STAND STRUCTURE AND COMPOSITION OF THE LITTLE LOST MAN CREEK RESEARCH NATURAL AREA, REDWOOD NATIONAL PARK

by

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ABSTRACT

The stand structure of an old-growth redwood forest was examined for the purpose of investigating age and diameter size-class distributions for redwood (Sequoia sempervirens), Douglas-fir (Pseudotsuga menziessi), western hemlock (Tsuga heterophylla), and tanoak (Lithocarpus densiflora).

Redwood, under both mesic and xeric site conditions, displayed evidence of an all-aged structure, suggesting a self-perpetuating replacement pattern. A similar pattern was also evident for western hemlock and tanoak. Douglas-fir indicated more of an even-aged, disturbance-induced pattern.

The composition of the stand in terms of density was examined, and findings were consistent with other observations in redwood forests.

Implications for park management strategies are discussed.

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INTRODUCTION

There are few trees which have received as much attention, or possess as many unique characteristics as the coast redwood, Sequoia sempervirens. It is unique in a number of ways, primarily in terms of its exceptional size and longevity. The tallest known tree in the world is a redwood measuring 112.1 meters (367.8 feet) in height, growing on an alluvial flat by Redwood Creek in Redwood National Park, and ages of individual redwood have been recorded that place this species among the longest living (Fritz 1929).

Despite the considerable attention redwood has received in forestry literature, there is no consensus on a successional status, nor on a characteristic stand structure for an old-growth forest. Differing opinions of the ecology of a species of a forest type, however, are common.

Prediction of future vegetation composition is speculative. The best method is one of examining past characteristics, in light of silvical characteristics of species involved (Veirs, 1982). Stand structure analysis, an evaluation of the composition of species present, their age-classes (an indication of regeneration patterns), and size-classes (an indication of their role in the system), offers some insight into expected trends, and may provide for development of management objectives.

In one of the earlier studies of this kind, it was concluded (Fritz 1929) that the redwood forest is typically all-aged in structure:

> I have often heard the redwood forest spoken of as being overmature, and some have even described it as being even-aged. Nothing is farther from the fact. There is not a forest in the world (where there) is such an inequality of ages and where there are so many vigorously growing trees as contrasted to decadent trees.

A later study by Fritz (1957) of age and size distributions revealed a pattern of trees in all age and size classes. It was concluded that such a profile constituted the characteristics of a self-perpetuating forest. This conclusion was also reached by Veirs (1972), working on plots in Del Norte and Humboldt County. He found a wide spectrum of ages and diameter sizes on stumps from harvested timber, suggestive of an all-aged stand. Cooper (1965), however, reported that both redwood and Douglas-fir (*Pseudotsuga menziesii*) grow as a mixed-conifer forest in a patchwise pattern of even-aged stands.

Stone et al. (1969) also concluded that redwood can only maintain its role in the vegetation complex by the influence of periodic disturbance (flooding or fire), and that in the absence of those factors, other species would emerge as the eventual forest composition, not dominated with redwood. These conclusions, however, were based on observations of conditions primarily found in the alluvial forest environment.

Previous research into the ecology of redwood has been focused on the environment of the alluvial flat (Stone 1966, Zinke 1966, Becking 1968, and Fritz 1934). Most investigators have confirmed that periodic flooding and silt deposition have favorably influenced redwood reproduction at the expense of other species not as capable of withstanding water or silt inundation.

Stone and Vasey (1968), reported that redwood has unique physiological capabilities to adapt to flooding conditions through the ability of the root system to grow vertically into newly deposited silt layers. Additionally, evidence from fallen trees in the alluvial flat environment has revealed that an adventitious root system develops from portions of the stem buried beneath silt deposits (Fritz 1934, Zinke 1966).

Zinke (1966), retraced the flood history in the Bull Creek basin through the examination of silt-deposited layers and found that floods have historically occurred on the average of every 50 years, over the past 1000 years. It was theorized that ages of redwood correspond to the dates of floods, indicating a relationship between flood occurrence and successful redwood establishment. Redwood's success in this environment was due in part to the fact that its tolerance of flood conditions gave it a competitive advantage over other species such as Douglas-fir, grand fir (*Abies grandis*), and western hemlock (*Tsuga heterophylla*).

Newly deposited silt layers also provide an ideal medium for the germination of seeds of most species, and with a dominance of redwood in the alluvial flat, there is little interspecific competition for redwood seedling establishment in these areas from other species (Stone 1968).

The role of fire in redwood vegetation has also been the subject of differing theories. Stone (1969) maintained that redwood dominance is fire-dependent, and in the absence of fire, composition would change toward a greater predominance of hardwoods, Douglas-fir, Sitka spruce (*Picea sitchensis*), grand fir, and western hemlock. The argument was that redwood was dependent on fire to remove accumulated forest litter that impedes seed germination and seedling survival (Florence 1965). Redwood also has a comparatively fire-resistant bark (on mature trees), is more capable of withstanding fire than other species, and therefore dominates recolonization in burned areas. The combining influence of the removal of competing vegetation and site preparation has been interpreted by some as a dependency factor.

However, Fritz (1929) stated that "fire is a genuine enemy of the redwood and should therefore be kept out". This was also suggested by Roy (1966).

The concepts of forest age-structure, size-structure, density, and successional status are all intimately related, and help define the requirements of an individual species, as well as the synecological relations within a forest. Knowledge of these characteristics may provide useful information in terms of management.

If redwood dominated vegetation is dependent on flood or fire, and if regeneration is exclusively disturbance induced, the age-structure should exhibit a pattern resembling an even-aged profile.

The primary objective of this study, therefore, was to test an hypothesis that the stand structure of redwood more closely resembled that of an all-aged stand than other possible stand structures. A secondary objective was to examine this stand structure with that of associated tree species.

The focus of this study was on the upland, old-growth forest, which comprises a significant portion of the area of Redwood National Park, and which has received less attention than the alluvial flat forest.

The implications of this study may be of significance in terms of silvicultural practice, and especially in terms of preservation management in the park environment.

METHODS AND DESCRIPTION OF STUDY AREA

This study was conducted in the Little Lost Man Creek watershed of Redwood National Park, near Orick, California, during the months of March-June, 1977.

The general watershed boundaries of Little Lost Man Creek were used to delineate the area sampled. The study area (Figure 1) was approximately 890 hectares (2200 acres) in size, and has been, for the most part, undisturbed by human activity. For the purposes of this study, it was necessary to work in such an area, wherein succession and other vegetation processes were occurring at their natural rate.

Certain areas, particularly along the periphery of Bald Hills Road on the western edge of the watershed were excluded from the study area due to disturbances to soil or vegetation resulting from road construction and partial timber harvesting. A 16.2 hectare (40 acre) block, harvested for timber in 1962, was excluded from the study, as were certain areas which, due to remoteness or terrain, were inaccessible.

The main drainage in the area is Little Lost Man Creek, a perennial watercourse which flows in general from southeast to northwest. The area is characterized by steep terrain from the main ridges to the creek bottom, especially steep toward the lower reaches of the slopes, and by

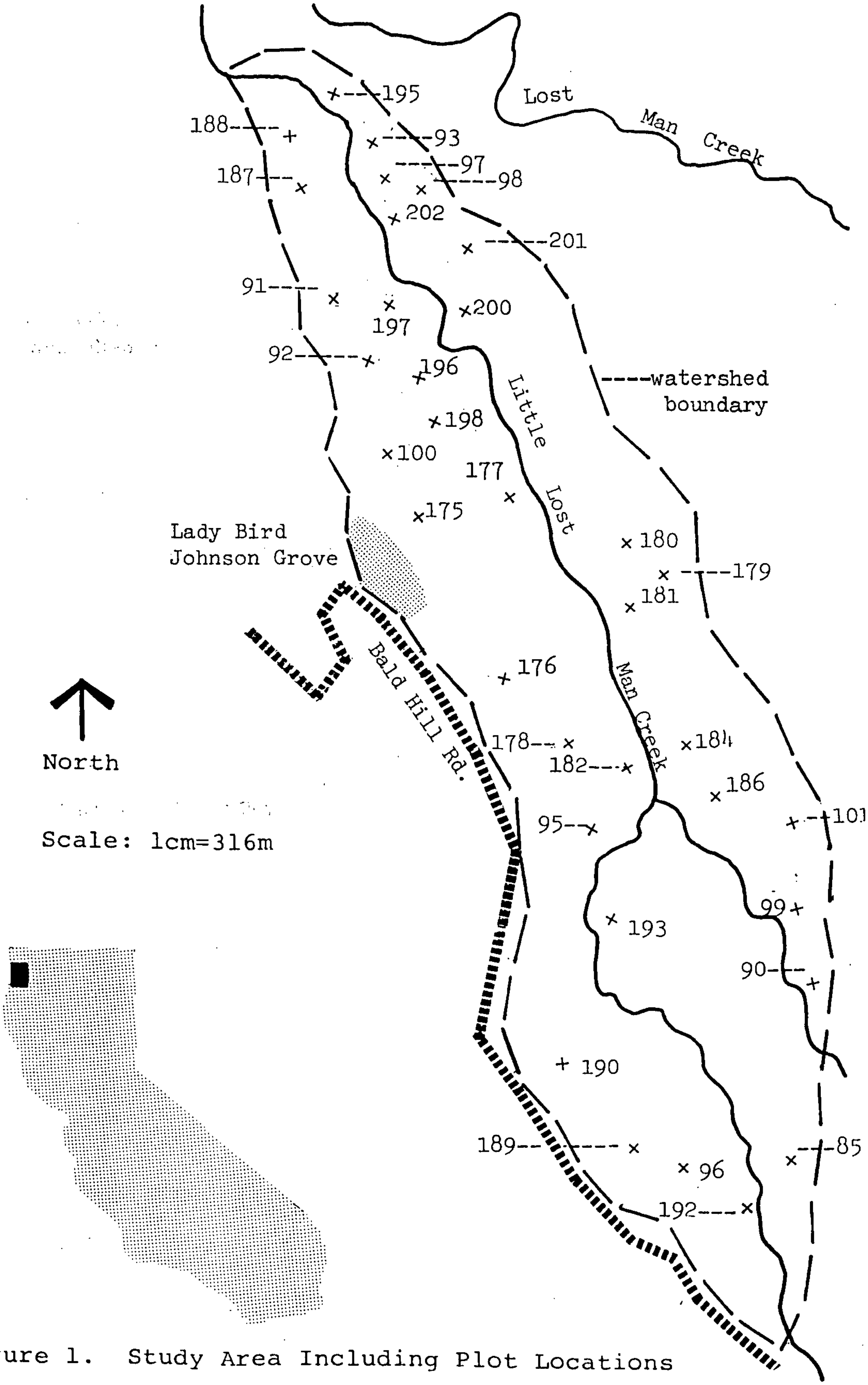

Figure 1. Study Area Including Plot Locations

steeply sloping lateral triburary drainages. The canyon is generally V-shaped, and there is no area that could be classified as an alluvial flat.

This area was made a part of Redwood National Park with the passage of the legislation creating the Park in 1968 (Veirs, personal communication). This area includes the Lady Bird Johnson Grove, a section of the Park that is relatively flat, features impressive groves of trees, and is among the more popular spots of visitation.

Immediately outside the Grove, however, the terrain is steep, the understory vegetation dense, and there are no designated trails; visitor usage in this area is very limited, and therefore the impact on vegetation is almost nonexistent. It is designated a Research Natural Area by the National Park Service, which suited the requirements for this study.

Soils and Geology of Study Area

Soil series found in the Little Lost Man Creek basin include the Melbourne, Hugo, Mendocino, and Usal series (DeLapp et al. 1959). Approximate area distributions of these series are shown in Table 1.

The soils in the study area are generally clay loams derived from sandstone and shale parent material. Soils typically display rapid permeability, good drainage, and moderate to high erosion hazard potential.

Table 1. Soils of the Little Lost Man Creek Watershed

Soil Series	Hectares	Acres	Percent of Total
Hugo	17.8	44	2%
Melbourne	258.2	638	29%
Hugo/Melbourne Assoc.	569.8	1408	64%
Mendocino	17.8	44	2%
Usal	26.7	66	3%
Total	890.0	2200	100%

All soils in the basin have high potential timber productivity and in all but a few isolated locations are rated as Site Class II (DeLapp et al. 1959) for Redwood/ Douglas-fir. Similarily, all soils are classified as being from moderately deep, 0.91-1.2 meters (3 to 4 feet), to deep (greater than 1.2 meters or 4 feet). The soil series of each of the study plots is detailed in the plot description summary in the appendix.

The study area and most of Redwood National Park is underlain by the Franciscan formation. The composition of this formation is described as graywacke, interbedded shale, minor conglomerate, thin-bedded chert, and some undifferentiated spilitic rocks altered to greenstone, with small masses of glaucophane schist (Strand 1963).

