Ecological Assessment of Biomass Thinning in Coastal Forests –

Phase II: Pre and post-harvest stand assessment of woody biomass harvesting

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Introduction

The Mendocino County biomass working group has long been interested in assessing the environmental impacts of woody biomass removal. They initiated a literature review of the topic (Giusti 2013) as a first step (Phase I) in helping interested constituents better understand the scientific basis for woody biomass management. The review identified several key factors important for consideration when making decisions on which trees to harvest, and which should be retained in the stand.

Some of the key points identified by the literature in Phase I included:

Key points:

- Variable density thinning in even-aged stands can improve the light mosaic having general positive impacts to both understory vegetation and small mammals;
- Variable density thinning is generally viewed as a positive action if the reduction is generally between 24-30% reduction in basal area (Carey and Wilson, 2001) ;
- Not all wildlife species can be expected to respond identically. Some species with specific habitat element needs should be given site specific consideration;
- Thinning forest structure by reducing overall tree density by > 60% and canopy bulk density by 50% has shown to reduced susceptibility to crown fire (Harrod et al, 2009).

This second installment (Phase II) was designed to demonstrate woody biomass removal while being mindful and applying the key points identified in the literature review (Phase I). In other words "putting the words into practice" in order to demonstrate the applicability of addressing ecologically important criteria while extracting woody biomass from a forest.

Study Site

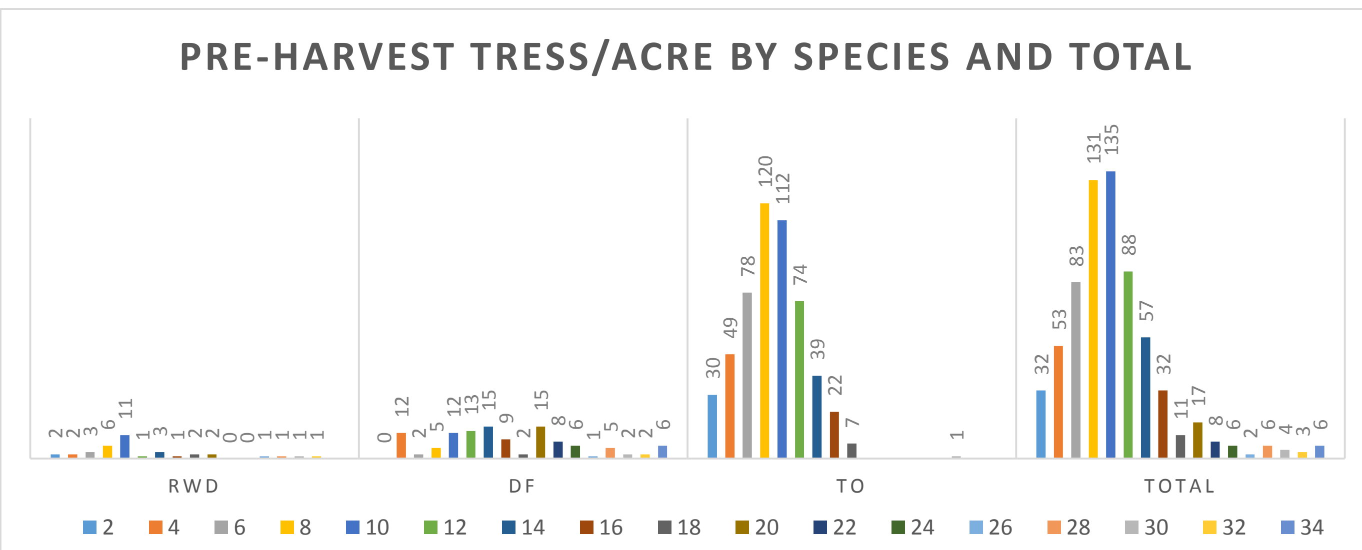
A 2½ acre (1 ha) demonstration plot on the Usal Redwood Forest in northwestern Mendocino County, California was identified as a suitable site for the application. The demonstration site was selected based on a) stand structure and composition – it represents a "typical" stand on the Usal Redwood Forest; b) it's on relatively flat ground within short walking distance from a main road and landing to accommodate visitors; c) and the location provides accessible roads for future log hauling and product transportation.

