43.3		
B	*Sequoia sempervirens*	X		1	
B	*Sequoia sempervirens*			2	X
B	*Sequoia sempervirens*			8	
B	*Sequoia sempervirens*		6.4		X
B	*Sequoia sempervirens*		7.1		
B	*Sequoia sempervirens*	X	8.6		X
B	*Sequoia sempervirens*		8.8		
B	*Sequoia sempervirens*		9.7		
B	*Sequoia sempervirens*		16		
B	*Sequoia sempervirens*		16.9		X
B	*Sequoia sempervirens*		19.9		X
B	*Sequoia sempervirens*		21.3		
B	*Sequoia sempervirens*		23.3		
B	*Sequoia sempervirens*		72.7		
B	*Sequoia sempervirens*		138.9		
B	*Sequoia sempervirens*		165.5		
B	*Sequoia sempervirens*		171.2		
B	*Sequoia sempervirens*		177.3		X
B	*Sequoia sempervirens*		227.8		
B	*Sequoia sempervirens*		230.5		X
B	*Sequoia sempervirens*		296.6		X

Sample Site	Species	Dead	DBH (cm)	Density of Sapling-sized Stems	Found within Subplot (7.32 m radius)
B	*Sequoia sempervirens*		444.5		
B	*Umbellularia californica*	X		2	X
B	*Umbellularia californica*	X		8	
B	*Umbellularia californica*			16	
B	*Umbellularia californica*		5.1		
B	*Umbellularia californica*	X	5.4		X
B	*Umbellularia californica*		5.4		
B	*Umbellularia californica*		5.8		
B	*Umbellularia californica*	X	6.1		X
B	*Umbellularia californica*		6.6		
B	*Umbellularia californica*		6.7		
B	*Umbellularia californica*		6.9		
B	*Umbellularia californica*		7.4		
B	*Umbellularia californica*		7.6		
B	*Umbellularia californica*		8.1		
B	*Umbellularia californica*		8.7		X
B	*Umbellularia californica*		9.3		
B	*Umbellularia californica*		9.6		X
B	*Umbellularia californica*		10.4		
B	*Umbellularia californica*		11.8		
B	*Umbellularia californica*		14.7		
B	*Umbellularia californica*		15.8		
B	*Umbellularia californica*		15.8		
B	*Umbellularia californica*		17.8		
B	*Umbellularia californica*		26.4		
B	*Umbellularia californica*		57.3		
C	*Notholithocarpus densiflorus*			3	
C	*Notholithocarpus densiflorus*	X	24.8		
C	*Sequoia sempervirens*	X		1	
C	*Sequoia sempervirens*			3	X
C	*Sequoia sempervirens*			17	
C	*Sequoia sempervirens*		6.6		
C	*Sequoia sempervirens*		6.7		
C	*Sequoia sempervirens*	X	7		
C	*Sequoia sempervirens*		12.8		
C	*Sequoia sempervirens*		20		
C	*Sequoia sempervirens*	X	20.6		X
C	*Sequoia sempervirens*		21.4		
C	*Sequoia sempervirens*		21.5		
C	*Sequoia sempervirens*		26.3		
C	*Sequoia sempervirens*		34.1		
C	*Sequoia sempervirens*		36.5		
C	*Sequoia sempervirens*		38.5		
C	*Sequoia sempervirens*		42.6		
C	*Sequoia sempervirens*		42.6		
C	*Sequoia sempervirens*		43.2		X
C	*Sequoia sempervirens*		44.3		
C	*Sequoia sempervirens*		50.4		X

