REHABILITATION AND LONG-TERM PARK MANAGEMENT OF CUTOVER REDWOOD FORESTS: PROBLEMS OF NATURAL SUCCESSION

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Abstract. There is no known natural equivalent of clearcut timber harvest in the redwood vegetation of Redwood National Park. Thus no prediction of future forest development on cutover parklands can be made without formulation of models based on data from young second growth forests and descriptions of the dynamics of uncut (old growth) forests. Preliminary observations suggest that Douglas-fir (Pseudotsuga menziesii) will be strongly over-represented with respect to coast redwood (Sequoia sempervirens) and that this condition may persist for centuries. Studies now underway may be used to predict long-term second growth stand dynamics and suggest rehabilitation methods for speeding the development of an old growth mimic.

INTRODUCTION

Old growth redwood forests occupy about 15,800 hectares (39,000 acres) in Redwood National Park. Redwood vegetation, especially in the northern half of its range in northern California has been categorized as a climax vegetation type (Weaver and Clements, 1939), but little data has been presented to support the view. Fritz (1929) described an all-aged redwood stand while Veirs (1980) found additional evidence to support the climax concept in coast redwood forests.

Within the present parklands approximately 20,650 hectares (51,000 acres) were clearcut during this century, producing even-aged second growth forests dominated by Douglas-fir (Pseudotsuga menziesii) instead of coast redwood (Sequoia sempervirens).

Park managers must evaluate the natural dynamics of old growth stands and the patterns of succession on the clearcut lands in order to establish long-term vegetation management policies. The objectives of these policies should be (1) to maintain the old growth forests free from substantive modern human influences and (2) to rehabilitate the second growth forests or speed their conversion to a mimic of the old growth forests in keeping with National Park Service policies (USDI, 1978).

BACKGROUND

Stable old growth redwood stands in and around Redwood National Park have been described as part of the long-term management research effort at

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Redwood. Typically these stands have low densities of overstory redwood and Douglas-fir (Table 1). The overstory redwood component of these stands is all aged with average ages of 200 to 800 years. Ages of a few individual redwood exceed 1,000 years, and the oldest redwood was more than 1,600 years old when cut. The Douglas-fir component of these stands is even-aged and occurs in various discrete age groups up to about 600 years. The age distributions are obviously in strong contrast with the ages of trees established following logging twenty, thirty, or sixty years ago.

No patterns of upland redwood succession have been described although some have been proposed (Stone and others, 1969, Cooper, 1965) in which redwood would be replaced by other species in the absence of fire.

Data exist for several normal old growth stands and several "young" stands of old growth redwood (Veirs, 1980). This type of information may be used to develop predictive models for "normal" redwood stand dynamics, while data from stands established following clearcut logging may be used to develop similar models for second growth stands. Based on predictions derived from these models, recommendations may be made for rehabilitation to restore or speed the restoration of second growth stands which mimic the natural old growth stands.

Stand density in relation to time has been described for both old growth and second growth forests including redwood (Harper, 1977). In the case of a climax forest type the number of standing trees decreases from young to old age classes. Most young trees present at any given time have little probability of surviving to older age classes or canopy tree status. In second growth stands this age pyramid is replaced by a pyramid of size classes. Of the many seedlings established about the same time following logging or burning in a forest, only a relatively small number will reach dominance. The balance die suppressed. In some special cases whole second growth stands may remain in an "autosuppressed" condition where there is little mortality and many very slow growing trees survive for long periods forming a stagnated stand (Diamond, 1978). This condition may exist in some stands within the park.

RESULTS

Stand density and tree age for redwood and Douglas-fir is presented in Table 1 for upland stands of old growth and second growth redwood forest and for stands reestablished following landslides. Alluvial forests are not discussed here, nor are the roles of associates and understory species including hemlock (*Tsuga heterophylla*), tanoak (*Lithocarpus densiflora*), grand fir (*Abies grandis*), big leaf maple (*Acer macrophyllum*) and others.

The ratio of redwood/Douglas-fir canopy trees (greater than 60 cm, dbh) in an old growth stand ranges from about 10:1 to 3:1 depending on individual stand history. In young second growth stands the situation is reversed, with Douglas-fir outnumbering redwood by a factor of 2 to 10, depending on aspect and slope position. These values are presented for discussion and should be interpreted with caution due to sampling limitations. Our sampling has not permitted us to establish mortality rates for either species in second growth stands, so we are not yet able to predict the composition of these stands in the post logging succession. It is clear that on most sites Douglas-fir is vastly over represented in comparison with normal old growth stands.