The site was last harvested in 1977 (THP 1-77-873 MEN). Records indicate that it was an even-aged silvicultural treatment - most likely a Seed-Tree treatment with a diameter limit cut. The stand age is considered to be 50 years though some individual conifers and hardwoods are undoubtedly older. The site is heavily dominated by tanoaks *(Notholithocarpus densiflorus)* (Fagaceae), a hardwood species native to the western United States and common on harvested sites in Mendocino County. Tanoaks can achieve a height of 130’ (40m) though 50’-80’ (15-25m) is more common. When undisturbed trunk diameters can achieve sizes up to 75” (190 cm) although on harvested sites substantially smaller trees <15” often dominate. Though once valued for its tannin content used in curing leather during the horse and buggy era tanoak has lost most of its economic value and has become a challenge in managing second growth coast redwood stands due to legacy management decisions.

Stand Structure (pre-harvest)

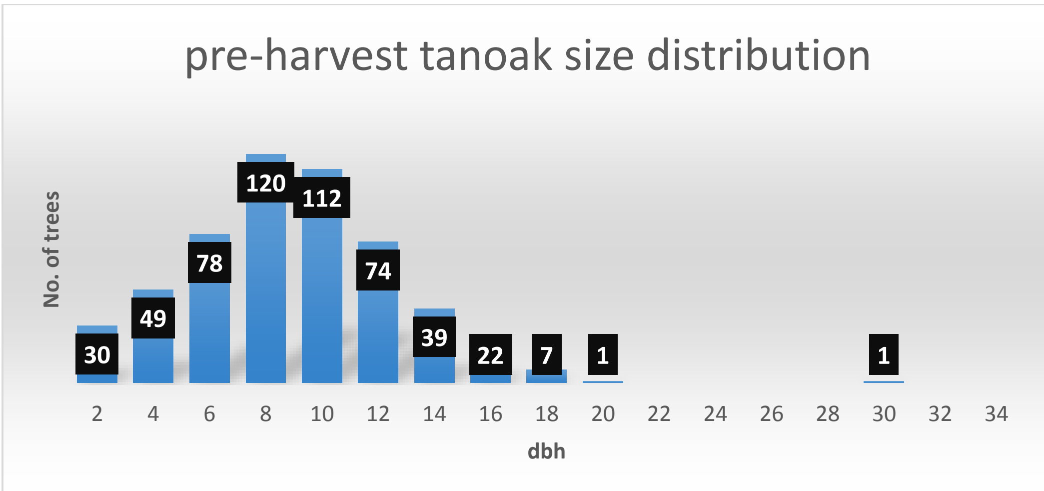
Pre-harvest stand composition had representatives of coast redwood, Douglas-fir, tanoak, and pacific madrone (Fig 1). With the exception of madrone which was a minor component of the stand; coast redwood, Douglas fir and tanoak where distributed among size classes between 2”-30” dbh. In the pre-harvest state the approximate density of the stand for all species among all size classes was approximately 686 trees/acre.

Fig. 1. Pre-harvest size class distribution, by trees per acre (TPA) for coast redwood, Douglas-fir and tanoak across on the 2 ½ acre demonstration plot.



Stand structure was heavily skewed in favor of small to mid-sized tanoaks. Pre-harvest tanoak densities were approximately 533 trees/acre with 350 ft^2/ac of basal area (Fig 2). Intermediate size tanoaks between 6-12” dbh were dominant and where targeted for harvest. Of those, any trees with structural anomalies, e.g. trunk hollows, broken tops, cracked bark, etc. where not selected for removal.

Fig. 2. A pre-harvest representation of the distribution of tanoak size cohorts on the demonstration plot.



Methodology

Using the criteria identified in the literature review as a guide tree markers developed a decision matrix that was used to identify suitable harvestable trees. These criteria included:

1. Only tanoaks were selected for harvest;
2. Tanoaks between 4-18” dbh could be marked;
3. Trees with obvious trunk hollows were to be retained;
4. Trees with broken tops were to be retained;
5. Any tree with structural anomalies e.g. cracked bark etc. was retained;
6. Trees, that if removed, would disturb large downed logs would not be marked;
7. Appropriate trees (tanoaks) would be selected if their removal would benefit conifer release;

Trees were marked using standard tree marking (blue) paint. Selected trees were “ringed” with paint at breast height and a blue “spot” was placed at the base to insure and validate only marked trees were harvested.