Sample Site	Species	Dead	DBH (cm)	Density of Sapling-sized Stems	Found within Subplot (7.32 m radius)
C	*Sequoia sempervirens*		53.2		
C	*Sequoia sempervirens*	X	62.3		
C	*Sequoia sempervirens*		70		
C	*Sequoia sempervirens*		71.1		
C	*Sequoia sempervirens*		71.3		X
C	*Sequoia sempervirens*		80		X
C	*Sequoia sempervirens*		80.4		X
C	*Sequoia sempervirens*		85.5		
C	*Sequoia sempervirens*		89		
C	*Sequoia sempervirens*		90.8		
C	*Sequoia sempervirens*		94.5		
C	*Sequoia sempervirens*		99.6		
C	*Sequoia sempervirens*		99.8		
C	*Sequoia sempervirens*		131.4		
C	*Sequoia sempervirens*		145.8		
C	*Sequoia sempervirens*		149.7		
C	*Sequoia sempervirens*		203.2		
C	*Sequoia sempervirens*		220.5		
C	*Sequoia sempervirens*		245.5		
C	*Sequoia sempervirens*		300.1		X
C	*Umbellularia californica*		14.3		
C	*Umbellularia californica*		14.5		
D	*Corylus cornuta*			2	
D	*Notholithocarpus densiflorus*			4	X
D	*Notholithocarpus densiflorus*	X		6	X
D	*Notholithocarpus densiflorus*	X		9	
D	*Notholithocarpus densiflorus*			26	
D	*Notholithocarpus densiflorus*		5.8		
D	*Notholithocarpus densiflorus*	X	6.1		
D	*Notholithocarpus densiflorus*	X	6.2		X
D	*Notholithocarpus densiflorus*		6.7		
D	*Notholithocarpus densiflorus*		6.8		
D	*Notholithocarpus densiflorus*		8		
D	*Notholithocarpus densiflorus*		8.2		
D	*Notholithocarpus densiflorus*	X	8.9		
D	*Notholithocarpus densiflorus*	X	10.3		
D	*Notholithocarpus densiflorus*	X	11.5		X
D	*Notholithocarpus densiflorus*		11.5		
D	*Notholithocarpus densiflorus*		12.7		X
D	*Notholithocarpus densiflorus*	X	13.8		
D	*Notholithocarpus densiflorus*	X	13.9		
D	*Notholithocarpus densiflorus*	X	16		
D	*Notholithocarpus densiflorus*	X	17		
D	*Notholithocarpus densiflorus*		23.8		
D	*Sequoia sempervirens*	X		4	X
D	*Sequoia sempervirens*			10	X
D	*Sequoia sempervirens*			28	
D	*Sequoia sempervirens*		5.5		

Sample Site	Species	Dead	DBH (cm)	Density of Sapling-sized Stems	Found within Subplot (7.32 m radius)
D	*Sequoia sempervirens*	X	5.9		
D	*Sequoia sempervirens*		7.1		
D	*Sequoia sempervirens*		7.4		
D	*Sequoia sempervirens*		7.5		X
D	*Sequoia sempervirens*		8.7		
D	*Sequoia sempervirens*		9.2		
D	*Sequoia sempervirens*		9.7		
D	*Sequoia sempervirens*		9.8		
D	*Sequoia sempervirens*	X	10		
D	*Sequoia sempervirens*		10.4		
D	*Sequoia sempervirens*		10.6		X
D	*Sequoia sempervirens*		11.1		
D	*Sequoia sempervirens*		11.1		
D	*Sequoia sempervirens*		12.5		
D	*Sequoia sempervirens*		14.3		
D	*Sequoia sempervirens*		14.5		X
D	*Sequoia sempervirens*		14.9		
D	*Sequoia sempervirens*		15.2		
D	*Sequoia sempervirens*		17.3		
D	*Sequoia sempervirens*		22		X
D	*Sequoia sempervirens*		22.1		
D	*Sequoia sempervirens*		25.2		
D	*Sequoia sempervirens*		31.2		
D	*Sequoia sempervirens*		32.8		X
D	*Sequoia sempervirens*		35.4		X
D	*Sequoia sempervirens*		35.4		
D	*Sequoia sempervirens*		44		
D	*Sequoia sempervirens*		46.6		
D	*Sequoia sempervirens*		47.6		
D	*Sequoia sempervirens*		52.2		
D	*Sequoia sempervirens*		70.4		
D	*Sequoia sempervirens*		71		
D	*Sequoia sempervirens*		71.1		
D	*Sequoia sempervirens*		72		
D	*Sequoia sempervirens*		72.1		
D	*Sequoia sempervirens*	X	75.5		
D	*Sequoia sempervirens*		88.1		
D	*Sequoia sempervirens*		95.8		
D	*Sequoia sempervirens*		96.9		
D	*Sequoia sempervirens*		98.1		
D	*Sequoia sempervirens*		102.9		
D	*Sequoia sempervirens*		106.6		
D	*Sequoia sempervirens*		110.3		
D	*Sequoia sempervirens*		113.5		
D	*Sequoia sempervirens*		118.4		
D	*Sequoia sempervirens*		118.9		
D	*Sequoia sempervirens*		120.3		X
D	*Sequoia sempervirens*		128.3		

