

Costs and Benefits of Integrated Treatments on Steep Ground in Dry Forests: A Summary Report on the Boaz Project

**George McKinley
Boaz Project Contractor**

**To: Blair Moody
Boaz Project BLM Collaborator
Medford District Lead on Biomass, Small Diameter and Stewardship Contracting
4/5/07**

Introduction and Purpose

Previous and ongoing studies assess general costs, benefits and impacts for harvest systems, but fewer exist for systems intended to remove primarily smaller diameter trees and forest biomass on steep ground in dry forests. Fewer still address the additional complexities and costs related to high visibility public projects that also address the avoided costs and additional benefits of treatments which prioritize the utilization of smaller diameter material in the context of treatments that integrate both forest health and fuels reduction prescriptions.

This report addresses that gap in the context of a small diameter removal, fuel reduction and forest health project on 26 acres of steep ground in a dense mixed-conifer dry forest, similar to that found across the Klamath-Siskiyou region of SW Oregon and NW California.

The Boaz Project: History, Goal and Objectives

The Boaz Forest Health and Small Diameter Utilization Project was a RAC-supported collaboration between the Jefferson Sustainable Development Initiative and the Medford District Bureau of Land Management. The project received RAC support in March 2002, was implemented during the field seasons of 2004-06, and completed in September 2006.

According to the original RAC Proposal:

The goal of this project is to enhance forest health and provide regional employment through a collaborative project to remove and process small diameter material.

Objectives include:

- assessing technical and economic feasibility;
- monitoring forest health and fire hazard reduction;
- determining market opportunities for small diameter material;
- expanding the capacity of the rural work force;
- improving community/agency relations; and
- informing policy discussions at various levels.

Projected long-term outcomes include contributions to improved on-the-ground operations, increased acres treated for fuels and forest health, expanded utilization of small diameter material and biomass generating a reduction in per acre treatment costs, and greater public and special interest support for landscape scale forest restoration and management.

A primary finding is that restoration and management focused upon the utilization of smaller, underutilized material is more cost effective and achieves broader goals than fuel treatments focused on piling and burning alone.

Environmental Context, Stand Characteristics and Prescription

To better understand economic constraints related to harvested material it is helpful to briefly glimpse stand characteristics and prescription outlines for the Boaz units. Much of the following is excerpted from the “Environmental Assessment for the Boaz Forest Health and Small Diameter Utilization Project” (OR-110-02-036).

Thousands of acres of Southern Oregon forest and shrub land are in poor ecological health and at a very high risk to loss from catastrophic wildfire, insect and disease outbreak. The policy of suppression of wildfires over the last eighty years has had profound environmental consequences. Many Southern Oregon forests, both conifer and hardwood, are very dense and are declining in health and vigor. They have slow growth rates, severe competition for water and nutrients, and increased susceptibility to insects, drought and catastrophic wildfire. These conditions are exacerbated by the drought conditions that have been impacting much of the West in recent years. (EA, p. 4)

Klamath-Siskiyou forests are some of the most diverse of all temperate forests. With a cool wet winter, hot dry summer, historically frequent fires, and marked topographical variation, the plant communities of southwestern Oregon tend to display a variation and patchiness seldom found. Managing such diverse forest landscapes is complex and presents a host of challenges. The Boaz Project addressed management on a Douglas fir dominated portion of the landscape.

The stands are dominated by Douglas fir with some scattered ponderosa pine, madrone and oak trees. The stands currently have over 500 trees per acre and will be thinned down to approximately 135 trees per acre. The treatment would consist of removing the majority of the smaller diameter conifer trees on the site and leaving most of the largest, healthiest trees. It is expected the trees left would be spaced approximately 15-30 feet apart depending on their vigor. The final result would be forest stands with very little understory vegetation and an open “park-like” look. The proposed silvicultural prescriptions are based upon the present vegetation structure, species composition, aspect, and vegetation condition class, to leave the tree species best adapted to a particular site and allow for the development of old-growth forest structure over time

The conifer trees in the stands selected for treatment have an estimated pre-treatment average diameter of 8.6 inches. The average (diameter) of all trees to be removed are estimated to be 7.7 inches. The treatment would increase the stand's average diameter to an estimated 11.4 inches. Estimates of the stands prior to treatment show 76 percent of the trees in the stands to be treated are below 10 inches in diameter and 97 percent of the trees in the stands to be treated are less than 16 inches in diameter. (EA, p.8)

