Dry Forest Mechanized Fuels Treatment Trials Project

Project Locations:
Central Oregon (Deschutes National Forest), Sisters, Oregon
Okanogan/Wenatchee (Okanogan/Wenatchee National Forests), Wenatchee, Washington
Idaho City (Boise National Forest), Idaho City, Idaho
Blue Mountains (Malheur National Forest), John Day, Oregon

Final Report
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Executive Summary

Many studies exist about costs, production, and impacts for sawlog and commercial wood chip market harvest systems, but very little information of this type exists for systems intended to treat primarily non-commercial forest biomass, especially in the dry forests of the Intermountain West. This project was funded by the USDA Forest Service, using National Fire Plan funding, to organize and coordinate realistic fuels treatment trials in four locations in three states, and synthesize and disseminate results to natural resource agency personnel involved with fuels treatment planning decisions, potential local contractors, and other interested groups and organizations. Expected short-term outcomes include: 1) Improved ability of government agencies to plan and budget for future fuels treatment projects; 2) More informed local contractor business decisions about what equipment to buy or lease; and 3) Demonstrate effectiveness of treatments when they are designed with the expressed purpose of reducing fire hazard. Anticipated long-term project outcomes include reduced site impacts, increase in acres treated to reduce hazardous fuels, and local job retention and creation.

A variety of equipment was demonstrated, broadly grouped into extraction systems that remove hazardous fuels material from the woods, and mastication systems that treat fuels in the woods. Systems included conventional equipment, small-scale equipment designed specifically to deal with small-diameter material, and systems designed specifically for fuel reduction. A total of 15 systems, some involving more than one piece of equipment, were demonstrated during the four field trials

Production data was collected over a short time frame in limited stand conditions. Production rates and costs are given as ranges and should be viewed with skepticism.[1] Assuming 800 stems to be treated per acre, production rate estimates ranged from as low as 0.2 acres per day (ATV with Forwarding Arch; steep-slope cable yarder with government production rates) to as high as 3.3 acres per day (Bandit Whole-Tree Chipper with feller-buncher and rubber tired grapple skidder) but in general were between 0.5 and 1.5 acres per day. Production costs for the same standardized conditions ranged from a low of $330 per acre (Promac) to a high of $2,489 per acre (downhill steep-slope cable yarder), with the majority of the extractive systems ranging from $500 to $1000 per acre while the mastication system ranged in cost from $400 to $850 per acre.

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[1] The Dry Forest Mechanized Fuels Treatment Trials (DFMT) were in no way designed as comprehensive studies of all pieces of machinery capable of or appropriate for fuels reduction work. The time study portion of the trials was conducted solely to gain a general estimate of production rates and costs. Time studies were not conducted in a replicated, statistically verifiable manner. Sample sizes were not statistically significant and were taken over a limited range of forest conditions that were too limited to be practically useful for predicting the performance of any given machine set. Publication of proprietary production cost information would violate federal research and development standards. In no way should the production cost estimates included in this report be used to judge the appropriateness of the machinery sets demonstrated. The machine costing data does not try to replicate participating contractor actual costs nor should the method used to generate costing figures be considered accurate for the myriad of forest types, ground conditions, regional operator rates, operator experience, and contractor availability. Neither the DFMT study nor participating agencies endorse one machinery brand and/or contractor over another. The differences in costs per acre are due to variables beyond the protocols of the DFMT studies and are reproduced here as rough generalities.

The majority of systems created negligible soil impacts. The exception would be the Fecon system as demonstrated at the Idaho City trial where the operator's goal was to incorporate mulched biomass into the soil.

The systems demonstrated created three important changes in the structure of the stands following treatment: 1) Canopy base height was raised, thereby improving the stands resistance to initiation of passive or active crown fire in the future as these stands progress through time; 2) Basal area was reduced, which improves stand resiliency to disturbances such as drought, insects, diseases, and fire; and 3) Average height of the stand was increased, without a significant increase in fuel bed depth in a majority of the treatments.

Each system demonstrated has both advantages and disadvantages and no one system is clearly better than another. The choice of a preferred system must be site specific and matched to the goals and objectives for the treatment under consideration. Each system demonstrated has the ability to treat non-merchantable fuels and not cause excessive damage to the residual stand or soils, as long as it is matched with the right site conditions.

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Introduction

Project Purpose

Many studies exist about costs, production, and impacts for sawlog and commercial wood chip market harvest systems, but very little information of this type exists for systems intended to treat primarily non-commercial forest biomass and the potential benefits mechanical treatments could have on reducing extreme fire behavior, especially in the dry forests of the Intermountain West. Past silvicultural prescriptions for similar stands as those selected for the trials would have prescribed small tree thinning to manage tree densities. Slash treatment, if included, likely would have consisted of lopping, or less likely, piling. This somewhat mitigated the fuel problem, but often still left an increased surface fuel problem resulting from the thinning. Prescribed fire alone in many landscapes is often less effective at killing the targeted live small trees when they have reached larger diameters, without unwanted damage to the larger trees in the stand.

This project was funded by the USDA Forest Service, using National Fire Plan funding, to organize and coordinate realistic fuels treatment trials in four locations in three states, and synthesize and disseminate results to natural resource agency personnel involved with fuels treatment planning decisions, potential local contractors, and other interested groups and organizations. Expected short-term outcomes include: 1) Improved ability of government agencies to plan and budget for future fuels treatment projects; 2) More informed local contractor business decisions about what equipment to buy or lease; and 3) Effectiveness of mechanical treatments when they are designed with the expressed purpose of reducing fire hazard. Anticipated long-term project outcomes include reduced site impacts, increase in acres treated to reduce hazardous fuels, and local job retention and creation.

Contractors and Cooperators

Implementation of the mechanized fuels treatment trials was led by a team of consultants that included Tad Mason of TSS Consultants (Red Bluff, CA) and Keith and Elizabeth Coulter of The Yankee Group, Inc. (Philomath, OR). Overall technical guidance was provided by a Steering Committee consisting of industry and local contactor representatives, local agency site liaisons, and U.S. Forest Service and university researchers. Members of the Steering Committee are listed in Appendix A. Local Forest Service Site Liaisons were Cindy Glick (Central Oregon), Richy Harrod (Okanogan/Wenatchee National Forest), Leonard Roeber (Boise National Forest), and Ken Rockwell (Blue Mountains). Site Liaisons assisted with site-specific coordination and implementation of trials. Larry Swan, U.S. Forest Service, State and Private Forestry, assisted the grant administrator for this project, Central Oregon Intergovernmental Council (COIC), with overall technical oversight and as a liaison for different site location issues.

Trial Locations

A total of four mechanized fuels treatment trials were conducted in three Western U.S. states in the winter and late spring of 2002: two in Oregon (the Central Oregon trial on the Deschutes National Forest near Sisters, Oregon, February 12-16, 2002 and the

Blue Mountain trial on the Malhuer National Forest near John Day, Oregon, June 4-7, 2002), one in Washington (the Okanogan/Wenatchee trial located on the Okanogan and Wenatchee National Forests near Leavenworth, Washington, February 26- March 1, 2002), and one in Idaho (the Idaho City trial on the Idaho City Ranger District of the Boise National Forest, near Idaho City, Idaho, May 28-31, 2002). Each location represented different dry forest management challenges.

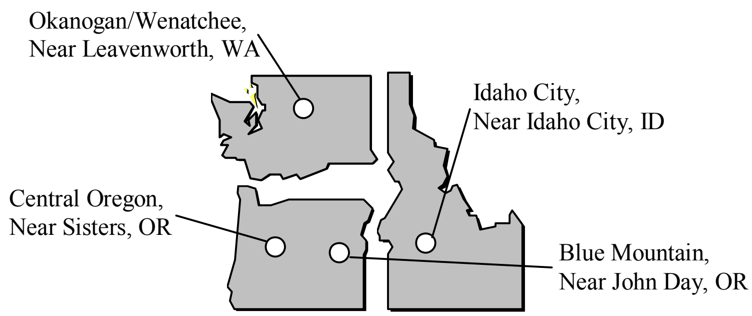

Figure 1: Project Location Map

Environmental Setting

Each trial site was chosen in consultation with the local Site Liaison and contractor representative. Sites selected had to be representative of lands available for treatment within the next five to 10 years within Wildland Urban Interface (WUI) and non-WUI areas. Emphasis was placed on the selection of areas that would lend themselves to ground based equipment. None of the selected sites had high surface fuel loadings. All sites did have an excess of biomass accumulating in the live trees. Overtime, tree densities, if left to progress without intervention will eventually lead to stem exclusion (tree mortality) and the accumulation of high surface fuel loadings while retaining sufficient ladder fuel in the live tree component to become high hazard areas. As with other areas of the dry Intermountain West, fire exclusion along with other management actions have contributed to the accumulation of biomass and changes in forest structure at the test sites.

Central Oregon

The Central Oregon trial site was located approximately five miles northwest of Sisters, Oregon near Highway 20 on the Sisters Ranger District of the Deschutes National Forest. Prior to treatment, the stand was composed of approximately 10 mature ponderosa pine (*Pinus ponderosa*) greater than 20-inches DBH (diameter at breast height) per acre with an understory of approximately 670 stems less than five-inches DBH stems of ponderosa pine and western juniper (*juniperus occidentalis*) per acre and 50 five to twenty-inch DBH ponderosa pine stems per acre. Scattered bitterbrush and fescue dominated the shrub layer. The site has been selectively logged and salvaged logged within the last 40 years. The dominant soil type for the site is a 10-30 inch thick layer of volcanic ash over glacial outwash. The prescription for the unit called for removal of stems less than eight-inches DBH (ladder fuels) while retaining a spacing of 20 to 50-feet and maintaining a mosaic/clumpy appearance on 15-20% of the area.

Okanogan/Wenatchee

The Okanogan/Wentachee trial was located approximately 20 miles northwest of Leavenworth, Washington, at the Fish Lake Sno-Park on the Okanogan/Wehatchee National Forests. Two distinct stands were treated during the Okanogan/Wenatchee trial. The first was a "designated" cut-to-length unit. This unit consisted of a plantation dominated by ponderosa pine 6 to 8-inches DBH with a total of 360-520 trees per acre. A smaller amount of lodgepole pine (*Pinus contota*), Douglas-fir (*Pseudotsuga menziesii* var. *glauca*), western white pine (*Pinus monticola*), and western redcedar (*Thuja plicata*) was also present in the overstory. The understory was dominated by ceanothus (*Ceanothus* spp.) and huckleberry (*Vaccinimu* spp.). The soil is a stony sandy-loam. Smaller trees were removed to retain a density of 140 trees per acre (approximately 18-foot spacing) with a species preference for ponderosa pine. The site was clearcut in 1965 and replanted to ponderosa pine.

The second unit, where the remainder of the systems were demonstrated consisted of a mixed conifer stand of mixed ages with 120-140 stems per acre greater than six-inches DBH and another 300-1400 stems per acre less than 6-inches DBH. Species included Douglas-fir, grand fir (*Abies grandis*), western white pine, and western hemlock (*Tsuga heterophylla*). The crowns of most trees reached nearly to the ground. Ceanothus and huckleberry dominated the understory. The dominant soil type was a stony sandy-loam. The stand was partially cut in 1973 and has had no entries since that time. The prescription called for the removal of the understory (ladder fuels) from around the mature trees with a spacing of approximately 18 feet where no overstory existed.

Idaho City

The Idaho City trial was located near the town of Idaho City, Idaho, on the Idaho City Ranger District of the Boise National Forest. Much of the area around Idaho City was terraced and planted to ponderosa pine after wildfires in the mid 1900's. No other silvicultural activity had occurred in these stands since planting. This has resulted in relatively uniform stands of ponderosa pine averaging eight-inches DBH and 30-feet in height with 200-500 trees per acre. Sagebrush and grasses dominate the shrub understory. Crowns often extend to within a couple feet of the forest floor. Soils in the trail area were dominated by decomposed granite.

Blue Mountains

The Blue Mountain trial was located approximately 20 miles southeast of John Day, Oregon on the Malheur National Forest. The stand was composed of large ponderosa pine (20-60 trees per acre) greater than 21-inches DBH and an understory composed of 800-8000 stems per acre of suppressed ponderosa pine and lodgepole pine less than 6-inches DBH. The stand was commercially harvested approximately three years ago when the commercial component of the understory was removed (stems from 6 to 20-inches DBH, not included in the above stand condition estimate). Soils were composed of silt loams to clay loams. This stand was considered high risk to mountain pine beetle, and there were moderate levels of dwarf mistletoe and western gall rust infecting the lodgepole pine. Treatment objectives were to: 1) increase growth and vigor to reduce mountain pine beetle risk; 2) reduce lodgepole pine dwarf mistletoe and western gall rust; 3) maintain visual quality by maintaining a relatively unmanaged appearance by retaining a variety of tree sizes and spacings; and 4) enhance visibility of large, old ponderosa pine trees more characteristic of historic conditions which were more resistant to disturbance.

The treatment prescription was to pre-commercially thin trees from 1.5 feet in height to nine-inches in DBH. Species preference in descending order was ponderosa pine, western larch (*Larix occidentallis*), Douglas-fir, lodgepole pine, and grand fir. All trees within 30-feet of large (greater than 21-inches in DBH) ponderosa pine trees with trunks visible from roads were to be removed.

Previous Work

There is little published about the costs, production rates, and environmental impacts of treating non-merchantable trees as part of a hazardous fuels reduction project. Past efforts have primarily concentrated on finding and/or creating markets for material that has been traditionally seen as non-merchantable (see for example the Forest Service Small Diameter Timber Utilization program at http://www.fs.fed.us/fmsc/sdu/index.php). These efforts generally utilize existing harvesting equipment to handle small diameter material. In the past most treatments have taken a more traditional silvicultural approach to treatments with the goal of influencing future growth and yield.

A national scale project that is tackling the problem of dealing with the overabundance of natural fuels is the Fire Surrogate Study, funded by the Joint Fire Sciences Program (see http://ffs.fs.fed.us/). This project consists of 12 long-term study sites across the United States, each looking at the effects of silvicultural treatments intended to mimic natural wildfire. Again, much of this work is focused on the treatment of trees considered merchantable.

Efforts concentrating on non-merchantable fuels have been mainly limited to equipment demonstrations. Colorado State University conducted one such demonstration in October, 2001. The stated objectives of the demo were to help to provide possible solutions to those interested in addressing the hazardous fuel build up along the Front Range, provide a location where agency representatives, homeowners association leaders, fire departments and political leaders could meet and discuss the situation, provide media coverage to inform the public of issues, and get some idea of the effectiveness of the equipment that was demonstrated. Equipment present at the demo included:

- loader grapple/winch combination, root rake grapple (ImpleMax Equipment Co., Inc.)
- ATV with forwarding arch, tree ascender, and pruning saws (Future Forestry Products)
- forestry tree shear, forestry rake (New Dymax Inc.)
- ASV 4800, Caterpillar 277 rubber tracked skid steers (Wagner Rents)
- Jonsred Iron Horse mini-skidder (Boulder County Open Space)

Over 100 participants attended the demonstration. No published information concerning outcomes or observations were made public (see http://www.colostate.edu/programs/cowood/)

Similar demonstration-level efforts have been undertaken by individual management units. One such example is the Bonners Ferry Ranger District of the Idaho

Panhandle National Forest, which gave a public tour of fuel reduction and restoration efforts during the winter of 2002 (see http://www.fs.fed.us/fmsc/sdu/vegmgt/kattail/index.php).

A number of projects are now underway to assess various aspects of treating non-merchantable fuels. Most of these projects have just begun data collection and no published results are yet available. A partial list of these project can be found in Appendix B.

The best source for machine specifications, costs, and production rates is the *Understory Biomass Reduction Methods and Equipment Catalog*. Published in April of 2000 it contains an exhaustive review of published and non-published work in the area of fuels treatment.

Field Trials Methodology

Methodologies were adopted to achieve the goals set for each trial. These goals included contractor, agency, and public participation, estimation of production rates and costs for each system, and environmental impacts of each system.

Public Participation

A Communication Plan was developed for each trial with the assistance of the local Forest Service Public Affairs Officer. The Communication Plan helped to guide interactions with target audiences. A sample Communication Plan from the Idaho City trial is located in Appendix C.

<u>Target Audiences</u>

Key target audiences identified for this project included:

- Local contractors,
- Agency personnel,
- Fiber purchasers and biomass consumers,
- Private forest landowners,
- Elected officials, and
- Interested public.

Public outreach efforts were coordinated with state logging contractors associations (Associated Oregon Loggers, Washington Contract Loggers Association, and the Associated Contract Loggers of Idaho) to help attract potential contractors to the demonstrations. These state associations provided credit towards professional certification (Pro-Logger) for those contractors that attended one of the field trials.

Forest Service and other agency personnel, both state and federal, were encouraged to attend trials through a variety of mechanisms. Of particular interest were personnel from regulatory agencies such as the U.S. Fish and Wildlife Service and National Marine Fisheries Service.

Fiber and biomass purchasers were involved in the planning of each of the four trials as local industry representatives. This was done primarily to aid in the dialogue concerning the development of local markets for treated material and to ensure that highly knowledgeable local (non-Agency) stakeholders were involved early on in the design of the trials

The accumulation of forest biomass is not a problem only for public land managers. For this reason, private landowners were also encouraged to attend the treatment trial demonstrations. Groups such as the Oregon Small Woodlands Association and the Idaho Forestry Association helped to inform landowners about the trials as well as to encourage their participation.

Elected officials often have significant input regarding which projects and programs receive sustained funding support. For this reason, an attempt was made to encourage the attendance and participation of elected and appointed officials at the local, states, and federal levels to attend the field trials to observe for themselves some of the options for treating overstocked stands that are progressing towards hazardous situations. Interested public, specifically local environmental and other groups were also encouraged to actively participate in the field trials and the discussions that lead to and surrounded the field trials.

A major tool used to inform the target audiences of the goals and specifics of the DFMT project has been the project web page, located at http://www.theyankeegroup.com/mechfuels.

Trials were scheduled such that the key target audiences listed above were invited to participate during at least two consecutive days of each trial. Participants assembled at a designated welcoming area and asked to sign in. Participants were then given a safety briefing, issued hard hats if they did not arrive with one, and gathered into groups with a designated tour guide. Individual groups would then tour the demonstration area, viewing each system “in action”, and ask questions of the equipment operators and distributors. A typical tour took approximately two hours. Participants were asked to fill out an evaluation form after completion of their tour.

