# Management Practices Related to the Restoration of Old Forest Characteristics in Coast Redwood Forests.

A Report to The Save the Redwood League

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## Preface

When Save the Redwood League (League) approached me to undertake this project I realized that I was being handed the opportunity to investigate a suite of management approaches across the range of coast redwood (*Sequoia sempervirens*) in an abbreviated period of time. This afforded me the opportunity to assimilate a great deal of information in such a manner that I was able to make visual comparisons between properties while the images of my previous visit(s) were still etched in my mind. This unique project has impressed upon me the diversity and range of physical and edaphic heterogeneity that is expressed within the redwood forest.

Save the Redwoods League's desire to expand its conservation efforts to include the purchase and restoration of depleted redwood landscapes is laudable. However, this new direction will certainly present challenges that will test the League, but these challenges should not deter the organization from this noble venture. With the purchase and desired management of the Mill Creek property in Del Norte County, the League has undertaken a bold new direction that will be realized, and valued by future generations of Californian's. This project and this report are intended to support and guide them in their efforts.

## Introduction

### Justification for this project

Historic and contemporary forestry practices have simplified the structural components of coast redwood forests (O'Dell 1996). Recruiting the structural elements commonly found in older forests is recognized as an important management objective in younger forest stands to address issues of biological diversity and forest integrity (Mladenoff 1993; Spies 2002). Obviously, old forest features are a function of time; as such they often include stand characteristics not associated with younger stands. Old forest characteristics are often the result of chaotic events e.g. storms, fire, and landslides whose legacies shape forest structure and composition and which may be difficult to mimic.

**Coast Redwood Old Forest Structure and Composition**

The League has made a wise decision in not falling into the trap of focusing on the development of yet another definition of *Old Growth* to guide its intentions. The decision by the League's science advisory committee to instead focus on understanding the biological and physical characteristics of older forests rather than articulating (and most likely arguing) over a working definition will most likely result in positive and fruitful actions.

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

The coast redwood forest, being dispersed along a north-south axis, has characteristics affected by geographic location and localized climate and edaphic conditions (Sawyer and others 2000). Any comparison between redwood stands from differing geographic locations should be viewed as reference points and not as absolute guidance factors. Furthermore, any numerical comparison between stands should also recognize that differences exist in structural attributes between trees growing on upland sites vs. trees growing on alluvial flats. As illustrated in Figure 1 stands that have been described growing on alluvial deposits generally have higher tree densities then those stands on adjacent upland sites. This illustrates the need to recognize that no one description will define or articulate the structural elements of any particular site and any reference data should be used conservatively in management discussions.

**Figure 1**. Stand density comparison between Old Growth coastal redwood stands from different geographic locations with differing climatic and edaphic conditions.

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

There does exist some limited descriptive fieldwork for non-tree attributes of older redwood forests. Sholars (in Sawyer 2000) has cataloged 47 species of lichens as part of the Bryophytic component for an old growth forest. Similarly, Largent (in Sawyer 2000) has identified over 323 species of fungi associated with old growth redwoods. Others (Thornberg, pers. comm.) have taken their leads and are now pursuing field studies to determine the opportunities to inoculate previously logged stands that are missing these non-vascular botanical components. If successful, their work should complement silviculturalists focusing on the development of structural attributes in old forest restoration.

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

In the latter part of the 20th Century a political movement based on environmental awareness took hold in this country. The beginning of this movement is often associated with the inaugural Earth Day in the early 1970s. However, the political undercurrents leading up to that day had already set into motion a surge in conservation activities not witnessed since the days of President Theodore Roosevelt. By 1969 the U.S. Department of Interior had initiated a project to identify and purchase what is now known as Redwood National Park in the northwestern corner of California. As a result, stand

structure data were collected for a number of properties in old growth redwood stands that were being proposed for acquisition (Hammon, Jensen & Wallen, 1969). The information provides an opportunity to compare size class distributions on un-logged sites (Figs. 2, 3, & 4).

The resultant data from the approximately 9,000 aggregated acres cruised demonstrates a relatively similar size class distribution. Given the acreages of the cruised parcels, one can surmise that both upland and riparian sites were sampled. The average tree density of the three ownerships was 32 trees/acre, with tree sizes below 50" dbh dominating. In each case, trees >50" dbh were common and averaged >2 trees/acre. Similarly, each property averaged approximately one tree >90" dbh per acre.

**Fig. 2**. Size Class Distribution of Old Growth Redwood Trees. Miller-Rellim Timber Company. Del Norte County. 1,001 acres. ≈ 31 trees/acre. Source: HJW(a) 1969.

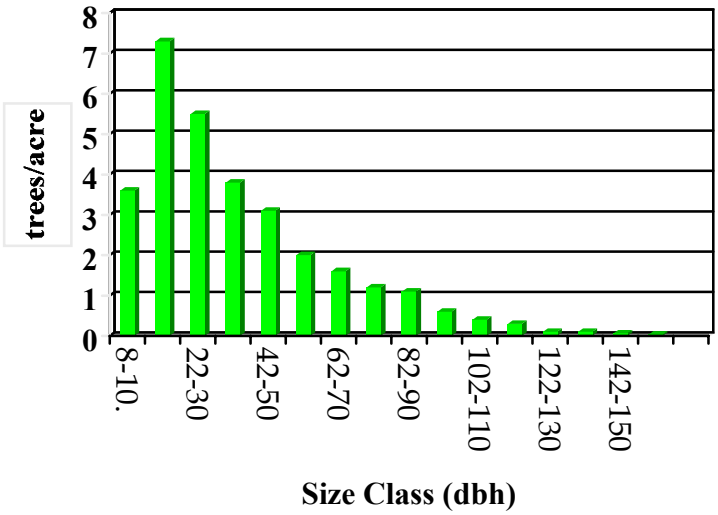


**Fig. 3.** Size Class Distribution of Old Growth Redwood Trees. Simpson Timber Company. Del Norte County. 436 acres. ≈ 33 trees/acre. Source: HJW(b) 1969.