Climatic conditions are nearly uniform throughout the study area, with average annual precipitation of approximately 241.3 centimeters (95 inches) (Veirs, personal communication).

Data Collection Methods

Sample plots were located in a stratified random sample method from a grid system overlaid on aerial photographs. Plots were 0.10 hectare (0.25 acre) in size, with rectangular dimensions of 45.7 meters (150 feet) by 22.1 meters (72.5 feet) with the longer dimension running parallel with the contour on slopes. The length of the shorter dimension was adjusted for slope, as necessary.

A plot marker with identification number was placed in each sample plot.

Within each plot a series of measurements and observations were made, for the purpose of determining tree species composition, density, age classes, diameter-size classes, and height classes. The diameter at breast height (d.b.h.) was measured to the nearest inch for each tree species present. Conversions to metric units were made later and are included. Diameters were measured by diameter tape, which yields the most accurate measurement for large timber (Dilworth 1976).

All trees greater than 121.9 cm (48 in) d.b.h. were classified together in one group. This was done to facilitate the inventory, and because the primary concern of this study was to document relatively recent reproduction patterns. The only species exceeding 121.9 cm (48 in) d.b.h. were redwood and Douglas-fir.

Some species found in this area may be classified as either a shrub or tree, depending on the growth form it may take. In the case of tanoak (Lithocarpus densiflora), and madrone (Arbutus menziesii), stems to a minimum d.b.h. of 2.54 cm (1 in) were inventoried as trees. Tree species occuring as at least one observation in any plot included the following: coast redwood, Douglas-fir, western hemlock, tanoak, Sitka spruce, grand fir, and madrone.

A height class indicating canopy position was estimated for each tree into one of the following height class categories: Dominant (D), Co-dominant (CD), Intermediate (I), or Suppressed (S). This classification was based on the terminology of Smith (1962). The height class assigned to each tree was made relative to the height of the dominant tree or trees in that particular plot, rather than to the overall height values of the entire study area. These observations were made in order to have information on canopy stratification in the forest, and also for the purposes of age determination.

An estimation was made of the composition and density of species in the understory vegetation in each plot. Species present in either dominant roles or as significant site indicators included the following: sword fern (Polystichum munitum), salmonberry (Rubus spectabilis), dwarf Oregon-grape (Berberis nervosa), oxalis (Oxalis oregana), evergreen huckleberry (Vaccinium ovatum), coast Rhododendron (Rhododendron macrophyllum), salal (Gaultheria shallon), and tanoak (when taking the growth habit of a shrub).

Two categories were established, based on empirical data of Waring and Major (1965), from which they identified the ecological optimum of each of those species in terms of a moisture gradient. For this study, sites dominated by sword fern, salmonberry, dwarf Oregon-grape, and oxalis represented mesic conditions, while evergreen huckleberry, coast Rhododendron, salal, and tanoak represented xeric conditions.

Age determinations were made by boring selected trees in each plot. For redwood, Douglas-fir, and hemlock, sample trees were aged that represented the height classes present in the stand. Ages were not determined for tanoak, which cannot be reliably aged by increment boring (Thornburgh, personal communication). Other tree species occurred in insufficient numbers to sample.

Trees to be aged were selected on the basis of uniformity of circular dimensions, and regularity and form of branching, so that growth rings would as uniform around the tree as possible (Fritz 1924). For those trees with a smaller radius than the length of the increment borer, borings were made to the center of the tree. On trees with a radius greater than the available length of the borer, the average number of rings per radial inch (2.54 cm) were determined so that extrapolation of ages to the center of the tree could be made.

The increment borings were made at breast height (1.4 m), to correspond with the height of diameter measurement. The age of the tree at breast height approximates the true age of the tree, but in each case is systematically lower than the true age.

Age determinations were made on randomly selected sample trees that displayed the characteristics previously described, rather than all trees in order to maximize field time and to allow for sampling in a greater number of plots.

Although radial growth rates may vary widely for a species over different environmental circumstances, these rates should not have been sufficiently different within the same 0.10 hectare (0.25 acre) (in which the principal factors affecting radial growth--density, climate, and soil conditions, would be nearly constant for all trees).

Some variation can be expected from canopy position, density change over time, and from genetic variability. The factor of canopy position was addressed by selecting a sample tree from each of the height classes present. It can be expected that dominant and co-dominant trees will grow at somewhat faster rates than intermediate or suppressed trees, due to greater availability of solar radiation and more photosynthetic surface (Smith 1962).

Generally, the conditions were representative of optimum growing conditions for redwood. Trees growing under their optimum conditions usually do not show great variation in growth rates, although there may be a gradual decrease in ring width with maturity (Avery 1975).

There was no practical means of accounting for genetic variability, other than to acknowledge that it may have influenced the data.

When possible, redwood appearing to originate from a parent-tree root-crown as sprouts were not sampled together, although they were credited as observations, because each obviously represented potential replacement trees.

Approximate ages were calculated for all redwood, Douglas-fir, and hemlock trees 2.54 cm to 121.9 cm (1 to 48 in) d.b.h. Bark thicknesses were measured from sample trees of redwood and Douglas-fir, along with d.b.h. From this sample, a linear regression showed a significant correlation between d.b.h. and bark thickness. The thin bark of mature hemlock made bark thickness measurements unnecessary.

A count of the total number of annual growth rings in each core sample was made. This figure divided by the length of the increment boring, provided the average number of annual rings per inch (2.54 cm) of radial growth.

Ages for redwood and Douglas-fir were then determined by the method:

Age (at breast height) = Radius (inches, and cm)
x (Average number of years/radial inch, and cm)

where Radius = 1/2 Diameter inside bark (d.i.b.)

and d.i.b. = (d.b.h.) - (2 x bark thickness)

For hemlock, no deductions of bark thickness were made, and age determinations were made by the same method, where Radius = 1/2 x d.b.h.

The determination of dominant understory vegetation and general site was made by visual estimation of the plot, rather than by quantitative means.

RESULTS

It appeared that redwood in this environment generally conformed to an all-aged and all-sized stand structure.

Figure 2 and Tables 2 and 3 present data from all plots in both mesic and xeric sites. In both cases, the shape of the curves derived from the data basically conformed to the inverse "J-Shape" curve characteristic of the all-aged stand (Smith 1962).

Results from age-class distributions suggested that there was a more distinctive all-aged pattern for redwood in mesic site than xeric (Figure 2).

Other species occurred in insufficient quantity to form a distinctive pattern in terms of age or size structure. Based on limited observations, it appeared that hemlock conformed closely to the all-aged and all-sized stand structure, similar to redwood (Figure 3 and Table 4).

This pattern was not as clearly evident among Douglas-fir (Figure 4 and Table 5), nor in the size distribution for tanoak (Figure 5 and Table 6).

An analysis was made of differences in populations between observations in the mesic site and xeric site for the primary species that were aged (redwood, hemlock, and Douglas-fir).

Mean values for numbers of trees per hectare were compared by use of the "t" test for analysis of variance. Critical values for the "t" distribution were taken from Zar (1974). The test employed a 95% confidence level.

There was not a significant difference in density for redwood between the mesic and xeric sites, with a test value for "t" of 0.551, less than the critical "t" value of 2.069 at the 0.05 level with 23 degrees of freedom.

Hemlock was a more prominant component of the mesic site than the xeric, with a test value for "t" of 2.21, which was greater than the critical "t" value of 2.069 at the 0.05 level with 23 degrees of freedom.

An opposite pattern was observed for Douglas-fir, which was more abundant in the xeric site than the mesic, with a test value for "t" of 2.77, which was greater than the critical "t" value of 2.064 at the 0.05 level with 24 degrees of freedom.

Figure 6 and Tables 7 and 8 show stand density in percentage of stand composition for each plot, and cumulative values. These findings were consistent with the observations of Waring and Major (1965) in terms of the arrangement of species along a moisture gradient, with increasing density as an indication of ecological optimum.

In both the mesic and the xeric site, redwood was observed the most often, representing 65.8% and 41.2%, respectively, of the observations in each site.

Evidence of past fires, in the form of fire scars on the outer bark, was noted as encountered (Table 9). This observation would suggest that it was unlikely that any large-scale, high intensity fires had occurred in this study area within the past 160 years, approximately. That was the age of the youngest trees observed with fire scars on the outer bark.

One of the curious aspects of fire evidence in this study was the indication that fires may have occurred on a very localized basis. It was sometimes observed that within one plot, certain trees would show fire scars, while adjacent and older trees showed none.

There are a number of possible explanations. A single tree struck by lightning may be individually burned and scarred without any damage occurring to neighboring trees. Differing quantities of fuel on the ground may cause the intensity of fires to vary within the same immediate location, with burn-scars occurring on those trees with heavier accumulations of fuel at their base. The relative position of a tree on a slope may be a factor, also, whereby trees on the upslope position of the point of initiation of a fire may be effected, while trees on the downslope position are not.

The majority of fire-scarred trees were in the 121.9 cm+ (48 in+) class, representing 86% of the observations for redwood, and 78% of the observations for Douglas-fir (Table 9). Evidence of fire was scattered, with both mesic sites as well as xeric sites affected.

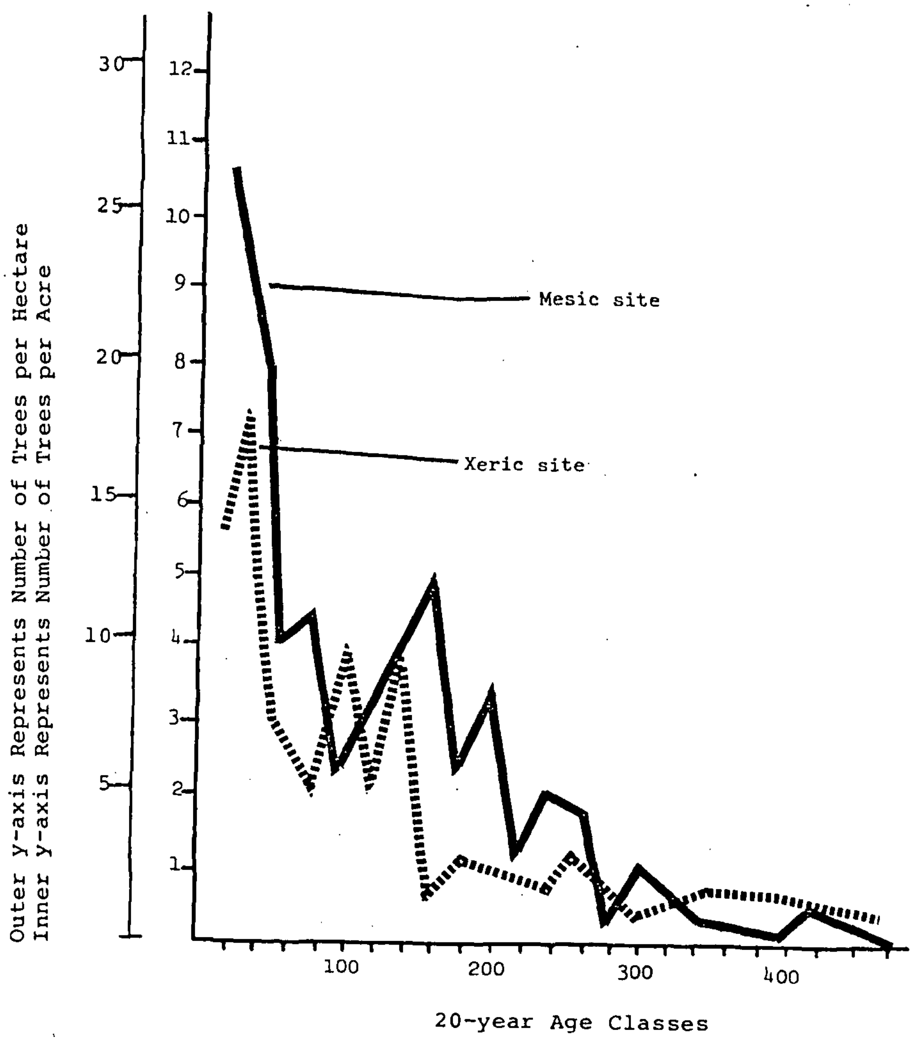

Figure 2. Redwood Age-Class Distributions.