Sample Site	Species	Dead	DBH (cm)	Density of Sapling-sized Stems	Found within Subplot (7.32 m radius)
D	*Sequoia sempervirens*		129.1		
D	*Sequoia sempervirens*		136.9		
D	*Sequoia sempervirens*		137.2		X
D	*Sequoia sempervirens*		144.4		
D	*Sequoia sempervirens*		152.2		X
D	*Sequoia sempervirens*		183.4		X
D	*Umbellularia californica*	X		1	
D	*Umbellularia californica*			6	X
D	*Umbellularia californica*			17	
D	*Umbellularia californica*		7.3		
D	*Umbellularia californica*		7.7		X
D	*Umbellularia californica*		8.4		
D	*Umbellularia californica*		10.1		
D	*Umbellularia californica*		14.3		
E	*Notholithocarpus densiflorus*		6.1		
E	*Sequoia sempervirens*	X		3	
E	*Sequoia sempervirens*			53	X
E	*Sequoia sempervirens*			227	
E	*Sequoia sempervirens*		5.9		
E	*Sequoia sempervirens*		5.9		
E	*Sequoia sempervirens*		6.3		
E	*Sequoia sempervirens*		6.3		
E	*Sequoia sempervirens*		7.2		
E	*Sequoia sempervirens*		7.7		X
E	*Sequoia sempervirens*		8.5		
E	*Sequoia sempervirens*		8.5		
E	*Sequoia sempervirens*		8.9		
E	*Sequoia sempervirens*		12.1		
E	*Sequoia sempervirens*	X	12.7		
E	*Sequoia sempervirens*		12.7		
E	*Sequoia sempervirens*	X	13		X
E	*Sequoia sempervirens*		14.2		X
E	*Sequoia sempervirens*		18.2		X
E	*Sequoia sempervirens*		19.6		
E	*Sequoia sempervirens*		23.4		X
E	*Sequoia sempervirens*		24.8		
E	*Sequoia sempervirens*		25		
E	*Sequoia sempervirens*		26.7		
E	*Sequoia sempervirens*		31.1		
E	*Sequoia sempervirens*		33.6		X
E	*Sequoia sempervirens*		36		
E	*Sequoia sempervirens*		42.4		
E	*Sequoia sempervirens*		45.3		
E	*Sequoia sempervirens*		49.7		
E	*Sequoia sempervirens*		54.8		
E	*Sequoia sempervirens*		66.5		
E	*Sequoia sempervirens*		68.4		X
E	*Sequoia sempervirens*		75.1		X