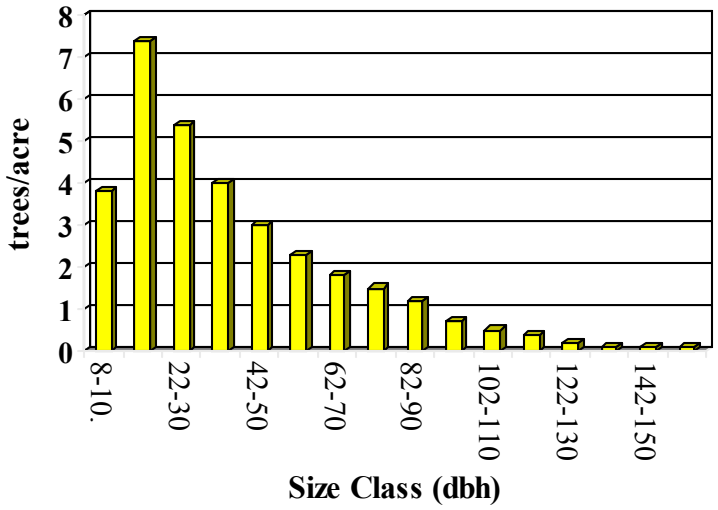
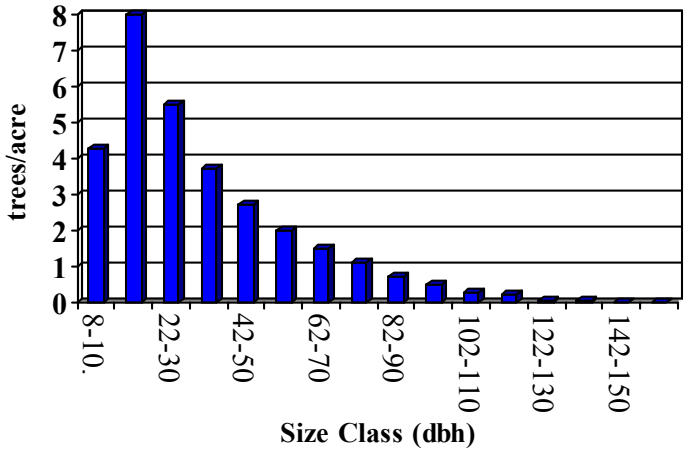
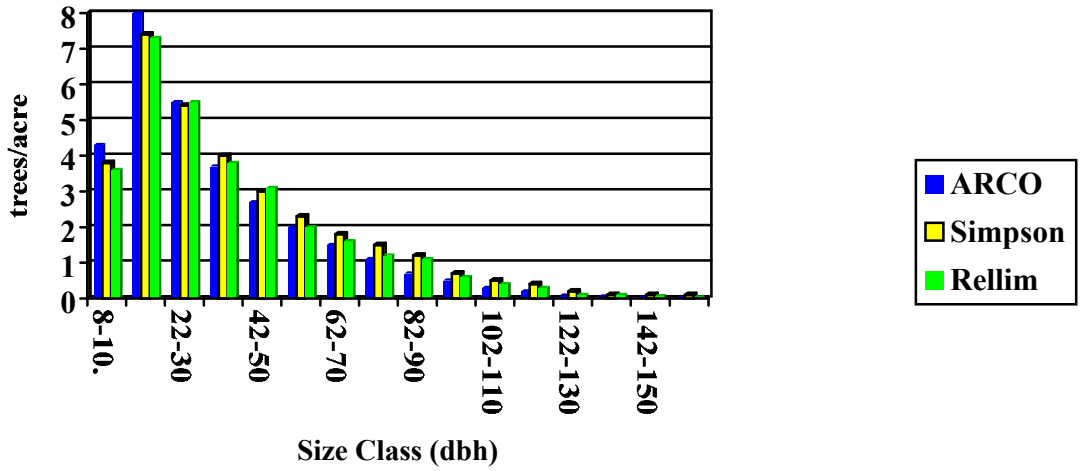



**Fig.4.** Size Class Distribution of Old Growth Redwood Trees. Arcata Redwood Company (ARCO). Del Norte County. 7,941 acres. ≈ 31 trees/acre. Source: HJW(c) 1969.



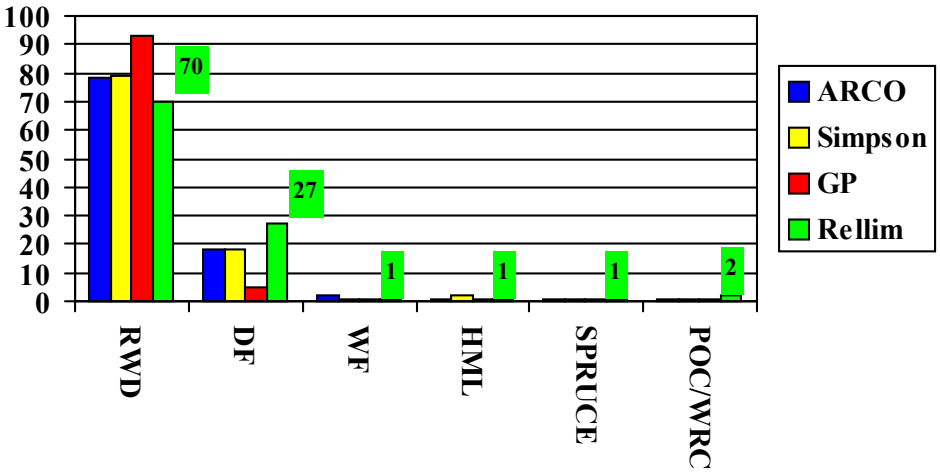

A comparison of the three property cruise reports demonstrates a similarity of size class distribution across each of the ownerships (Fig. 5).