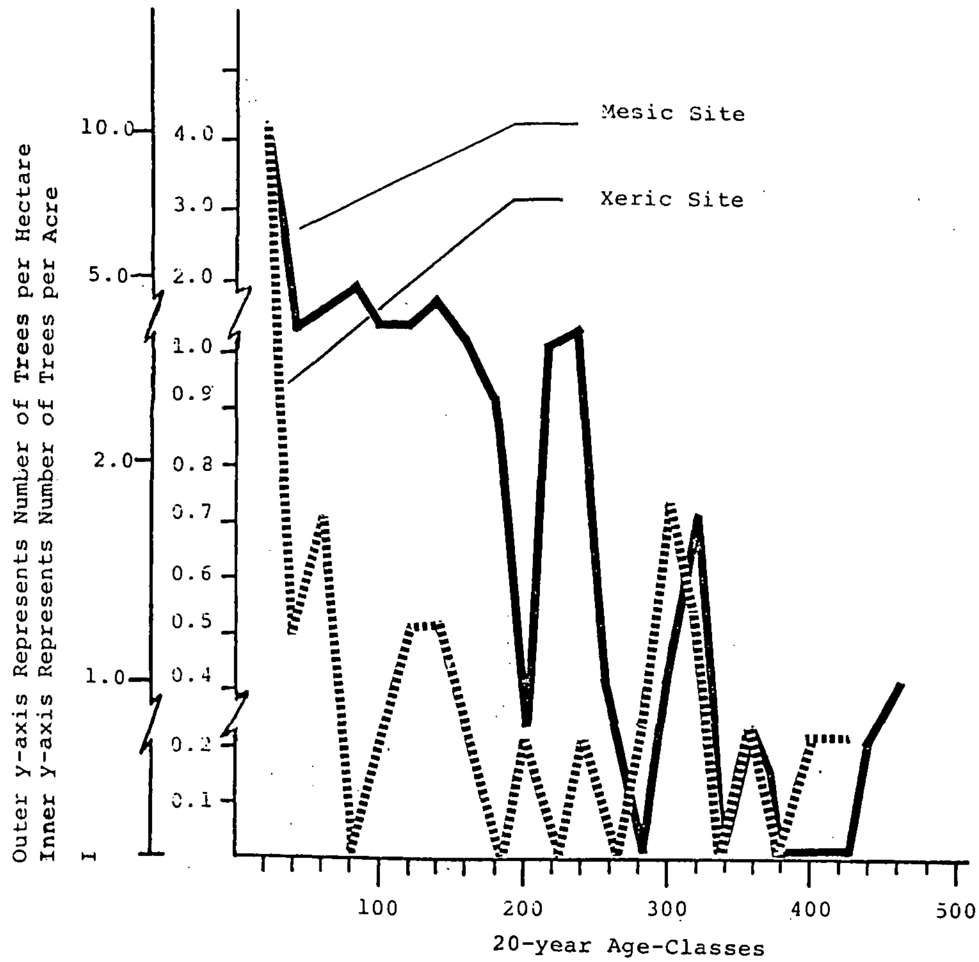

Figure 3. Hemlock Age-Class Distributions.

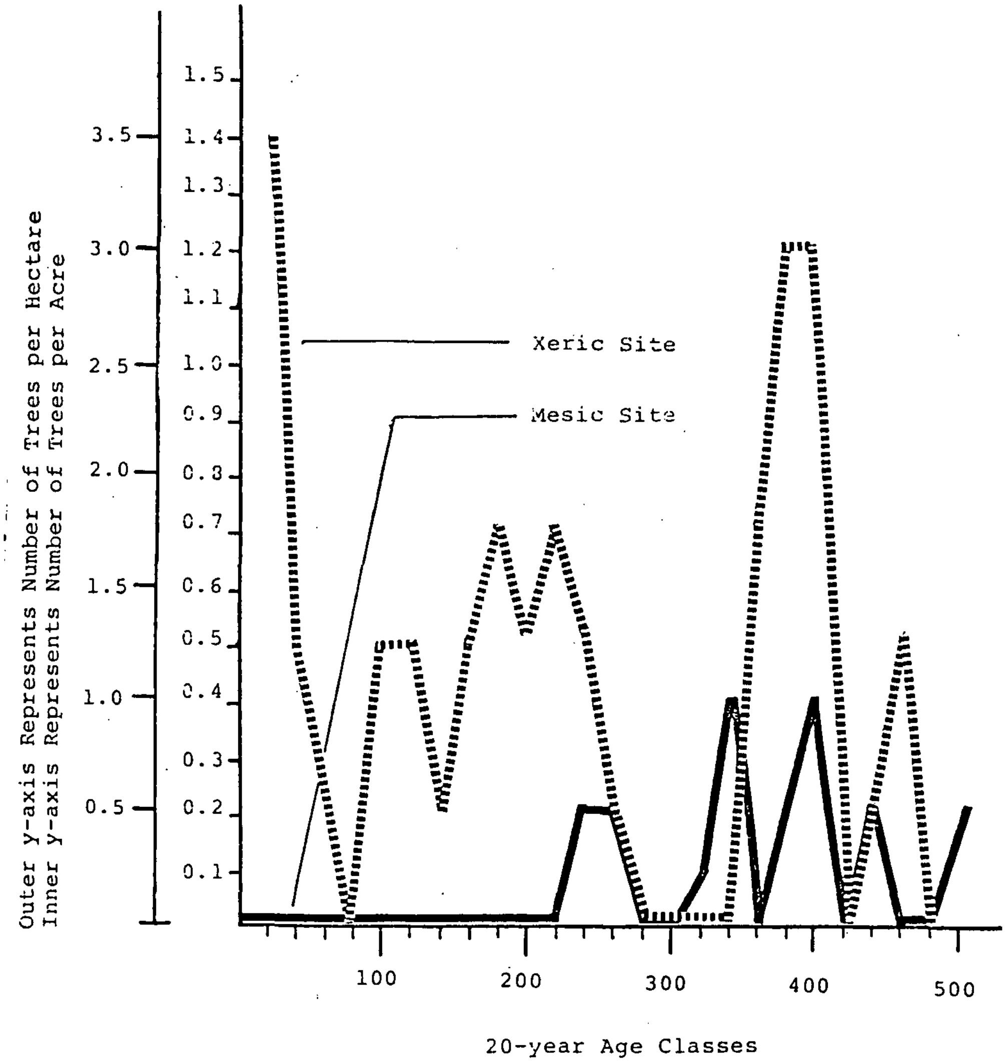

Figure 4. Douglas-fir Age-Class Distributions.

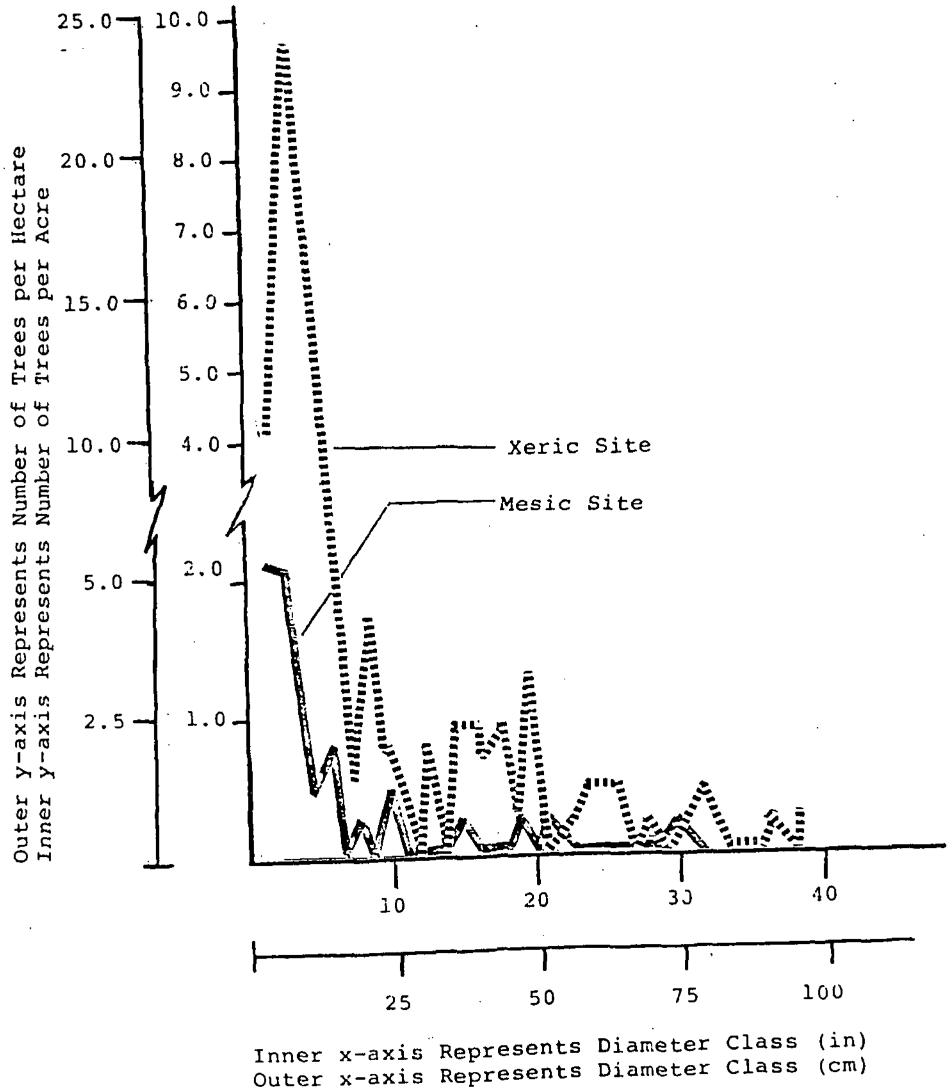

Figure 5. Tanoak Diameter Distributions.

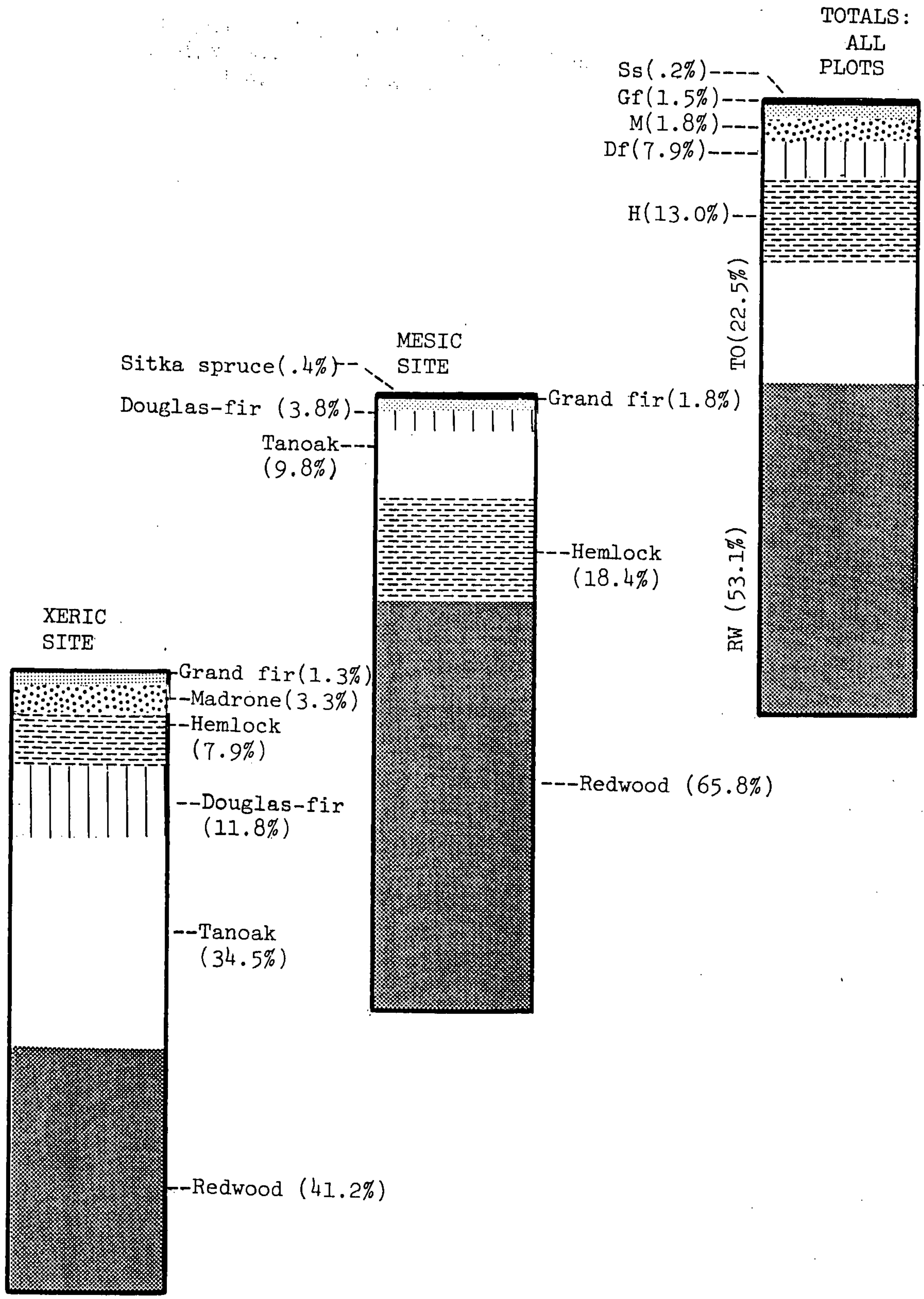

Figure 6. Percentage of Stand Composition.