Production and Cost Estimation

One day of each trial was set aside for time and motion study data collection. This data was collected according to accepted time and motion study methodology: the production cycle of each system was broken down into distinct activities such as travel, cut, or process. The set of activities used for a system was unique to the functions of that system. For each activity, time in one-hundredths of a minute, and other relevant information were recorded. Additional information could include measurements such as tree diameter (inches at breast height, visually estimated to the nearest inch), travel distance (in feet, visually estimated to the nearest five feet at the time of travel and checked periodically with a hip chain), or number of stems per turn (visual estimation or count). The combination of production information with costing data ($/hour) allowed the estimation of production costs ($/acre)[2].

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Environmental Impacts

Two specific measures of environmental impact were of concern: positive or negative changes in the fire/fuels environment and damage to the soil resource.

Changes in the fire/fuels environment

Stand conditions and how they related to fire hazard/behavior was modeled using the FMAPlus computer program designed by Fire Program Solutions, LLC (http://www.fireps.com/fmanalyst/). This program uses tree plot data and fuels transect data to make an estimate of fire behavior at the surface and above the ground in the stand canopy. Data were collected prior to treatment (the equipment trial) as well as post-treatment for each system that participated in each trial. For the two trials in over-snow conditions (Central Oregon and Okanogan/Wenatchee), control units representative of pre-treatment trials were set aside and pre- and post-treatment data were collected in late spring.

Tree plot data for both the pre- and post-treatment measurements consisted of 1/20- acre fixed radius plots. For each plot, all diameters and species were recorded starting due north and working in a clockwise direction. Heights were measured on a representative sample of diameters and species. Crown ratios were ocularly estimated for each sample tree as an input to the program in order to model average crown base height and canopy bulk densities.

Fuel profiles were collected pre- and post-treatment following the planar transect method described by Brown (1971). In this method, a tape was laid out on the forest floor at a random location in a random direction. The number of woody pieces of fuel (this does not include needles) less than ¼-inch in diameter were counted along the first three feet of the transect, woody pieces greater than ¼-inch in diameter but less than three-inches in diameter were counted along the first 10-feet of the transect, and woody pieces greater than three inches in diameter were counted and diameter recorded along 40-feet of the transect. Additionally, fuel and duff layer depths were estimated along each transect. This sampling procedure is the excepted standard for accurate surface determination of fuel loading.

Soil Impacts

Impact to the soil resources were estimated for each system participating in the trials using a visual soil assessment protocol created by Weyerhaeuser, Co. and later adapted by Steve Howes, US Forest Service Soils Program Manager for Washington and Oregon, for use by Forest Service units in the Pacific Northwest. This method involves setting up random transects both pre- and post-treatment, and recording soil condition at given intervals along that transect. Soil conditions are segregated into seven soil disturbance categories ranging from no soil disturbance to massive, drainage-altering disturbance (see Appendix G). Distribution of soil disturbance classes was compared

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types, ground conditions, regional operator rates, operator experience, and contractor availability. Neither the DFMT study nor participating agencies endorse one machinery brand and/or contractor over another. The differences in costs per acre are due to variables beyond the protocols of the DFMT studies and are reproduced here as rough generalities.

pre- and post-treatment to estimate extent of soil disturbance caused by each system participating in the trials.

Field Trials Results

Four field trials were carried out. Two of the trials, Central Oregon and Okanogan/Wenatchee, were performed in over-the-snow conditions in early spring of 2002. The two other trials, Idaho City and Blue Mountains, were conducted in late spring 2002.

Equipment Systems Demonstrated

A minimum of four fuel reduction systems was demonstrated at each of the four field trials. If data did not exist on the "conventional" system used in the area, a system representing the "conventional" method of fuel reduction was included in the field trial for comparative reasons. A description of each system demonstrated at the trials and contact information is provided below. Contact information is specified as to either a "Vendor" (seller) or "Contractor" (user) of the equipment systems demonstrated.

System: All-Terrain Vehicle (ATV) with Forwarding Arch
Specifications: ATV Forwarding Arch

Photo:


Description: This system consists of a wheeled arch with winch pulled by an ATV. Trees were felled, limbed, and bucked manually. The operator then manually piled brush (limbs and tops) and used a pair of hand tongs to bunch logs into bunches of 4-8 logs. The forwarding arch was manually picked up and placed over the turn of logs to be skid. A choker was placed around the turn of logs and a winch attached to the forwarding arch was used to raise the front end of the logs off the ground. The turn of logs was then skid to a road-side landing.
System Cost: $1,500 for ATV Forwarding Arch; $3,000-$7,000 for ATV
Trial(s): Central Oregon, Blue Mountain
Vendor: Future Forestry Products, Mark Havel
P.O. Box 1083, Willamina, OR 97396
Phone/Fax: 1-888-258-1445
email: contact@futureforestry.com
web: www.futureforestry.com

System: Cut-to-Length

Specifications: Timberjack Harvester, 1210 Timberjack Forwarder

Photo:


Description: This system is composed of two machines, a harvester and a forwarder. The harvester passes through an area first following designated skid trails. The harvester is a six-wheeled tractor with a processing head mounted on the end of a 25-foot boom. The harvester grips the base of a tree to be cut, severs the tree from the stump, then uses the processing head to draw the tree through a set of delimbing knives mounted on the top of the processing head, measures length as the tree is being delimbed, and bucks the tree into log lengths using the same saw bar that severed the tree from the stump. Slash consisting of limbs and tops are placed in front of the harvester so that as it travels forward processing trees it is running on top of a bed of slash, decreasing effective ground pressure. The forwarder, a six-wheeled tractor with a bunk for logs on the back and a loading boom, follows along the same trail behind the harvester picking up processed logs. Logs are then off loaded at a roadside landing.

System Cost: $500,000 Harvester; $350,000-$400,000 Forwarder

Trial(s): Central Oregon

Contractor: 4-M Fiber, Scott and Robbie Melcher
P.O. Box 600, Sweet Home, OR 97386-0600
Phone: 541-367-3232
Fax: 541-367-7299
email: thi@proaxis.com

System: Cut-to-Length

Specifications: Kobelco excavator with Keto processing head, 1210 Timberjack Forwarder

Photo:

Description: See above.

System Cost: $250,000 Harvester; $350,000-$400,000 Forwarder

Trials(s): Okanogan/Wenatchee

Contractor: TimberTec, Inc., John Walter
PO Box 339
Bellingham, WA 98227
phone: 360-734-1480
email: dryfly@northsound.net

System: All-Surface Vehicle (ASV) with attachments
Specifications: ASV with shear, Bobcat skid steer with grapple
Descriptions: This is the conventional system owned and operated by the Sisters Ranger District to deal with fuel reduction. Trees from four- to eight-inches in diameter at breast height are fist severed from the stump using the ASV with an attached shear. The shear works like a large pair of scissors, pinching the stem away from the stump. The Bobcat with an attached grapple then skids trees to a roadside landing. In practice, this conventional system is followed by crews, generally convict labor crews, that hand cut and pile stems less than four inches in diameter and the resulting piles are burned when weather permits. Decked logs are sold as firewood.
System Cost: \$60,000-\$80,000 ASV with shear; \$60,000-\$80,000 Bobcat with grapple
Trial(s): Central Oregon, Okanogan/Wenatchee (ASV only)
Contractor: Deschutes National Forest, Sisters Ranger District, Dave Moyer
Phone: 541-549-7718
Cell: 541-549-7700
email: dmoyer@fs.fed.us

System: All-Surface Vehicle (ASV) with multiple attachments
Specifications: ASV with Dymax Tree Shear, Davco Hot Saw, Davco Mastication System, Pull-Through Delimber, and Grapple

Photo:

Descriptions: See above for ASV, shear, and grapple descriptions. The hot saw consists of a constantly-revolving cutting head that severs a tree from the stump as it grabs the tree with a pair of mechanical arms. The tree is then placed on the ground or bunched with other trees to facilitate skidding. The mastication system consists of a mower deck with rotating knives attached to the front of the ASV. The pull-through delimber is a non-motorized, stand-alone unit used in conjunction with the ASV and grapple. One end of a tree is placed in the delimber and pulled through delimbing knives by the ASV with grapple.

System Cost: $60,000-$80,000 ASV; $8,000-$10,000 shear; $5,000-$10,000 hot saw; $5,000-$7,000 mastication system; $3,000-$5,000 delimber; $5,000-$7,000 grapple
Trial(s): Blue Mountain
Vendor: Grouse Mountain Tractor, George Meredith
8484 Lake Elmo Ave.
Stillwater, MN 55082
Grouse Mountain Tractor, Byron Haberly
193 Ford Road
John Day, OR 97845
Phone: 541.575.2908
Web: www.ASVI.com

System: Steep Slope Cable Yarder
Specifications: Clearwater-class truck-mounted yarder with 20-foot tower
Photo:

Description: This small yarder is used to yard logs up steep slopes (inaccessible to ground-based machinery) to a landing. Mounted on a converted military five-ton truck this approximately 25-foot tower has a skyline drum capacity of 800-feet of ½-inch line and mainline drum capacity of 900-feet 3/8-inch line. The system demonstrated used a live skyline configuration and self-locking Christy carriage, a configuration that does not allow the use of intermediate supports. The yarder is owned by the U.S. Forest Service Idaho City Ranger District and operated with the assistance of the Southern Idaho Correctional Institution inmate forestry program. It should be noted that this operation is as much as work program as it is a fuel reduction program.
System Cost: $130,000
Trial(s): Idaho City
Contractor: US Forest Service Idaho City Ranger District, Leonard Roeber
PO Box 129
Idaho City, ID 83631
Phone: 208-392-3701
Email: lroeber@fs.fed.us

System: Downhill Steep Slope Cable Yarder
Specifications: Koller K-500 yarder with 30-foot tower
Photo:

Description: This small yarder is used to yard logs steep slopes (inaccessible to ground-based machinery) to a landing. In this situation, the yarder was set up for downhill logging, meaning the yarder sat on a road at the bottom of a unit and skid logs from up the hill down to a landing where the yarder sat. This is generally considered to be more difficult than uphill logging as it requires a greater amount of rigging and expertise. The system studied used a standing skyline configuration and a motorized Eaglet carriage. Average settings for this yarder include multiple intermediate supports and external yarding distance averages 1,200 feet. The yarder was operated with the support of a Link Belt log loader on the landing and a total crew of six.

This yarder was not part of the formal demonstration and therefore no pre- and post-treatment stand and soil condition information was collected.

System Cost: $130,000 yarder, $30,000 carriage, $40,000 used log loader
Trial(s): Leavenworth (not part of the organized equipment demonstration)

System: Fecon Bullhog
Specifications: Fecon Bullhog mounted on an ASV, excavator, and RT400
Photo:


Description: This mastication head has a horizontal drum with fixed teeth. The inside of the guarding also has opposing teeth. As the head is run over slash or other material, it is swept up into the head and run between the two sets of teeth, breaking material up into small pieces. The head can be mounted on nearly any type of equipment. For the Central Oregon trial, the Fecon head was mounted on the front of the US Forest Service ASV and was run over the skid trails in the CTL unit, therefore is included in analysis with the CTL. At the Okanogan/Wenatchee trial, the Fecon head was mounted on a 40,000-pound excavator. For the Idaho City trial, the Fecon head was mounted on a purpose-built 400 horsepower carrier: the RT400.

System Cost: $40,000-$60,000 Fecon Bullhog; $60,000-$80,000 ASV; $110,000-$130,000 excavator; $290,000 RT400 with Fecon Bullhog head

Trial(s): Central Oregon, Okanogan/Wenatchee; Idaho City

Vendor: Fecon, Inc.
10350 Evendale Drive, Cincinnati, OH 45241
Phone: 800-528-3113/513-956-5700
Fax: 513-956-5701
E-mail: fecon@fuse.net
Web: www.fecon.com

System: Unnamed Mastication System

Specifications: Mastication head with 42-inch wheel, mounted on 30,000-45,000-pound excavator

Photo:

Description: The mastication head consists of a cast wheel 42-inches in diameter and 2-inches thick with fixed teeth mounted on the top, bottom, and around the edge of the wheel. This system employs a low-RPM (revolutions per minute), high torque design. The wheel is hydraulically driven, and as it spins it breaks whatever material it comes into contact with into small pieces. The head is mounted on the end of the excavator boom.

System Cost: $35,000-$50,000 Unnamed mastication head installed, $110,000-$130,000 excavator

Trial(s): Central Oregon, Okanogan/Wenatchee, Idaho City, Blue Mountain

Vendor: (none)

System: Promac
Specifications: Promac 52 Brush Cutting Head mounted on a 30,000-pound excavator

Photo:


Descriptions: Unlike the other mastication heads demonstrated, the Promac Brush Cutting head uses swinging knives mounted in the center of the head as opposed to fixed teeth. The Promac head is mounted on the end of the excavator boom.
System Cost: $40,000-$60,000 Promac 52 Bush Cutting Head; $110,000-$130,000 excavator
Trials(s): Okanogan/Wenatchee
Contractor: Kelly Mountain Contracting Ltd., Guy Bailey
1801 Kosmina Drive
Vernon, BC V1T 8I1
phone: 250-549-2369
email: kellmountain@telus.net

System: Nordstrom
Specifications: Nordstrom Mechanical Brush Cutter mounted on an 80,000-pound excavator

Photo:


Description: This brush cutter attachment has a 48” rotating disk with 24 replaceable cutting teeth and was mounted on a Caterpillar 322BLL Excavator. The head also has a hydraulically powered thumb that allows it to pick up and move material such as logs and brush. The head can rotate 270 degrees. In addition to the excavator power plant, there is an auxiliary 125-horsepower Caterpillar engine that powers the cutting attachment.

System Cost: $485,000
Trial(s): Idaho City
Vendor/Contractor:
C. Richard "Dick" Nordstrom
404 Klette Rd.
Kingston, ID 83839
Phone: 208-682-2660

System: Bandit
Specifications: Bandit Tracked Whole-Tree Chipper with harvester and rubber-tired skidder with grapple
Photo:

Description: The Bandit is a 20,000-pound chipper mounted on tracks. After trees have been cut by the harvester (see description under CTL system) and skid with the rubber-tired skidder to a roadside, either a haul road or a skid road, the Bandit uses an attached boom and grapple to feed whole trees into the chipper. The Bandit can propel itself around the woods and process whole trees or logging slash into chips.
System Cost: $250,000-$290,000 Bandit Whole-Tree Chipper; $200,000-$500,000 harvester; $120,000-$180,000 rubber-tired skidder with grapple
Trial(s): Idaho City
Vendor: Wesspur L.L.C. (Bandit dealer)
1680 Baker Creek Pl.
Bellingham, WA 98226
Phone: 800-268-2141, 360-734-5242
Cell: 350-815-0461
Fax: 360-733-6311
email: andymcmurry@wesspur.com
Web: www.wesspur.com

System: Spyder
Specifications: Kaiser Spyder
Photo:

Description: The Kaiser Spyder is a four-wheeled excavator. Each wheel is mounted on an independently controlled outrigger than can be moved up, down, in, and out from the machine, allowing the Spyder to navigate steep and uneven terrain. The mastication head demonstrated with the Spyder consisted of swinging knives mounted in the center of a guarded head. This mastication head is mounted on the end of the excavator boom
System Cost: $290,000
Trial(s): Idaho City, Blue Mountain
Vendor: Kemp West, Inc. (Kaiser Spyder)
4911 Bickford Ave.
Snohomish, WA 98290
Phone: 425-334-8253
Cell: 425-508-4609
Fax: 425-334-5366
email: kari.hasko@get.net

System: Hakmet
Specifications: Hakmet Arbro Strokharvester mounted on a 11,000-pound excavator and Hakmet Merri Crusher mounted on a JD 550 crawler tractor
Photo:

Description: The Arbro Strokharvester is a low-flow processing head that fells and processes trees into logs (see harvester description under CTL system) mounted on a small (11,000-pound) excavator. After trees were processed into logs, slash was treated using the Merri Crusher. This is a mastication system involving a rotating horizontal drum with fixed teeth mounted to the back of a mid-sized crawler tractor.

System Cost: $20,000-$30,000 Hakmet Arbro Strokharvester; $50,000-$70,000 Excavator; $20,000-$30,000 Hakmet Merri Crusher; $70,000-$90,000 crawler tractor
Trial(s): Blue Mountain
Vendor: Hakmet USA, Inc., Reijo "Ray" Ulmonen
613 Iris Drive
Redding, CA 96002
Phone: 800-566-0690, 530-224-1397
Cell: 530-515-8423
Fax: 530-224-1398
email: kakmetus@jett.net
web: www.hakmetusa.com

All vendor and contractor time was donated to the project. A total of 13 vendors and 18 contractors donated time and materials approaching $89,000. Appendix H describes the in-kind contributions made by these individuals and businesses to the project.

Public Participation

The DFMT was successful in attracting forest contractors, Forest Service personnel, interested public, and to a limited degree local media, elected officials, and other agency personnel. Summaries of participation for each of the four trials is given below.

Central Oregon

Approximately 100 individuals participated in the Central Oregon trial, 74 of who signed in. Of these, about 45% were U.S. Forest Service personnel, 20% were local contractors, and the remainder representatives of public agencies and private landowners. Two media representatives attended from *The Bend Bulletin* and the *Sisters Nugget*. Additionally, a film crew and reporter from TV station Z-21 (NBC affiliate from Bend, OR) toured the trial site with a news story airing that evening highlighting the trial. A local collaborative group – Central Oregon Partnerships for Wildfire Risk Reduction (COPWRR) scheduled a field trip in conjunction with the trial.

Okanogan/Wenatchee

Approximately 100 individuals participated in the Okanogan/Wenatchee trial, 78 of who signed in. Of these, about 40% were local contractors and foresters representing private landowners, 25% were U.S. Forest Service personnel, and the remainder interested citizens and representatives of public agencies, such as National Marine Fisheries Service.

Idaho City

Approximately 165 individuals participated in the Idaho City trial. Of these, about 20% were local contractors, one-third were U.S. Forest Service personnel, and the remainder interested citizens and representatives of public agencies, such as National Marine Fisheries Service, Bureau of Land Management, and the Nez Perce Tribe. Media in attendance included *Timber West* magazine (a publication aimed at the timber industry), Channel 7 (NBC Affiliate – Boise, ID), and Channel 12 (Fox affiliate – Boise, ID).

Blue Mountains

Approximately 145 individuals participated in the Blue Mountain trial. Of these, about 20% were local contractors, 45% were U.S. Forest Service personnel, and the remainder interested citizens and representatives of public agencies, such as National Marine Fisheries Service, Bureau of Land Management, and Grant County Economic Development. Media in attendance included the *Blue Mountain Eagle*.