Sample Site	Species	Dead	DBH (cm)	Density of Sapling-sized Stems	Found within Subplot (7.32 m radius)
E	*Sequoia sempervirens*		75.1		
E	*Sequoia sempervirens*		84.6		
E	*Sequoia sempervirens*		105		
E	*Sequoia sempervirens*		110.8		
E	*Sequoia sempervirens*		123.2		
E	*Sequoia sempervirens*		126.9		
E	*Sequoia sempervirens*		145.1		X
E	*Sequoia sempervirens*		155.1		
E	*Sequoia sempervirens*		157.4		
E	*Sequoia sempervirens*		159		
E	*Sequoia sempervirens*		172.5		
E	*Sequoia sempervirens*		175.2		X
E	*Sequoia sempervirens*		180		
E	*Sequoia sempervirens*		180.5		
E	*Sequoia sempervirens*		189.4		
E	*Sequoia sempervirens*		199.7		X
E	*Sequoia sempervirens*		201.9		
E	*Sequoia sempervirens*		205.1		
E	*Sequoia sempervirens*		207.3		X
E	*Umbellularia californica*		15.5		
E	*Umbellularia californica*		17.2		
F	*Acer macrophyllum*		31.7		
F	*Acer macrophyllum*		44.4		
F	*Corylus cornuta*	X		2	X
F	*Corylus cornuta*			4	X
F	*Corylus cornuta*			15	
F	*Notholithocarpus densiflorus*	X		6	
F	*Notholithocarpus densiflorus*			9	X
F	*Notholithocarpus densiflorus*			30	
F	*Notholithocarpus densiflorus*		5.1		X
F	*Notholithocarpus densiflorus*		5.2		X
F	*Notholithocarpus densiflorus*		5.6		
F	*Notholithocarpus densiflorus*		6		X
F	*Notholithocarpus densiflorus*		6		
F	*Notholithocarpus densiflorus*		6.2		
F	*Notholithocarpus densiflorus*		6.2		
F	*Notholithocarpus densiflorus*		7		
F	*Notholithocarpus densiflorus*		7.1		X
F	*Notholithocarpus densiflorus*		8.5		
F	*Notholithocarpus densiflorus*		9		
F	*Notholithocarpus densiflorus*		9.9		X
F	*Notholithocarpus densiflorus*		10.2		
F	*Notholithocarpus densiflorus*		11		
F	*Notholithocarpus densiflorus*		12.1		
F	*Notholithocarpus densiflorus*		15.5		
F	*Notholithocarpus densiflorus*		16		
F	*Notholithocarpus densiflorus*		18.6		
F	*Sequoia sempervirens*		12.1		

Sample Site	Species	Dead	DBH (cm)	Density of Sapling-sized Stems	Found within Subplot (7.32 m radius)
F	*Sequoia sempervirens*		19.4		
F	*Sequoia sempervirens*		33.9		
F	*Sequoia sempervirens*		39.4		
F	*Sequoia sempervirens*		42.1		X
F	*Sequoia sempervirens*		100.9		
F	*Sequoia sempervirens*		137.1		X
F	*Sequoia sempervirens*		168.3		
F	*Sequoia sempervirens*		168.7		
F	*Sequoia sempervirens*		172.6		
F	*Sequoia sempervirens*		200		
F	*Sequoia sempervirens*		202.4		
F	*Sequoia sempervirens*		314.8		
F	*Sequoia sempervirens*		351.1		
F	*Umbellularia californica*			1	
F	*Umbellularia californica*		7.4		
F	*Umbellularia californica*		8.8		X
F	*Umbellularia californica*		16.9		
F	*Umbellularia californica*		20.5		
F	*Umbellularia californica*		41		
G	*Acer macrophyllum*		17.4		
G	*Acer macrophyllum*		27		
G	*Acer macrophyllum*		53.7		X
G	*Corylus cornuta*			1	X
G	*Corylus cornuta*			1	
G	*Notholithocarpus densiflorus*	X		2	X
G	*Notholithocarpus densiflorus*	X		3	
G	*Notholithocarpus densiflorus*			4	X
G	*Notholithocarpus densiflorus*			27	
G	*Notholithocarpus densiflorus*		5.2		
G	*Notholithocarpus densiflorus*		5.8		
G	*Notholithocarpus densiflorus*		6.1		X
G	*Notholithocarpus densiflorus*		7.2		
G	*Notholithocarpus densiflorus*		7.5		
G	*Notholithocarpus densiflorus*		7.5		
G	*Notholithocarpus densiflorus*		7.7		
G	*Notholithocarpus densiflorus*	X	8.5		
G	*Notholithocarpus densiflorus*		8.7		
G	*Notholithocarpus densiflorus*		10.9		
G	*Notholithocarpus densiflorus*		11.5		X
G	*Notholithocarpus densiflorus*		11.5		X
G	*Notholithocarpus densiflorus*		11.5		
G	*Notholithocarpus densiflorus*		13.1		
G	*Notholithocarpus densiflorus*		13.8		
G	*Notholithocarpus densiflorus*	X	16.6		X
G	*Notholithocarpus densiflorus*	X	19.6		
G	*Notholithocarpus densiflorus*		23.1		
G	*Notholithocarpus densiflorus*		32.9		
G	*Sequoia sempervirens*			3	