Table 2. Redwood Age-Class Distributions. Based on all Trees 2.54-121.9 cm (1-48 in) d.b.h.

Age-Class (yrs)	Mesic Site			Xeric Site			Both		
	No/Per Ac/Per Ha			No/Per Ac/Per Ha			No/Per Ac/Per Ha		
1-020	48	10.7	26.4	24	5.6	13.8	72	8.2	20.2
21-040	38	8.4	20.7	33	7.8	19.2	71	8.1	20.0
41-060	19	4.2	10.3	12	2.8	6.9	31	3.5	8.6
61-080	20	4.4	10.9	8	1.9	4.7	28	3.2	7.9
81-100	11	2.4	5.9	17	4.0	9.9	28	3.2	7.9
101-120	15	3.3	8.1	9	2.1	5.2	24	2.7	6.7
121-140	18	4.0	9.9	17	4.0	9.9	35	4.0	9.9
141-160	22	4.8	11.9	2	0.5	1.2	24	2.7	6.7
161-180	11	2.4	5.9	17	4.0	9.9	35	4.0	9.9
181-200	15	3.3	8.1	9	2.1	5.2	24	2.7	6.7
201-220	5	1.1	2.7	3	0.7	1.7	8	0.9	2.2
221-240	9	2.0	4.9	3	0.7	1.7	12	1.4	3.5
241-260	8	1.8	4.4	6	1.4	3.5	14	1.6	4.0
261-280	1	0.2	0.5	2	0.5	1.2	3	0.3	0.7
281-300	5	1.1	2.7	4	0.9	2.2	9	1.0	2.5
301-320	3	0.7	1.7	4	0.9	2.2	7	0.8	2.0
321-340	2	0.4	1.0	2	0.5	1.2	4	0.5	1.2
341-360	2	0.4	1.0	4	0.9	2.2	6	0.7	1.7
361-380	1	0.2	0.5	3	0.7	1.7	4	0.5	1.2
381-400	0	0.0	0.0	4	0.9	2.2	4	0.5	1.2
401-420	2	0.4	1.0	3	0.7	1.7	5	0.6	1.5
421-440	1	0.2	0.5	0	0.0	0.0	1	0.1	0.2
441-460	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
461-480	1	0.2	0.5	2	0.5	1.2	3	0.3	0.7
481-500	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2

Table 3. Redwood Diameter Distributions, for Trees 2.54 cm (1 in) d.b.h., or Greater.

1-inch Diameter Class	(cm)	Mesic Site No	Mesic Site Per Ac	Mesic Site Per Ha	Xeric Site No	Xeric Site Per Ac	Xeric Site Per Ha	Both No	Both Per Ac	Both Per Ha
1	2.5	44	9.8	24.2	21	4.9	12.1	65	7.4	18.3
2	5.1	14	3.1	7.7	21	4.9	12.1	35	4.0	9.9
3	7.6	15	3.3	8.2	16	3.7	9.1	31	3.5	8.7
4	10.2	17	3.8	9.4	9	2.1	5.2	26	2.9	7.2
5	12.7	12	2.7	6.1	2	0.5	1.2	14	1.6	4.0
6	15.2	6	1.3	14.9	9	2.1	5.2	15	1.7	4.2
7	17.8	9	2.0	4.9	7	1.6	4.0	16	1.8	4.4
8	20.3	4	0.9	2.2	3	0.7	1.7	7	0.8	2.0
9	22.9	7	1.6	4.0	7	1.6	4.0	14	1.6	4.0
10	25.4	13	2.9	7.2	9	2.1	5.2	22	2.5	6.2
11	28.0	9	2.0	4.9	1	0.2	0.5	10	1.1	2.7
12	30.4	9	2.0	4.9	5	1.2	3.0	14	1.6	4.0
13	33.0	2	0.4	1.0	0	0.0	0.0	2	0.2	0.5
14	35.6	8	1.8	4.4	5	1.2	3.0	13	1.5	3.7
15	38.1	1	0.2	0.5	9	2.1	5.2	10	1.1	2.7
16	40.6	8	1.8	4.4	6	1.4	3.5	14	1.6	4.0
17	43.2	7	1.6	4.0	3	0.7	1.7	10	1.1	2.7
18	45.7	9	2.0	4.9	7	1.6	4.0	16	1.8	4.4
19	48.3	5	1.1	2.7	2	0.5	1.2	7	0.8	2.0
20	50.8	7	1.6	4.0	2	0.5	1.2	9	1.0	2.5
21	53.3	3	0.7	1.7	1	0.2	0.5	4	0.5	1.2
22	55.9	4	0.9	2.2	1	0.2	0.5	5	0.6	1.5
23	58.4	8	1.8	4.4	5	1.2	3.0	13	1.5	3.7
24	61.0	4	0.9	2.2	1	0.2	0.5	5	0.6	1.5

Table 3. Redwood Diameter Distributions, for Trees 2.54 cm (1 in) d.b.h., or Greater. (continued)

1-inch Diameter Class	(cm)	Mesic Site No	Mesic Site Per Ac	Mesic Site Per Ha	Xeric Site No	Xeric Site Per Ac	Xeric Site Per Ha	Both No	Both Per Ac	Both Per Ha
25	63.5	4	0.9	2.2	1	0.2	0.5	5	0.6	1.5
26	66.0	4	0.9	2.2	0	0.0	0.0	4	0.5	1.2
27	68.8	2	0.4	1.0	0	0.0	0.0	2	0.2	0.5
28	71.1	4	0.9	2.2	1	0.2	0.5	5	0.6	1.5
29	73.7	1	0.2	0.5	0	0.0	0.0	1	0.1	0.2
30	76.2	3	0.7	1.7	4	0.9	2.2	7	0.8	2.0
31	78.8	1	0.2	0.5	0	0.0	0.0	1	0.1	0.2
32	81.3	5	1.1	2.7	1	0.2	0.5	6	0.7	1.7
33	83.9	1	0.2	0.5	3	0.7	1.7	4	0.5	1.2
34	86.4	1	0.2	0.5	0	0.0	0.0	1	0.1	0.2
35	89.0	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
36	91.4	3	0.7	1.7	3	0.7	1.7	6	0.7	1.7
37	94.0	4	0.9	2.2	1	0.2	0.5	5	0.6	1.5
38	96.5	2	0.4	1.0	6	1.4	3.5	7	0.8	2.0
39	99.0	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
40	101.6	0	0.0	0.0	4	0.9	2.2	4	0.5	1.2
41	104.1	1	0.2	0.5	0	0.0	0.0	1	0.1	0.2
42	106.7	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
43	109.2	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
44	111.8	0	0.0	0.0	3	0.7	1.7	3	0.3	0.7
45	114.3	2	0.4	1.0	2	0.5	1.2	4	0.5	1.2
46	116.9	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
47	119.4	0	0.0	0.0	3	0.7	1.7	3	0.3	0.7
48	121.9	6	1.3	3.2	1	0.2	0.5	7	0.8	2.0
48+	121.9	67	14.9	36.9	53	12.5	30.9	120	13.7	33.9

Table 4. Hemlock Age-Class Distributions, for Trees 2.54-121.9 cm (1-48) d.b.h.

Age-Class (yrs)	Mesic Site			Xeric Site			Both		
	No/Per	Ac/Per	Ha	No/Per	Ac/Per	Ha	No/Per	Ac/Per	Ha
1-020	18	4.0	9.9	18	4.2	10.3	36	4.1	10.1
21-040	6	1.3	3.2	2	0.5	1.2	8	1.9	4.7
41-060	7	1.6	4.0	3	0.7	1.7	10	1.1	2.7
61-080	8	1.8	4.4	0	0.0	0.0	8	0.9	2.2
81-100	6	1.3	3.2	1	0.2	0.5	7	0.8	2.0
101-120	6	1.3	3.2	2	0.5	1.2	8	0.9	2.2
121-140	7	1.6	4.0	2	0.5	1.2	9	1.0	2.5
141-160	5	1.1	2.7	1	0.2	0.5	6	0.7	1.7
161-180	4	0.9	2.2	0	0.0	0.0	4	0.5	1.2
181-200	2	0.4	1.0	1	0.2	0.5	3	0.3	0.7
201-220	5	1.1	2.7	0	0.0	0.0	5	0.6	1.5
221-240	6	1.3	3.2	1	0.2	0.5	7	0.8	2.0
241-260	2	0.4	1.0	1	0.0	0.0	2	0.2	0.5
261-280	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2
281-300	2	0.4	1.0	3	0.7	1.7	5	0.6	1.5
301-320	3	0.7	1.7	2	0.5	1.2	5	0.6	1.5
321-340	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
341-360	1	0.2	0.5	1	0.2	0.5	2	0.2	0.5
361-380	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
381-400	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2
401-420	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2
421-440	1	0.2	0.5	0	0.0	0.0	1	0.1	0.2
441-460	2	0.4	1.0	0	0.0	0.0	2	0.2	0.5

Table 5. Douglas-fir Age-Class Distributions. Based on all Trees 2.54-121.9 cm (1-48 in) d.b.h.

Age-Class (yrs)	Mesic Site			Xeric Site			Both		
	No/	Per Ac/	Per Ha	No/	Per Ac/	Per Ha	No/	Per Ac/	Per Ha
1-020	0	0.0	0.0	6	1.4	3.5	6	0.7	1.7
21-040	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
41-060	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2
61-080	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
81-100	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
101-120	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
121-140	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2
141-160	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
161-180	0	0.0	0.0	3	0.7	1.7	3	0.3	0.7
181-200	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
201-220	0	0.0	0.0	3	0.7	1.7	3	0.3	0.7
221-240	1	0.2	0.5	2	0.5	1.2	3	0.3	0.7
241-260	1	0.2	0.5	1	0.2	0.5	2	0.2	0.5
261-280	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
281-300	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
301-320	1	0.1	0.2	0	0.0	0.0	1	0.1	0.2
321-340	2	0.4	1.0	0	0.0	0.0	2	0.2	0.5
341-360	0	0.0	0.0	3	0.7	1.7	3	0.3	0.7
361-380	1	0.2	0.5	5	1.2	3.0	6	0.7	1.7
381-400	2	0.4	1.0	5	1.2	3.0	7	0.8	2.0
401-420	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
421-440	1	0.2	0.5	1	0.2	0.5	2	0.2	0.5
441-460	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
461-480	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
481-500	1	0.2	0.5	0	0.0	0.0	1	0.1	0.2

Table 6. Tanoak Diameter Distributions, for Trees 2.54-121.9 cm (1-48 in) d.b.h.

1-inch Diameter Class	(cm)	Mesic Site No/Per	Ac/Per	Ha	Xeric Site No/Per	Ac/Per	Ha	Both No/Per	Ac/Per	Ha
1	2.5	10	2.1	5.2	17	4.0	10.0	27	3.0	7.4
2	5.1	9	2.0	5.0	30	7.0	17.3	39	4.4	10.9
3	7.6	6	1.3	3.2	40	9.4	23.2	46	5.2	12.9
4	10.2	2	0.4	1.0	26	5.8	14.3	28	3.2	8.0
5	12.7	3	0.7	1.7	15	3.3	8.1	18	2.0	5.0
6	15.2	0	0.0	0.0	6	1.4	3.5	6	0.7	1.7
7	17.8	1	0.2	0.5	2	0.5	1.2	3	0.3	0.7
8	20.3	0	0.0	0.0	7	1.6	4.0	7	0.8	2.0
9	22.9	2	0.4	1.0	4	0.9	2.2	6	0.7	1.7
10	25.4	2	0.4	1.0	3	0.7	1.7	5	0.5	1.2
11	28.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
12	30.4	0	0.0	0.0	3	0.7	1.7	3	0.3	0.7
13	33.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
14	35.6	1	0.2	0.5	4	0.9	2.2	5	0.6	1.5
15	38.1	0	0.0	0.0	4	0.9	2.2	4	0.5	1.2
16	40.6	0	0.0	0.0	3	0.7	1.7	3	0.3	0.7
17	43.2	0	0.0	0.0	4	0.9	2.2	4	0.5	1.2
18	45.7	1	0.2	0.5	1	0.2	0.5	2	0.2	0.5
19	48.3	0	0.0	0.0	5	1.2	3.0	5	0.6	1.5
20	50.8	1	0.2	0.5	0	0.0	0.0	1	0.2	0.5
21	53.3	1	0.2	0.5	0	0.0	0.0	1	0.1	0.2
22	55.9	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2
23	58.4	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
24	61.0	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
25	63.5	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
26	66.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
27	68.6	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2
28	71.1	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2
29	73.7	1	0.2	0.5	0	0.0	0.0	1	0.1	0.2

Table 6. Tanoak Diameter Distributions, for Trees 2.54-121.9 cm (1-48 in) d.b.h. (continued)

1-inch Diameter Class	(cm)	Mesic Site No/Per Ac	Mesic Site No/Per Ac	Mesic Site Per Ha	Xeric Site No/Per Ac	Xeric Site No/Per Ac	Xeric Site Per Ha	Both No/Per Ac	Both No/Per Ac	Both Per Ha
30	76.2	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2
31	78.8	0	0.0	0.0	2	0.5	1.2	2	0.2	0.5
32	81.3	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2
33	83.9	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
34	86.4	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
35	89.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
36	91.4	0	0.0	0.0	1	0.2	0.5	1	0.1	0.2
37	94.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
38	96.5	0	0.0	0.0	1	0.2	0.5	1	0.1	0.1
39	99.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0

Table 7. Stand Composition and Density - Xeric Site. First Entry Represents Number of Trees per Hectare, Second Entry Percent of Stand.