System Production and Cost Estimates

Cost Estimates

For each piece of equipment demonstrated hourly machine costs were calculated following the standard Cat Handbook Method (Caterpillar, 1997). This is clearly not an appropriate method for all of the equipment involved in these trials. However, it was used for all pieces of equipment in order to ensure comparability and standardization. For many of these equipment types, no standard for determining hourly owning and operating costs exists. Major assumptions have been made in order to arrive at hourly costs. The assumptions specific to each piece of equipment can be found in Appendix D. The following assumptions were used for all equipment:

- Initial costs used were the mean of the ranges given in the system descriptions
- Machine life of five years
- Operating season of 1600 hours per year
- After five years the owner would expect to receive 20% of the purchase price for the equipment (salvage value)
- Interest cost is 10% of the average annual investment
- Insurance cost is 2% of the average annual investment
- Property tax cost is 3.4% of the average annual investment
- Fuel cost is $1.25 per gallon
- Operator wages plus benefits is $20 per hour
- Profit and risk is 15% of owning and operating costs, excluding labor

All production costs ($/acre) are calculated based on 800 stems to treat per acre and assume a balanced system. For example, here the production cost for the Bandit whole-tree-chipper assumes the system is composed of one feller-buncher, one rubber-tired grapple skidder, and one Bandit whole-tree chipper even through the production rates used here would indicate the skidder would be sitting idle at least half the time. Production rates are calculated based on the most limiting machine (the machine with the highest hours per acre estimate, in other words the slowest machine in the system) and assume an eight-hour operating day. Please see the disclaimer given in footnote 2 above (page 11-12).

Extractive Systems

All-Terrain-Vehicle with Forwarding Arch

The ATV with Forwarding Arch was timed forwarding nine turns for a total of 28.95 minutes and building two turns, seven logs total, for a total of 43.24 minutes. Of the turns forwarded to an adjacent CTL skid trail, each averaged 5.7 logs per turn and 315 feet. This averaged out to per turn times of 3.22 minutes to forward and 21.62 minutes to fall, buck, limb, pile brush, and bunch logs for a total of 24.84 minutes per turn. With these estimates, 87% of the time was spent falling, limbing, bucking, piling, and bunching (all by hand) while only 13% of the time was spent with the operator using the ATV to forward logs to a CTL skid trail. At a machine rate of $23.89 per hour, it is estimated production costs will range from $908 to $1,433 per acre. Production rates using these estimates would range from 0.1 to 0.2 acres per day.

Cut-To-Length

Two different CTL systems were used at the Central Oregon and Okanogan/Wenatchee trials. The forwarder was the same model in both trials while the harvester differed. Figure 2 graphically shows production data collected on each of the two harvesters demonstrated (Timberjack (Central Oregon) n=40; Kobelco (Okanogan/Wenatchee) n=34).

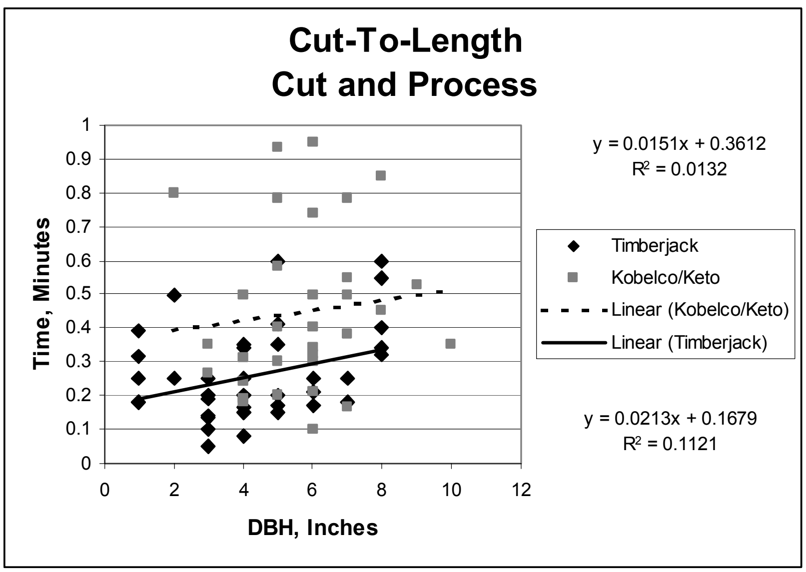

Figure 2: CTL Harvester Production

The data displayed indicate there is little correlation between tree size and time to cut and process. While the sample size obtained here is quite small, it is predicted that this correlation would not increase significantly with an increased sample size.

Figure 2 also displays a difference in cut and process time between the two systems demonstrated. This is consistent with other comparisons of similar processors (Coulter, 1999). Here, the purpose-built Timberjack harvester averaged 0.3 minutes per stem while across the same diameter range, the Kebelco excavator with Keto processing head averaged 0.4 minutes per stem to cut and process.

Snow depths in Central Oregon were generally less than six inches while snow depths during the Okanogan/Wenatchee trial ranged from one to three feet. Differences in snow conditions resulted in drastically different times for travel and positioning of the harvesters. The Timberjack harvester spent 3% of its time traveling and positioning while the Kebelco spent nearly 35% of its time at the same activity.

The Timberjack forwarder at the Okanogan/Wenatchee trial averaged a load every 22.5 minutes. Of this time, 36% (7.9 minutes) was spent loading, 31% (6.8 minutes) traveling and positioning, and 34% (7.4 minutes) sorting and unloading at the landing. Again, travel and positioning times were higher in deep snow conditions experienced here as opposed to dry conditions. This forwarder load contained approximately half sawlogs and half pulp logs by volume. This volume composition was in stark contrast to the Central Oregon demonstration where the forwarder picked up two merchantable sawlogs in four days of demonstration.

When hourly costs of the Timberjack harvester ($125.40/hour), Timberjack forwarder ($102.73) and the Kobelco excavator with Keto processing head ($82.06) are combined with these production estimates, production costs are estimated to range from $675 to $944 per acre for the Timberjack/Timberjack system and from $799 to $999 per acre for the Kobelco/Timberjack system. Production rates using these estimates would range from 1.7 to 2.5 acres per day for the Timberjack/Timberjack system and from 1.0 to 1.3 acres per day for the Kobelco/Timberjack system.

All-Surface-Vehicle

The ASV showed a weak positive correlation between stem diameter and time to cut and bunch (n=21), as shown in Figure 3.

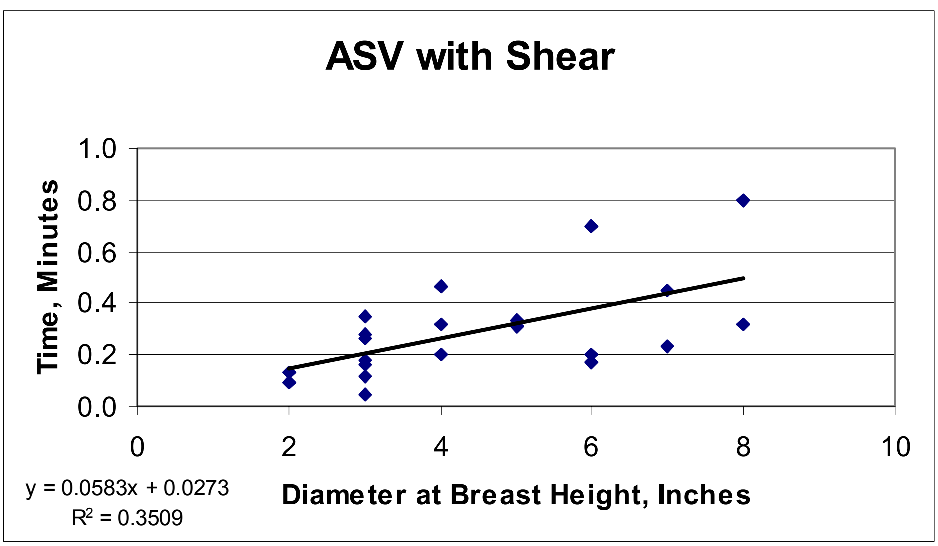

Figure 3: ASV Production

Generally, the ASV system as demonstrated at the Central Oregon trial does not shear stems less than 4 inches in diameter, leaving these stems to be processed by hand. Travel time amounted to approximately 31% of the total turn time. Of the other attachments demonstrated, the grapple averaged 0.7 minutes per turn (n=5), the mower deck (mastication) averaged 0.3 minutes per tree (n=27), the hot saw averaged 0.4 minutes per tree (n=16), and the delimber averaged 1.3 minutes to delimb each tree (n=5).

The hourly cost calculated for either an ASV or Bobcat with an attachment was $46.18 per hour. The system demonstrated at the Central Oregon trial included an ASV with a shear and a Bobcat with a grapple. Using the production estimates for these two functions, a production cost of $493 to $677 per acre is calculated. This corresponds to a production rate of 0.9 to 1.0 acres per day. The system demonstrated at the Blue Mountain trial used one ASV to perform several tasks. If it is assumed that one ASV will be used to shear trees, skid logs, and masticate slash, a production cost of $640 to $899 per acre is estimated based on a production rate of 0.4 to 0.6 acres per day.

Steep-Slope Cable Yarder

The turns studied averaged 3 logs in size, 475-foot yarding distance, and 6.9 minutes in duration (n=7). This time included outhaul, hook, inhaul, and unhook. Three chokers were rigidity attached to the mainline so turns were limited to three logs. A delay of 3.0 minutes was recorded while the bullet that stops the carriage was repositioned. The cost to government for this system is estimated at $42.98 per hour. When combined with the sampled production rate, the cost to treat 800 stems per acre is estimated to range between $967 and $1,504 per acre with a production rate of 0.2 to 0.4 acres per day. It should be noted that the crew and supervisors were learning to operate the equipment and were not yet proficient.

Downhill Steep-Slope Cable Yarder

The turns studied averaged 4 logs in size, 410-foot yarding distance, and 3.7 minutes in duration (n=48). This time included outhaul, hook, inhaul, and unhook/deck. The average total delay time was equal to 1.3 minutes per turn, and included 12.7 minutes of unproductive delay while dealing with Forest Service personnel and 41 minutes of productive delay time to clear the landing of yarded logs. The cost for this system is estimated at $186.64 per hour and includes the yarder, motorized carriage, used log loader, and a crew of six. When combined with the sampled production rate, the cost to treat 800 stems per acre is estimated to range between $1,866 and $2,489 per acre with a production rate of 0.6 to 0.8 acres per day. It should be noted that this operation was producing an average of four loads per day of merchantable material, one load of sawlogs and three loads of chip-and-saw.

Mastication Systems

Fecon

The Fecon mastication system demonstrated at Okanogan/Wenatchee was mounted on the end of an excavator boom. The operator was an experienced equipment operator but the demonstration was the first time he had used the Fecon system. The system averaged 1.13 minutes across 9 trees (n=9) averaging 5 inches in diameter. It is estimated significant increases in production would be seen after the operator has used the system for a longer period of time. For this system configuration the hourly cost is estimated at $68.69 per hour. If it is assumed the operator would improve to a production rate of 0.8 to 1.3 acres per day, this would result in production costs of $440 to $659 per acre.

The Fecon mastication system demonstrated at Idaho City was a rigidly-mounted system. As such, it was able to fell a tree near the stump in approximately 0.1 minute then had to maneuver around to process the tree as it lay on the ground. The time to completely process a stem depended on the terrain, other vegetation to maneuver around or masticate, and the desired end condition of the material. As expected, it took less time to break the tree up into large pieces and more time if the masticated material was incorporated into the soil. Assuming the Fecon system is operated as it was at Idaho City, with the goal of fully mulching material and incorporating that mulch into the soil, a production rate of 0.8 to 1.3 acres per day and an hourly cost of $90.46 per hour would yield production costs estimates of $479 to $868 per acre.

Unnamed Mastication System

Unlike CTL, the mastication systems generally showed a strong correlation between tree size and processing time. This relationship is shown graphically in Figure 4 (n=16). In general, as the mastication head had to process more material, it took longer.

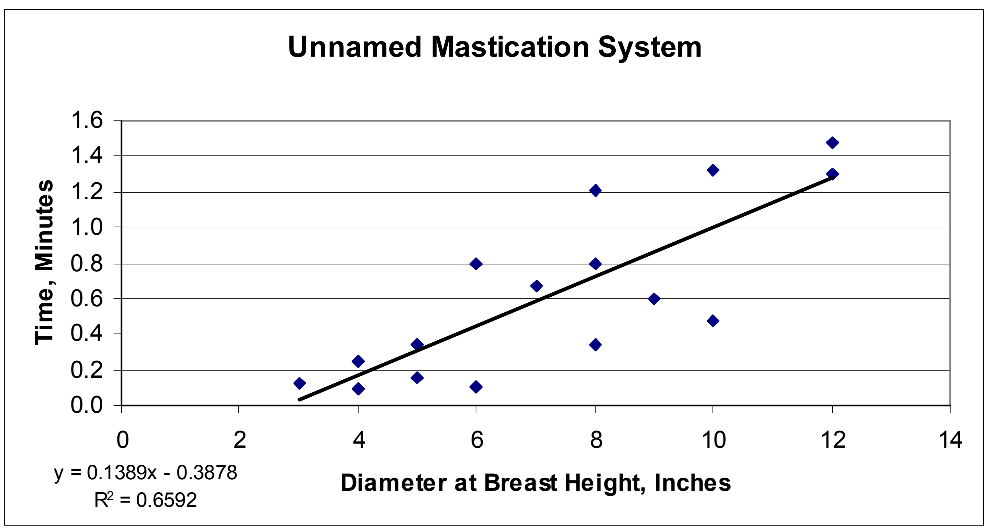

Figure 4: Unnamed Mastication System Production

With an hourly cost of $67.33 and a production rate of 0.6 to 1.3 acres per day, production costs are estimated at $431 to $862 per acre.

Promac

The production times for the Promac mastication system are shown in Figure 5 (n=12). Once again, as diameter increased, an increasingly larger increase in processing time was experienced by the Promac system.

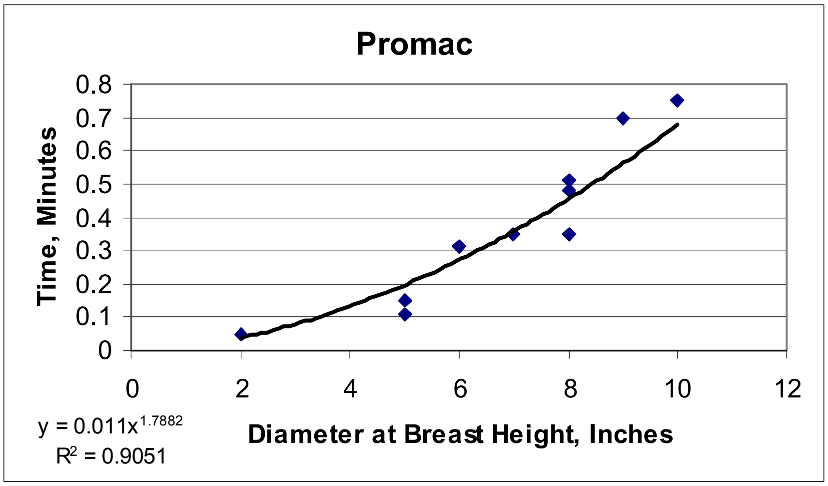

Figure 5: Promac Production

With an hourly cost of $68.69 and production rate of 1.0 to 1.7 acres per day, production costs are estimated at $330 to $550 per acre.

Nordstrom

The Nordstrom Mechanical Brushcutter averaged 0.3 minutes per stem for stems ranging from six to 10-inches DBH (n=14). This resulted in an estimated production rate of 1.3 to 2.5 acres per day. At a cost of $125.84 per hour, production costs are estimated at $403 to $805 per hour.

Bandit Whole-Tree Chipper

The Bandit whole-tree chipper averaged 0.3 minutes to chip a bundle of trees that averaged 3, six-inch diameter trees (n=8 for a total of 23 logs). The feller-buncher averaged 0.2 minutes per tree to cut and bunch into decks for the skidder (n=6). Machine rates were calculated at $86.84 per hour for the Bandit whole-tree chipper, $100.20 per hour for the feller-buncher, and $61.30 for the rubber-tired skidder. At an estimated production rate of 2.5 to 3.3 acre per day, production costs for the system are estimated at $428 to $672 per acre.

Kaiser Spyder

The Spyder averaged 0.4 minutes per three-inch DBH stem to process (n=61) during the Blue Mountain trial. No data was available for the Spyder from the Idaho City trial because all trees within the trial area were generally greater than six-inches DBH – too large for the Spyder to efficiently masticate. The hourly rate for the Spyder was calculated at $85.40 per hour. At a production rate of 1.0 to 1.3 acres per day, a production cost of $547 to $583 per acre was estimated.

Hakmet Arbro Low-Flow Processing Head

The Arbro processing head operated like a stroke-boom delimber mounted on the end of a boom. The production of the Arbro head is shown graphically in Figure 6 (n=6).

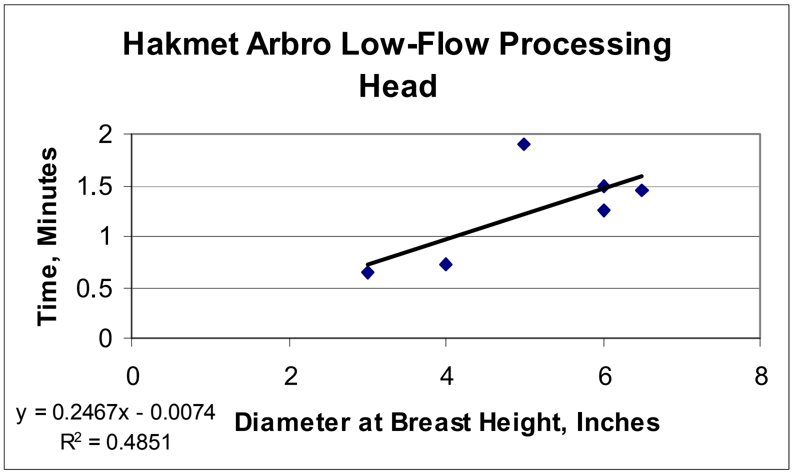

Figure 6: Hakmet Arbro Low-Flow Processing Head Production

Figure 6 shows a weak positive correlation between piece size (DBH) and time to cut and process. Times to cut and process a stem ranged from 0.65 to 1.9 minutes. It is not surprising the slope of the correlation between piece size and time to cut and process is much steeper (greater increase in cut and process time per one inch increase in DBH) as compared to the two harvesters shown in Figure 2. The Timberjack and Kebelco are designed to handle diameters much larger and not necessarily as small as seen during the trials.

The Arbro Strokharvester had a calculated machine rate of $49.25 per hour while the Merri Crusher was $86.84 per hour. At a production rate of 0.3 to 0.6 acres per day, production costs are estimated at $1,265 to $2,094 per acre.