The silvicultural prescription for the Boaz project units are within forest stands designated as dry Douglas-fir prescription areas. Some of these stands may have small areas where the ponderosa pine prescriptions are appropriate. Pine group selection areas are also appropriate where healthy pine seed trees are present. All units shall be a "leave tree marked" with yellow paint. Trees 2 inches DBH and larger marked with yellow paint shall not be harvested. Trees 2 inches to 8 inches DBH shall be marked to leave at a 20 to 30-foot bole spacing. These small trees are spaced off of the largest diameter trees in the forest. Leave trees in this diameter class range shall have a minimum live crown ratio of 30 percent if possible. Always leave the healthiest tree available with the longest terminal leader and the largest live crown. Always attempt to perform a "low thinning" by cutting the smaller diameter class trees from within the dripline of larger diameter trees. Trees larger than 16 inches DBH may be marked for forest health reasons such as releasing ponderosa pine. Trees larger than 16 inches may also have to be cut if located in a designated logging corridor. (EA, p.12-13)

The stands originated between 1864 and 1917, following small and large-scale fires that spread across the project area. Thus, most trees are between 80 and 170 years old. Little logging activity has occurred, though some units show signs of minor salvage logging of dead and dying trees in the early 1990's. Due to lack of natural disturbance and fire suppression, stocking levels are high, tree vigor low, and suppressed trees common. Some bark beetle infestations and other forest pathogens are present.

It has become increasingly apparent that abstaining from active on-the-ground management can have a negative forest health impact. "No action" can sometimes produce negative consequence. Active restoration can help stands regain vigor and a more natural composition, and also reduce fuel hazard. This is recognized in the Boaz EA.

No action contradicts the Medford District Resource Management Plan forest condition objectives in regard to forest health. The plan states that management emphasis be placed on treatments and harvests that restore stand conditions and ecosystem productivity. (EA, p.16)

Harvest System and Cost Estimation

Similar layout and equipment was used in the Boaz harvest cost estimations summarized below. However, harvest costs reveal less about layout and equipment than the range and

variation of the units included within the Boaz project. Findings discuss how similar projects can achieve better returns, and advocate expanding forest health treatments that focus on utilization.

Harvested units were all on steep (35-70%) ground. Trees were directionally hand cut, yarded to existing roads, grapple skidded to a landing, sorted by skidder or truck mounted loader, and hauled to market by self-loaders. In general, all green material above four inches in diameter was removed. Down wood was left; snags were left when not a risk to workers. The use of existing roads and landings was prioritized and minimized disturbance.

Two small three-drum, trailer-mounted thinning yarders were used. Both were capable of full suspension, ran narrow (6-10 ft.) corridors up to 1500 feet long, allowed multiple corridors from a fixed position, and were able to reach 200 feet laterally. Ground disturbance from yarding was negligible to minimal in all units. Residual tree damage was minimal and the result of exceptional circumstances, e.g., a hung tree sprung free.

In general, yarder turns were short and efficient, an estimated 2-5 minutes per turn. Shorter corridors made turns quicker on average, but required more time for rigging. The shorter the skid distances the better. In some units the skid distance was over ¼ mile from yarder to landing. This not only complicated sorting, but also allowed the slip beneath the yarder to fill up. Not surprisingly, units with larger average trees and largest per acre volumes showed best economic return.

The material harvested was 98% Douglas fir. The average sawlog was 27 feet long with a top diameter of 6 inches and a volume of 43 board feet. Ton-wood material for poles and firewood was also harvested; the material ranged from 17-35 feet long, most with a top diameter of 3 inches. Slash - tops, branches, and broken and degraded logs - was left in landing piles or near the yarder. This material was either cleaned up through a “goods for services” arrangement with local firewood contractors or left for later fuels treatment.

In general, small units along narrow roads with smaller landings like those in the project greatly increase set-up time and decrease operating efficiencies. However, project design required work from existing roads, and targeted small units with easy access and significant treatment needs. It is expected that larger units, larger landings and larger projects would reduce operating costs. However, much of the landscape in need of treatment in the Klamath-Siskiyou region is situated in areas similar to these units and will be challenged by similar operational limitations. WUI (wild-urban interface) landscapes will tend to produce similar limitations with additional challenges.

Summary Findings and Recommendations

The below findings are intended to be helpful in determining revenue and volume estimations from treatments that focus on and prioritize the removal and utilization of small diameter timber. The findings provide a basis to suggest that integrated treatments – those with both restoration and fuel reduction goals - are an appropriate management

target for agency planning, and achieve broader ecologic and economic gains that fuel reduction projects alone.

It is important to realize that a high-visibility project involving agency-NGO collaboration brings with it an inherent set of expenses beyond those directly related to operations. This is the case even when operations are a primary focus. These expenses stem from a complicated set of obligations related to project administration, project design, media outreach, tours, presentations, information sharing, background research, and reports. It is sometimes assumed that subsidized projects are free from fiscal challenge. The reality, however, is that innovation and collaboration in tandem often conspire to provide some of the most fiscally challenging situations – particularly when on-the-ground operations are involved.

Three basic types of material were removed. Two of these had market value, while the third provided no market return. These include sawlogs, tonwood and slash.