Plot	Rw		Df		T		H		Gf		M		Total	
85	79	11.9%	89	13.5%	494	74.6%	0	0.0%	0	0.0%	0	0.0%	662	100%
90	99	32.3%	10	3.2%	158	51.6%	0	0.0%	0	0.0%	40	12.9%	307	
95	109	37.9%	40	13.9%	20	7.0%	119	41.2%	0	0.0%	0	0.0%	288	
96	40	16.6%	49	20.8%	128	54.2%	0	0.0%	0	0.0%	20	8.4%	237	
99	267	52.9%	49	9.8%	178	35.3%	10	2.0%	0	0.0%	0	0.0%	504	
100	237	88.9%	30	11.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	267	
101	79	30.8%	0	0.0%	148	57.7%	0	0.0%	0	0.0%	30	11.5%	257	
175	148	53.6%	49	17.8%	79	28.6%	0	0.0%	0	0.0%	0	0.0%	276	
176	40	20.0%	40	20.0%	99	50.0%	20	10.0%	0	0.0%	0	0.0%	199	
178	59	24.0%	40	16.0%	138	56.0%	10	4.0%	0	0.0%	0	0.0%	247	
179	207	61.8%	0	0.0%	89	26.5%	10	2.9%	30	8.8%	0	0.0%	336	
182	119	46.2%	49	19.2%	20	7.7%	49	19.2%	20	7.7%	0	0.0%	257	
189	49	12.5%	30	7.5%	217	55.0%	5	2.5%	0	0.0%	89	22.5%	390	
192	138	51.9%	30	11.1%	10	3.7%	79	29.6%	10	3.7%	0	0.0%	267	
193	158	59.3%	0	0.0%	10	7.4%	89	33.3%	0	0.0%	0	0.0%	257	
196	217	68.8%	59	18.8%	20	6.4%	10	3.0%	0	0.0%	0	0.0%	306	
Mean	128	41.2%	37	11.8%	106	34.5%	25	7.9%	5	1.3%	10	3.3%	311	

Rw=redwood
Df=Douglas-fir
T=tanoak
H=hemlock
Gf=grand fir
M=madrone

Table 8. Stand Composition and Density - Mesic Site. First Entry Represents Number of Trees per Hectare, Second Entry Percent of Stand.

Plot	Rw		Df		T		H		Gf		Ss		Total	
91	128	65.0%	20	10.0%	40	20.0%	10	5.0%	0	0.0%	0	0.0%	198	100%
92	247	96.2%	10	3.8%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	257	
93	306	81.6%	0	0.0%	0	0.0%	59	15.8%	0	0.0%	10	2.6%	375	
97	79	61.5%	40	30.7%	10	7.8%	0	0.0%	0	0.0%	0	0.0%	129	
98	99	58.8%	40	23.5%	0	0.0%	30	17.7%	0	0.0%	0	0.0%	169	
180	158	36.4%	0	0.0%	138	31.8%	49	11.3%	89	20.5%	0	0.0%	434	
181	119	42.8%	0	0.0%	89	32.2%	69	25.0%	0	0.0%	0	0.0%	277	
184	119	54.5%	0	0.0%	0	0.0%	99	45.5%	0	0.0%	0	0.0%	218	
186	79	21.0%	10	2.7%	59	15.8%	227	60.5%	0	0.0%	0	0.0%	375	
187	306	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	306	
188	158	94.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	10	5.9%	168	
190	158	50.0%	0	0.0%	49	15.7%	109	34.3%	0	0.0%	0	0.0%	316	
195	257	96.3%	0	0.0%	0	0.0%	10	3.7%	0	0.0%	0	0.0%	267	
197	109	35.5%	40	12.9%	89	29.0%	69	22.6%	0	0.0%	0	0.0%	306	
198	158	48.5%	30	9.1%	0	0.0%	138	42.4%	0	0.0%	0	0.0%	326	
200	227	92.0%	0	0.0%	10	4.0%	10	4.0%	0	0.0%	0	0.0%	247	
201	277	90.3%	0	0.0%	0	0.0%	30	9.7%	0	0.0%	0	0.0%	306	
202	267	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	267	
Mean	180	65.8%	10	3.8%	27	9.8%	49	18.4%	5	1.8%	1	0.4%	272	

Rw=redwood
Df=Douglas-fir
T=tanoak
H=hemlock
Gf=grand fir
Ss=Sitka spruce

Table 9. Summary of Observed Fire Scars on Outer Bark of Trees in Sample Plots.

d.b.h. Class	(inches)	(cm)	Redwood Number	(Age)	Douglas-fir Number	(Age)
	1- 3	2.54- 7.6	0		0	
	4- 6	10.2 - 15.2	0		0	
	7- 9	17.8 - 22.9	0		0	
	10-12	25.4 - 30.4	0		0	
	13-15	33.0 - 38.1	0		0	
	16-18	40.6 - 45.7	1	(160)	0	
	19-21	48.3 - 53.3	0		0	
	22-23	55.9 - 58.4	1	(187)	0	
	24-26	61.0 - 66.0	0		0	
	27-29	68.6 - 73.7	1	(266)	0	
	30-32	76.2 - 81.3	1	(377)	0	
	33-35	83.9 - 89.0	1	(452)	0	
	36-38	91.4 - 96.5	2	(307) (497)	1	(381)
	39-41	99.0 -104.1	0		0	
	42-44	106.7 -111.8	1	(410)	1	(442)
	45-47	114.3 -119.4	1	(417)	0	
	48+	121.9+	57		7	
Total			66		9	
Xeric Site			31		3	
Mesic Site			35		6	

DISCUSSION

Many of the results confirm earlier observations of the ecology of the redwood forest. Other results, however, raise questions.

There has been disagreement in the literature as to a typical stand structure for redwood. A possible explanation for these differences is that the ecological role of redwood is not uniform throughout the extent of its natural range, and that even within the same general location, some variation can be found that can be associated with environmental differences.

Here, redwood had an all-aged stand structure, and was the dominant species in all plots in terms of number, canopy position, and basal area.

Based on personal observation, it was found that an upland redwood forest is characterized by a dense understory and significant accumulations of forest litter, ranging in size from fine, nearly decomposed material to large-sized fallen timber in varying stages of decomposition.

As such, the environment at the forest floor is not greatly conducive to seed germination or seedling survival. Some species, such as tanoak and hemlock, are comparatively more successful at seed reproduction in such environments, although still likely to be dependent on some type of micro-site disturbance.

Because of this situation, the ability of some species (redwood, tanoak, and madrone) to vegetatively reproduce is a positive ecological adaptive strategy (Stone et al. 1969).

This capability is most dramatic in the case of redwood, in terms of its longevity, in that sprouting may take place well into the mature stages in the tree's life. However, there is a tendency for sprouting activity to decrease with age. In one experimental cutting in an old-growth stand, there was a higher precentage of stumps sprouting that were under 142.2 cm (56 in) d.b.h. (79%), than on trees 142.2-294.6 cm (56 to 116 in) d.b.h. (44%) (Boe 1965). In their study of stump sprouting behavior of second-growth redwood, Powers and Wiant (1970) found that the greatest sprout production was found on trees in the 200 to 400 year age-class.

In terms of individual tree replacement, the combined effects of sprouting ability, longevity, and even reproduction by seed on a limited basis, give redwood a competitive advantage over its associates in terms of long-term occupation and dominance (Veirs 1982).

As has been observed in other studies in old-growth stands, very few redwood seedlings were evident in plots, although a precise inventory of seedlings was not made. This seemingly disturbing situation has lead to the conclusion by some (Stone 1968) that redwood is dependent on disturbance for seedling establishment and replacement reproduction. Seedlings, though, did exist in small numbers in the areas sampled.

Nonetheless, this study showed the J-Shape curve indicating a large number of younger age-class of redwood, with decreasing numbers of older trees. Some trees appeared to have originated from seed, but a greater number were from sprouts. The ecological role redwood plays in the system is obviously influenced substantially by its ability to reproduce vegetatively as well as by seed.

Depite the relatively low success rate of establishment by seed for redwood (Muelder and Hansen 1961), compensation for this deficiency is made by the fact that replacement may be accomplished by sprouting for subsequent generations, and by the longevity of the species.

During each generation there is also the potential for successful seed germination and replacement. This concept of replacement levels was discussed by Veirs (1972 and 1982). Assuming that most canopy redwood trees were to survive for 1000 years, and that one were to find 50 to 60 dominant and codominant trees per hectare, then on the basis of mortality and replacement occurring on an individual tree basis, Veirs suggested that replacement trees would need enter the stand only once every 40 or 50 years, on the average, in order to assure replacement age-classes of trees.

Much attention has been given to the stage of seed germination and initial seedling development in redwood (Muelder and Hansen 1961 and Becking 1968). If the redwood seedling survives the first few years, its chances for continued survival are usually good (Roy 1966). Redwood displays high photosynthetic efficiency (Roy 1966) and may survive in a suppressed condition for a considerable period of time, and displays an increased rate of growth following release.

The important point is that if redwood were a short-lived and non-sprouting species, it undoubtedly would not occupy the role as dominant species. Redwood's longevity, however, gives it a longer period of time than most for potential seed reproduction, and its sprouting ability provides additional reproductive potential. It's resistance to damage or death from insects and disease (Roy 1966) as well as from fire, complements this capability.

As stated by Muelder and Hansen (1961), in their study of the comparatively low survival rates of redwood seedlings:

> For the strictly natural maintenance of the redwood type the very low survival rate of seedlings may not be serious. Considering the extreme longevity of this species and its sprouting habits, very few seedlings are needed to replace mortality.

Even if reproduction were to take place only on an exposed seed bed, for example, the probability of the creation of such a bed, at some point in time over a 50 year period, whether by a windthrown tree, a minor fire, surface erosion, or even from openings created by hiking recreationists or animals is rather great.

The point is, with regard to the age-class distribution for redwood, that while an abundance of seedlings would be expected for a species demonstrating the pattern of all all-aged stand, this is generally not the case for redwood.

In terms of observed age and size structure for other species, it would appear that hemlock presents the closest resemblance in terms of a typical all-aged population. There are factors, however, which appear to prevent hemlock from attaining the long-term dominance more evident of redwood. In many plots situated in mesic sites, abundant hemlock seedlings were seen, most noticeably growing in clusters on fallen logs. Hemlock seed will successfully germinate in such a setting (Bernsten 1958) and profuse seedling establishment may occur. However, the stand structure indicated that few of these hemlock seedlings reach maturity. A fallen log or organic debris may be suitable for initial establishment, and occasionally a seedling will survive and grow under these conditions.

Once it has become established, continued hemlock survival is dependent on a number of factors. Hemlock does have a physiological advantage in that it is considered to be very tolerant and can respond readily to release but it is much more vulnerable to fire and disease than redwood.

Fire occurrence in this study area can perhaps be interpreted by the presence of hemlock in certain plots. It is probably not by coincidence that hemlock trees were not observed with fire scars on the outer bark. Even mature hemlock have comparatively thin bark, and a low intensity fire will usually result in death. Thus, it may be a valid hypothesis that the age of the oldest hemlock in a plot indicated the length of time since a fire.

Douglas-fir may germinate in a wide variety of seedbeds, but seedlings are very susceptible to moisture stress, shading, predation, and disease (Isaac and Dimock 1958). Successful regeneration is therefore usually dependent on seedbed preparation as created by fire or other similar disturbance. Limited observations of age-classes and size-classes from these study plots suggested that Dougals-fir regeneration was mostly disturbance induced, and that an uneven-aged stand structure was characteristic, a pattern more clearly evident in xeric sites than mesic.