Changes in the fire/fuels environment

A commercially available program FPMAPlus (www.fireps.com) was used to estimate fire behavior and changes in the surface and vertical fuel profiles for pre-treatment and post-treatment stands for each system demonstrated at each trial.

Environmental elements that contribute to fire behavior (temperature, humidity, wind, and live fuel moisture) were held constant for all stands and were set for late summer conditions (See Appendix E). Model results are shown in the following tables.

Figure 7: Central Oregon Fuel Model Results

System	Crown Base Height (ft)	Change in Crown Base Height (ft)	Basal Area (ft^2/ac)	Fuel[3] Model	Fire Type	Rate Of Spread (ch/hr)	Flame Length (ft)	Ave Stand Height (ft)
Pretreatment	1		335.48	8A	Surface	1.7	1	36
ASV	19	18	113.05	8A	Surface	1.7	1	61
Unnamed Mastication System	21	20	132.23	9M	Surface	9.6	3.5	73
ATV	33	32	114.49	8M	Surface	2.4	1.3	61
Fencon/ Cut To Length	23	22	174.95	8M	Surface	2.4	1.3	73
Average		23						60.8

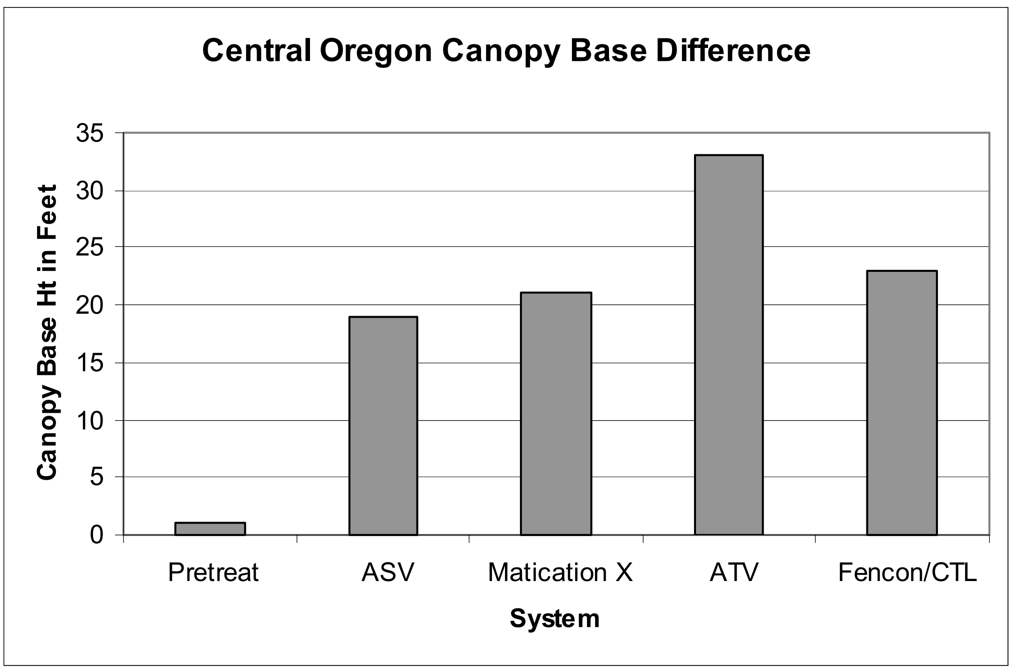

Figure 8: Central Oregon Canopy Base Heights

[3] Fuel Model ID and Descriptions see Appendix F

Figure 9: Okanogan/Wenatchee Fuel Model Results

System	Crown Base Height (ft)	Change in Crown Base Height (ft)	Basal Area (ft^2/ac)	Fuel[1] Model	Fire Type	Rate Of Spread (ch/hr)	Flame Length (ft)	Ave Stand Height (ft)
Pretreatment	1		135.55	8A	Surface	1.7	1	42
Pretreatment CTL	1		165.2	8A	Surface	1.7	1	26
CTL	4	3	24.28	8A	Surface	1.7	1	33
Fecon	9	8	268.22	10Z	Passive	16.7	8.9	69
Promac	12	11	151.41	8A	Surface	1.7	1	69
ASV	14	13	154.4	8M	Surface	1.2	0.8	23
Unnamed Mastication System	28	27	68.92	8A	Surface	1.7	1	40
Average		12.4						

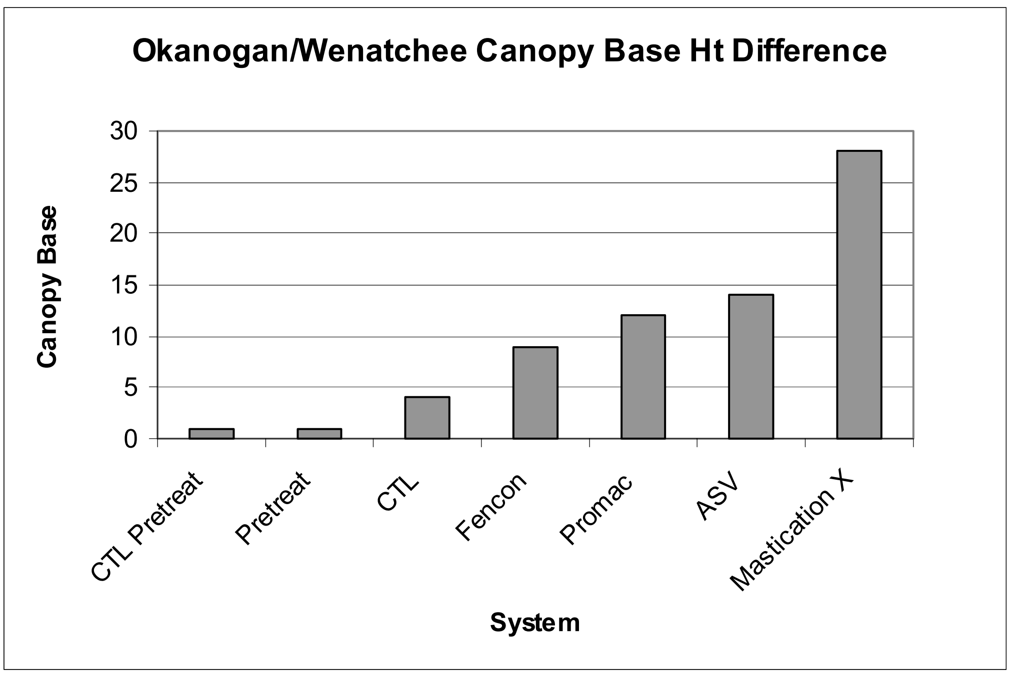

Figure 10: Okanogan/Wenatchee Canopy Base Height Difference

Figure 11: Idaho City Fuel Model Results

System	Crown Base Height (ft)	Change in Crown Base Height (ft)	Basal Area (ft^2/ac)	Fuel[1] Model	Fire Type	Rate Of Spread (ch/hr)	Flame Length (ft)	Ave Stand Height (ft)
Pretreatment Tower	1		105.41	8A	Surface	1.7	1	33
Pretreatment	2		107.78	8A	Surface	1.3	0.8	31
Bandit	5	4	10.91	10A	Passive	6.7	4.4	30
Tower	6	5	24.28	8A	Surface	1.7	1	33
Unnamed Mastication System	7	6	11.35	10A	Surface	5.6	3.8	38
Fecon	9	8	81.45	10A	Surface	5.6	3.8	38
Nordstrom	9	8	41.44	10A	Surface	6.7	4.4	37
Spyder (No Data)								
Average		6.2						

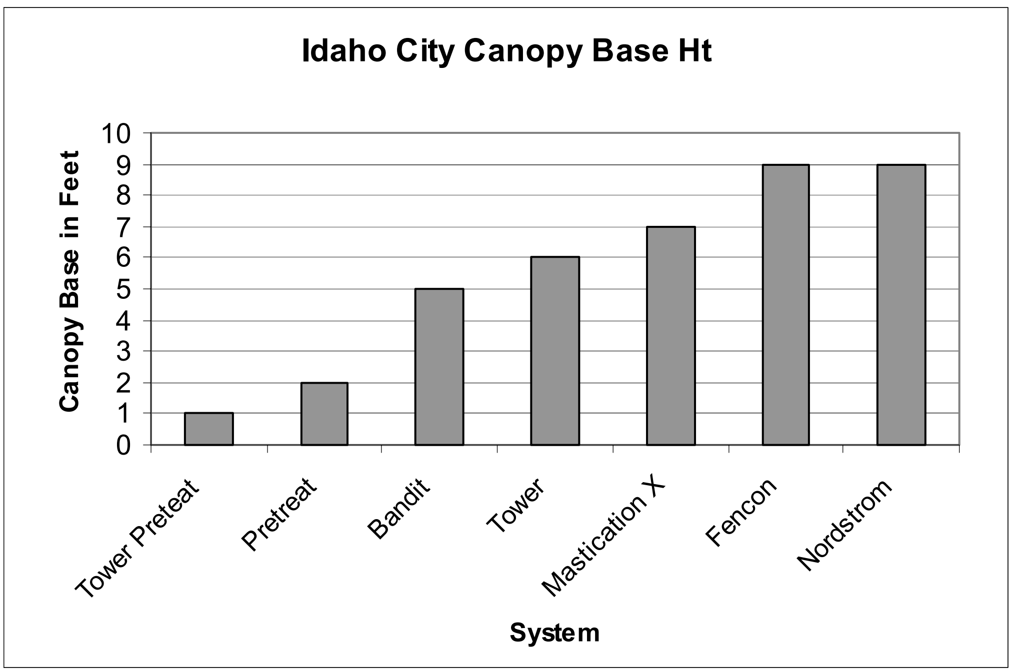

Figure 12: Idaho City Base Crown Height Difference

Figure 13: Blue Mountain Fuel Model Results

System	Crown Base Height (ft)	Change in Crown Base Height (ft)	Basal Area (ft^2/ac)	Fuel[1] Model	Fire Type	Rate Of Spread (ch/hr)	Flame Length (ft)	Ave Stand Height (ft)
Pretreatment	3		143.71	8A	Surface	1.1	0.8	23
Hakmet	32	29	203.91	8Z	Surface	2.1	1.4	65
Unnamed Mastication System	51	48	203.91	8Z	Surface	2.1	1.4	79
ATV	81	78	330.27	9A	Surface	4.4	2.1	63
ASV	50	47	64.51	8A	Surface	1.1	0.8	103
Spyder	22	19	10.05	8Z	Surface	2.1	1.4	65
Average		44.2						

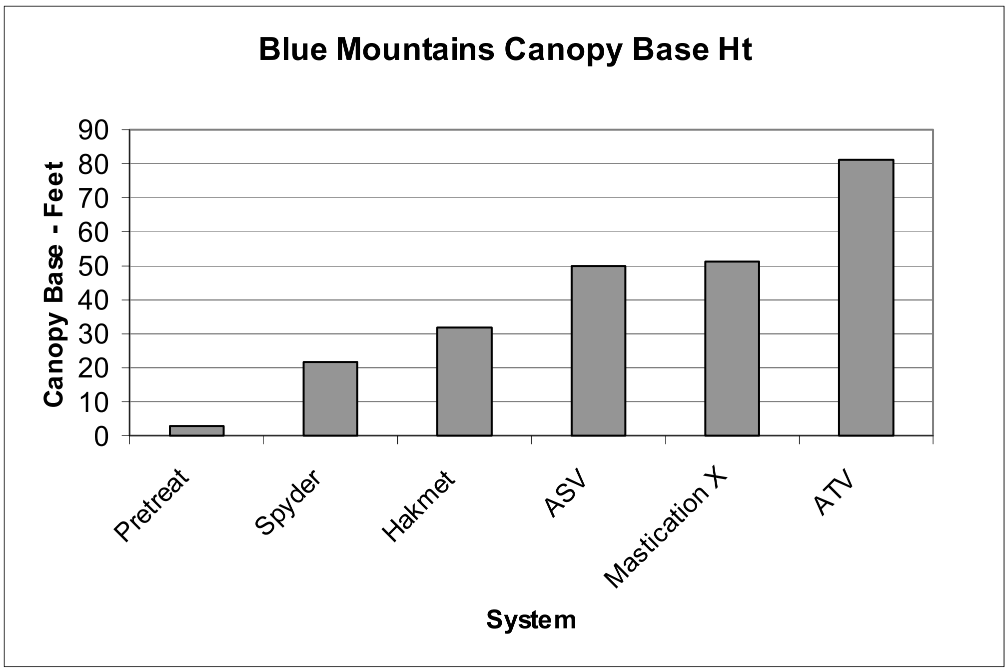

Figure 14: Blue Mountain Canopy Base Height Difference

The model did not predict that any of the stand and fuel conditions measured would create active crown fire behavior. Two treated stands did create passive crown fire conditions – Idaho City Bandit and Okanogan/Wenatchee Fecon treatments ("passive crown fire" is a type of fire with single tree and groups of trees torching, but does not involve a fire burning actively in the crown independent of surface fuel conditions). Pre-treatment surface fuel conditions at all four of the sites were not serious enough to produce either a passive or active crown fire (in the model) absent of stronger winds. Stronger wind speeds than those used in the modeling in some cases would result in passive crown fire conditions, e.g. the Okanogan/Wenatchee pretreatment stand exhibited passive crown fire when 20-foot wind speeds were increased by three miles per hour (13 mile per hour) which results in a 3.9 mile per hour midflame wind speed, not an uncommon event for this area of the Eastern Cascades. A cautionary note would be treatments that significantly reduce residual basal area resulting in less midflame wind reduction and an increase in solar radiation.

Central Oregon, Okanogan/Wenatchee, and Blue Mountain trial sites were all characterized by scattered mature timber with a crowded understory of suppressed timber with crown ratios approaching one (crown the full height of the tree). Not surprisingly, the mastication systems increased rate of spread, flame length, and fireline intensity estimates as compared with pre-treatment and extractive systems because what had been vertical biomass was now distributed on the surface. What the treatments did demonstrate were three important changes in the structure of the stands following treatment: 1) Canopy base height was raised, thereby improving stand resistance to initiation of passive or active crown fire in the future as these stands progress through time; 2) Basal area was reduced, which improving stand resiliency to disturbances such as drought, insects, diseases, and fire; and 3) The average height of the stand was increased, without a significant increase in fuel bed depth in a majority of the treatments. The changes were accomplished without a dramatic change in surface fuel models toward more hazardous conditions – even in those treatments that were not extractive, with the exception of the two areas that the model did predict passive crown fire behavior.

Extractive systems generally showed little increase in rate of spread, flame length, and fireline intensity estimates while reducing potential crown percentage scorched and estimated probability of mortality of residual trees.

Prescribed fire would often be a logical next step in these dry forest types, particularly in those situations where the pretreatment biomass was extensive and thus results in higher surface loadings following treatments. Further reduction in the surface fuel loading would occur and permit the stands to be managed under a "maintenance" prescription in the future. These types of maintenance underburns are generally lower risk projects, cost less to implement, and produce fewer emissions. Without applied fire, rates of decomposition will determine how long these increases in predicted fire behavior measures remain higher in mastication units as compared to pre-treatment conditions. In these dry sites the process is slower than on more moist landscapes; however what moisture these sites do receive generally comes in the form of snow, which has the positive effect of further reducing fuel bed depth and decreasing the air spaces surrounding the fine fuels. The answer to this question is beyond the scope of this project, but needs to be considered when planning for mechanical treatments.

In general, the extractive systems left debris concentrated either in piles or in skid trails, while debris from the mastication systems was relatively evenly distributed across the site.

It should be noted here and for the soil impacts assessment that the entire Central Oregon trial site, including areas that had been set aside as control units, was treated with the conventional system of ASV/hand labor before pre- and post-treatment measurements of stand and soil conditions could be made. A small, untreated area was found and used as a control. However, the pre-treatment stand was highly variable in both stand and soil conditions and these variations could not be captured.

The following photos show pre- and post-treatment stand and soil conditions for Central Oregon (Figures 15 and 16), Okanogan/Wenatchee (Figure 17 and 18), Idaho City (Figures 19 and 20), and the Blue Mountain trial (Figures 21 and 22).

Figure 15: Central Oregon Pre-Treatment Stand Conditions

Figure 16: Central Oregon Post-Treatment Stand and Soil Conditions

Figure 17: Okanogan/Wenatchee Pre-Treatment Cut-to-Length Stand Conditions

Figure 18: Okanogan/Wenatchee Post-Treatment Cut-to-Length Stand Conditions

Figure 19: Idaho City Pre-Treatment Stand Conditions

Figure 20: Idaho City Post-Treatment Nordstrom Stand Conditions

Figure 21: Blue Mountain Pre-Treatment Stand Conditions

Figure 22: Blue Mountain Post-Treatment Spyder Stand Conditions

Soil Impacts

The following tables give the results of the soil impact assessments for each of the trial locations. The values given in each table are the percent of observations made in each soil disturbance class. Pre-treatment observations followed the "Old Disturbance

Class" while the post-treatment observations followed the rules for "New Disturbance Class". In general terms, as the Disturbance class increases from "0" to "6", the amount of disturbance found at the site is also increase. Refer to Appendix G for specific descriptions of the seven soil disturbance classes.

Central Oregon

As mentioned above, the entire Central Oregon trial site, including areas that had been set aside as control units, was treated with the conventional system of ASV/hand labor before pre- and post-treatment measurements of stand and soil conditions could be made. A small, untreated area was found and used as a control. However, the pre-treatment stand was highly variable in both stand and soil conditions and these variations could not be captured.

Snow covered the ground for most of the trial. A slight increase in soil disturbance was caused by the Fecon system mounted on the Forest Service ASV. This increase was caused by the turning action of the ASV. In the table below, the Fecon mastication system is combined with the results for the cut-to-length (CTL) system because the Fecon system was used to treat slash left in the CTL trails.

Figure 23: Soil Impact Summary for the Central Oregon Trial

Disturbance Class	Pre-Treatment	Unnamed Mastication System	ASV	CTL/ Fecon	ATV
0	0%	0%	0%	0%	0%
1	100%	100%	100%	80%	100%
2	0%	0%	0%	20%	0%
3	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%
6	0%	0%	0%	0%	0%

Okanogan/Wenatchee

For the Okanogan/Wenatchee trial, the cut-to-length (CTL) system was in a different stand than the other four systems and so has a different set of pre-treatment stand and soil conditions. No increase in soil disturbance was caused by any of the five systems demonstrated. This was helped greatly by the relatively deep snow pack (Figure 24). One consequence of the snow pack was high stumps in many of the units (Figure 25), even with operators specifically trying to keep stumps low.