Sample Site	Species	Dead	DBH (cm)	Density of Sapling-sized Stems	Found within Subplot (7.32 m radius)
G	*Sequoia sempervirens*		8		X
G	*Sequoia sempervirens*		8.2		X
G	*Sequoia sempervirens*		8.7		X
G	*Sequoia sempervirens*		15.4		
G	*Sequoia sempervirens*		21.2		
G	*Sequoia sempervirens*		22.4		X
G	*Sequoia sempervirens*		23.7		
G	*Sequoia sempervirens*		25		
G	*Sequoia sempervirens*		44.4		
G	*Sequoia sempervirens*		61.3		
G	*Sequoia sempervirens*		66.5		X
G	*Sequoia sempervirens*		78.8		
G	*Sequoia sempervirens*		94		X
G	*Sequoia sempervirens*		101.8		
G	*Sequoia sempervirens*		104.1		X
G	*Sequoia sempervirens*		111.4		
G	*Sequoia sempervirens*		119.1		
G	*Sequoia sempervirens*		136		X
G	*Sequoia sempervirens*		136.1		
G	*Sequoia sempervirens*		181.9		
G	*Sequoia sempervirens*		223.9		
H	*Corylus cornuta*			1	
H	*Notholithocarpus densiflorus*	X		1	X
H	*Notholithocarpus densiflorus*	X		2	
H	*Notholithocarpus densiflorus*			8	X
H	*Notholithocarpus densiflorus*			16	
H	*Notholithocarpus densiflorus*		5.2		
H	*Notholithocarpus densiflorus*		5.9		
H	*Notholithocarpus densiflorus*	X	6		
H	*Notholithocarpus densiflorus*		6.2		
H	*Notholithocarpus densiflorus*	X	6.6		
H	*Notholithocarpus densiflorus*	X	10.2		
H	*Notholithocarpus densiflorus*	X	10.9		
H	*Notholithocarpus densiflorus*		11.1		
H	*Notholithocarpus densiflorus*		11.2		
H	*Notholithocarpus densiflorus*		12.1		
H	*Notholithocarpus densiflorus*	X	14.6		
H	*Notholithocarpus densiflorus*		15.6		
H	*Notholithocarpus densiflorus*		21.6		
H	*Notholithocarpus densiflorus*	X	22.5		
H	*Notholithocarpus densiflorus*	X	24.6		
H	*Notholithocarpus densiflorus*	X	26		
H	*Notholithocarpus densiflorus*		26.3		
H	*Notholithocarpus densiflorus*		26.8		X
H	*Notholithocarpus densiflorus*		28.4		
H	*Notholithocarpus densiflorus*		28.9		X
H	*Notholithocarpus densiflorus*		33		
H	*Notholithocarpus densiflorus*		37.5		