Tanoak is a prolific seed producer, but germination is not easily accomplished under the conditions of heavy forest litter and competing vegetation found in the old growth forest (Roy 1957). Tanoak seedlings are susceptible to a number of limiting factors, and in its early life is shade intolerant, although tolerance increases with maturity (Roy 1957). No distinct stand-structure pattern was evident for tanoak, although densities of smaller-sized (and most likely younger) trees were greater than large-sized. Similar to hemlock, tanoak appeared to be a species well-adapted to initial establishment, but for various reasons does not have the longevity or stature to achieve dominance, with the exception of isolated areas.

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

This investigation may be relevant to land management decisions in public reserves in redwood forests.

A landscape management plan must reflect the objectives or policy goals of the Park Service which are to preserve significant examples of the primeval redwood forest.

In keeping with policy, the character of the forest should reflect, as much as possible, the vegetation complex that existed before European settlement and influence in North America (Leopold 1963).

The term "management" can imply a number of activities; it may imply the type of active management usually associated with commercial forest production, including site preparation, thinning, removal of undesired vegetation, and silvicultural treatment. Management may also imply a policy of non-active involvement, of allowing processes to occur at natural rates. The management plan must reflect the composition and character of the vegetation that is desired by policy.

A primary goal of the management plan should be to ensure replacement age-classes of redwood, so that the species is perpetuated and that an adequate rate of reproduction is achieved to compensate for mortality.

Based on the evidence from this study, it is suggested that in certain areas representative of optimum redwood development (mesic sites), a minimum of management activity will maintain the status quo. In such locations, redwood displayed an all-aged stand structure, and was the dominant species in terms of numbers, canopy position, and basal area.

The same approach in xeric sites will result in the composition presently found, with redwood still the dominant species, but more of a mixed forest will result. Areas of this type should be encouraged to create greater variety in the forest landscape.

Biotic agents are a potentially significant factor in the composition, abundance, and age-structure of vegetation in the redwood forest. The longevity of redwood is attributable in part to its resistance to disease and animal damage, as well as to fire. Mortality of Douglas-fir, hemlock, and tanoak is influenced to a much greater degree by these factors. A vegetation management plan that seeks to control or modify biotic agents will tend to favor the success of associated species rather than redwood, in that it will tend to equalize some of the competitive advantages of redwood.

In the discussion of upland redwood management, a principal question concerns the use of fire as a management tool. It has been suggested (Stone 1969) that redwood has developed from a history of influence from fire, that it must continue to have that influence to perpetuate itself, and that the long-term exclusion of fire will work to the advantage of species other than redwood. In view of this, it might be concluded that a manipulative strategy, such as prescribed burning, is necessary in order to perpetuate redwood in the role it presently serves.

Based on these observations, however, it is suggested that a fire exclusion policy might alter the vegetation composition, but not have an adverse effect on stand structure. A prescribed burn program might well, in fact, result in undesirable vegetation changes.

For example, in attempting to stimulate regeneration by fire in an all-aged mesic site, the resultant age-structure may not be consistent with the objective. Even a low intensity ground fire may be enough to kill recent reproduction and leave only larger and older trees. With subsequent reproduction, a distinct uneven-aged stand would result, and the all-aged character of the stand would be lost.

Another factor to consider in the use of fire would be the amount of tanoak and madrone present in the stand. Because tanoak and madrone sprout vigorously following fire (Roy 1957), stands with an abundance of those species would provide severe competition for redwood following burning, at least for an initial period of time. Similarly, burning for seedbed preparation for redwood would also result in site preparation for Douglas-fir, which could possibly assume an advantage at that stage.

In regard to the question of the use of prescribed burning, it might be assumed that with modern fire control activity, the absence of prescribed burning will result in the complete absence of any fire. This may not be a realistic assumption, however. Despite the best efforts of fire management organizations, and the comparatively low fire risk in Redwood National Park, it is unrealistic to assume that fires can be permanently eliminated from the park entirely.

Lightning initiated fires have occurred in the past and will likely occur in the future; suppression efforts will be taken with such fires, but some amounts of area will be affected. Man-caused fires have also been an influence in the past, and an increase in the occurrence of fire from this source may be expected with increasing visitation to the park.

Even though it may not be necessary to instigate a prescribed burning program exclusively for the purpose of encouraging redwood regeneration, it may be worthwhile to consider limited prescribed burning or some form of "let burn" policy on naturally occurring fires for the purposes of reducing dangerous fuel accumulations in the Park and preventing a major, high intensity fire in the future. The same objective may be realized through alternative methods, such as mechanical removal. The comparative merits and economics of each approach may be the basis of another study.

It might also be advantageous, from the standpoint of maximizing visitor enjoyment of the Park, to mechanically reduce dense undergrowth in certain locations in order to enhance scenic vistas or to provide greater access.

There is little doubt that more certain regeneration and complete site utilization can be expected through site preparation, which may be accomplished by burning, not only for redwood but for most other species as well. Such activity is commonly a silvicultural practice for commercial forest lands, wherein the primary objective is to obtain the most efficient growth possible, and the greatest amount of merchantable volume per unit area in the shortest period of time (Smith 1962). In the case of park vegetation management, however, it may not be necessary to expect or desire the same rates of regeneration or species composition that one would expect in an intensively managed commercial forest.

This study suggests that even with the recent implementation of a fire control policy, regeneration of redwood has been observed in areas from which fire has been excluded for a period of time exceeding the ages of younger trees.

Although regeneration of redwood may be assisted by fire or other disturbance, the evidence indicated that redwood was certainly not dependent on such disturbance.

In summary, the dominant species in a given environment is that species most capable of successful replacement and development under certain environmental circumstances.

In an upland, old-growth stand, which is typical of many other areas in the redwood forest, redwood displayed an adaptive strategy that allowed it to be the dominant species, and a stand structure arrangement that indicated that it was achieving replacement-rate regeneration levels.

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APPENDIX A. Individual Plot Data are Presented. Individual Observations are Shown as Recorded in Standard English Units.

Individual Plot Data

Plot number 90
Location NW1/4 Sec. 6, T10N,R1E
Plot size .25 acre
Elevation 1950 ft.
Slope 30-50 %
Aspect SW

Soil series Hugo-Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation:
Vaccinium o., Rhododendron m.
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
37	D	307	48+	D					12	I	22	CD				
23	CD	187							14	I	20	CD				
30	D	249							3	S	21	CD				
12	I	139							2	S	16	CD				
33	D	273							16	CD						
3	S	32							15	CD						
16	I	186							15	CD						
8	S	83							26	D						
48+	D	*							32	D						
48+	D	*							33	D						
									8	S						
									3	S						
									5	S						
									4	S						
									5	S						
									5	S						
n=10 n/acre=40			n=1 n/acre=4						n=16 n/acre =64		n=4 n/acre =16					
Growth rate D=21.8 I=31.5 S=27.7																

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 91
Location NE 1/4,Sec.26,T11N,R1E
Plot size .25 acre
Elevation 720 ft.
Slope 30-50%
Aspect NE

Soil series Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Polystichum m., Oxalis o.
Site type Moist/mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
9	S	110	43	D	385	2	S	23	2	S						
48+	D	*	37	D	332				9	S						
48+	D	*							3	S						
3	S	39							2	S						
20	I	183														
30	I	282														
48+	D	*														
48+	D	*														
48+	D	*														
11	I	101														
37	CD	322														
48+	D	*														
22	CD	187														
n=13 n/acre=52			n=2 n/acre=8			n=1 n/acre=4			n=4 n/acre =16							
Growth rate D=28.5 I=24.7 S=32.4			D=22.8			S=23.5										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 92
Location NE1/4 Sec.26, T11N,R1E.
Plot size .25 acre
Elevation 920 ft.
Slope 30-50 %
Aspect NE

Soil series Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Polystichum m., Oxalis oregana
Site type Moist/mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
3	S	29	48+	D												
3	S	29														
11	S	100														
1	S	10														
48+	D	*														
48+	D	*														
18	I	194														
23	CD	181														
8	S	73	n=1													
4	S	36	n/acre=4													
3	S	29														
23	I	248														
23	CD	181														
20	CD	155														
12	I	127														
15	I	159														
28	CD	186														
14	S	126														
2	S	19														
7	S	65														
32	CD	216														
1	S	10	----------			--Redwood										
1	S	10				n=25										
23	I	248				n/acre=100										
Growth rate D=17.7 CD=21.0 I=28.9 S=24.2																

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 93
Location SE1/4 Sec.23, T11N, R1E
Plot size .25 acre
Elevation 240 ft.
Slope 50-70 %
Aspect SW

Soil series Melbourne-Hugo
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Polystichum m., Oxalis oregana
Site type Moist/mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
23	I	142				26	D	305							1	S
48+	D	*				15	I	234								
9	I	56				15	I	234								
32	CD	201				16	I	250								
7	S	54				15	I	234								
36	D	226				27	CD	317								
48+	D	*														
5	S	38														
1	S	7														
48+	D	*														
5	S	38														
1	S	7														
48+	D	*														
20	CD	122														
37	CD	233														
1	S	7														
1	S	7														
7	I	54														
5	I	38														
3	S	34														
24	CD	149														
24	CD	149														
48+	D	*														
48+	D	*														
3	S	24														
continue next page																

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 93 continued
Location
Plot size
Elevation
Slope
Aspect

Soil series
Soil depth
Site class
Dominant understory vegetation:

Site type

Redwood				Douglas-fir				Western Hemlock				Tanoak			Madrone			Grand Fir			Sitka Spruce		
d.b.h.	height	class	age	d.b.h.	height	class	age	d.b.h.	height	class	age	d.b.h.	height	class	d.b.h.	height	class	d.b.h	height	class	d.b.h.	height	class
7	S		54																				
26	D		154																				
5	S		38																				
20	I		122																				
9	I		56																				
1	S		7																				
1	S		7																				
n=34 n/acre=136				n=6 n/acre =24																	n=1 n/acre =4		
Growth rate D=28.6 CD=16.5 S=20.1				CD=23.5 I=31.2																			

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 95
Location SE1/4 Sec.36, T11N,R1E
Plot size .25 acre
Elevation 1400 ft.
Slope 30-50 %
Aspect E

Soil series Hugo-Melbourne
Soil depth 4 ft.+
Site class II
Dominant understory vegetation: Vaccinium o., Gaultheria shallon
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
3	S	34	27	CD	234	8	S	116	5	S						
38	CD	354	15	I	127	3	S	44	1	S						
2	S	23	19	I	161	31	D	344								
48	D	444	29	CD	245	1	S	15								
48+	D	*				1	S	15								
48+	D	*				1	S	15								
15	I	105				1	S	15								
44	D	410				1	S	15								
45	D	417				3	S	44								
23	CD	210				28	CD	316								
3	S	34				25	CD	254								
						28	CD	316								
n=11 n/acre=44			n=4 n/acre=16			n=12 n/acre=48			n=2 n/acre=8							
Growth rate D=24.4 CD=* I=19.3 S=28.6			I=21.5			CD=28.7 S=29.6										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 96
Location SW1/4 Sec.6,T10N, R1E
Plot size .25 acre
Elevation 1750 ft.
Slope 30-50 %
Aspect NE

Soil series Hugo-Melbourne
Soil depth 4 ft.+
Site class II
Dominant understory vegetation:
Gaultheria shallon, Vaccinium ovatum
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
11	I	81	48+	D	*				4	S	29	CD				
3	S	24	21	I	232				25	I	21	CD				
9	I	67	36	D	355				7	S						
48+	D	*	22	CD	218				3	S						
			44	D	430				3	S						
									8	S						
									7	S						
									8	S						
									3	S						
									2	S						
									4	S						
									2	S						
									19	I						
n=4 n/acre=16			n=5 n/acre=20						n=13 n/acre =52		n=2 n/acre =8					
Growth rate D=25.6 I=19.8			D=25 I=29.6													

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 97
Location SE1/4 Sec.23, T11N, R1E
Plot size .25 acre
Elevation 360 ft.
Slope 50-70 %
Aspect SW

Soil series Melbourne-Hugo
Soil depth 4 ft. +
Site class II
Dominant understory vegetation:
Polystichum munitum, Oxalis oregana
Site type Moist/mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
9	S	137	36	D	375				1	S						
19	I	234	38	D	396											
48+	D	*	24	CD	251											
28	CD	351	48+	D	*											
12	I	147														
5	S	76														
14	I	174														
38	D	416														
n=8 n/acre=32			n=4 n/acre=16						n=1 n/acre=1							
Growth rate D=28.7 I=19.8			D=24.5 I=27.6													