Sawlogs are defined in relation to the regional market. In this context, sawlogs (primarily used for peelers) were greater than 8 inches dbh with a top diameter in excess of 5 inches. Tonwood was material less than 8 inches dbh. This material is traditionally considered without commercial value, and left on the ground as slash, or piled and burned. Regional pole markets and residential/commercial firewood purchasers provide market outlets for this type of material, though operations that focus solely on this material do not currently prove economically viable.

There were no viable markets for slash generated by the project. Haul distance, market forces related to residuals and energy, price considerations, and operational constraints all played a role in this situation. “Goods for services” pole and firewood contractors cleaned up slash piles and the remaining material was left at the landing or roadside for later fuels treatment or public firewood use.

The following averages relate to removed sawlogs, tonwood and slash.

Sawlogs and value:

A total of 133mbf or 1000 tons of sawlogs were removed
for an average of 5.1 mbf/acre
with a gross revenue of \$663/1000 or \$88/ton or \$28/log
44 loads were removed with an average of 3,033 bf and 71 logs
average sawlog length 27 feet
average sawlog top diameter 6 inches
average board feet per log 43

Tonwood and value:

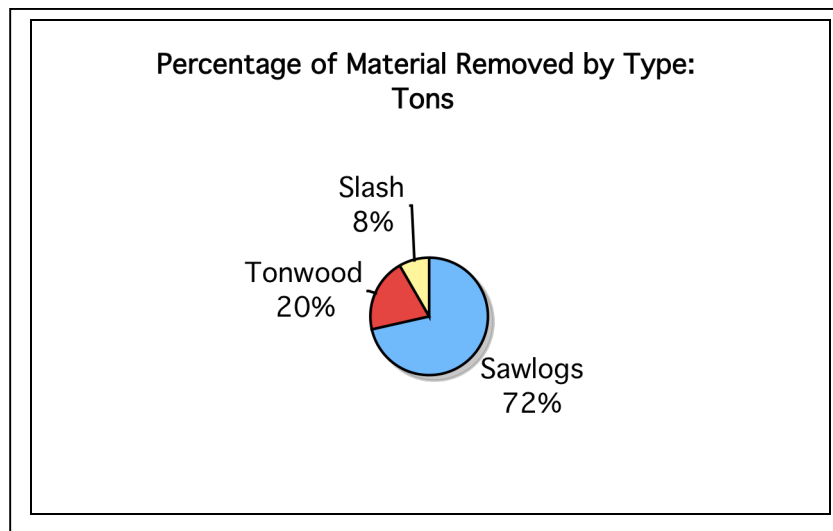
A total of 285 tons of tonwood was removed
for an average of 11 tons/acre
105 tons utilized for poles @ \$32/ton
185 tons utilized for firewood @ \$28/ton

16 loads were removed with an average of 200 pieces/load
average range of tonwood 17-25 feet in length to a 3 inch top
average tonwood return \$29/ton

Slash:

A total of 112 tons of tops, branches, broken, cull removed
for an average of 4.3 tons/acre
60 tons of “goods for services” clean-up
52 tons left as landing slash and public firewood

Total tons removed (logs, tonwood and slash):
1397 tons or 54 tons/acre



Operation costs

Operation costs relate to the cost of on-the-ground operations. For project summary purposes, costs are compared to revenue generated by removed material. Suggestions for adjustments to improve overall return are noted in relation to respective cost categories.

Cost categories include:

- Mobilization - moving equipment in and out;
- Maintenance and supplies - for in field operations and repair;
- Cut – falling expenses;
- Yard - yarder rigging and yarding to road;
- Skid - skidding material to landing with minimal sort;
- Sort - loader sort at landing;
- Haul - truck to market; and
- Fuel - for operations.

Operation Costs	
Mobilization	\$1/ton
Maintenance	\$2/ton
Cut	\$9/ton
Yard	\$26/ton
Skid	\$12/ton
Sort	\$14/ton
Haul	\$16/ton
Fuel	<u>\$2/ton</u>
Total	\$82/ton

As noted above, gross revenue was \$88/ton for sawlogs and \$29/ton for tonwood. Taken together these generated average gross revenue of \$76/ton. Balancing revenue against operations a total cost or negative revenue of \$6/ton was realized.

It should be noted that tonwood would not traditionally have been utilized. Instead, the removal of tonwood by piling and burning or chipping would have incurred marked additional expense. For this project, the utilization of tonwood generated \$7/ton and also avoided additional treatment expense. To give a better feel for treatment costs, the above figures can be converted to per acre costs.

Total treatment cost *with* utilization was \$350/acre. Total treatment cost *without* utilization would have been \$670/acre. Revenue gained through the utilization of tonwood was \$320/acre.