**Fig. 5.** Size Class Distribution of Old Growth Redwood Trees ARCO, Simpson & Rellim Timber Companies. Del Norte County. 9,378 acres. ≈ 32 trees/acre. Source: HJW 1969.




Though each property shared similar traits when comparing size class distribution, they had strikingly different conifer composition. Of the properties surveyed by HJW in 1969 the Rellim property had the least percent by volume of redwood and the highest percent by volume of Douglas-fir (Fig. 6).

**Fig. 6.** Relative percent by volume of tree species on ARCO, Simpson, Georgia-Pacific and Rellim Redwood Companies. Source: HJW 1969 (a,b,c,d)



(Legend: RWD (redwood); DF (Douglas fir); WF (White fir/Grand fir); HML (W. Hemlock); Spruce (Sitka Spruce); POC/WRC (Port Orford Cedar/W. Red Cedar).

This disparity in species composition is reflective of the spatial distribution of the Rellim property relative to the coast and the "redwood belt". Much of the property is eastward, relative to the other holdings, where Douglas-fir becomes dominant.

Since a majority of the primordial forest has been logged and hence altered for the foreseeable future these data can serve as a useful benchmark to assist the League and its forest managers in future decision making for the Mill Creek property and any other sites in northwestern California they or others may decide to manage to achieve old forest conditions.

**Redwood Ecology – Habitat Relationships**

Plants and animals have evolved under environmental conditions that have determined a number of behavioral traits and biological dependencies. These traits can express themselves in physiological behaviors that may aid in such things as water conservation or moderating the various impacts of ambient temperatures (e.g. hibernation). Other traits may be expressed as habitat relationships that have evolved over time between an organism and its surroundings e.g. nest site selection, or predator-prey avoidance behavior. Many of these relationships are not so absolute that an individual cannot adapt to change. Having the ability to adapt to changing conditions is important for forest species whose physical environment is subject to disturbance from abiotic and biotic factors i.e. wind, fire, landslides, floods, pest or disease outbreaks, etc. However, if the rate and spatial distribution of disturbance is accelerated beyond what evolutionarily developed attributes can sustain, a population's stability will be at risk (Bury 1983).

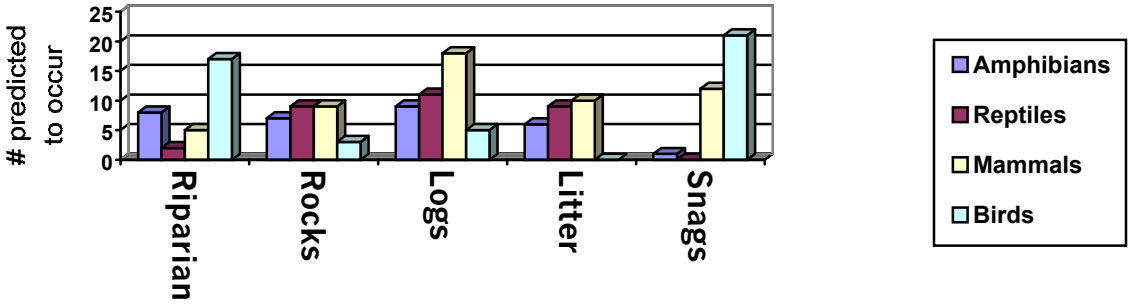
In the case of coast redwood, where so much of the physical condition of the primordial forest has been altered in a relatively short time, species that have adapted to peculiar old forest characteristics are unable to adapted to their new surroundings e.g. marbled murrelet. This species, which exhibits a unique nesting behavior (for alcids) in the upper portions of old trees in California, is primarily a ground/burrow nester in the northern reaches of its range (Carter et. al. 1988). Consequently, the loss of suitable

nesting structure and strong evidence of a continually declining population throughout California were principle arguments that led to the bird's eventual listing under the Federal Endangered Species Act (ESA) (Beissinger 1995).

Large, reiterative branches, important for murrelet nesting, are just one unique structural component of an old redwood forest. Other elements that provide important habitat structures include fallen logs, vegetation mats, dead standing trees (snags), tree hollows, and stream corridors (Gellman and Zielinski 1996). A comparison of habitat relationships among vertebrate species demonstrates the importance and reliance of many species to the various physical elements found within a forest (Fig. 7).

Many species will partition habitat elements seasonally (Cooperrider and others 2000). For example, riparian corridors are used for reproduction site by many amphibians in winter and spring, while down logs in upland sites can provide summer refugia. The availability of different habitat elements provides the basis for the biological diversity of one site vs. another. Conventional wisdom promotes the notion that an old forest with its various layers of vegetation from ground cover to canopy, different age and size classes of vegetation in combination with other elements (rocks, litter, logs, etc.) provides a higher index of structural diversity than a similar forest type that has been logged in a manner that reduces forest structure and complexity (Spies 1996; Carey 2001; Youngblood 2001). It is the loss of these structural and compositional elements that has resulted in the listing of many terrestrial and aquatic species. In many cases, restoration of a particular habitat element may be the only viable option for species recovery.

**Fig. 7.** Vertebrates predicted to use habitat elements found in coast redwood (source: CWHR)



Vertebrate species assemblages found in coastal redwoods are not unique with many species found in other forest types throughout California and the Pacific Northwest (Fig. 8).

**Fig. 8.** Number of vertebrate species predicted to occur in redwood and Douglas-fir forests.

| | **Number of** | **Native** | **Species** |
|---|---|---|---|
| | Redwood Forest | Douglas-fir Forest | Species in Common |
| Amphibians | 18 | 18 | 16 |
| Reptiles | 16 | 18 | 15 |
| Birds | 105 | 110 | 101 |
| Mammals | 63 | 66 | 61 |
| Totals | 202 | 212 | 193 |

The occurrence of similar species and taxonomic assemblages can assist managers in the short-term until more redwood-based information becomes available.