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 98
Location SE1/4 Sec. 23,T11N,R1E
Plot size .25 acre
Elevation 480 ft.
Slope 50-70 %
Aspect W

Soil series Melbourne-Hugo
Soil depth 4 ft. +
Site class II
Dominant understory vegetation:
Polystichum munitum, Oxalis oregana
Site type Moist/mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
8	I	96	30	CD	236	9	I	144								
10	I	122	48+	D	*	4	S	64								
17	I	201	48+	D	*	30	CD	285								
48+	D	*	48+	D	*											
10	I	122														
48+	D	*														
11	I	131														
20	CD	237														
3	S	38														
12	I	141														
n=10 n/acre=40			n=4 n/acre=16			n=3 n/acre=12										
Growth rate D=30.1 S=31.7			D=19.8			I=31.9										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 99
Location SW1/4 Sec.31,T10N,R1E
Plot size .25 acre
Elevation 1650 ft.
Slope 30-50 %
Aspect W

Soil series Hugo-Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Vaccinium o., Gaultheria shallon
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
1	S	14	48+	D	*	13	CD	156	3	S						
1	S	14	48+	D	*				3	S						
35	D	452	48+	D	*				9	S						
38	D	497	42	D	442				16	CD						
48+	D	*	36	D	381				5	S						
1	S	14							4	S						
3	S	42							3	S						
1	S	14							3	S						
10	I	92							3	S						
14	I	126							3	S						
10	I	92							2	S						
1	S	14							2	S						
2	S	28							9	I						
31	D	316							3	S						
21	CD	217							3	S						
48+	D	*							3	S						
1	S	14							2	S						
15	I	133							3	S						
6	S	79							3	S						
12	I	106														
3	S	42														
Continue next page																

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 99 continued
Location
Plot size
Elevation
Slope
Aspect

Soil series
Soil depth
Site class
Dominant understory vegetation:

Site type

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
3	S	42														
2	S	28														
1	S	14														
1	S	14														
5	S	65														
48+	D	*														
n=27 n/acre=108			n=5 n/acre=20			n=1 n/acre=4			n=19 n/acre =76							
Growth rate D=27.8 I=24.2 S=34.3			D=26.8			CD=24.0										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 100
Location SE1/4 Sec.26, T11N,R1E
Plot size .25 acre
Elevation 1160 ft.
Slope 30-50 %
Aspect NE

Soil series Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Vaccinium ovatum
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
23	CD	189	48	D	*											
29	CD	240	45	D	455											
38	CD	319	48+	D												
48+	CD	*														
18	I	147														
3	S	.21														
4	S	26														
4	S	26														
28	CD	231														
16	I	129														
4	S	26														
15	I	121														
4	S	26														
22	CD	180	n=3													
20	I	163	n/acre=12													
15	I	121														
3	S	21														
47	D	302														
7	S	48														
48+	D	*														
7	S	48														
6	S	41	------------			--Redwood										
26	CD	213				n=24										
9	S	60				n/acre =96										
Growth rate D=16.9 CD=22.0 S=17.6			D=25.9													

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 101
Location SW1/4 Sec.31, T10N,R1E
Plot size .25 acre
Elevation 1700 ft.
Slope 30-50%
Aspect SW

Soil series Mendocino (conglomerate)
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Rhododendron macrophyllum, Vaccinium o.
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
47	D	464							15	S	21	I				
48+	D	*							26	CD	18	I				
47	D	464							22	CD	18	I				
48+	D	*							23	CD						
48+	D								2	S						
39	D	383							1	S						
40	D	394							25	CD						
9	I	125							10	S						
									19	S						
									20	CD						
									8	S						
									17	I						
									18	I						
									15	I						
									12	S						
n=8 n/acre=32									n=15 n/acre =60		n=3 n/acre =12					
Growth rate D=25.9 I=36.9																

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 175
Location SW1/4 Sec.25,T11N,R1E
Plot size .25 acre
Elevation 1240 ft.
Slope less than 30%
Aspect NE

Soil series Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Vac--cinium o., Rhododendron macrophyllum
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
14	I	99	48+	D	*				4	S						
23	CD	177	10	I	104				8	I						
38	D	299	9	I	94				5	S						
2	S	20	11	I	112				4	S						
9	S	84	48+	D	*				4	S						
18	I	128							1	S						
14	I	99							2	S						
48+	D	*							1	S						
10	I	73														
17	I	120														
4	S	37														
33	CD	258														
17	I	120														
48+	D	*														
45	D	352														
n=15 n/acre=60			n=5 n/acre=20						n=8 n/acre =32							
Growth rate D=20.6 I=19.1 S=24.8			I=26.0													

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 176
Location NW1/4 Sec.36, T10N,R1E
Plot size .25 acre
Elevation 1400 ft.
Slope less than 30%
Aspect NE

Soil series Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Vaccinium ovatum, Lithocarpus d.
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class
33	D	266	48+	D	*	4	S	46	9	S
40	D	324	33	CD	380	10	I	115	17	I
9	S	98	48+	D	*				14	I
30	D	243	48+	D	*				16	I
									14	I
									10	I
									12	I
									9	S
									3	S
									8	I
n=4 n/acre=16			n=4 n/acre=16			n=2 n/acre=8			n=10 n/acre =40	
Growth rate D=21.3 S=28.9			D=29.8			S=23.0				

Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	d.b.h	height class	d.b.h.	height class

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 177
Location SW1/4 Sec.25, T11N,R1E
Plot size .25 acre
Elevation 840 ft.
Slope 30-50%
Aspect NE

Soil series Melbourne
Soil depth 4 ft.+
Site class II
Dominant understory vegetation: Gaultheria shallon, Vaccinium ovatum
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
3	S	32	32	CD	381	40	D	420	2	S						
3	S	32	29	CD	342											
38	D	284	33	D	393											
26	CD	190	31	D	369											
48+	D	*	12	I	141											
18	I	188	31	D	369											
48+	D	*														
6	S	64														
48+	D	*														
48+	D	*														
8	S	81														
48+	D	*														
48+	D	*														
n=13 n/acre=52			n=6 n/acre=24			n=1 n/acre=4			n=1 n/acre=4							
Growth rate D=19.6 I=28.1 S=27.7			I=30.3			D=21.0										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 178
Location SE1/4 Sec.36, T11N,R1E
Plot size .25 acre
Elevation 1480 ft.
Slope less than 30%
Aspect NE

Soil series Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Vac--cinium ovatum, Rhododendron m.
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
40	D	376	21	D	213	10	I	125	18	I						
17	CD	160	21	CD	213				20	I						
40	CD	376	38	D	375				10	S						
42	CD	393	7	S	96				28	D						
39	CD	366							17	CD						
4	S								4	S						
									32	D						
									6	S						
									4	S						
									4	S						
									24	CD						
									15	I						
									29	D						
									31	D						
n=6 n/acre=24			n=4 n/acre=16			n=1 n/acre=4			n=14 n/acre=56							
Growth rate CD=23.8 S=33.0			CD=24.4			I=25.4										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 179
Location SE 1/4 Sec.25,T11N,R1E
Plot size .25 acre
Elevation 1320 ft.
Slope 50-70 %
Aspect W

Soil series Hugo-Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Gaultheria shallon
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
42	D	358				2	S	16	1	S			6	I		
48+	D	*							4	S			42	D		
46	D	394							2	S			48	D		
1	S	12							1	S						
16	I	146							1	S						
48+	D	*							1	S						
15	I	136							1	S						
38	D	326							1	S						
48	D	410							5	S						
35	D	297														
15	I	136														
10	I	94														
48+	D	*														
48+	D	*														
15	I	136														
10	I	94														
48+	D	*														
48+	D	*														
7	I	67														
1	S	12														
12	CD	99														
n=21 n/acre=84						n=1 n/acre=4			n=9 n/acre =36				n=3 n/acre =12			
Growth rate D=22.5 I=24.7 S=29.2						S=16.4										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 180
Location SE1/4 Sec.25,T11N,R1E
Plot size .25 acre
Elevation 1240 ft.
Slope 50-70 %
Aspect W

Soil series Hugo-Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Polystichum munitum, Berberis nervosa
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
16	I	159				12	I	149	2	S			48+	D		
3	S	29				37	D	459	3	S			2	S		
2	S	19				3	S	42	2	S			2	S		
1	S	10				4	S	56	2	S			1	S		
1	S	10				2	S	28	2	S			1	S		
13	CD	130							1	S			1	S		
6	S	55							1	S			1	S		
48+	D	*							1	S			12	I		
48+	D	*							2	S			22	CD		
12	I	106							2	S						
3	S	29							2	S						
17	CD	170							3	S						
4	S	36							2	S						
23	CD	232							2	S						
48+	D	*														
3	S	29														
n=16 n/acre=64						n=5 n/acre=20			n=14 n/acre =56				n=9 n/acre =36			
Growth rate D=18.7 CD=27.7 S=24.1						D=24.8 S=28.1										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 181
Location SE1/4 Sec.25,T11N,R1E
Plot size .25 acre
Elevation 1000 ft.
Slope 50-70 %
Aspect W

Soil series Hugo-Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Polystichum munitum, Berberis nervosa
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
41	D	319				2	S	23	5	I						
1	S	7				1	S	12	3	S						
38	D	299				1	S	12	2	S						
48+	D	*				4	S	46	2	S						
36	D	282				12	I	138	4	S						
12	I	76				7	I	81	1	S						
26	CD	168				18	CD	167	1	S						
28	CD	182							1	S						
18	CD	116							2	S						
48+	D	*														
18	CD	116														
48+	D	*														
n=12 n/acre=48						n=7 n/acre=28			n=9 n/acre =36							
Growth rate D=20.6 CD=17.3			CD=18.5 S=23.0													

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 182
Location NE1/4 Sec.36, T11N,R1E
Plot size .25 acre
Elevation 1240 ft.
Slope 30-50 %
Aspect NE

Soil series Melbourne-Hugo
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Gaultheria shallon, Rhododendron m.
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
48+	D	*	48+	D	*	15	I	128	7	I			37	D		
48+	D	*	48+	D	*	22	CD	187	3	S			38	D		
48+	D	*	48+	D	*	33	D	282								
48+	D	*	48+	D	*	26	CD	222								
10	I	74	18	I	146	2	S	32								
16	I	114														
48+	D	*														
12	I	85														
12	I	85														
18	CD	166														
48+	D	*														
48+	D	*														
n=12 n/acre=48			n=5 n/acre=20			n=5 n/acre=20			n=2 n/acre =8				n=2 n/acre =8			
Growth rate D=24.8 I=19.4			I=20.6			D=18.0 S=32.6										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 184
Location NE1/4 Sec.36, T11N, R1E
Plot size .25 acre
Elevation 1280 ft.
Slope 30-50 %
Aspect SW

Soil series Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation:
Polystichum munitum, Oxalis oregana
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
48+	D	*				20	CD	217								
19	CD	224				5	S	44								
32	D	288				10	I	88								
14	I	123				7	I	61								
1	S	7				5	I	44								
10	S	63				6	I	53								
4	S	25				20	I	175								
1	S	7				33	CD	358								
18	CD	158				9	I	79								
16	CD	139				23	CD	250								
48+	D	*														
48+	D	*														
n=12 n/acre=48						n=10 n/acre=40										
Growth rate D=22.0 CD=23.6 S=16.6			CD=21.7 I=17.5													

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 186
Location SW1/4 Sec.31,T11N,R1E
Plot size .25 acre
Elevation 1550 ft.
Slope 30-50 %
Aspect SW

Soil series Hugo-Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation Polystichum munitum, Berberis nervosa
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
25	CD	237	48+	D	*	1	S	10	5	I						
1	S	8				2	S	20	2	S						
48+	D	*				8	I	81	1	S						
48+	D	*				10	CD	101	2	S						
4	S	29				6	I	61	1	S						
3	S	23				40	D	460	3	S						
24	I	171				1	S	10								
48+	D	*				1	S	10								
						1	S	10								
						1	S	10								
						1	S	10								
						1	S	10								
						1	S	10								
						1	S	10								
						2	S	20								
						14	I	145								
						7	I	73								
						2	S	20								
						2	S	20								
						5	S	52								
						2	S	20								
						13	CD	135								
						1	S	10								
n=8			n=1			n=23			n=6							
n/acre=32			n/acre=4			n/acre=92			n/acre=24							
Growth rate D=25.5 S=19.4						D=23.4 S=20.7										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 187
Location SE1/4 Sec.23,T11N,R1E
Plot size .25 acre
Elevation 620 ft.
Slope 30-50 %
Aspect NE