As noted, there was cost avoidance with utilization. According to Brian Keating, formerly of the Medford District BLM, estimated fuels treatment costs to cut, pile, and burn 5.6 tons/acre are over \$800/acre.

At a minimum:

Slash	\$265/acre
Pile	\$490/acre
<u>Burn</u>	<u>\$49/acre</u>
Total	\$804/acre

This does not include any additional administrative obligations, burn plans, mop up costs, and related risk or smoke factors. This is for treating one-third the volume of tonwood per acre that was removed during Boaz for utilization. If this direct avoided cost is added

to the direct return from utilizing the material, the estimated minimal contribution of utilization - removing tonwood for market as opposed to paying for treatment - is \$1,124/acre.

In this case, primarily through avoided costs of additional treatment, savings to the government from integrated restoration and fuels reduction treatments may exceed returns to government typically earned through stumpage. And as noted below, this is simply one facet of integrated treatments. Other benefits (social, economic, ecological) accrue and other expenses (contract administration, additional fuels treatments) are avoided.

Operational Adjustments to Improve Revenue

In order to reduce per acre treatment costs a number of operational adjustments are suggested. If these adjustments are implemented, operational cost reductions are be anticipated.

Adjustments to operations for best return, based on above operation cost categories:

Mobilization - in this trial, equipment was moved long distances for a relatively small project; keeping equipment closer to home would reduce mobilization costs and larger projects would allow better amortization of mobilization costs.

Maintenance and supplies - these are inescapable obligations; sound general equipment care and an on site equipment truck are major assets.

Cut - expense can be minimized and safety maximized by using expert fallers; a clear understanding of layout requirements and the ability to cut to scale is important; good cutting makes for better yarding.

Yard - as little rigging for sets and roads as possible is preferable; roads 1,000-1,200 feet long have a good balance of short turns and reduced rigging time, and likely generate greater efficiency than short (400 feet) or long (1,500 feet) roads. Placing the yarder to allow maximum clearance for cleaning the slip is important for productivity and safety.

Skid - long skids increase expense, while large landings are an asset that can allow skidders to provide cost-effective sorting; bunching grapples hold small diameter material and slash well.

Sort - a loader sort at the landing is an expense made greater though perhaps necessary by small diameter material and slash; it's best to minimize reliance on a loader unless long loggers (as opposed to self loaders) are used to haul; a dangle head processor would likely improve efficiency in a number of ways (sorting, cut-to-length, loading).

Haul - next to yarding, haul costs were the highest cost component of operations; long loggers may reduce rates and improve load volume; long hauls will be increasingly burdensome economically as fuel costs escalate.

Fuel - efficiency in light of rising cost is increasingly important.

Conclusion: Recommendations

But can it pay for itself?

In general and as currently configured, forest health treatments that focus on utilization and fuels reduction will struggle without subsidies. However, when the gathered revenues, avoided costs and the additional benefits of improved utilization are considered, the economic picture begins to shift.

To make forest health treatments on steep ground more economically viable on landscapes similar to the above in SW Oregon:

1. Project units should exceed 40 acres (and proceed to landscape scale), and remove at least 4mbf/acre above 8 inches dbh;
2. At least 70% of the total volume on a ton basis should meet the regional definition of sawlog;
3. Goods for services, stewardship contracts or other means of valuation should be used to mitigate stumpage expense for contractors;
4. The avoided costs and actual benefits of forest health treatments that reduce fuels and utilize material should be better assessed and valued, with economic benefits accruing to contractors in order to assure profitable operations.

In the above scenario, forest health treatments would emerge economically viable.

How do forest health and restoration treatments compare to fuels reduction?

If subsidies, budgets and agency focus directed toward fuels reduction alone were shifted toward integrated treatments that emphasize utilization, a broader set of ecological, economic and social returns would be realized. In this instance “fuel reduction” refers to actions that focus on slash/pile/burn activities and mastication, without consideration for utilization or goals beyond fuel load, condition class and fire behavior. Forest health or restoration treatments refer to those that set broader ecological goals related to stand health and ecosystem services, and emphasize utilization of material as a means toward successful implementation. Though additional focused research is needed in this regard, an emerging paradigm reveals that in comparison to fuels reduction alone, forest health and restoration treatments:

1. Offer increased per acre fuel load reduction in stands dominated by conifers;
2. Provide broader ecological benefits that serve to enhance stand vitality;
3. Diminish the risks and social annoyance associated with prescribed fires and smoke;
4. Expand the contribution of federal management to rural economies;
5. Strengthen the existing wood products manufacturing sector and increase the odds of success for innovation related to small diameter and biomass utilization;
6. Reduce administrative expenses related to management and contracting.

Integrated treatments that focus on restoration, fuels reduction and utilization hold promise as a means to re-invigorate pro-active management on federal lands, able to enjoy wide public support while generating a broad spectrum of benefits.