Figure 24: Deep Snow Pack at Okanogan/Wenatchee trial

Figure 25: Okanogan/Wenatchee Post-Treatment Stand and Soil Conditions

Figure 25 also shows a good representation of pre-treatment stand conditions behind the area that has been treated.

Figure 26: Soil Impact Summary for the Okanogan/Wenatchee Trial

Disturbance Class	Pre-Treatment	Unnamed Mastication System	ASV	Fecon	Promac	Pre-treatment, CTL	CTL
0	0%	0%	0%	0%	0%	0%	0%
1	80%	100%	100%	100%	100%	100%	100%
2	20%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%	0%
6	0%	0%	0%	0%	0%	0%	0%

Idaho City

As in the Okanogan/Wenatchee trial, one of the systems, here the tower system, was located in a different stand and therefore has a different set of pre-treatment stand and soil conditions. It was difficult to decide on the soil disturbance class for the pre-treatment conditions. In both of the pre-treatment units, no ground-disturbing activities had taken place since the ground was terraced 40 years ago. Unquestionably the terracing has altered the soil profile.

As with the treatment debris, ground disturbance was generally localized for the extractive systems (tower) and relatively constant across the unit for the mastication system (Figure 27). The greatest amount of soil disturbance was caused by the Fecon mastication system (Figure 28). This, however, was by design as the operators specifically intended to mulch debris into the soil.

Figure 27: Idaho City Post-Treatment Bandit Soil Conditions

Figure 28: Idaho City Post-Treatment Fecon Soil Conditions

Figure 29: Soil Impact Summary for the Idaho City Trial

Disturbance Class	Pre-Treatment	Slash-buster	Bandit	Fecon	Nordstrom	Spyder	Pre-Treatment, Tower	Tower
0	0%	0%	0%	0%	0%	0%	0%	0%
1	100%	50%	0%	0%	0%	0%	100%	50%
2	0%	50%	0%	8%	10%	80%	0%	50%
3	0%	0%	100%	33%	90%	20%	0%	0%
4	0%	0%	0%	58%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%	0%	0%
6	0%	0%	0%	0%	0%	0%	0%	0%

Blue Mountain

The stand for the Blue Mountain trial had been commercially thinned three years prior to the trial and skid trails and other disturbance from that operation were still quite visible. None of the systems demonstrated at the Blue Mountain trial created soil disturbance beyond conditions already present at the site (Figure 30).

Figure 30: Blue Mountain Post-Treatment Unnamed Mastication System Soil Conditions

Figure 31: Soil impact summary for the Blue Mountain Trial

Disturbance Class	Pre-Treatment	Unnamed Mastication System	ASV	ATV	Hakmet	Spyder
0	0%	0%	0%	5%	0%	0%
1	33%	43%	50%	86%	14%	21%
2	0%	52%	43%	9%	36%	79%
3	67%	4%	7%	0%	50%	0%
4	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%
6	0%	0%	0%	0%	0%	0%

Data Interpretation and Analysis

Hourly costs, production rates, and production costs are summarized below for the systems demonstrated during the trials (Figure 32). Please see the disclaimer in footnote 2 above (page 11-12).

Production costs range from a low of $330 per acre (Promac) to a high of $2,489 per acre (downhill steep-slope yarder). However, it should be repeated that this operation was producing an average of four loads per day of merchantable material to offset these costs. As Figure 32 shows, many of the systems overlap in price. The majority of the extractive systems range from $500 to $1000 per acre while the mastication system range in cost from $400 to $850 per acre. It must be noted that the treatments provided by these systems might not be the only treatment required for a given stand. For example, many managers noted during the trials that many treatments would require one or more prescribed fires in order to meet the management objectives for the stand. Other costs such as administrative costs have not been included in these estimates. Additionally, these production rates reflect the influences of the particular operator, stand conditions, and treatment goals that were in place at the time the data was taken.

Figure 32: Summary of System Hourly Costs, Production Rates, and Production Costs

System	System Cost per Hour	Hours per Acre		Acres per 8-hour Day		System Cost per Acre	
		Low	High	Low	High	Low	High
ATV with Forwarding Arch	$ 23.89	32	50	0.2	0.3	$ 756	$ 1,194
CTL (Timberjack)	$228.13	3	5	1.7	2.5	$ 675	$ 944
CTL (Kobelco, Timberjack)	$184.78	6	8	1.0	1.3	$ 799	$ 999
ASV (cut and skid, 2 machines)	$ 92.37	8	9	0.9	1.0	$ 493	$ 677
ASV (cut, skid, and masticate, 1 machine)	$ 46.18	14	19	0.4	0.6	$ 640	$ 899
Yarder – Government	$42.98	24	38	0.2	0.3	$ 1,044	$ 1,624
Yarder - Contractor	$194.39	10	13	0.6	0.8	$ 1,866	$ 2,489
Fecon (ASV-mounted)	$ 54.07						
Fecon (excavator-mounted)	$ 68.69	6	10	0.8	1.3	$ 440	$ 659
Fecon (RT400-mounted)	$ 90.46	6	10	0.8	1.3	$ 579	$ 868
Unnamed Mastication System	$ 67.33	6	13	0.6	1.3	$ 431	$ 862
Promac	$ 68.69	5	8	1.0	1.7	$ 330	$ 550
Nordstrom	$125.84	3	6	1.3	2.5	$ 403	$ 805
Bandit (with harvester and rubber-tired skidder)	$248.34	2	3	2.5	3.3	$ 428	$ 672
Spyder	$ 85.40	6	8	1.0	1.3	$ 547	$ 683
Hakmet (Arbro Strokharvester and Merri Crusher)	$136.08	14	26	0.3	0.6	$ 1,265	$ 2,094

The following table (Figure 33) lists advantages and disadvantages of each of the systems demonstrated during the four field trials. When the same or similar systems were demonstrated at more than one site, comments have been grouped and generalized.

While no one system works better than any other system in all aspects, there are advantages and disadvantages to each. For example, mastication systems that use knives

(Promac, Spyder) may be faster in dealing with smaller material (i.e. trees less than three-inches DBH) while the mastication system with fixed teeth on a rotating wheel (Nordstrom, Unnamed Mastication System) may be faster and more efficient when it comes to treating larger diameter material (i.e. trees greater than six inches in diameter). Additionally, the location and position of material may also dictate the most appropriate system. For example, if the goal is to treat biomass that is already on the ground, it may be most prudent to use a mastication system with a horizontal drum (Fecon, Merri Crusher) as opposed to a head mounted on the end of an excavator boom (Nordstrom, Unnamed Mastication System, Spyder, Promac).

Treatment goals for a particular stand will most likely dictate whether an extractive system or a system that treats biomass in the woods would be the most appropriate. Obviously, if some of the material that is to be treated were merchantable, an extractive system would be preferable in order to help offset the costs of treatment as well as to meet local economic development and community stability goals.

Systems could be easily combined. For example, an extractive system could be followed up by a mastication system to treat slash and small stems not removed by the extractive system.

Figure 33: System Advantages and Disadvantages

System	Advantages	Disadvantages
ATV with Forwarding Arch	▪ Low initial cost ▪ Low ground impact ▪ Minimal disturbance to residual stand, neighbors, recreationists, etc.	▪ Low production rates ▪ Not applicable to landscape-scale treatment of fuels ▪ Operators are not protected by safety structures (ROPS, FOPS), so ATV operators are limited to owner/operators
CTL	▪ High production rates ▪ Easily handles small diameter stems ▪ Operator is enclosed in a protected cab ▪ Worked well in over-the-snow conditions, lengthening the potential operating season	▪ Relatively high initial investment ▪ High treatment cost (cost per acre) if no merchantable volume is removed ▪ Residual slash can contribute to post-treatment fuel load

System	Advantages	Disadvantages
ASV	▪ Low ground pressure ▪ Versatile – can be used with a number of attachments	▪ Relatively high initial investment ▪ Low production rate ▪ Can cause soil disturbance while turning (operator dependant) ▪ Ergonomic concerns for the operator ▪ Limited to relatively flat, even terrain, had difficulty in deep (1-3 feet) snow ▪ Not a purpose-built forest machine ▪ Rocky soils may cause excessive track wear
Steep Slope Cable Yarder	▪ Able to work in steep terrain inaccessible to ground-based equipment ▪ Removes biomass from the forest ▪ Can fully suspend loads meaning little to no ground disturbance ▪ Yarding distances up to 2000 feet	▪ Relatively high system cost ▪ In most cases manual felling is required, exposing workers to increased danger as compared with mechanical felling ▪ Requires a relatively large crew to operate ▪ Requires an understanding of cable system dynamics ▪ Concern for how to dispose of non-merchantable material once it reaches a landing
Fecon	▪ High production rate ▪ Can handle both brush and small trees ▪ Leaves non-merchantable material in the woods ▪ Operator is inside an enclosed cab ▪ Can be mounted on nearly any excavator or rigid carrier, potentially utilizing a contractors excess capacity ▪ Little soil disturbance in dry conditions (machine can be confined to designated trails) and virtually no soil disturbance in over-the-snow conditions	▪ Relatively high initial investment ▪ Capable of high levels of soil disturbance if the operator chooses to mulch material into the soil ▪ Depending on the prime mover, Fecon head may have less ability to maneuver in tight stands

System	Advantages	Disadvantages
Unnamed Mastication System	▪ High production rate ▪ Can handle both brush and small to medium-sized trees ▪ Leaves non-merchantable material in the woods ▪ Operator is inside an enclosed cab ▪ Can be mounted on nearly any excavator, potentially utilizing a contractors excess capacity ▪ Little soil disturbance in dry conditions (machine can be confined to designated trails) and virtually no soil disturbance in over-the-snow conditions ▪ This machine has a reach of thirty-feet, allowing a large area to be treated from fewer trails	▪ Relatively high initial investment ▪ Can throw material up to 300 feet, producing a potential safety concern for personnel on the ground
Promac	▪ High production rate ▪ Can handle both brush and small trees ▪ Leaves non-merchantable material in the woods ▪ Operator is inside an enclosed cab ▪ Can be mounted on nearly any excavator, potentially utilizing a contractors excess capacity ▪ Little soil disturbance in dry conditions (machine can be confined to designated trails) and virtually no soil disturbance in over-the-snow conditions	▪ Relatively high initial investment ▪ Can throw chips up to 300 feet, producing a potential safety concern for personnel on the ground

System	Advantages	Disadvantages
Nordstrom Mechanical Brush Cutter	▪ High production rate ▪ Can handle both brush and small to medium-sized trees ▪ Leaves non-merchantable material in the woods ▪ Operator is inside an enclosed cab ▪ Little soil disturbance in dry conditions (machine can be confined to designated trails) and virtually no soil disturbance in over-the-snow conditions ▪ Prime mover is a purpose-built forest machine so is able to handle a wider variety of terrain as compared to a standard excavator ▪ The addition of a power plant to specifically power the mastication head allows an increase in productive capacity	▪ High initial investment ▪ Can throw chips up to 300 feet, producing a potential safety concern for personnel on the ground
Bandit Whole-Tree Chipper	▪ Can operate in a forest stand as opposed to being limited to road-side operation only ▪ Quickly reduces large diameter stems to chips ▪ Relatively compact in size ▪ Purpose-built to travel through a forest stand ▪ Maneuverable	▪ Relatively high initial investment ▪ Requires a felling operation separate from the chipper which has the potential to increase per acre costs ▪ No variation in chip sizes ▪ Machine components may not be guarded well enough for consistent in-woods use

System	Advantages	Disadvantages
Spyder	▪ Capable of working in steep terrain ▪ May prove to be useful in working around sensitive areas such as streams and wetlands ▪ Can handle both brush and small trees ▪ Leaves non-merchantable material in the woods ▪ Operator is inside an enclosed cab ▪ Little soil disturbance in dry conditions (machine can be confined to designated trails)	▪ Relatively high initial cost ▪ Relatively low production rate ▪ Limited power to the mastication head means that the Spyder is limited in the size of material that can be handled practically ▪ Can throw chips up to 300 feet, producing a potential safety concern for personnel on the ground
Hakmet Arbro Strokharvester	▪ As compared to other mechanized equipment, relatively low initial investment ▪ Easily handles small diameter stems ▪ Operator is enclosed in a protected cab ▪ Can be attached to nearly any small excavator ▪ Requires only a low-flow hydraulic system ▪ Small and maneuverable ▪ Low ground impact	▪ Relatively low production
Hakmet Merri Crusher	▪ Versatile – can be mounted on nearly any farm tractor or construction equipment	▪ Capable of high levels of soil disturbance if the operator chooses to mulch material into the soil

As seen in Figure 33, each system has both advantages and disadvantages, and no one system is clearly better than another. The choice of a preferred system must be site specific and matched to the goals and objectives for the treatment under consideration. Each system demonstrated has the ability to treat non-merchantable fuels, and not cause excessive damage to the residual stand or soils as long as it is matched with the right conditions.

Summary, Implications, and Recommendations

Summary

Mechanized fuels treatment trials were conducted during the winter and late spring of 2002 in two locations in Oregon (Central Oregon February 12-16, 2002 and Blue Mountains June 4-7, 2002), one location in Washington (Okanogan-Wenatchee National Forests February 26- March 1, 2002), and one location in Idaho (Boise National Forest May 28-31, 2002). All locations represented different dry forest management challenges. A total of approximately 510 people attended the four trials and 15 equipment systems were demonstrated.

A variety of equipment was demonstrated, broadly grouped into extractive systems that remove fuels material from the woods, and mastication systems that treat fuels in the woods. Both types of systems consisted of conventional equipment, small-scale equipment designed specifically to deal with small-diameter material, and systems designed specifically for fuel reduction. Production rate estimates ranged from as low as 0.2 acres per day (ATV with Forwarding Arch and steep-slope cable yarder using inmate forestry work program) to as high as 3.3 acres per day (Bandit Whole-Tree Chipper with feller-buncher and rubber tired grapple skidder) but in general were between 0.5 and 1.5 acres per day. These production rates created production costs that ranged from a low of $330 per acre (Promac) to a high of $2,489 per acre (downhill steep-slope cable yarder). The majority of the extractive systems ranged from $500 to $1000 per acre while the mastication system ranged in cost from $400 to $850 per acre.

The majority of systems created negligible soil impacts (Steve Howes, Personal Communication). The exception would be the Fecon system demonstrated at the Idaho City trial, where the operator's goal was to incorporate mulched biomass into the soil.

The systems demonstrated created three important changes in the structure of the stands following treatment: 1) Canopy base height was raised, thereby improving the stands resistance to initiation of passive or active crown fire in the future as these stands progress through time; 2) Basal area was reduced, which improves stand resiliency to disturbances such as drought, insects, diseases, and fire; and 3) Average height of the stand was increased, without a significant increase in fuel bed depth in a majority of the treatments.

Implications

This project presented a number of different options for dealing with non-merchantable fuels. These options allow a land manager to match a system with the specific goals and objectives of a fuel treatment prescription.

The results from the two over-the-snow trials emphasized that winter fuel reduction operations are an option for many land managers. Benefits from winter operations include:

- Working over snow and over frozen ground virtually eliminated soil impacts when measured with the visual criteria used here.
- The ability to extend the operating season allows owning costs to be spread out over a longer period of time, reducing a contractor's per hour cost, thereby reducing treatment costs.

The only disadvantages to over-the-snow operations observed were that travel and positioning times were increased as compared to operations not over the snow. The impact of snow on mobility will vary from system to system. Additionally, residual stump height may be an issue if snow depths are too great.

It was found that, in general, extractive systems tended to be more expensive on a per acre basis than non-extractive systems (mastication). However, this is assuming that no merchantable material from the extractive systems is being utilized to offset treatment costs. Systems need to be matched with not only the appropriate stand conditions, but also the appropriate market (economic) conditions.

All of the fuel reduction systems demonstrated are in current use across the Western United States, yet little data is publicly available to help managers and contractors decide on appropriate systems. This means that: 1) More data needs to be generated concerning these systems, their impacts, and their costs; and 2) Data that is available needs to be better disseminated to those who can use it, namely forest contractors and land managers.

Recommendations

Subsequent trials are needed to gather more representative samples of production data in realistic settings. Most of the data sets generated during these trials had from five to 20 observations. This is far too few observations over too narrow a range of operating conditions to have a significant level of confidence in the resulting production estimates. Additionally, because accepted costing methods do not adequately capture the true owning and operating costs of many of the systems of equipment demonstrated, data sufficient to provide these estimates needs to be collected over longer periods of time than were available to the DFMT.

Discussions with fire ecologists and others during the public presentations of findings indicate that the fire behavior model used (FMAPlus) may not be appropriate for modeling fire responses to mechanical treatments. Most fire behavior models are based on natural fuels and/or logging slash. Properties of fuels after mechanical treatments such as mastication are different from this natural slash. The applicability of FMAPlus and other available fire behavior models to model the effects of mechanical treatments needs to be further studied.

Also, more participation from regulatory agencies and citizens groups would help to make similar demonstrations more meaningful. This participation should be included in planning, implementation, and review.

A specific list of recommendations generated after each of the field trials can be found in Appendix I.

Future Work

We suggest the following be taken into consideration when planning future equipment trials and research surrounding mechanical fuel reduction:

- One day was not enough to collect adequate machine production information. It is suggested that at least one week be set aside to gather this information.
- Operators were reluctant to show up for a whole day of work prior to the public days to facilitate time and motion study data collection. This was not unexpected

as all machine and operator time was donated. Therefore, a financial incentive should be provided to offset vendor's time and expenses.

- Consider including monitoring and reporting requirements for actual fuel reduction contracts. This will be the only way to obtain and publicize reliable production data.
- Flat ground away from streams is easy. Consider trials on steep slopes not accessible to standard ground-based equipment as well as in sensitive areas, such as riparian management zones.
- Pre- and post-treatment sampling should use the same treatment locations with established photo points.