All trees were harvested using chainsaws with the aid of rubber-tired skidders using a grapple attachment to move the trees to the landing. Trees were then stacked on the landing to facilitate future transport and handling (Fig 3).

Fig. 3. Harvest tanoak logs on the landing in preparation for processing.

Results - Post-harvest assessment

Tanoak basal area was reduced from 350 ft^2/ac to 174 ft^2/ac. Approximately 270 trees/ac between 4-18” dbh were harvested using the decision matrix selection criteria.

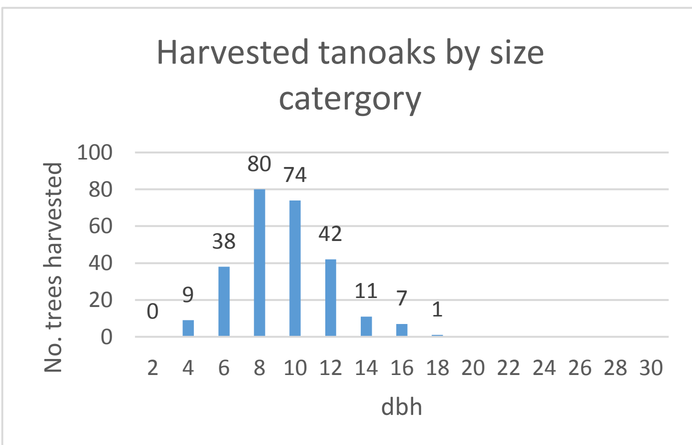


Fig. 4. Number of tanoak harvest by size class per acre.

Residual tanoak density and size class distribution is shown in Figure 4. The results of the harvest changed the density and size class distribution of tanoak from a density of approximately 533 trees/acre and 350 ft^2/ac of basal area to approximately 286 trees/acre and 174 ft^2/ac of basal area (Table 1).

Table 1. Change in tanoak density pre and post harvest.

Tanoak	Trees/Acre	Range in size distribution	Basal area
Pre-harvest	532	2-30”	350 ft^2/ac
Post-harvest	286	4-30	174 ft^2/ac

Table 2 shows the percentage change in tanoak size classes from the original density and the number harvested within the size class. Smallest trees where not harvested as they could not be utilized while larger trees where retained for the ecological values.

Table 2. Percent change/acre in tanoak density by age class.

Size class	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**
Pre-harvest	30	49	78	120	112	74	39	22	7	1	---	---	---	---	1
No. harvested	---	9	38	80	74	42	11	7	1	1	---	---	---	---	1
TO % change	0	-18	-49	-66	-66	-56	-28	-32	-14	0					0

Following the harvest, all tanoak size classes remained on site (Fig. 5). Despite the heavy selection on mid-sized individuals, mid-sized tanoaks remained dominant within the stand.

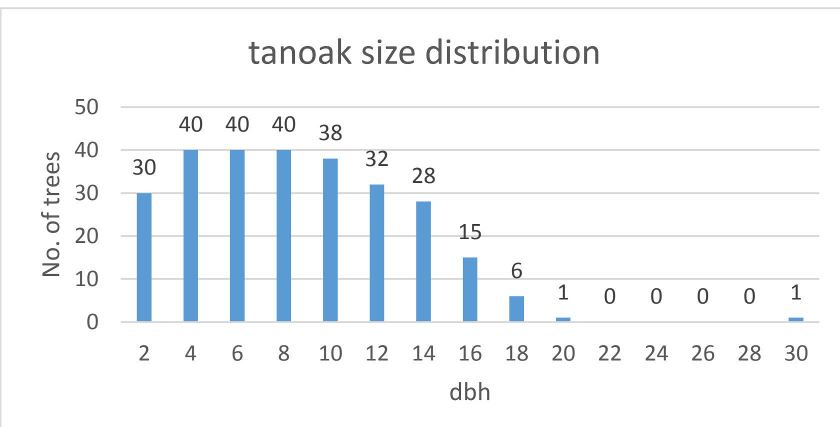


Fig. 5. Post-harvest size class distribution of tanoak.