Table 1: Densities of *Sequoia sempervirens* and *Pseudotsuga menziesii* in upland redwood forest vegetation of various ages and conditions, Redwood National Park and vicinity.

STAND AGE AND DESCRIPTION	DENSITY OF STANDS (TREES/HECTARE)		RATIO
	COAST REDWOOD (*Sequoia sempervirens*)	DOUGLAS-FIR (*Pseudotsuga menziesii*)	REDWOOD / DOUGLAS-FIR
10 to 15 YEARS AFTER CLEARCUTTING	420	3,226	0.1
25 YEAR OLD THINNED CLEARCUT	522	325	1.6
60 YEAR OLD CLEARCUTS	112	343	0.3
REVEGETATED LANDSLIDE SURFACES 120 YEARS OLD			
1	245	163	1.5
2	808	17	47.5
3	209	38	5.5
STANDS LESS THAN 1,000 YEARS OLD (TREES >60 CM DBH) (3 STANDS)	97	11	8.8
STANDS MORE THAN 1,000 YEARS OLD (TREES >60 CM DBH) (9 STANDS)	37	14	2.6

The data for densities of redwood and Douglas-fir in stands reestablished following landslides which occured in 1861 are presented in Table 1. These landslides are not analogous to modern clearcut hillslopes. This is due to the relatively small size of the landslides and their low slope position. These factors would be expected to produce a more shaded, moist environment favorable to redwood reestablishment and is in strong contrast to the hotter, drier full sunlit conditions found on large clearcut and burned upland sites. For this reason data from only the largest (driest, hottest) of the three sites was used in the regression.

Selected data from Table 1 are plotted in a common logarithm form in Figure 1. Some liberties have been taken in selection and pooling of these data, presented here for conceptual purposes. Stand age for stands less than 1,000 years was taken as 500 years and stand age for stands termed "greater than 1,000 years" was taken as 1,000 years. Linear regressions were computed for redwood and Douglas-fir density in second growth and old growth stands, over time. From this data it may be observed that a redwood/Douglas-fir ratio of 1:1 occurs after stands reach 100 years of age. A ratio of 2:1 is obtained after 250 or 300 years.