Soil series Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Polystichum munitum, Oxalis oregana
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
1	S	13														
1	S	13														
1	S	13														
1	S	13														
5	S	61														
12	I	145														
2	S	29														
5	S	61														
3	S	29														
48+	D	*														
24	CD	254														
4	S	48														
13	I	158														
4	S	48														
48+	D	*														
12	I	145														
1	S	13														
3	S	29														
14	I	171														
22	CD	231														
48+	D	*														
48+	D	*														
5	S	60														
18	CD	188														
Continue next page																

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 187 continued

Location

Plot size

Elevation

Slope

Aspect

Soil series

Soil depth

Site class

Dominant understory vegetation:

Site type

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
1	S	13														
30	I	377														
9	S	109														
5	S	61														
48+	D	*														
21	I	257														
5	S	61														
n=31 n/acre=124																
Growth rate D=20.0 CD=28.2 I=33.0 S=32.3																

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 188
Location SE1/4 Sec.23, T11N,R1E
Plot size .25 acre
Elevation 600 ft.
Slope 30-50 %
Aspect NE

Soil series Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Polystichum munitum, Oxalis o. Vaccinium
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
45	D	311													46	D
17	I	135														
48+	D	*														
17	I	135														
1	S	12														
33	CD	254														
19	I	150														
10	S	111														
16	I	126														
5	S	55														
1	S	12														
4	S	44														
48+	D	*														
9	I	73														
20	I	158														
21	I	167														
n=16 n/acre=64															n=1 n/acre =4	
Growth rate D=18.2 CD=20.3 I=21.4 S=29.2																

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 189
Location SE1/4 Sec.1, T11N,R1E
Plot size .25 acre
Elevation 1720 ft.
Slope 30-50 %
Aspect NE

Soil series Melbourne-Hugo
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Gaultheria shallon, Vaccinium ovatum
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
36	D	259	21	D	218	1	S	9	1	S	4	S				
36	D	259	19	D	195				37	D	4	S				
36	D	259	4	I	46				39	D	5	I				
48+	D	*							6	S	9	I				
9	I	85							5	S	7	I				
									4	S	6	I				
									4	S	6	I				
									2	S	7	I				
									24	CD	8	CD				
									18	I						
									2	S						
									2	S						
									2	S						
									3	S						
									3	S						
									3	S						
									3	S						
									1	S						
									4	S						
									15	I						
									20	CD						
									20	CD						
n=5 n/acre=20			n=3 n/acre=12			n=1 n/acre=4			n=22 n/acre=88		n=9 n/acre= 36					
Growth rate D=18.9 I=24.9			D=26.0 I=28.5			S=18.5										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 190
Location SE1/4,Sec.1,T10N,R1E.
Plot size .25 acre
Elevation 1640 ft.
Slope less than 30%
Aspect NE

Soil series Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Polystichum munitum, Gaultheria s.
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
17	D	166				9	I	108								
48+	D	*				24	CD	226								
1	S	12				6	S	75								
48+	D	*				31	D	291								
1	S	12				30	CD	282								
48+	D	*				21	CD	197								
48+	D	*				11	I	132								
1	S	12				9	I	108								
1	S	12				12	CD	113								
48+	D	*				9	S	113								
18	I	188														
2	S	24														
48+	D	*														
27	D	266														
48+	D	*														
23	I	244														
10	S	112														
2	S	24														
7	I	76														
3	S	36														
19	CD	84														
n=21 n/acre=84						n=10 n/acre=40										
Growth rate D=26.3 I=28.0 S=29.6						CD=18.8 I=23.9 S=25.0										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 192
Location NW1/4 Sec.7,T10N,R1E
Plot size .25 acre
Elevation 1750 ft.
Slope 30-50 %
Aspect NE

Soil series Usal
Soil depth 4 ft. +
Site class III
Dominant understory vegetation: Gaultheria shallon
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
2	S	26	48+	D	*	3	S	34	1	S			1	S		
1	S	13	48+	D	*	23	CD	279								
1	S	13	48+	D	*	24	CD	288								
1	S	13				13	I	121								
2	S	26				33	D	400								
48+	D	*				1	S	11								
2	S	26				1	S	11								
1	S	13				1	S	11								
1	S	13														
1	S	13														
1	S	13														
6	S	81														
2	S	26														
3	S	39														
n=14 n/acre=56			n=3 n/acre=12			n=8 n/acre=32			n=1 n/acre=4				n=1 n/acre =4			
Growth rate S=32.5			D=27.0			D=24.3 I=18.6 S=22.8										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 193
Location NE1/4 Sec. 1,T10N,R1E
Plot size .25 acre
Elevation 1320 ft.
Slope 30-50 %
Aspect SW

Soil series Melbourne
Soil depth 3-4 ft.
Site class III
Dominant understory vegetation: Gaultheria shallon
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
30	D	351				1	S	9	2	S						
3	S	36				1	S	9								
2	S	24				1	S	9								
48+	D	*				1	S	9								
48+	D	*				1	S	9								
7	S	83				1	S	9								
2	S	24				1	S	9								
10	I	117				1	S	9								
2	S	24				9	I	85								
44	D	517														
2	S	24														
7	S	83														
48+	D	*														
48+	D	*														
48+	D	*														
2	S	24														
n=16 n/acre=64						n=9 n/acre=36			n=1 n/acre=4							
Growth rate D=30.8 S=24.4						S=18.9										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 195
Location NE1/4 Sec.23,T11N,R1E
Plot size .25 acre
Elevation 200 ft.
Slope 50-70 %
Aspect SW

Soil series Melbourne-Hugo
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Polystichum munitum, Oxalis oregana
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
1	S	10				14	I	179								
14	I	125														
1	S	10														
3	S	30														
48+	D	*														
4	S	38														
21	I	188														
48+	D	*														
48+	D	*														
48+	D	*														
18	CD	161														
5	S	48														
34	CD	311														
17	I	52														
27	CD	243														
1	S	10														
11	I	99														
48+	D	*														
23	CD	207														
36	D	330														
48	D	438														
10	I	92														
48+	D	*														

Continue next page

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 195 continued
Location
Plot size
Elevation
Slope
Aspect

Soil series
Soil depth
Site class
Dominant understory vegetation:

Site type

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
2	S	20														
1	S	10														
12	I	106.														
n=26						n=1										
n/acre=104						n/acre=4										
Growth rate																
D=24.1						I=25.5										
S=25.3																

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 196
Location NW1/4 Sec.25,T11N,R1E
Plot size .25 acre
Elevation 600 ft.
Slope 50-70 %
Aspect NE

Soil series Melbourne-Hugo
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Gaultheria shallon, Vaccinium o.
Site type Xeric

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
16	I	109	48+	D	*	27	D	211	8	I			31	D		
6	I	43	48+	D	*				3	S						
4	I	28	31	D	251											
6	I	43	48+	D	*											
18	CD	124	20	CD	163											
4	S	28	20	CD	163											
2	S	21														
3	S	31														
9	I	63														
18	CD	124														
24	CD	167														
6	I	43														
8	I	56														
3	S	31														
2	I	15														
6	I	43														
5	I	35														
19	CD	124														
1	S	10														
20	CD	137														
15	CD	102														
6	I	43														
n=22 n/acre=88			n=6 n/acre=24			n=1 n/acre=4			n=2 n/acre=8				n=1 n/acre=4			
Growth rate CD=18.5 S=26.0			CD=20.4			D=15.6										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 197
Location NE1/4 Sec. 26,T11N,R1E
Plot size .25 acre
Elevation 400 ft.
Slope 50-70 %
Aspect NE

Soil series Melbourne-Hugo
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Polystichum munitum
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
4	I	34	29	CD	330	35	D	434	5	S						
23	CD	196	48+	D	*	14	I	196	1	S						
48+	D	*	28	D	319	2	S	28	4	S						
48	D	473	38	D	435	48+	D	*	3	S						
16	I	134				7	I	98	1	S						
1	S	14				16	CD	224	1	S						
1	S	14				17	CD	238	10	S						
7	I	62							1	S						
10	I	86							2	S						
18	I	152														
16	CD	134														
n=11 n/acre=44			n=4 n/acre=16			n=7 n/acre=28			n=9 n/acre =36							
Growth rate D=26.0 CD=22.7 S=35.6			D=29.3			D=24.8 CD=28.0										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 198
Location NW1/4 Sec.25,T11N,R1E
Plot size .25 acre
Elevation 840 ft.
Slope 30-50 %
Aspect NE

Soil series Melbourne-Hugo
Soil depth 4 ft. +
Site class II
Dominant understory vegetation:
Polystichum munitum, Oxalis oregana
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
8	I	79	48+	D	*	3	S	48	9	I						
4	S	45	46	D	576	11	I	176								
1	S	12	39	D	493	7	I	112								
10	I	100				5	I	80								
48+	D	*				8	I	128								
4	I	39				10	I	160								
25	CD	260				13	I	208								
10	I	100				5	I	80								
6	I	60				6	I	96								
2	S	24				15	CD	204								
10	I	99				8	I	128								
6	I	60				6	I	96								
2	S	24				15	CD	203								
10	I	100				8	I	128								
4	I	39														
7	I	70														
n=16 n/acre=64			n=3 n/acre=12			n=14 n/acre=56			n=1 n/acre=4							
Growth rate D=28.0 I=26.4 S=30.3			D=32.0			CD=27.8 I=32.5										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 200
Location NW1/4 Sec. 25,T11N,R1E
Plot size .25 acre
Elevation 480 ft.
Slope 30-50 %
Aspect SW

Soil series Hugo-Melbourne
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Rubus spectabilis, Polystichum m.
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
48+	D	*				3	S	23	3	S						
48+	D	*														
48+	D	*														
11	I	106														
11	I	106														
1	S	9														
11	I	106														
22	CD	161														
2	S	19														
48+	D	*														
6	I	60														
28	CD	206														
32	CD	240														
48+	D	*														
5	S	45														
48+	D	*														
17	I	163														
48+	D	*														
16	CD	116														
14	I	135	---Redwood													
4	S	35	n=23			n=1			n=1							
16	I	153	n/acre=92			n/acre=4			n/acre=4							
4	S	35														
Growth rate D=19.6 CD=25.9 S=23.5						S=21.8										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 201
Location SW1/4 Sec. 24, T11N,R1E
Plot size .25 acre
Elevation 560 ft.
Slope 50-70 %
Aspect SW

Soil series Melbourne-Hugo
Soil depth 4 ft. +
Site class II
Dominant understory vegetation: Oxalis oregana, Polystichum munitum
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
22	CD	189				11	I	141								
48+	D	*				16	CD	205								
11	I	82				1	S	11								
32	CD	281														
12	I	96														
1	S	11														
10	I	76														
22	CD	189														
11	I	82														
4	I	30														
20	I	148														
48+	D	*														
48+	D	*														
48+	D	*														
17	I	126														
8	I	60														
48+	D	*														
48+	D	*														
2	S	22														
1	S	11														
26	CD	223														
18	CD	154														
48	D	419														
Continue			next page													

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 201 continued
Location
Plot size
Elevation
Slope
Aspect

Soil series
Soil depth
Site class
Dominant understory vegetation:

Site type

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
7	S	73														
10	I	76														
2	S	22														
48+	D	*														
6	S	62														
n=28 n/acre=112						n=3 n/acre=12										
Growth rate D=23.0 I=20.0 S=27.2						I=25.6 S=22.2										

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed

Individual Plot Data

Plot number 202
Location SE1/4 Sec.23,T11N,R1E
Plot size .25 acre
Elevation 360 ft.
Slope 50-70 %
Aspect SW

Soil series Melbourne-Hugo
Soil depth 4 ft. +
Site class II
Dominant understory vegetation:
Polystichum munitum, Oxalis oregana
Site type Moist-mesic

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
7	I	79														
1	S	12														
48+	D	*														
25	CD	196														
1	S	12														
1	S	12														
1	S	12														
2	S	24														
37	D	296														
14	CD	109														
19	CD	147														
48+	D	*														
4	I	44														
48+	D	*														
1	S	12														
48+	D	*														
6	I	67														
1	S	12														
45	D	360														
2	S	24														
14	I	151														
16	I	171														

Continue next page

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant
I=intermediate S=suppressed

Individual Plot Data

Plot number 202 continued
Location
Plot size
Elevation
Slope
Aspect

Soil series
Soil depth
Site class
Dominant understory vegetation:

Site type

Redwood			Douglas-fir			Western Hemlock			Tanoak		Madrone		Grand Fir		Sitka Spruce	
d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	age	d.b.h.	height class	d.b.h.	height class	d.b.h	height class	d.b.h.	height class
48+	D	*														
1	S	12														
25	CD	195														
1	S	12														
2	S	24														
n=27																
n/acre=108																
Growth rate																
CD=21.0																
I=29.1																
S=30.3																

Growth rate: annual rings per radial inch / D=dominant CD=co-dominant I=intermediate S=suppressed