Unfortunately, though the information base for vertebrates is weak, even less information currently exists for arguably the more important bacteria, fungi and other invertebrates found in coastal redwoods (Hoekstra 1995). Undoubtedly, as our knowledge base increases regarding the diversity of all of these species our understanding of their role in facilitating multiple ecological functions will grow. Until that time, the best we can hope to accomplish is to provide a diversity of habitat elements including soil and litter attributes that can sustain populations for future study.

## Research Design

### Field Review Objective

This project was designed to "identify and articulate the applied knowledge that exists from practitioners who have experience with silvicultural operations that might affect forest restoration efforts". This is to be accomplished by identifying

knowledgeable individuals widely recognized by their peers and others who have demonstrated an ability to successfully recruit old forest characteristics into their managed stands.

**Scope and Tasks of Field Survey**

The objective is to conduct a regional survey of management experiences, to document management treatments aimed at restoring old-forest characteristics in coast redwoods. The management review will include the following tasks:

1. Identification of public and private landowners and land managers either (a) managing ancient coast redwood forests, or (b) conducting silviculture directed towards restoration of old-forest characteristics in coast redwood forests.

2. Develop a questionnaire to ensure that interviews are consistent and replicable, including identification of a sub-set of landowners and land managers to interview reflecting the diversity of the coast redwood forest.

3. Conduct and document interviews, including map and photo based documentation of ongoing management studies, identification of management goals, and identification of monitoring techniques (if any).

4. Develop a workshop in collaboration with Professor Kevin O'Hara, U.C. Berkeley, to review draft findings of literature review and survey of management practices.

5. Produce a white paper detailing the findings from the literature and management review projects. A key component of this report will be to identify those management activities (both documented in the scientific literature and from practical experiences) that should be evaluated and expanded upon.

The management review will seek to document experience relevant to answering the following questions:

*Premise 1. Silviculture is widely viewed as the management option that holds the greatest potential to accelerate and restore old forest characteristics. The following questions are intended to identify those practices that best accomplish this objective.*

**1a. Do you have an existing stand of older trees? How are you managing that stand to maintain old forest characteristics? Do you manage older stands of trees differently than any other?**

**Key Findings:** In every case where older trees still exist they are identified by the owner/manager as an important component of the ownership that has High Conservation Values "HCV". In all cases, the owner/manager recognizes the older trees as "old growth" delineated as either whole stands or residual trees left from past harvest activities. In every case, stands that have not yet been harvested will not be entered and are being preserved. Where partial harvesting has occurred and residual trees remain, future harvest activities will focus on the trees within the matrix surrounding the residual old trees. In three instances, specific policy language has been developed that 1) articulates the qualitative description of the stands/trees to be protected, 2) identifies the stands of old trees to bereserved, and 3) describes the management options available for the conservation of their values. Old forest management policies have been developed and are publicly available for the Mendocino Redwood Company, The Soquel Demonstration State Forest and the Jackson Demonstration State Forest.

**1b. What are your management goals, monitoring techniques etc. toward redwood regeneration?**

**Key Finding**: In every case, the properties visited are being managed for the long-term production of timber and sawlogs. Hence, regeneration is a key

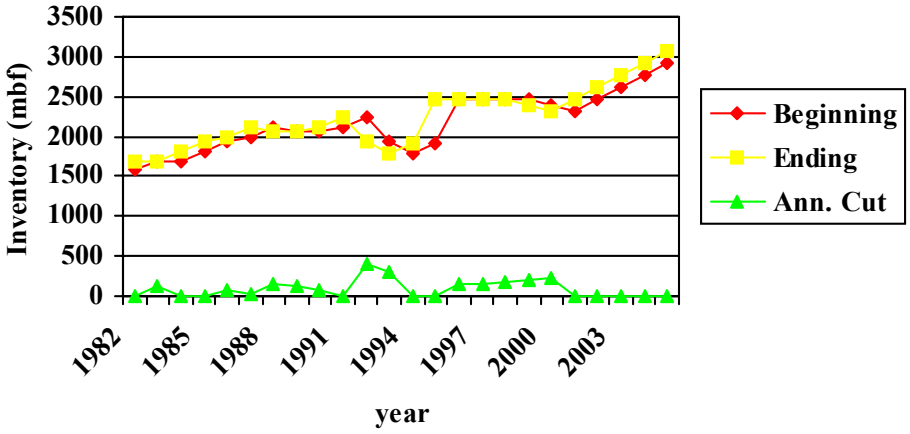
component of the property's management objectives. Shared management objectives regarding regeneration included:

1) Stump sprouting is promoted since it is a unique attribute of coastal redwood and it avoids genetic contamination of the stand. Sprouting clumps are the principle source of juvenile tree recruitment, while inter-planting is conducted on an "as needed" basis to achieve stocking objectives.
2) Harvest activities focus on the dominant and co-dominant trees within a sprout clump retaining the smaller size cohorts for future harvests. Thus retaining the genetic architecture of the redwood component of the stand. Harvest trees within clumps are selected on the basis of achieving both spacing and regeneration criteria.
3) Care is taken by the forester to work with the LTO to ensure that damage to recruitment trees during harvest activities is minimized.
4) Vertebrate damage (rodents, deer, elk and black bear) is monitored and addressed where appropriate on an as needed basis.
5) Timber volume data are collected and monitored using conventional field plots in combination with growth and yield models. Standing timber volumes and recruitment estimates across all size and age classes are commonly collected to ensure that regeneration and future harvest objectives will be assured.

**1c. What are the most commonly applied silvicultural treatments on the properties you manage?**

**Key Finding:** 1) Commercial thinning of redwood is far and away the most widely applied silvicultural practice witnessed. In all cases, the RFP is selecting trees "from below" selecting co-dominant trees while retaining dominant individuals. This prescription concurrently achieves spacing, growth and volume objectives while maintaining contiguous canopy cover (Fig. 9).