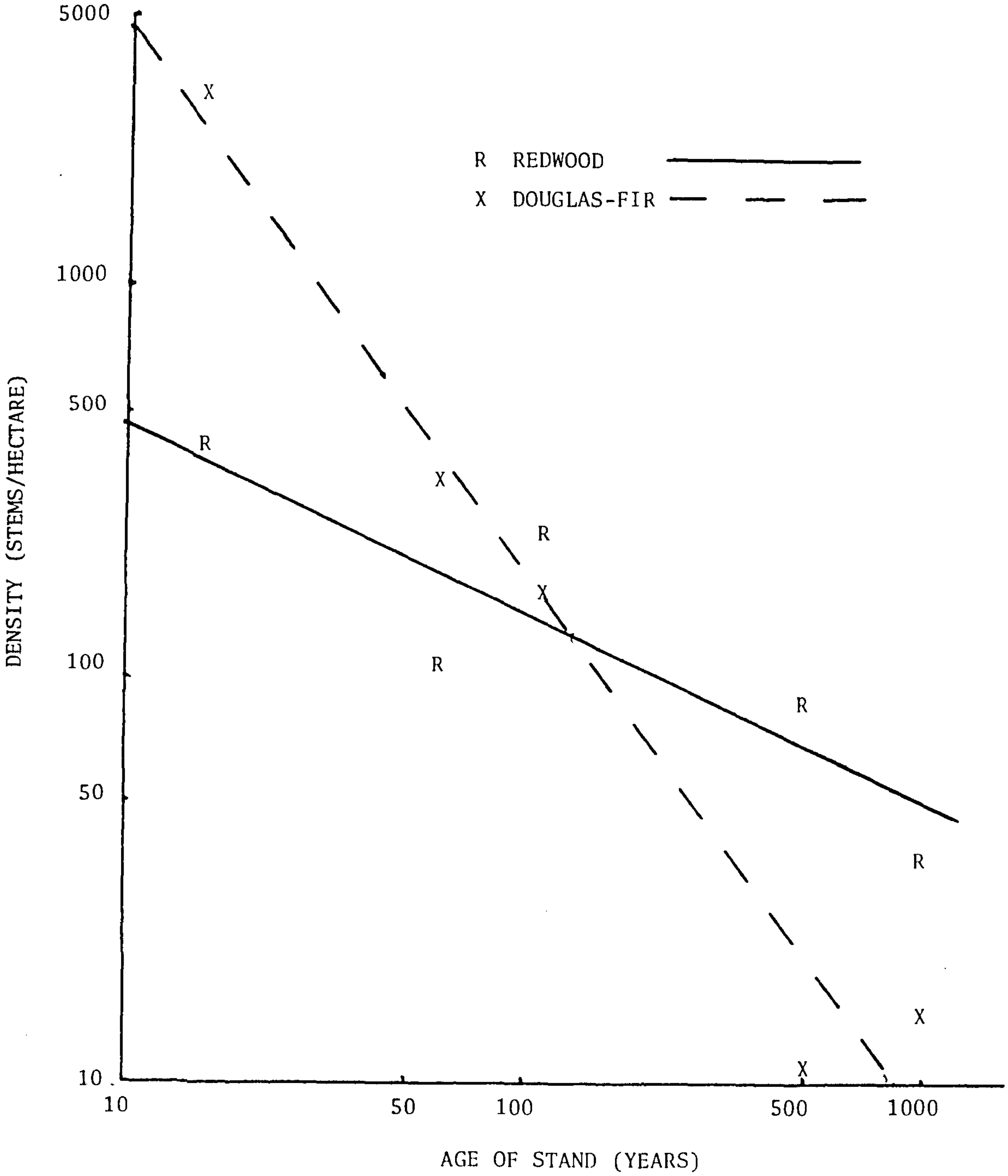
In 1978-9, shortly after park expansion, a large scale experimental thinning project was carried out in several second growth stands about 25 years after logging. Pooled data for these sites show that Douglas-fir numbers were reduced to about 60% of the redwood after operational thinning to several prescriptions. Results from similar sites can be used to demonstrate that thinning in a 25-year-old stand can produce a redwood/Douglas-fir ratio comparable with that found in an untreated 60-year-old stand. Thinning also substantially changes the visual and physical character of the treated second growth forests. Complete results of the thinning study will be presented elsewhere.

DISCUSSION AND CONCLUSIONS

Natural successional processes in second growth redwood vegetation may slowly restore a mimic of the former old growth forests on lands within Redwood National Park. The data presented here lend support to the idea that this process may take centuries. The question of the role of stump sprouting was not addressed, but clusters of redwood stems around stumps now occur in much greater numbers than similar natural clusters in uncut stands. Thinning young stands is a management tool which may be employed to adjust the redwood/Douglas fir ratio and to decrease densities. Our experience in thinning suggests that there are practical and political problems associated with thinning in stands older than 25 years. Increasing tree size is a barrier to mechanical thinning as the stand develops. Thinning may be useful in changing the visual and physical character of young stands. This might be desirable for certain park purposes beyond biological rehabilitation or stand naturalization. Early thinning to stand densities of 250-600 stems per hectare has produced stands similar to those observed in untreated stands 60 years old.

These stands, however, remain well above desired densities and Douglas-fir continues to be over-represented relative to redwood. Further artificial reduction of tree densities and alteration of species proportions by other procedures might be found to selectively accelerate individual tree mortality where desirable to continue speeding the return to a more nearly natural forest appearance.

Figure 1. Linear regressions of density changes over time in numbers of redwood and Douglas-fir in upland redwood. (Data from Table 1, untreated stands and landslide 1 only.)



Long-term management of old growth redwood forests and young second growth stands within Redwood National Park will depend on the acquisition of additional information concerning old growth and second growth ecological processes. Direct manipulation to speed stand naturalization is a tool which should be examined further on an experimental basis. Results of these studies may establish rationale and techniques which will speed the restoration of the natural grandeur of the virgin redwood forest in those stands leveled before establishment of Redwood National Park.

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