Discussion

Though challenging for forest landowners and managers interested in conifer management or restoration, tanoak plays an important ecological role in California's native forests. The structural variability they provide in tree configuration; mast production; bark and leaf structure; and the invertebrates and bryophytes associations add components that support the biological diversity found in coast redwood forests. The problem is that tanoak density within stands has been greatly altered during the 20th century as undisturbed coastal redwood forests were harvested and allowed to follow a "natural" course of recovery. In many instances this strategy resulted in tanoaks becoming the dominant tree species on site. For several past decades efforts to reverse this current state have given rise to mixed results in which none of have been exclusively successful.

Phase I focused on developing a literature review that identified key scientific elements to consider when removing woody biomass from within forest structure. This first phase was important to address social concerns that contemporary woody biomass harvesting would follow past management mistakes by not considering the scientific advancements of the past 40 years. Since the listing of the Northern Spotted Owl (*Strix occidentalis*) under the Federal Endangered Species Act ecological understanding of northwest forests has grown exponentially. The owl's listing was a watershed event that changed society's perception and understanding of how *biological structure and composition* affects *ecological integrity and functionality*. It was important for the framers of this project to insure a skeptical public that the natural components of the forest stand would not be irrevocably harmed through woody biomass extraction.

Phase II took the key criteria identified in the literature review and designed an approach that insured; 1) the maintenance of ambient temperature and humidity of the stand pre and post-harvest; 2) identified downed wood for protection and retention to provide forest floor structure and cover; 3) retained all trees, regardless of size, that exhibited a special habitat attribute i.e. cracked bark, trunk hollow, basal cavity, broken top, etc.; 4) limited percent canopy reductions to inhibit the germination of undesirable plant species; and 5) selected appropriate tanoaks that would enhance the growing conditions of residual conifers.

Based on ocular analysis the harvest did not remove any existing unique habitat elements that were present within the stand. The harvested trees did not alter the structural components of the stand present prior to the harvest.

The harvest did reduce the number of tanoaks occupying the site thereby re-directing site resources (water, nutrients and light) to the remnant individuals left on site. Though the harvest retained approximately 286 trees/acre many of those trees where too small to utilize and the larger trees provided the key attributes identified in the literature review.

This demonstration clearly showed how woody biomass utilization can be approached with a scientific basis to retain key ecological attributes and components important in addressing coast redwood forest sustainability. Furthermore, this demonstration showed that care and time must be given to critically assess each tree prior to marking and harvesting in order to insure the retention of key habitat elements. In order to retain the key components identified in the literature it is encumbered upon those who are marking the trees to evaluate each individual to insure that key elements are identified and retained.

Literature Cited

Carey, A.B., Wilson, S.M., 2001. Introduced spatial heterogeneity in forest canopies: responses of small mammals. J. Wildl. Manage. 65, 1014–1027.

Giusti, G. A. 2013. Ecological Assessment of Biomass Thinning in Coastal Forests – A Literature Review. A Report to the Mendocino County Biomass Working Group. 24 pp.

Harrod, R.J., Peterson, D.W., Povak, N.A., Dodson, E.K., 2009. Thinning and prescribed fire effects on overstory tree and snag structure in dry coniferous forests of the interior Pacific Northwest. For. Ecol. Manage. 258, 712–721.

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Glossary of Terms

Basal Area- means the sum of the cross-sectional areas at breast height (4 ½ feet) of the tree stems.

Diameter at Breast Height (DBH) – point at which diameters of trees are usually measured, 4 ½ feet above the average ground level.

Diameter limit cut - , all of the trees above a certain diameter limit are cut, and all trees below the limit are left in place.

Seed- Tree silviculture – removal in one cut the mature timber from an area, leaving a number of seed bearing trees singly or in small groups.

Variable thinning - deliberately creates non-uniform conditions through a stand. Non-uniform thinning -- often called variable-density thinning -- has some advantages over uniform thinning in accelerating the development of wildlife habitat and in preserving or developing biodiversity.