**Fig. 9.** Humboldt Co. Commercial thinning 1982- 2000. Site II. 70 acres. Birth of Stand 1915-1925. First commercial thin 1976. (Source: Able Forestry).




2) To a lesser degree single-tree selection was the second most applied silvicultural practice. This selection approach was utilized to achieve specific site or ownership objectives regarding growth or volume.

3) Variable retention prescriptions, a relatively new approach in the redwood region, are being applied on an experimental basis by some of the larger acreage owners/managers (Mendocino Redwood Company, Jackson Demonstration State Forest). Assumptions about the utility of this prescription to achieve future desired old forest characteristics are yet to be validated. This silvicultural prescription promises the greatest opportunity for future research and demonstration opportunities.

**1d. What is your philosophy regarding early spacing treatments (pre-commercial thinning) and when is it best applied (if ever)?**

**Key Finding:** 1) Pre-commercial thinning (PCT) is virtually ignored as a management approach on most of the sites visited. Most of the interviewees are currently managing stands that are beyond the optimum time for pre-commercial thinning. However, many of those interviewed believe that

harvesting activities achieves benefits akin to PCT in younger stands by removing undesirable species or reducing tree numbers in over-stocked sites through mechanical disturbance from tractors, falling trees, or cable corridor placement.

2) Those individuals who practice PCT consider the optimum stand age to achieve desirable stand characteristics to be between 8 and 18 years (JDSF & MRC). This is based on their field experience for optimal release of remaining redwoods.

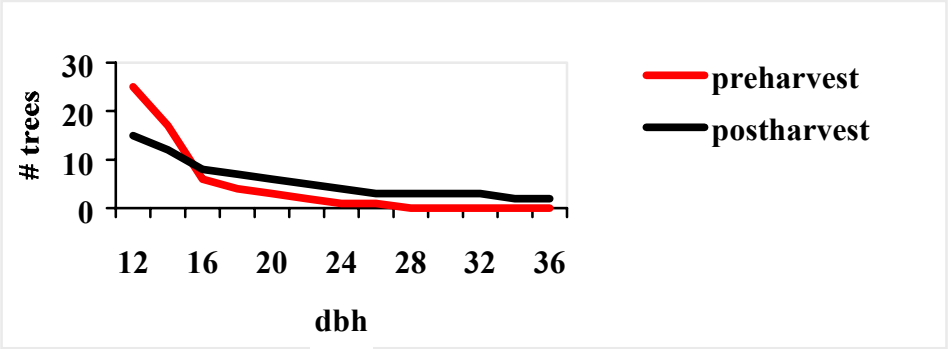
**1e. What is your philosophy about the relationship between commercial (mid-rotation) thinning and redwood regeneration? When is it best applied?**

**Key Finding**: Commercial thinning is the most widely utilized silvicultural practice of the sites visited. In all cases, the approach is similar. The RPF chooses the harvest trees after assessing dominant and co-dominant trees. Generally, dominant trees are retained in the stand to increase stand volume through release. Volume is increased from both increased diameter and height. Additionally, commercial thinning initiates gap phase successional processes allowing for natural recruitment of future crop trees from stump sprouting. Theoretically, commercial thinning should assist seedling establishment, however, throughout most of the northern range of coast redwood, seedlings are conspicuously absent.

The amount of wood volume harvested during each entry is dependent on the forester and the site. In some cases, RPF's concentrate on removing 30% of the volume per entry, while other RPFs, remove 1/3 of the trees. In either scenario the intent is to increase area volume and tree size over time (Fig. 10).

**Fig. 10.** Desired outcome over time from commercial thinning.

Source: Blencowe Forestry.




**1f. What experiences relative to recruiting old forest characteristics can you share regarding those treatments?**

**Key Findings:**

1) By design or happenstance the use of mid-rotation selection cutting has resulted in the gradual increase in both average tree girth and height while maintaining dense forest canopy.
2) Mid-rotation thinning further allows the forester to identify and retain distinctive habitat elements that are present in the stand prior to harvest.
3) Furthermore, selection cutting allows for development of multiple age stands that address both old forest characteristic retention and future crop tree recruitment.
4) When recruitment goals are not being met, mid-rotation thinning allows the RPF to select appropriate sites for group selection harvest units. This combination of silvicultural treatments allows for increased regeneration while minimizing canopy disturbance and retaining old forest characteristics in the remainder of the stand.
5) Following the forth entry, stands (in Humboldt County) begin to take on visual characteristics of older forests (approximately 90-120 years)

including the presence of bryophytes, larger lateral branches, mid-layer canopy trees, and visual aspects of stand decadence.

**1g. Does your approach to regeneration require active vegetation control for undesirable species?**

**Key Findings:** The majority of interviewees have no need to consider vegetation management scenarios in established stands. They are achieving control of noxious plants or maintaining desired species composition through:

1) Maintaining contiguous tree canopy to increase shade on the forest floor thereby inhibiting seedling recruitment of undesirable and noxious species.
2) Eliminating undesired, shade tolerant species during harvesting activities.

In areas of disturbance i.e. landings, roads, areas of stump removals, etc. ocular monitoring and removal of rosettes or juvenile plants prior to seed development is key to minimizing their spread.

**1h. Is pruning a viable option for improving tree vigor, stand characteristics, and economic returns?**

**Key Findings:** Pruning is not generally being applied at the sites visited to improve tree vigor. The consensus by those interviewed is that pruning is an activity to promote "clean log production" and the cost of pruning is not justified under the silvicultural methods being used. Furthermore, concern was expressed over the accelerated rate of lower branch loss from pruning and the potential impact to perching birds. Pruning is generally viewed, as an activity that further simplifies stand complexity therefore affecting functional forest attributes.

Where pruning has been applied it was used to achieve specific stand level objectives including: 1) road clearing to increase visibility, and 2) minimize vegetation along roadways for fire prevention.