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Appendix A: Steering Committee

Name		Position/Company
Jamie	Barbour	USFS PNW Research Station
Beth	Coulter	The Yankee Group
Keith	Coulter	The Yankee Group
Carl	Davis	Soil Scientist Okanogan-Wenatchee NFs
Cindy	Glick	Central Oregon Site Liaison
Richy	Harrod	Okanogan-Wenatchee NFs Site Liaison
Steve	Howes	USFS Soils Program Mgr. WA/OR
Roger	Jackson	Idaho City Contractor Representative
Greer	Kelly	Crown Pacific
Tad	Mason	TSS Consultants
Jim	McIver	Research Ecologist
Scott	Melcher	Sisters Industry Representative - Melcher Logging
Glen	Murphy	Oregon State University - Forest Engineering
Mark	Nechodom	PSW Sierra Nevada Research Center
Bob	Powers	USFS R5 Soils
Ken	Rockwell	Blue Mountain Site Liaison
Leonard	Roeber	Idaho City Site Liaison
Bob	Rummer	USFS Southern Research Station
Ron	Simon	Okanogan-Wenatchee Contractor Representative, Longview Fibre Co.
Andrew	Spreadborough	Contract Coordinator, COIC
Rex	Storm	Associated Oregon Loggers - Forest Policy Analyst
Larry	Swan	USFS Grand Poobah Winema NF
Rick	Toupin	USFS Logging Engineer WA/OR
Keith	Windell	USFS Missoula Technology and Development Center

Appendix B: Similar Studies in Progress

The following list of studies in progress has been compiled from personal communication and the following web sources:

- www.fs.fed.us/fmsc/sdu
- http://www.nifc.gov/joint_fire_sci/
- http://www.fireplan.gov/

Project Name	Brief Description	Funding Agency	Contact
Performance of a Small Scale Harvester	Production study of a small-scale harvester and comparison with conventional hand piling methods to reduce fuel loadings	US Forest Service Southern Research Station	Robert Rummer, rrummer@fs.fed.us
Medicine Bow-Routt Small-Wood Harvesting Systems	Demonstration and production study of several small-scale harvesting systems to treat small diameter fuels	US Forest Service Southern Research Station	Robert Rummer, USFS, Southern Research Station, rrummer@fs.fed.us
A National Study of the Economic Impacts of Biomass Removals to Mitigate Wildfire Damages on Federal, State, and Private Lands	Evaluation of the economic consequences of introducing biomass removals into wood products markets	Joint Fire Sciences	Jefferey Prestemon, USFS, Southern Research Station, jprestemon@fs.fed.us
Financial Analysis and Processing Options for Hazardous Fuel Reduction Integrated with Silviculture, Harvesting, and Evaluation of Business Opportunities	Define additional wood characteristics that are important in determining the economic success of various fuels mitigation treatments	National Fire Plan	Jamie Barbour and Roger Fight, PNW Research Station, jbarbour01@fs.fed.us and rfight@fs.fed.us

Project Name	Brief Description	Funding Agency	Contact
Capacity Building in Fire Management-Related Research	Five fuel reduction strategies will be applied to shrub-dominated sites across northern California	Pacific Southwest Research Station	Robert Powers, USFS, PSW Research Station, rpowers@fs.fed.us
Integrated Fuels Treatment Assessment: Ecological, Economic and Financial Impacts	Evaluate economic, ecological, and financial aspects of alternative fuels treatment options	Joint Fire Sciences	Halely Hesseln, University of Montana, habley@forestry.umt.edu
Assessing the Need, Costs, and Potential Benefits of Prescribed Fire and Mechanical Treatments to Reduce Fire Hazard	Determine the magnitude of hazard reduction treatment needs, treatment costs, and associate benefits at the state level	Joint Fire Sciences	Jamie Barbour, USFS, PNW Research Station, jbarbour@fs.fed.us
Two Demonstration Sites in Northern Arizona for Forest Thinning, Fire Use, and Fire Surrogate Treatments in the Ponderosa Pine Type	Develop two demonstration sites to promote thinning and prescribed fire	Joint Fire Sciences	Edward Smith, The Nature Conservancy, ebsmith@flagstaff.az.us
Using Goats to Prevent or Reduce Wildland Fire Danger in Shrub Dominated, Wildland-Urban Interface Areas	Determine the degree to which goats can modify fuel types and model the resulting fire behavior	Joint Fire Sciences	Allen Rasmussen, Utah State University, allenr@ext.usu.edu
Mechanical Midstory Reduction Treatment: an Alternative to Prescribed Fire	Investigate the effects of using mechanical midstory reduction treatments as an alternative to prescribed fire	Joint Fire Sciences	Robert Rummer, USFS, Southern Research Station, rrummer@fs.fed.us

Project Name	Brief Description	Funding Agency	Contact
Using Cattle as Fuel Reduction and Seeding Agents in Annual and Perennial Grass Stands in the Great Basin	Determine the feasibility of using cattle as fuel reduction and seeding agents in fire management and rehabilitation actions	Joint Fire Sciences	Christopher Call, Utah State University, cacall@cc.usu.edu
Fuels Management and Non-Native Plant Species: an Evaluation of Fire and Fire Surrogate Treatments in Chaparral Plant Community	Evaluate the use of fire surrogate methods to be used in the Whiskeytown National Recreation Area	Joint Fire Sciences	Tim Bradley, National Park Service, tim_Bradley@nps.gov
In-Woods Decision Making of Utilization Opportunities to Lower Costs of Fire Hazard Reduction Treatments	Examine innovative ways to lower costs through the evaluation of in-woods decision-making regarding tree selection, residuals left on site, product suitability, and market opportunities	Joint Fire Sciences	Eini Lowell, USFS, PNW Research Station, elowell@fs.fed.us
The Lick Creek Demonstration – Forest Renewal Through Partial Harvest and Fire	Public demonstration of partial harvest and prescribed fire management techniques	Joint Fire Sciences	Ben Zamora, Washington State University, bzamora@mail.wsue.edu
Fire Hazard Reduction in Ponderosa Pine Plantations	Contrast the efficacy of mechanical and hand methods with and without prescribed burning in reducing fire hazard severity in plantations	Joint Fire Sciences	John Swanson, USFS, Stanislaus NF, jrswanson@fs.fed.us

Appendix C: Sample Communication Plan

Dry Forest Mechanized Fuels Treatment Strategic Communication Plan

The USDA Forest Service is sponsoring forest fuels treatment trials at four locations in three states – Oregon, Washington, and Idaho. It is anticipated that information from this study will significantly aid efforts to pro-actively treat Western states hazardous forest fuels with mechanized equipment.

April 2002
Boise National Forest

DEVELOPMENT AND REVIEW TEAM

Developed by:	David Olson	3/7/02
Reviewed by:		Date
Accepted by:		Date

EXECUTIVE SUMMARY

The Dry Forest Mechanized Fuels Treatment Trials will evaluate mechanical equipment used to treat noncommercial forest biomass for fuels reduction purposes. The project will conduct realistic fuels treatment trials at four locations in three states (Oregon, Washington, and Idaho) and synthesize and disseminate the results.

The trial, instigated by private sector industry, will develop operational and cost information about the equipment available for this type of work. Many studies exist about costs, production and impacts for sawlog and commercial wood chip market harvest systems, but very little information exists for systems intended to treat noncommercial forest biomass.

This communication plan provides a comprehensive framework for actions that will support the successful publicity and involvement for these trials. The goals are to facilitate appropriate media coverage; ensure interested local groups, organizations and contractors can observe the trials and ask questions; and ensure the results reach interested parties and a general audience.

The primary target audience is potential contractors for mechanized fuels reduction work. The goal is to inform them of the trials, engage their interest, encourage their participation, and inform them of the results. They will gain the following:

- More information about fuel treatment technology;
- Capabilities;
- Costs;
- Resource impacts of various equipment; and
- Ability to make more informed business decisions.

Secondary audiences include natural resource agency fuels treatment specialists and managers, forest landowners, non-government organizations involved in small-wood and biomass utilization efforts, and industry associations. The goal is to inform them of the following:

- The trials and the results to increase their knowledge of fuels treatment opportunities;
- Techniques;
- Technology; and
- Concurrent costs and impacts.

Their participation in the trials, while welcome, is not a primary communication goal.

Finally, communication with people interested in natural resource management, in general, will increase their understanding of the complexities of fuel treatment activities.

The communication goals will be achieved using a variety of methods including media releases, tours, industry contacts, public meetings, Internet web-site, and publication of results.

BACKGROUND

Throughout much of the Inland West, concentrations of hazardous forest fuels are placing rural communities, sensitive habitat and entire watersheds at significant risk to catastrophic wildfire events. During the 2000 fire season over 8 million acres of wild lands in the West were impacted by fire. Total fire suppression costs during this record setting fire season exceeded 2 billion dollars.

A primary factor influencing the intensity of these wildfire events is the unnaturally high concentrations of vegetation. As noted in the April 1999 General Accounting Office report (GAO/RCED-99-65) Western Forests: A cohesive Strategy is Needed to Address Catastrophic Wildfire Threats, **"The most extensive and serious problem related to the health of national forests in the interior West is the over-accumulation of vegetation"**

A century of successful fire exclusion efforts have facilitated a serious and unnatural concentration of vegetation - mostly small trees. To contribute to the restoring the health of western forests and reduce the risk of wildfire, these dense stands require treatment. This treatment of non-commercial trees – also know as biomass, is fast becoming the fuel management option of choice for federal land managers throughout the dry forests of the Intermountain West.

Mechanized fuel treatments are one of many different tools used to help restore forest health and reduce the risk of wildfire. Mechanized fuels treatments often work in support of other methods.

While a number of research studies exist regarding the costs, production and site impacts for treatment and removal of commercial material – sawlogs, pulp grade wood chips, etc., very little information exists addressing these same issues for treatment and removal of non-commercial material – biomass. The Dry Forest Mechanized Fuels Treatment Trials (DFMT) project seeks to organize and coordinate realistic fuels treatment trials on four sites in three states. Funds supplied by the US Department of Agriculture, Forest Service – National Fire Plan have been secured to facilitate these trials.

Information from this practical study will be processed, synthesized and distributed to interested natural resource agency personnel, local contractors, media, and other interested parties to aid on the ground efforts in the pro-active treatment of hazardous fuels.

Outlined below is a summary of the DFMT project administrative structure:

- **PRIMARY FUNDING SUPPORT:** USDA Forest Service – National Fire Plan
- **ADMINISTRATION:** Central Oregon Intergovernmental Council
- **IMPLEMENTATION - CONTRACTORS:** TSS Consultants (Rancho Cordova CA) and The Yankee Group (Philomath OR)
- **IMPLEMENTATION – AGENCY PRIMARY SUPPORT:**
  - Deschutes National Forest
  - Okanogan/Wenatchee National Forests
  - Boise National Forest
  - Malhuer National Forest
- **IMPLEMENTATION – AGENCY ADDITIONAL SUPPORT:**
  - Pacific Northwest Research Station
  - Pacific Northwest Regional Office
  - Pacific Southwest Research Station

PROBLEM OR OPPORTUNITY STATEMENT

Problem Statement:

- Throughout much of the Inland West, concentrations of hazardous forest fuels are placing rural communities, sensitive habitat and entire watersheds at significant risk to catastrophic wildfire events. Hazardous fuels include a high concentration of biomass and/or non-commercial trees. (Define – biomass)
- To aid in restoring the health of western forests and reduce the risk of wildfire, this biomass (non-commercial trees) requires treatment. Little information exists addressing treatment and removal of biomass.

Opportunity Statement:

- The USDA Forest Service is sponsoring forest fuels treatment trials at four locations in three states – Oregon, Washington, and Idaho. It is anticipated that information from this study will significantly aid efforts to pro-actively treat hazardous forest fuels, in the West.
- These hazardous fuels projects could potentially contribute additional economic opportunities for rural communities.

GOALS

Successfully demonstrate to private contractors and agency personnel options available to treat the non-commercial trees that will assist with fuel management decisions. This will lead to implementing additional methods that will decrease fire risk and provide economic opportunities to local communities.

OBJECTIVES

Short-term objectives of this project include:

- Improved ability of federal and state agencies to plan and budget for future fuels treatment projects.
- Development of an informed cadre of local fuels treatment contractors.
- Education of the general public (including media, forest landowners, etc.) with regards to fuels treatment opportunities, techniques and latest technology.
- Promotion of cost effective, minimum impact fuels treatment alternatives.

Long-term objectives include:

- Significant increase in the number of acres treated in support of the reduction of fuels and forest health improvement.
- Reduction of site impacts from fuels treatment work.
- Creation of long-term sustainable jobs.
- Promotion of an informed public, one that more fully appreciates the complexities of fuels treatment activities.

AUDIENCES

Key Audiences

- Independent Contractors – Interested in purchasing equipment and or fiber purchasers, small diameter logs, biomass, etc.
- Small Woodland Association – define
- Land Management Agency's – FS, BLM, IDL,
- Other Federal Agency's - NMFS, IDFG, USFWS, RAC, RC&D's, NRCS
- Elected Officials – Federal, State, County
- NGO's - Watershed Councils, Advisory Councils, Wilderness Ranch
- Media and general public

KEY MESSAGES

- **Very little information is available about mechanized systems intended to treat noncommercial forest biomass. Forest contractors need objective information about equipment capabilities, costs and site impacts to make sound business decisions.**
- **The Mechanized Fuels Treatment Trial will improve the ability of land managers to plan and budget for fuel treatment projects, increasing their ability to reduce forest fire risks and improve the health of forest ecosystems.**
- **Information learned from these trials, will help public and private landowners be better equipped to conduct fuel treatments that reduce impacts on other resources and are cost effective for the landowner and the operator.**

- **Mechanized fuel treatments are one of many different tools used to help restore forest health and reduce the risk of wildfire. Mechanized fuels treatments often work in support of other methods.**
- **The Mechanized Fuels Treatment Trial was stimulated by forest contractors who need objective information about equipment capabilities, costs and impacts to make sound business decisions.**

COMMUNICATION STRATEGY

Present demonstration trials for Dry Forest Mechanized Fuels Treatment involving key audiences to present information and results available with the use of various equipment.

TACTICS

Under no circumstances should any official activity identified in this plan be misused to influence Congress. Although the definition of lobbying differs within each statute or regulation, the restrictions generally prohibit contacting or encouraging others to contact federal legislators in an attempt to influence the enactment or modification of legislation or other specified activities. Should any questions arise as to the appropriateness of an activity, Legislative Affairs staff should be contacted prior to conducting the activity.

ACTION PLAN

DATE	ACTIVITY	PURPOSE	RESPONSIBLE PARTIES
3/07/02	Finalize Communication Plan	Meet DFMT objectives	Tad Mason David Olson Leonard Roeber
3/15/02	Send pre-notification fact sheet to key audiences		David Olson
5/6/02	Organize contacts	Assure info reaches T.A. (Target Audiences)	David Olson Leonard Roeber
5/8/02	Issue Press Alert with briefing paper	Provide media with dates of event	David Olson Tad Mason
5/6/02	Make Personal contacts with T.A.	Assure T.A. participation	Tad Mason Leonard Roeber David Olson
5/15/02	Email project announcements	Same	Dave Olson
5/28/02	Issue Press Release	same	Dave Olson
5/29/02	Logger Training Day	same	Shawn Keough Tad Mason Keith Coulter Leonard Roeber David Olson

DATE	ACTIVITY	PURPOSE	RESPONSIBLE PARTIES
5/30/02	Media Days	Facilitate media attendance	David Olson
6/3/02	Evaluate effectiveness of Communication Plan and its implementation	Improve communication effort	Leonard Roeber Tad Mason Larry Swan

Communication Tools/Products

Communica-tion Tool	Prepared By	Independent Contractors	Small Woodland Association	Land Management Agencies	Other Agencies	Elected Officials	Media & Public
Talking Points (key messages)							
News Releases	Dave	X	X	X	X	X	X
Fact Sheet (target audiences)	Tad	X	X		X		X
Website Updates	Beth	X	X	X	X	X	X
Briefing Paper	Dave	X				X	X
Evaluation Form	Tad	X					

Other communication tools include:

Establish a web site or link for each national forest home page showing digital photo's of the equipment and final report results.

EVALUATION

Nominal evaluation

Communication Tool	Completed Tasks
Talking Points	
News Release	
Fact Sheet	
Website updates	
Briefing Paper	
Evaluation Form	
Media Contacts	
Number of web site hits and media spots/articles	

Effectiveness of outcomes evaluation

- Include participant evaluation/feedback
- Attitude change, and opinion change

CONTACTS – COMMUNICATIONS PLAN

- Tad Mason, TSS Consultants, 530-528-2900
- Leonard Roeber, Idaho City Ranger District 208-392-6684
- David Olson, Public Affairs Officer, 208-373-4105
- Beth and Keith Coulter, The Yankee Group 541-929-6173

CONTINGENCY CONSIDERATIONS

- The major variable here is weather.
- Safety considerations – parking, sanitation

REFERENCES

- National Fire Plan – http://www.fireplan.gov/
- GAO Report – "*Western Forests: A Cohesive Strategy is Needed to Address Catastrophic Wildfire Threats*" – *www.*
- Dry Forest Mechanized Fuels Treatment Trials Project website – www.theyankeegroup.com/mechfuels/

Appendix

Intermountain Region 4 Contacts:

- Regional Office Timber, Fire and Public Affairs Staff
- All Idaho Forest Timber and Fire Staff Officers, District Rangers/Forest Supervisors and Public Affairs Officers.
- Research Station

Washington Office:

- George Lennon, Director USFS, Office of Communication
- Ann Bartuska, Director Forest Management
- Tim DeCoster, Director, USFS Legislative Affairs
- Jerry Williams, Director, USFS Fire and Aviation Management
- Harry Croft, Deputy Director, USFS Fire and Aviation Management
- Tim Hartzell, National Fire Plan Coordinator, BLM

Regional Office:
- Media relation specialists
- Technical experts
- Legislative contacts

Industry Contacts:
- Tad Mason 530-528-2900
- Boise Cascade (Boise)
- Evergreen Forest Products - LR
- Idaho Forest Products Commission
- Intermountain Forest Association – DO and TM
- Private contractors selected by Forest/District units
- South Idaho Timber Association
- Ikola Logging,
- Associated Logging Contractors - TM
- Forest Timber/Thinning Bidders List
- American Forest Resources Council – TM
- American Forest and Paper Association - TM

Elected Officials Contacts:
- Federal Congressional Offices
- State Legislative Natural Resource Committee Chairs
- County Commissioners
- Resource Advisory Council Chairpersons and/or Forest Designated Officers

Media Contacts:
- Television Stations – Local, PBS
- Radio Stations AM, FM, NPR
- News Papers.
- Loggers World Pub– TM
- Timber Harvesting Pub– TM
- Timber West Pub - TM

Other Land Management and other agency contacts:
- Boise State University
- Rural Homeowner Association Officers – Wilderness Ranch
- BLM
- USFWS
- NMFS
- USFWS
- Resource Conservation and Development Councils

Local Agencies/Organizations:
- Wilderness Ranch Association
- Local Volunteer Fire Departments

Conservation/Sportsman/Recreation Organizations:

- Rocky Mountain Elk Foundation
- Wild Turkey Federation
- Idaho Conservation League
- The Wilderness Society
- Sierra Club

State Agencies:

- Idaho Department of Lands
- Idaho Department of Fish & Game
- Idaho Forest Products Commission
- Idaho Department of Environmental Quality

Media – Logging Publications:

- Loggers World – TM
- Timber West - TM

Appendix D: Machine Costing

CAT Handbook Costing Method
ATV with Forwarding Arch

Hourly Owning and Operating Cost Estimate						
Machine Designation						ATV with Forwarding Arch
Estimated Ownership Period (Years)						3
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						4800
Owning Costs						
Delivered Price (Including Attachments)						$ 6,500.00
Less Tire Replacement Cost If Desired						$ 200.00
Delivered Price Less Tires						$ 6,300.00
Less Residual Value At Replacement				20%		$ 1,260.00
Value To Be Recovered Through Work						$ 5,040.00
Costs Per Hour						$ 1.05
Interest Cost				10%		$ 0.26
Insurance				2%		$ 0.05
Property Tax				3.4%		$ 0.09
TOTAL HOURLY OWNING COST						$ 1.45
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	0.5		$ 0.63
Lube Oil, Filter, Grease						$ 0.10
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.05	Labor	$ 0.05	$ 0.10	
Tires	Cost	$ 200.00	Life (hours)	2000		$ 0.10
Undercarriage	Impact	0	Abrasiveness	0		
	Z Factor	0	Basic Factor	0		$ -
Repair Reserve	Extended Use Multiplier			0		
	Basic Repair Factor			0		$ 1.00
Special Wear Items	Cost	$ -	Life (hours)		$ -	$ -
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 1.93
Machine Owning and Operating Costs						$ 3.38
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 0.51
Total Hourly Cost						**$ 23.89**

Time per Turn (minutes)		19	30
Time per Acre (hrs) - 100 turns per acre	(20% position and delay)	31.7	50.0
Cost per Acre		**$ 756.39**	**$ 1,194.31**

CAT Handbook Costing Method
Timberjack Harvester

Hourly Owning and Operating Cost Estimate

Machine Designation	Timberjack Harvester
Estimated Ownership Period (Years)	5
Estimated Usage (Hours/Year)	1600
Ownership Usage (Total Hours)	8000

Owning Costs

Delivered Price (Including Attachments)		$ 500,000.00
Less Tire Replacement Cost If Desired		$ 9,000.00
Delivered Price Less Tires		$ 491,000.00
Less Residual Value At Replacement	20%	$ 98,200.00
Value To Be Recovered Through Work		$ 392,800.00
Costs Per Hour		$ 49.10
Interest Cost	10%	$ 18.41
Insurance	2%	$ 3.68
Property Tax	3.4%	$ 6.26
TOTAL HOURLY OWNING COST		$ 77.46

Operating Costs

Fuel	Unit Price	$ 1.25	Consumption	4		$ 5.00
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ 9,000.00	Life (hours)	3000		$ 3.00
Undercarriage	Impact	0	Abrasiveness	0		
	Z Factor	0	Basic Factor	0		$ -
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ -	Life (hours)		$ -	$ -
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 14.20

Machine Owning and Operating Costs		$ 91.66
Operator Hourly Wage		$ 20.00
Profit and Risk	15%	$ 13.75
Total Hourly Cost		**$ 125.40**

Time per Tree (minutes)		0.2	0.3
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	3.2	4.8
Cost per Acre		**$ 401.29**	**$ 601.94**

CAT Handbook Costing Method
Timberjack Forwarder

Hourly Owning and Operating Cost Estimate						
Machine Designation						Timberjack Forwarder
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 375,000.00
Less Tire Replacement Cost If Desired						$ 9,000.00
Delivered Price Less Tires						$ 366,000.00
Less Residual Value At Replacement				20%		$ 73,200.00
Value To Be Recovered Through Work						$ 292,800.00
Costs Per Hour						$ 36.60
Interest Cost				10%		$ 13.73
Insurance				2%		$ 2.75
Property Tax				3.4%		$ 4.67
TOTAL HOURLY OWNING COST						$ 57.74
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	4		$ 5.00
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ 9,000.00	Life (hours)	3000		$ 3.00
Undercarriage	Impact	0	Abrasiveness	0		
	Z Factor	0	Basic Factor	0		$ -
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ -	Life (hours)		$ -	$ -
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 14.20
Machine Owning and Operating Costs						$ 71.94
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 10.79
Total Hourly Cost						**$ 102.73**

Time per turn (minutes)	20	25
Time per Acre (hrs) - 8 turns per acre	2.7	3.3
Cost per Acre	**$ 273.94**	**$ 342.42**

CAT Handbook Costing Method
Kobelco/Keto Harvester

Hourly Owning and Operating Cost Estimate

Machine Designation						Kobelco Harvester with Keto Processing Head
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 250,000.00
Less Tire Replacement Cost If Desired						$ -
Delivered Price Less Tires						$ 250,000.00
Less Residual Value At Replacement				20%		$ 50,000.00
Value To Be Recovered Through Work						$ 200,000.00
Costs Per Hour						$ 25.00
Interest Cost				10%		$ 9.38
Insurance				2%		$ 1.88
Property Tax				3.4%		$ 3.19
TOTAL HOURLY OWNING COST						$ 39.44
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	4.5		$ 5.63
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0.2	Abrasiveness	0.2		
	Z Factor	0.5	Basic Factor	3		$ 2.70
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ -	Life (hours)	1	$ -	$ -
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 14.53
Machine Owning and Operating Costs						$ 53.96
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 8.09
Total Hourly Cost						**$ 82.06**

Time per Tree (minutes)		0.4	0.5
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	6.4	8.0
Cost per Acre		**$ 525.16**	**$ 656.46**

CAT Handbook Costing Method
ASV/Bobcat with Attachment

Hourly Owning and Operating Cost Estimate							
Machine Designation						ASV/Bobcat with Attachment	
Estimated Ownership Period (Years)						5	
Estimated Usage (Hours/Year)						1600	
Ownership Usage (Total Hours)						8000	
Owning Costs							
Delivered Price (Including Attachments)						$ 76,500.00	
Less Tire Replacement Cost If Desired						$ -	
Delivered Price Less Tires						$ 76,500.00	
Less Residual Value At Replacement				20%		$ 15,300.00	
Value To Be Recovered Through Work						$ 61,200.00	
Costs Per Hour						$ 7.65	
Interest Cost				10%		$ 2.87	
Insurance				2%		$ 0.57	
Property Tax				3.4%		$ 0.98	
TOTAL HOURLY OWNING COST						$ 12.07	
Operating Costs							
Fuel	Unit Price	$ 1.25	Consumption	2		$ 2.50	
Lube Oil, Filter, Grease						$ 1.50	
Engine	Unit Price		Consumption		$ -		
Transmission	Unit Price		Consumption		$ -		
Final Drives	Unit Price		Consumption		$ -		
Hydraulics	Unit Price		Consumption		$ -		
Grease	Unit Price		Consumption		$ -		
Filters	Unit Price		Consumption		$ -		
OR							
Quick Estimator Table							
	Materials	$ 0.87	Labor	$0.63	$ 1.50		
Tires	Cost	$ -	Life	0		$ -	
Undercarriage	Impact	0	Abrasiveness	0			
	Z Factor	0	Basic Factor	0		$ -	
Repair Reserve	Extended Use Multiplier			0.4			
	Basic Repair Factor			8		$ 3.20	
Special Wear Items	Cost	$ 3,000.00	Life (hours)	1500	$ 2.00	$ 2.00	
	Cost		Life (hours)				
	Cost		Life (hours)				
	Cost		Life (hours)				
TOTAL HOURLY OPERATING COSTS						$ 10.70	
Machine Owning and Operating Costs						$ 22.77	
Operator Hourly Wage						$ 20.00	
Profit and Risk				15%		$ 3.42	
Total Hourly Cost						**$ 46.18**	
Time per Tree (minutes)						0.2	0.4
Time per Acre (hrs) - 800 stems per acre						2.7	5.3
Cost per Acre (cut)						**$ 123.15**	**$ 246.31**
Time per Tree (minutes)						0.6	0.7
Time per Acre (hrs) - 800 stems per acre						8.0	9.3
Cost per Acre (skid)						**$ 369.46**	**$ 431.04**
Time per Tree (minutes)						0.2	0.3
Time per Acre (hrs) - 800 stems per acre						3.2	4.8
Cost per Acre (masticate)						**$ 147.79**	**$ 221.68**

CAT Handbook Costing Method
Yarder - Government

Hourly Owning and Operating Cost Estimate						
Machine Designation						Yarder
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 130,000.00
Less Tire Replacement Cost If Desired						$ -
Delivered Price Less Tires						$ 130,000.00
Less Residual Value At Replacement				20%		$ 26,000.00
Value To Be Recovered Through Work						$ 104,000.00
Costs Per Hour						$ 13.00
Interest Cost				10%		$ 4.88
Insurance				2%		$ 0.98
Property Tax				3.4%		$ 1.66
TOTAL HOURLY OWNING COST						$ 20.51
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	3		$ 3.75
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0	Abrasiveness	0		
	Z Factor	0	Basic Factor	0		$ -
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ 3,000.00	Life (hours)	1000	$ 3.00	$ 3.00
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 12.95
Machine Owning and Operating Costs						$ 33.46
Operator Hourly Wage (inmate labor program)						$ 4.50
Profit and Risk				15%		$ 5.02
Total Hourly Cost						**$ 42.98**

Time per Turn (minutes)	5.4	8.4
Time per Acre (hrs) - 270 turns per acre	24.3	37.8
Cost per Acre	**$ 1,044.32**	**$ 1,624.50**

CAT Handbook Costing Method
Yarder - Contractor

Hourly Owning and Operating Cost Estimate								
Machine Designation				K-500 Yarder, Eaglet Carriage, KMC Shovel				
Estimated Ownership Period (Years)							5	
Estimated Usage (Hours/Year)							1600	
Ownership Usage (Total Hours)							8000	
Owning Costs								
Delivered Price (Including Attachments)							$ 200,000.00	
Less Tire Replacement Cost If Desired							$ -	
Delivered Price Less Tires							$ 200,000.00	
Less Residual Value At Replacement					20%		$ 40,000.00	
Value To Be Recovered Through Work							$ 160,000.00	
Costs Per Hour							$ 20.00	
Interest Cost					10%		$ 7.50	
Insurance					2%		$ 1.50	
Property Tax					3.4%		$ 2.55	
TOTAL HOURLY OWNING COST							$ 31.55	
Operating Costs								
Fuel		Unit Price	$ 1.25	Consumption	10		$ 12.50	
Lube Oil, Filter, Grease							$ 3.00	
	Engine	Unit Price		Consumption		$ -		
	Transmission	Unit Price		Consumption		$ -		
	Final Drives	Unit Price		Consumption		$ -		
	Hydraulics	Unit Price		Consumption		$ -		
	Grease	Unit Price		Consumption		$ -		
	Filters	Unit Price		Consumption		$ -		
	OR							
	Quick Estimator Table							
		Materials	$ 0.87	Labor	$ 0.63	$ 1.50		
Tires		Cost	$ -	Life	0		$ -	
Undercarriage		Impact	0	Abrasiveness	0			
		Z Factor	0	Basic Factor	0		$ -	
Repair Reserve		Extended Use Multiplier			0.4			
		Basic Repair Factor			8		$ 6.40	
Special Wear Items		Cost	$ 3,000.00	Life (hours)	1000	$ 3.00	$ 3.00	
		Cost		Life (hours)				
		Cost		Life (hours)				
		Cost		Life (hours)				
TOTAL HOURLY OPERATING COSTS							$ 26.40	
Machine Owning and Operating Costs							$ 57.95	
Operator Hourly Wage (crew of 6)							$ 120.00	
Profit and Risk					15%		$ 8.69	
Total Hourly Cost							**$ 186.64**	
Time per Turn (minutes)							3	4
Time per Acre (hrs) - 200 turns per acre							10.0	13.3
Cost per Acre							**$ 1,866.43**	**$ 2,488.57**

CAT Handbook Costing Method
Fecon on ASV

Hourly Owning and Operating Cost Estimate

Machine Designation						Fecon Bullhog mounted on an ASV
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000

Owning Costs

Delivered Price (Including Attachments)						$ 120,000.00
Less Tire Replacement Cost If Desired						$ -
Delivered Price Less Tires						$ 120,000.00
Less Residual Value At Replacement				20%		$ 24,000.00
Value To Be Recovered Through Work						$ 96,000.00
Costs Per Hour						$ 12.00
Interest Cost				10%		$ 4.50
Insurance				2%		$ 0.90
Property Tax				3.4%		$ 1.53
TOTAL HOURLY OWNING COST						$ 18.93

Operating Costs

Fuel	Unit Price	$ 1.25	Consumption	2		$ 2.50
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0	Abrasiveness	0		
	Z Factor	0	Basic Factor	0		$ -
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ 3,000.00	Life (hours)	1500	$ 2.00	$ 2.00
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 10.70

Machine Owning and Operating Costs		$ 29.63
Operator Hourly Wage		$ 20.00
Profit and Risk	15%	$ 4.44
Total Hourly Cost		**$ 54.07**
Time per Tree (minutes)		0
Time per Acre (hrs) - 800 stems per acre		0.0
Cost per Acre		**$ -**

CAT Handbook Costing Method
Fecon on Excavator

Hourly Owning and Operating Cost Estimate

Machine Designation	Fecon Bullhog mounted on an Excavator
Estimated Ownership Period (Years)	5
Estimated Usage (Hours/Year)	1600
Ownership Usage (Total Hours)	8000

Owning Costs

Delivered Price (Including Attachments)		$ 170,000.00
Less Tire Replacement Cost If Desired		$ -
Delivered Price Less Tires		$ 170,000.00
Less Residual Value At Replacement	20%	$ 34,000.00
Value To Be Recovered Through Work		$ 136,000.00
Costs Per Hour		$ 17.00
Interest Cost	10%	$ 6.38
Insurance	2%	$ 1.28
Property Tax	3.4%	$ 2.17
TOTAL HOURLY OWNING COST		$ 26.82

Operating Costs

Fuel	Unit Price	$ 1.25	Consumption	4.5		$ 5.63
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0.2	Abrasiveness	0.2		
	Z Factor	0.5	Basic Factor	3		$ 2.70
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ 150.00	Life (hours)	150	$ 1.00	$ 1.00
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 15.53

Machine Owning and Operating Costs		$ 42.34	
Operator Hourly Wage		$ 20.00	
Profit and Risk	15%	$ 6.35	
Total Hourly Cost		**$ 68.69**	
Time per Tree (minutes)		0.4	0.6
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	6.4	9.6
Cost per Acre		**$ 439.64**	**$ 659.46**

CAT Handbook Costing Method
Fecon on RT400

Hourly Owning and Operating Cost Estimate

Machine Designation						Fecon Bullhog mounted on an RT400
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 290,000.00
Less Tire Replacement Cost If Desired						$ -
Delivered Price Less Tires						$ 290,000.00
Less Residual Value At Replacement				20%		$ 58,000.00
Value To Be Recovered Through Work						$ 232,000.00
Costs Per Hour						$ 29.00
Interest Cost				10%		$ 10.88
Insurance				2%		$ 2.18
Property Tax				3.4%		$ 3.70
TOTAL HOURLY OWNING COST						$ 45.75
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	4.5		$ 5.63
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0.2	Abrasiveness	0.2		
	Z Factor	0.5	Basic Factor	3		$ 2.70
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ 150.00	Life (hours)	150	$ 1.00	$ 1.00
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 15.53
Machine Owning and Operating Costs						$ 61.27
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 9.19
Total Hourly Cost						**$ 90.46**

Time per Tree (minutes)		0.4	0.6
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	6.4	9.6
Cost per Acre		**$ 578.97**	**$ 868.45**

CAT Handbook Costing Method
Unnamed Mastication System

Hourly Owning and Operating Cost Estimate

Machine Designation		Unnamed Mastication System mounted on an excavator				
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 162,500.00
Less Tire Replacement Cost If Desired						$ -
Delivered Price Less Tires						$ 162,500.00
Less Residual Value At Replacement				20%		$ 32,500.00
Value To Be Recovered Through Work						$ 130,000.00
Costs Per Hour						$ 16.25
Interest Cost				10%		$ 6.09
Insurance				2%		$ 1.22
Property Tax				3.4%		$ 2.07
TOTAL HOURLY OWNING COST						$ 25.63
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	4.5		$ 5.63
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0.2	Abrasiveness	0.2		
	Z Factor	0.5	Basic Factor	3		$ 2.70
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ 10,000.00	Life (hours)	10000	$ 1.00	$ 1.00
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 15.53
Machine Owning and Operating Costs						$ 41.16
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 6.17
Total Hourly Cost						**$ 67.33**

Time per Tree (minutes)		0.4	0.8
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	6.4	12.8
Cost per Acre		**$ 430.93**	**$ 861.87**

CAT Handbook Costing Method
Promac

Hourly Owning and Operating Cost Estimate

Machine Designation	Promac 52 Brush Cutting Head mounted on an excavator					
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 170,000.00
Less Tire Replacement Cost If Desired						$ -
Delivered Price Less Tires						$ 170,000.00
Less Residual Value At Replacement				20%		$ 34,000.00
Value To Be Recovered Through Work						$ 136,000.00
Costs Per Hour						$ 17.00
Interest Cost				10%		$ 6.38
Insurance				2%		$ 1.28
Property Tax				3.4%		$ 2.17
TOTAL HOURLY OWNING COST						$ 26.82
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	4.5		$ 5.63
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0.2	Abrasiveness	0.2		
	Z Factor	0.5	Basic Factor	3		$ 2.70
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ 10,000.00	Life (hours)	10000	$ 1.00	$ 1.00
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 15.53
Machine Owning and Operating Costs						$ 42.34
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 6.35
Total Hourly Cost						**$ 68.69**

Time per Tree (minutes)		0.3	0.5
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	4.8	8.0
Cost per Acre		**$ 329.73**	**$ 549.55**

CAT Handbook Costing Method
Nordstrom

Hourly Owning and Operating Cost Estimate

Machine Designation			Nordstrom Mechanical Brushcutter, Cat 322L		
Estimated Ownership Period (Years)					5
Estimated Usage (Hours/Year)					1600
Ownership Usage (Total Hours)					8000
Owning Costs					
Delivered Price (Including Attachments)					$ 485,000.00
Less Tire Replacement Cost If Desired					$ -
Delivered Price Less Tires					$ 485,000.00
Less Residual Value At Replacement			20%		$ 97,000.00
Value To Be Recovered Through Work					$ 388,000.00
Costs Per Hour					$ 48.50
Interest Cost			10%		$ 18.19
Insurance			2%		$ 3.64
Property Tax			3.4%		$ 6.18
TOTAL HOURLY OWNING COST					$ 76.51

Operating Costs

Fuel	Unit Price	$ 1.25	Consumption	4.5		$ 5.63
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0.2	Abrasiveness	0.2		
	Z Factor	0.5	Basic Factor	3		$ 2.70
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ 150.00	Life (hours)	150	$ 1.00	$ 1.00
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 15.53