Sample Site	Species	Dead	DBH (cm)	Density of Sapling-sized Stems	Found within Subplot (7.32 m radius)
H	*Notholithocarpus densiflorus*	X	54.1		
H	*Sequoia sempervirens*			1	X
H	*Sequoia sempervirens*			3	
H	*Sequoia sempervirens*		13.4		
H	*Sequoia sempervirens*		24.9		
H	*Sequoia sempervirens*		33.3		
H	*Sequoia sempervirens*		34.8		
H	*Sequoia sempervirens*		42.1		
H	*Sequoia sempervirens*		47.9		
H	*Sequoia sempervirens*		64.4		
H	*Sequoia sempervirens*		84.1		
H	*Sequoia sempervirens*		100.8		
H	*Sequoia sempervirens*		112.1		
H	*Sequoia sempervirens*		131.2		
H	*Sequoia sempervirens*		143.2		
H	*Sequoia sempervirens*		147.3		
H	*Sequoia sempervirens*		148		
H	*Sequoia sempervirens*		161.9		
H	*Sequoia sempervirens*		166.8		
H	*Sequoia sempervirens*		177.2		
H	*Sequoia sempervirens*		178.6		
H	*Sequoia sempervirens*		229.1		
H	*Sequoia sempervirens*		238.7		
H	*Sequoia sempervirens*		313.7		
H	*Umbellularia californica*		19.5		
I	*Notholithocarpus densiflorus*	X		4	
I	*Notholithocarpus densiflorus*			4	X
I	*Notholithocarpus densiflorus*			24	
I	*Notholithocarpus densiflorus*		5.4		
I	*Notholithocarpus densiflorus*		5.4		
I	*Notholithocarpus densiflorus*		5.8		
I	*Notholithocarpus densiflorus*		6.7		
I	*Notholithocarpus densiflorus*		7		
I	*Notholithocarpus densiflorus*		9.6		
I	*Notholithocarpus densiflorus*		10.2		
I	*Notholithocarpus densiflorus*		10.6		
I	*Notholithocarpus densiflorus*		10.7		
I	*Notholithocarpus densiflorus*		12.1		
I	*Notholithocarpus densiflorus*		12.8		
I	*Notholithocarpus densiflorus*		13		
I	*Notholithocarpus densiflorus*		15		
I	*Notholithocarpus densiflorus*		16.4		
I	*Notholithocarpus densiflorus*	X	16.8		
I	*Notholithocarpus densiflorus*	X	17.4		
I	*Notholithocarpus densiflorus*		21.2		
I	*Notholithocarpus densiflorus*		32.6		
I	*Sequoia sempervirens*	X		1	
I	*Sequoia sempervirens*			4	X

Sample Site	Species	Dead	DBH (cm)	Density of Sapling-sized Stems	Found within Subplot (7.32 m radius)
I	*Sequoia sempervirens*			16	
I	*Sequoia sempervirens*		5.7		
I	*Sequoia sempervirens*		6		
I	*Sequoia sempervirens*		6.3		X
I	*Sequoia sempervirens*		6.3		
I	*Sequoia sempervirens*		15.3		X
I	*Sequoia sempervirens*		15.4		
I	*Sequoia sempervirens*		17.8		
I	*Sequoia sempervirens*		22.2		
I	*Sequoia sempervirens*		28.4		X
I	*Sequoia sempervirens*	X	37.8		
I	*Sequoia sempervirens*		44.1		X
I	*Sequoia sempervirens*		45.6		X
I	*Sequoia sempervirens*		48.2		X
I	*Sequoia sempervirens*		60.5		
I	*Sequoia sempervirens*	X	69.4		
I	*Sequoia sempervirens*		72.5		
I	*Sequoia sempervirens*		94.3		X
I	*Sequoia sempervirens*		112.3		X
I	*Sequoia sempervirens*		115.1		
I	*Sequoia sempervirens*		154.2		X
I	*Sequoia sempervirens*		160.8		
I	*Sequoia sempervirens*		217.5		
I	*Sequoia sempervirens*		280.4		
I	*Sequoia sempervirens*		309.9		