**1i. What has experience taught you about the type of un-even age prescriptions that may have the greatest potential to provide information useful in old forest restoration?**

**Key Finding**: This question represents the primary purpose for undertaking this project. The guidance provided by the interviewees will inform future management decisions with regard to stand manipulations intended to achieve old forest characteristics. Key points are:

1) Un-even age prescriptions allow the forester to identify and retain old forest characteristics already present in the stand while designing a system to ensure adequate stand regeneration to meet financial objectives.
2) Managers are exploring and evaluating the harvest of all stems within a stump sprout to achieve both volume and regeneration objectives while creating canopy gaps.
3) Stump sprout harvesting most likely mimic the natural disturbance pattern for individual tree replacement in coast redwood.
4) Silvicultural prescriptions should be viewed as a mechanism that achieves both volume production and initiates a stand response to set the path of growth and development into the future.
5) Un-even age management does not commit the entire stand to a predetermined path of growth and habitat development. It allows the forester to make adjustments at any point in the development of the stand.
6) Through the use of uneven-age management the forester is able to maintain continuous forest canopy thereby positively affecting

ambient conditions in the stand i.e. shade, humidly, temperature, forest floor cover, mid-level canopy characteristics.

*Premise 2. Natural disturbances are widely viewed as playing a key role in defining old forest characteristics. Many of those features include peculiar traits exploited by various species of terrestrial wildlife and flora.*

**2a. What specific habitat elements do you view as being uniquely characteristic to coastal redwood forests?**

**Key Finding**: The respondents each identified several habitat characteristics of coastal redwood that they are mindful of during their management decisions. These generally can be categorized into biotic and abiotic characteristics.

| Biotic Elements | Abiotic Elements |
|---|---|
| Trunk hollows (goose pens) the result of multiple burns. Not unique to coast redwood but difficult to recruit under current fire suppression regimes. | Soil types, depth, slope and aspect of management unit and how these conditions affect species composition and tree growth. |
| Broken tops, deformed trunks, large woody debris caused by lighting, wind, disease and pests (in hardwoods) etc. | Rock outcroppings and shallow soils in the middle and southern portions of the range. Steep slopes and numerous 1st order streams common throughout the region. |
| Reiterative branching unique of older trees and difficult to recruit using modern silvicultural time frames. | Influences of past fire events (natural and induced) on stand composition and structure. |

| |
|---|
| Multiple layered canopy with redwood and Douglas-fir being dominant. |
| Ability to sprout, a unique characteristic for a North American conifer. |
| Longevity, compared to other species found in the redwood region. |

**2b. What specific management practices (if any) have you applied or come to recognize that best create specific wildlife habitat feature(s)?**

**Key Findings:**

1) Timber harvesting allows for the creation of canopy gaps of any desired size and shape. This freedom allows for canopy management using timber harvest to achieve regeneration goals as well as meeting wildlife management objectives.
2) White woods are most likely to provide the greatest opportunity for rapid nest cavity recruitment. Recognizing the role of white woods, in addition to hardwoods, for habitat element maintenance and recruitment can assist a manager achieve desired wildlife habitat goals.
3) Timber harvesting provides for a source of down and dead wood of any desired size and soundness.

**2c. From your experiences, are there any habitat elements that are easily recruited through silvicultural practices?**

**Key Findings:** A number of habitat elements are widely recognized as being relatively easy to recruit. These elements include:

1) Dead and down wood,
2) Large trees can easily be retained,
3) White woods are easily regenerated and retained,
4) Timber harvesting creates soil disturbance which aids in the germination of many botanical species,
5) Slash and litter are easily recruited which provides for nutrient cycling and erosion prevention in addition to cover for small mammals and herps.

**2d. From your experiences, are there any particular habitat elements that are particularly difficult to recruit through silvicultural practices?**

**Key Findings:** Most of the respondents identified similar elements when answering this question.

1) They all recognize the difficulty in recruiting trunk hollows (goose pens) associated with repetitive fire scarring. Subsequently, they further acknowledged the importance of trunk hollows as a habitat element and expressed a desire to see applied research projects designed to address this question.

2) Each of the interviewees recognized the difficulty in recruiting and maintaining phenotypically inferior trees in the stand. This paradigm is entrenched namely that retaining any inferior tree will be viewed as "high-grading". Though an important consideration, overly aggressive sanitation policies can inhibit the recruitment of habitat elements often associated with less thrifty trees.

3) The other most notable characteristic not readily recruited through management are those elements directly associated with age i.e. reiterative branches, bryophyte colonization, rotten logs. Most recognize the importance of allowing these conditions to develop over time.

*Premise 3) Some natural disturbance patterns may not be easily mimicked by silvicultural practices i.e. fire, landslides. (These questions are designed to explore the practitioner's management approaches in light of the fact that some variables may be out of their control.)*

**3a. In this time of aggressive fire suppression, how do you manage forest fuels? Can silviculture affect fuel loads? If so, how?**

**Key Findings:** There is strong agreement that silviculture should not be viewed as a surrogate practice that can always be substituted for fire. It is further recognized that fire serves as a catalyst in many forest processes such as nutrient cycling and the formation of key habitat elements as well as potentially depletion of forest nutrients and downstream eutrophication. However, there was strong consensus among those interviewed that silvicultural practices can be used to mitigate fuel loading in the absence of fire. Specifically, silviculture and timber harvest activities are often aimed at reducing wildland fire fuels:

a) Lopping of slash is a common practice among RPFs working in areas where aesthetics and fuel suppression are equally important. All of the interviewees who employ lopping practices are convinced that the benefits of lopping far out weigh any costs associated with this practice.

b) Tractor crush. As the name implies, the machinery used in timber harvest is used specifically to reduce the height of slash and other residual vegetative materials generated by harvesting. The practice is employed either as an on-going activity during harvesting or prior to

completing the job assignment. Often, as a compliment to this practice, the slash is manipulated and placed on skid trails and other travel corridors, as a mulch, to minimize erosion.

c) Harvest activities that reduce ladder fuels are widely viewed as a positive activity associated with active silvicultural manipulations. If properly directed, the simple act of falling a tree can serve as a means of pruning lateral branches resulting in the removal of potential ladder fuels. Tractor activity often results in the incidental elimination of ladder fuels.

d) Windthrow. All of those interviewed recognize the positive relationship between silviculture and tree spacing as a means of inhibiting the spread of fire into the crowns. Additionally, several individuals further recognize the importance of incorporating naturally occurring fuel breaks into their silvicultural designs. Windthrow and other naturally occurring breaks in the vegetation across the landscape are generally viewed as opportunities that should be incorporated into management designs to maximize their effectiveness to limit the spread and impact of wildland fires.