Appendix C. Density Data Derived from 3 x 3 m Quadrats

Sample Site	**Transect**	***Notholithocarpus*-Tree**	***Notholithocarpus*-Sapling**	***Notholithocarpus*-Dead-Sapling**	***Notholithocarpus*-Seedling**	***Notholithocarpus*-Dead-Seedling**	***Sequoia*-Tree**	***Sequoia*-Dead-Tree**	***Sequoia*-Seedling**	***Sequoia*-Sapling**	***Umbellularia*-Tree**	***Umbellularia*-Sapling**	***Umbellularia*-Seedling**
A	30°											3	5
A	150°		1		3								
A	270°						1	1	13				
B	30°						1			1			1
B	150°			1	2						1		
B	270°							1					
C	30°						1			1			
C	150°												
C	270°												
D	30°												
D	150°		1				2			1			
D	270°										1	1	
E	30°						1			2			
E	150°									3			
E	270°				1								
F	30°			1									
F	150°	1	2		4						1		
F	270°		1		2								
G	30°												
G	150°												
G	270°												
H	30°	1			6								
H	150°	1			3								
H	270°		4	2	3								
I	30°		1			1							
I	150°				4								
I	270°												

Appendix D. Densiometer Data

Sample Site	Location	Open Sky Hits North	East	South	West	Percent Canopy Coverage (%)* North	East	South	West
A	30	5	5	1	3	94.8	94.8	98.96	96.88
A	150	1	2	4	2	98.96	97.92	95.84	97.92
A	270	3	3	1	6	96.88	96.88	98.96	93.76
A	Center	6	2	3	1	93.76	97.92	96.88	98.96
B	30	1	8	3	6	98.96	91.68	96.88	93.76
B	150	1	5	12	2	98.96	94.8	87.52	97.92
B	270	3	2	3	3	96.88	97.92	96.88	96.88
B	Center	1	3	3	4	98.96	96.88	96.88	95.84
C	30	6	6	7	5	93.76	93.76	92.72	94.8
C	150	5	3	3	5	94.8	96.88	96.88	94.8
C	270	6	4	6	5	93.76	95.84	93.76	94.8
C	Center	12	12	7	12	87.52	87.52	92.72	87.52
D	30	6	5	3	4	93.76	94.8	96.88	95.84
D	150	2	4	4	12	97.92	95.84	95.84	87.52
D	270	1	3	4	3	98.96	96.88	95.84	96.88
D	Center	4	5	5	4	95.84	94.8	94.8	95.84
E	30	11	13	7	7	88.56	86.48	92.72	92.72
E	150	6	3	3	4	93.76	96.88	96.88	95.84
E	270	6	5	4	5	93.76	94.8	95.84	94.8
E	Center	5	7	5	6	94.8	92.72	94.8	93.76
F	30	11	5	4	2	88.56	94.8	95.84	97.92
F	150	3	3	7	2	96.88	96.88	92.72	97.92
F	270	5	2	3	12	94.8	97.92	96.88	87.52
F	Center	3	7	7	12	96.88	92.72	92.72	87.52
G	30	8	11	5	5	91.68	88.56	94.8	94.8
G	150	3	8	3	2	96.88	91.68	96.88	97.92
G	270	7	3	7	5	92.72	96.88	92.72	94.8
G	Center	9	8	5	6	90.64	91.68	94.8	93.76
H	30	7	11	10	6	92.72	88.56	89.6	93.76
H	150	7	6	7	9	92.72	93.76	92.72	90.64
H	270	5	6	12	5	94.8	93.76	87.52	94.8
H	Center	19	10	10	12	80.24	89.6	89.6	87.52
I	30	8	4	12	3	91.68	95.84	87.52	96.88
I	150	7	5	4	4	92.72	94.8	95.84	95.84
I	270	4	4	2	1	95.84	95.84	97.92	98.96
I	Center	3	2	4	6	96.88	97.92	95.84	93.76

Percent canopy coverage (%) calculated with the following formula: % = 100 - (# of Open Sky Hits*1.04)

NPS 112/124788, May 2014

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