**3b. How do you discourage the recruitment of less desirable tree species using silvicultural practices in absence of other natural disturbance regimes?**

**Key Findings:** Respondents viewed this question more broadly to include all less desirable species, not just trees.

a) Canopy management to maintain shade. Since all of the participants for this project are utilizing un-even aged management they acknowledged the relationship between canopy management and the role of shade on the forest floor to inhibit the recruitment of some less desirable species into the forest canopy i.e. tanoak (*Lithocarpus densiflorus*). Subsequently,

respondents further acknowledged that maintaining high shade component creates a greater chance of recruiting other less desirable species that are more shade tolerant i.e. grand fir (*Abies grandis*).

b) Species management using market conditions. Where applicable, particularly in the management of less desired conifers, positive market conditions often provide an opportunity to mark a stand to reduce the number of undesired trees and thus reduce potential seed sources for future recruitment. This tactic is less suitable for species such as tanoak where markets opportunities are recently extremely limited.

c) Mechanical reduction of less desirable species. The mere fact that timber harvest activities often rely on heavy equipment provides another opportunity to remove less desiredtrees. Many of the respondents identified the disturbance associated with tree falling, yarding and other tractor related activities as an effective way to remove undesirable seedlings and saplings from the stand.

d) Neighbor awareness program. The Arcata Community Forest has initiated a neighbor awareness program aimed at increasing public consciousness to reduce the planting and introduction of exotic and noxious plant species on properties adjacent to the forest. By involving broader community participation, the managers of the forest hope they have been effective in slowing the recruitment of many less desirable species from the surrounding urbanized area.

**3c. Is fire a useful tool? Is it realistic to assume that fire can be used effectively?**

**Key Finding:** Yes. Fire was unanimously viewed as a useful tool. Cited as the "missing piece" in modern forestry practices, fire is seen as a key element in shaping the structure and composition of coastal redwood forests by all of the respondents. There was further consensus that serendipitous fire

occurrences i.e. lightning strikes, are generally viewed favorably if conditions allow for low-intensity burns.

Issues associated with liability immediately were raised when the second part of this question was addressed. In many parts of the redwood region, urbanization has dramatically altered the physical and political landscapes. This new reality is most evident in Santa Cruz County, parts of Mendocino County and even Humboldt County (Arcata Community Forest) where the urban-rural interface has grown in recent years. Several of the respondents suggested that fire will have to be addressed through appropriate "county-level" planning mechanisms if it is to be considered a serious management tool. Ideas that were shared included: 1) buffer zones between TPZ lands and adjacent non-TPZ zonings to enhance control burn opportunities, 2) property owner fire awareness programs to assist landowners develop vegetation management plans for their properties, 3) regulatory processes to address fuel loading reduction on absentee ownerships, 4) collaborative programs aimed at developing pro-burning county policies that address air quality and liability concerns.

*Premise 4. There may be differences in social preferences vs. scientific data for desirable characteristics of old forests. It is important to identify obstacles that exist that serve as an impediment to improving active management practices aimed at maintaining or recruiting old forest characteristics in redwood stands.*

**4a. Are there treatments or other considerations that we have not discussed that may be important in recruiting old forest characteristics and function while meeting landowner expectations?**

**Key Findings:** Several pragmatic factors were identified by the respondents that regularly affect how the best intentions of an RPF can be negatively influenced. They include:

1) Logging contractor decisions. The LTO, like the RPF, has to make a number of decisions during the course of logging activities. These decisions are based on safety issues, tree and log handling criteria, and machinery and vehicle considerations. Each of these considerations can affect what is ultimately accomplished at the stand level.

2) Cable yarding considerations. During the course of establishing a cable yarding corridor, individual trees may have to be removed for safety and worker health considerations even if the tree has desired old forest characteristics.

3) Harvesting techniques and landowner expectations. The RFP is a service provider. The ultimate decision of how a stand is to be managed is made by the landowner. Financial expectations and obligations readily influence silvicultural and forest management decisions.

4) Roads, landings and yarding corridors. The engineering requirements necessary to efficiently and safely handle large equipment and trees can influence tree growth, regeneration and recruitment at the stand level. The number, size and expanse of road systems and accompanying log handling areas can greatly influence old forest habitat functions, nutrient and energy flows.

5) Mill Infrastructure and availability influences the efficiency and costs associated with timber harvest thereby affecting the rate of return landowners can expect from their land. A reduction in mill infrastructure in the redwood region has increased logging and transportation costs, thereby influencing harvest rates as landowners attempt to recoup some of the added expense associated with log hauls of greater distance.

6) Disincentive to produce large logs. The regulatory process currently does not recognize silvicultural regimes that promote old forest characteristics.

7) Newly introduced pests and pathogens (SOD). Regardless of management activities aimed at achieving a desired outcome, the mobility of the modern world will repeatedly serve to introduce new threats to California's native forests.

**4b. Have you identified/delineated areas with High Conservation Values or other old forest characteristics? Have you articulated your management treatments in these areas in a management plan or some other document?**

**Key Findings:** In every case, interviewees have identified areas or elements of High Conservation Value (HCV). The degree to which the HCV areas/elements have been articulated is dependent on the acreage of the ownership and the planning/management document being used. Generally, the larger ownerships/parcels tended to have their HCV areas/elements delineated in landscape plans, while smaller, non-industrial ownerships used the NTMP as the vehicle to identify HCV components. The most commonly identified and/or delineated HCV areas or elements included:

a) Old Growth trees & stands. Larger ownerships tended to codify their policy(s) in management plans, corporate/agency position statements, and/or landscape level plans.

b) Riparian areas. Regardless of the size of ownership, riparian areas are viewed as HCV areas. Generally, the California Forest Practice Rules are used as guidance and not absolute thresholds to determine management

decisions within the riparian corridor. A majority of the interviewees regularly consult with (or employ) individuals knowledgeable with the management of riparian and other biological systems to assist them in developing their management designs.

c) Wet areas. A similar approach to recognition and management is applied to wet areas as is given to riparian zones. Wet areas include ephemeral pools, perennial pools, ponds, springs and seeps.

d) Threatened & Endangered (T&E) species sites. Depending on the geographic region in question landowners and managers are addressing specific habitat needs for a limited number of species. These include Northern Spotted Owl, Marble Murrelet, various amphibians, and anadromous fish.

e) Special project areas i.e. Carbon sequestration sites. Examples of unique HCV areas are present on many of the properties visited. They tend to be distinctive to the parcel and are delineated at the discretion of the landowner or manager.

f) Scenic Corridors. Many of the sites visited identified areas of scenic importance for themselves or their neighbors.

**Literature Cited**

Beissinger, S. 1995. Population Trends of the Marbled Murrelet Projected from Demographic Analyses. Pp 385-393 (in) Ralph C. J., G. L. Hunt, M. G. Raphael and J.F. Piatt (eds). Ecology and Conservation of the Marbled Murrelet. Gen. Tech. Rep. PSW-GTR-152. Albany, Ca. PSW, FS – USDS. 420 pp.

Bury, R. B. 1983. Differences in Amphibian Populations in Logged and Old Growth Redwood Forests. N. W. Sci. 57(3): 167-178.

Carter, H. R. and R. A. Erickson. 1988. Population status and conservation problems of the marbled murrelet in Califonia, 1892 – 1987. Sacramento, Calif. Dept. of Fish and Game; 74 pp.

Cooperrider, A., R. F. Noss, H.H. Welsh, Jr., C. Carroll, W. Zielinski, D. Olson, S. K. Nelson and B. G. Marcot. 2000. Terrestrial Fauna of Redwood Forests. pp. 119-163 *in* R. Noss (*ed*) The Redwood Forest: History, Ecology and Conservation of the Coast Redwood. Island Press. Wash. D. C. 337 pp.

Gellaman, S. T. and W. J. Zielinski. 1996. Use by bats of Old Growth Redwood Hollows on the North Coast of California. J. Mammal. 77(1) 255-265.

Hammon, Jensen, & Wallen. 1969(a). Timber Inventory Report. Proposed Rellim Redwood Company Allocation of the Northern Purchase Unit Lands. Del Norte County. A report to the US Dept. of Interior, Nov. 1, 1969. Humboldt State Univ. Humboldt Room, Ref. Library. Arcata, Ca.

Hammon, Jensen, & Wallen. 1969(b). Timber Inventory Report. Proposed Simpson Timber Company Allocation of the Northern Purchase Unit Lands. Del Norte County. A report to the US Dept. of Interior, Nov. 1, 1969. Humboldt State Univ. Humboldt Room, Ref. Library. Arcata, Ca.

Hammon, Jensen, & Wallen. 1969(c). Timber Inventory Report. Proposed Arcata Redwood Company Allocation of the Northern Purchase Unit Lands. Del Norte County. A report to the US Dept. of Interior, Nov. 1, 1969. Humboldt State Univ. Humboldt Room, Ref. Library. Arcata, Ca.

Hammon, Jensen, & Wallen. 1969(d). Timber Inventory Report. Proposed Georgia-Pacific Timber Company Allocation of the Northern Purchase Unit Lands. Humboldt County. A report to the US Dept. of Interior, Nov. 1, 1969. Humboldt State Univ. Humboldt Room, Ref. Library. Arcata, Ca.

Hoekstra, J. M., R. T. Bell, A. E. Launer, and D. D. Murphy. 1995. Soil arthropod abundance in coast redwood forest: Effect of selective timber harvest. Environmental Entomology 24: 246-252.

Mladenoff, D. J., M. A. White, J. Pastor, and T. R. Crow. 1993. Comparing Spatial Patterns in Unaltered Old Growth and Disturbed Forest Landscapes. Ecological Applications 3(2):294-306.

O'Dell, T. E. 1996. Silviculture in the Redwood Region: A Historical Perspective. pp. 15-17 in LeBlanc (ed). Proc. Coast Redwood Forest Ecology and Management. June 18-20, 1996. Humboldt State Univ., Arcata, Ca. 170 pp.

Sawyer, J. O., S. C. Sillett, J. H. Popenoe, A. LaBanca, T. Sholars, D. L. Largent, F. Euphrat, R. Noss and R. Van Pelt. 2000. Characteristics of Redwood Forests. pp. 39 – 79 in R. Noss (*ed*) The Redwood Forest: History, Ecology and Conservation of the Coast Redwood. Island Press. Wash. D. C. 337 pp.

Spies, T. A. and J. F. Franklin. 1996. The Diversity and Maintenance of Old Growth Forest. Pp. 296-314. *in* Szaro, R. C. and D. W. Johnson (eds) Biodiversity in Managed Landscapes. Oxford Press. N.Y. N.Y

Spies, T. 2003. New Findings about Old Growth Forests. Science Findings. No. 4. June 2003. Portland, Or., USDA Forest Service PNW Res. Sta. 11 pp.

Youngblood, A. 2001. Old Growth Forest Structure in Eastern Oregon and Washington. NW Sci. 75:110 118.