Machine Owning and Operating Costs		$ 92.03
Operator Hourly Wage		$ 20.00
Profit and Risk	15%	$ 13.81
Total Hourly Cost		**$ 125.84**

Time per Tree (minutes)		0.2	0.4
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	3.2	6.4
Cost per Acre		**$ 402.68**	**$ 805.37**

CAT Handbook Costing Method
Bandit

Hourly Owning and Operating Cost Estimate						
Machine Designation						Bandit Whole-Tree Chipper
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 270,000.00
Less Tire Replacement Cost If Desired						$ -
Delivered Price Less Tires						$ 270,000.00
Less Residual Value At Replacement				20%		$ 54,000.00
Value To Be Recovered Through Work						$ 216,000.00
Costs Per Hour						$ 27.00
Interest Cost				10%		$ 10.13
Insurance				2%		$ 2.03
Property Tax				3.4%		$ 3.44
TOTAL HOURLY OWNING COST						$ 42.59
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	4.5		$ 5.63
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0.2	Abrasiveness	0.2		
	Z Factor	0.5	Basic Factor	3		$ 2.70
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ 150.00	Life (hours)	150	$ 1.00	$ 1.00
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 15.53
Machine Owning and Operating Costs						$ 58.12
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 8.72
Total Hourly Cost						**$ 86.84**

Time per Tree (minutes)		0.1	0.2
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	1.6	3.2
Cost per Acre		**$ 138.94**	**$ 277.87**

CAT Handbook Costing Method
Feller-Buncher

Hourly Owning and Operating Cost Estimate						
Machine Designation						Feller-Buncher
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 350,000.00
Less Tire Replacement Cost If Desired						$ -
Delivered Price Less Tires						$ 350,000.00
Less Residual Value At Replacement				20%		$ 70,000.00
Value To Be Recovered Through Work						$ 280,000.00
Costs Per Hour						$ 35.00
Interest Cost				10%		$ 13.13
Insurance				2%		$ 2.63
Property Tax				3.4%		$ 4.46
TOTAL HOURLY OWNING COST						$ 55.21
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	4.5		$ 5.63
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0.2	Abrasiveness	0.2		
	Z Factor	0.5	Basic Factor	3		$ 2.70
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ -	Life (hours)	1	$ -	$ -
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 14.53
Machine Owning and Operating Costs						$ 69.74
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 10.46
Total Hourly Cost						**$ 100.20**

Time per Tree (minutes)		0.15	0.2
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	2.4	3.2
Cost per Acre		**$ 240.48**	**$ 320.63**

CAT Handbook Costing Method
Rubber-Tired Skidder

Hourly Owning and Operating Cost Estimate

Machine Designation						Rubber-Tired Skidder
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 150,000.00
Less Tire Replacement Cost If Desired						$ 6,000.00
Delivered Price Less Tires						$ 144,000.00
Less Residual Value At Replacement				20%		$ 28,800.00
Value To Be Recovered Through Work						$ 115,200.00
Costs Per Hour						$ 14.40
Interest Cost				10%		$ 5.40
Insurance				2%		$ 1.08
Property Tax				3.4%		$ 1.84
TOTAL HOURLY OWNING COST						$ 22.72
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	4		$ 5.00
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ 6,000.00	Life (hours)	3000		$ 2.00
Undercarriage	Impact	0	Abrasiveness	0		
	Z Factor	0	Basic Factor	0		$ -
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ -	Life (hours)		$ -	$ -
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 13.20
Machine Owning and Operating Costs						$ 35.92
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 5.39
Total Hourly Cost						**$ 61.30**

Time per turn (minutes)		0.4	0.6
Time per Acre (hrs) - 100 turns per acre	(20% position and delay)	0.8	1.2
Cost per Acre		**$ 49.04**	**$ 73.56**

CAT Handbook Costing Method
Kaiser Spyder

Hourly Owning and Operating Cost Estimate						
Machine Designation						Kaiser Spyder
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 290,000.00
Less Tire Replacement Cost If Desired						$ 1,000.00
Delivered Price Less Tires						$ 289,000.00
Less Residual Value At Replacement				20%		$ 57,800.00
Value To Be Recovered Through Work						$ 231,200.00
Costs Per Hour						$ 28.90
Interest Cost				10%		$ 10.84
Insurance				2%		$ 2.17
Property Tax				3.4%		$ 3.68
TOTAL HOURLY OWNING COST						$ 45.59
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	3		$ 3.75
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ 1,000.00	Life (hours)	3000		$ 0.33
Undercarriage	Impact	0	Abrasiveness	0		
	Z Factor	0	Basic Factor	0		$ -
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ 150.00	Life (hours)	150	$ 1.00	$ 1.00
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 11.28
Machine Owning and Operating Costs						$ 56.87
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 8.53
Total Hourly Cost						**$ 85.40**

Time per Tree (minutes)		0.4	0.5
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	6.4	8.0
Cost per Acre		**$ 546.59**	**$ 683.23**

CAT Handbook Costing Method
Hakmet Arbro Strokharvester

Hourly Owning and Operating Cost Estimate						
Machine Designation		Hakmet Arbro Strokharvester mounted				on an Excavator
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 85,000.00
Less Tire Replacement Cost If Desired						$ -
Delivered Price Less Tires						$ 85,000.00
Less Residual Value At Replacement				20%		$ 17,000.00
Value To Be Recovered Through Work						$ 68,000.00
Costs Per Hour						$ 8.50
Interest Cost				10%		$ 3.19
Insurance				2%		$ 0.64
Property Tax				3.4%		$ 1.08
TOTAL HOURLY OWNING COST						$ 13.41
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	2.5		$ 3.13
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0.2	Abrasiveness	0.2		
	Z Factor	0.5	Basic Factor	3		$ 2.70
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ -	Life (hours)	1	$ -	$ -
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 12.03
Machine Owning and Operating Costs						$ 25.43
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 3.82
Total Hourly Cost						**$ 49.25**

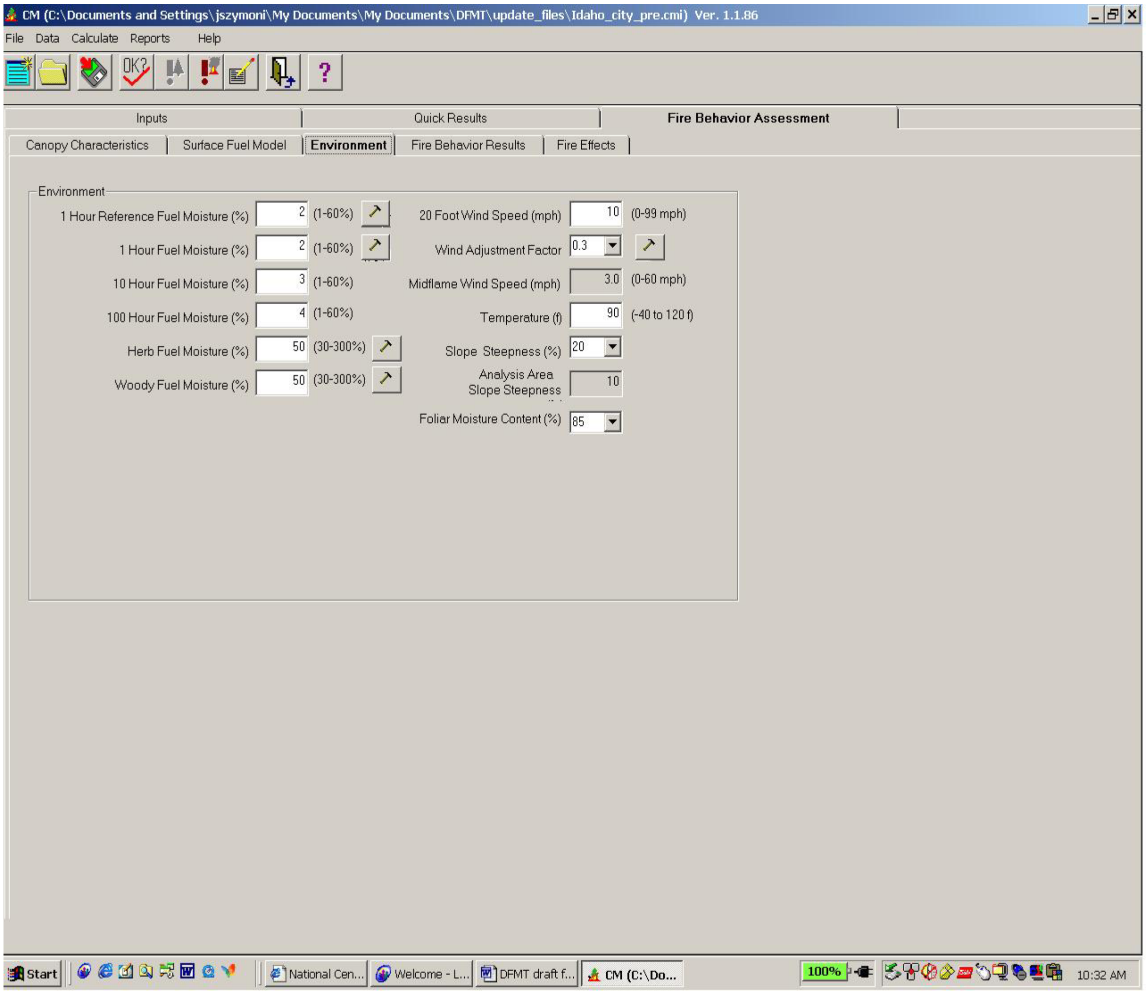
Time per Tree (minutes)		0.9	1.6
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	14.4	25.6
Cost per Acre		**$ 709.18**	**$ 1,260.77**

Hakmet Merri Crusher

Hourly Owning and Operating Cost Estimate						
Machine Designation			Hakmet Merri Crusher mounted on crawler tractor			
Estimated Ownership Period (Years)						5
Estimated Usage (Hours/Year)						1600
Ownership Usage (Total Hours)						8000
Owning Costs						
Delivered Price (Including Attachments)						$ 270,000.00
Less Tire Replacement Cost If Desired						$ -
Delivered Price Less Tires						$ 270,000.00
Less Residual Value At Replacement				20%		$ 54,000.00
Value To Be Recovered Through Work						$ 216,000.00
Costs Per Hour						$ 27.00
Interest Cost				10%		$ 10.13
Insurance				2%		$ 2.03
Property Tax				3.4%		$ 3.44
TOTAL HOURLY OWNING COST						$ 42.59
Operating Costs						
Fuel	Unit Price	$ 1.25	Consumption	4.5		$ 5.63
Lube Oil, Filter, Grease						$ 1.50
Engine	Unit Price		Consumption		$ -	
Transmission	Unit Price		Consumption		$ -	
Final Drives	Unit Price		Consumption		$ -	
Hydraulics	Unit Price		Consumption		$ -	
Grease	Unit Price		Consumption		$ -	
Filters	Unit Price		Consumption		$ -	
OR						
Quick Estimator Table						
	Materials	$ 0.87	Labor	$ 0.63	$ 1.50	
Tires	Cost	$ -	Life	0		$ -
Undercarriage	Impact	0.2	Abrasiveness	0.2		
	Z Factor	0.5	Basic Factor	3		$ 2.70
Repair Reserve	Extended Use Multiplier			0.4		
	Basic Repair Factor			8		$ 3.20
Special Wear Items	Cost	$ 150.00	Life (hours)	150	$ 1.00	$ 1.00
	Cost		Life (hours)			
	Cost		Life (hours)			
	Cost		Life (hours)			
TOTAL HOURLY OPERATING COSTS						$ 15.53
Machine Owning and Operating Costs						$ 58.12
Operator Hourly Wage						$ 20.00
Profit and Risk				15%		$ 8.72
Total Hourly Cost						**$ 86.84**

Time per Tree (minutes)		0.4	0.6
Time per Acre (hrs) - 800 stems per acre	(20% position and delay)	6.4	9.6
Cost per Acre		**$ 555.74**	**$ 833.62**

Appendix E: FPMAPlus Environmental Elements



Appendix F: FPMAPlus Fuel Model Descriptions

Fuel Model ID and Description	Total Loading (t/ac)	Fuelbed Depth (ft)	Fuel Loading (tons/ac)					Surface Area to Volume Ratio			Mc Content of Extinction	Heat Content
			1 hr	10 hr	100 hr	Herb	Woody	1 hr	Herb	Woody		
8A Closed timber litter Low	3.51	0.14	1.05	0.70	1.75	0.00	0.00	2000	N/A	N/A	0.30	8000
8M Closed timber - FBPS	5.01	0.20	1.50	1.00	2.50	0.00	0.00	2000	N/A	N/A	0.30	8000
8Z Closed timber litter High	6.51	0.26	1.95	1.30	3.26	0.00	0.00	2000	N/A	N/A	0.30	8000
9A Hardwood (long-needle pine) - Low	2.44	0.14	2.04	0.29	0.11	0.00	0.00	2500	N/A	N/A	.25	8000
9M Hardwood (long-needle pine) FBPS	3.48	.20	2.92	0.41	0.15	0.00	0.00	2500	N/A	N/A	.25	8000
10A Timber (litter and understory) Low	8.41	0.70	2.10	1.40	3.51	0.00	1.40	2000	N/A	1500	.25	8000

Appendix G: Visual Soil Assessment Class Descriptions

Old (Existing) Soil Disturbance:

Class 0	Undisturbed	No evidence of past equipment operation. Soils are undisturbed or considered to be in a natural state.
Class 1	Slight Disturbance	Site is virtually undisturbed. Old litter and duff layers intact. Vegetation present or redeveloping with well established root systems. Some faint impressions of heel tracks or slight depressions evident. Surface soils (A horizons) intact. Surface soil structure unaffected by past equipment operation. No evidence of platiness developing in surface soils.
Class 2	Some Disturbance	Site is virtually undisturbed. Old litter and duff layers intact. Vegetation present or redeveloping with well established root systems. Some visible indications of past equipment operation. Surface soils (A horizons) intact but may show some signs of compaction (i.e. minor amounts or discontinuous platiness at soil surface). No evidence of surface soil removal.
Class 3	Moderate Disturbance	Old litter and duff layer partially intact or missing. New litter layer developing. Vegetation present or redeveloping. Surface soils (A horizons) intact but show evidence of compaction and puddling (surface platiness or lack of structure). Depressions of old wheel tracks evident. Small amounts of surface soil removal.
Class 4	High Disturbance	Old litter land duff layer removed. New litter layer may be redeveloping. Surface soils (A horizons) partially or totally removed or mixed with subsoil material. Evidence of surface soil removal. Some pedestalling at base of trees.
Class 5	Severe Disturbance	Old litter and duff layer removed. New litter layer redeveloping or absent. Evidence of excessive or extreme surface soil removal. Surface soils (A horizon) absent. Subsoils exposed, compacted, or removed.
Class 6	Altered Drainage	Alteration of internal soil drainage characteristics. Results in permanently saturated soils or standing water.

New Soil Disturbance:

Class 0	Undisturbed	No evidence of equipment operation. Soils are undisturbed or are considered to be in a natural state.
Class 1	Slight Disturbance	Site is virtually undisturbed. Litter and duff layers intact. Surface soil (A horizons) intact. Impressions of wheel tracks or slight depressions in surface soils may be present. No exposed surface soils (unless natural). No exposed subsoils.

Class 2	Some Disturbance	Litter and duff layers generally intact. Surface soils (A horizon) intact but may show some evidence of platiness. No evidence of surface soil removal or deposition.
Class 3	Moderate Disturbance	Litter and duff layers only partially intact or missing. Surface soil (A horizons) intact but shows evidence of platiness or lack or structure. Equipment tire tracks or cleat marks evident.
Class 4	High Disturbance	Litter and duff layers totally removed. Surface soils (A horizons) partially removed or may be mixed with subsoil material. Surface soil structure destroyed (large, thick plates instead of granular or crumb structure). Some shiny or slick appearing soil surfaces may be present.
Class 5	Severe Disturbance	Litter and duff layers totally removed. Surface soils (A horizons) nearly all or completely removed. Evidence of topsoil removal and/or gouging. Subsoils partially or totally exposed.
Class 6	Altered Drainage	Alteration of internal soil drainage characteristics by equipment operation. Results in permanently saturated soils or standing water.

Appendix H: In-Kind Contributions

Dry Forest Mechanized Fuels Treatment Trials Project
Matching Funds By Trial

Central Oregon - February 13-16

Vendor	Activity	Hours/Days /Miles	Rate	Subtotal	Total
4-M Fiber					
	Low-boy	8	$ 95.00	$ 760.00	
	Machine Time	3	$ 1,500.00	$ 4,500.00	
	Mileage	480	$ 0.325	$ 156.00	
					$ 5,416.00
Unnamed Mastication System					
	Low-boy	14	$ 65.00	$ 910.00	
	Machine Time	3	$ 1,000.00	$ 3,000.00	
	Support Personnel	9	$ 200.00	$ 1,800.00	
	Mileage	1000	$ 0.325	$ 325.00	
	Meals	16	$ 25.00	$ 400.00	
	Lodging	6	$ 60.00	$ 360.00	
					$ 6,795.00
Forest Service ASV and Skid Steer					
	Machine Time - ASV	3	$ 360.00	$ 1,080.00	
	Machine Time - Skid Steer	3	$ 360.00	$ 1,080.00	
					$ 2,160.00
Future Forestry Products					
	Machine Time	3	$ 280.00	$ 840.00	
	Mileage	400	$ 0.325	$ 130.00	
	Meals	3	$ 25.00	$ 75.00	
	Lodging	3	$ 60.00	$ 180.00	
					$ 1,225.00
Total for Central Oregon					**$ 15,596.00**

Okanogan/Wenatchee, February 26-March 1

Vendor	Activity	Hours/Days /Miles	Rate	Subtotal	Total
Fecon					
	Low-boy	16	$ 95.00	$ 1,520.00	
	Machine Time	3	$ 1,000.00	$ 3,000.00	
	Meals	4	$ 25.00	$ 100.00	
	Lodging	3	$ 80.00	$ 240.00	
					$ 4,860.00
Unnamed Mastication System					
	Low-boy	14	$ 65.00	$ 910.00	
	Machine Time	3	$ 1,000.00	$ 3,000.00	
	Support Personnel	6	$ 200.00	$ 1,200.00	
	Mileage	1000	$ 0.325	$ 325.00	
	Meals	12	$ 25.00	$ 300.00	
	Lodging	6	$ 80.00	$ 480.00	
					$ 6,215.00
Kelly Mountain Contracting					
	Low-boy	10	$ 95.00	$ 950.00	
	Machine Time	3	$ 1,000.00	$ 3,000.00	
	Support Personnel	3	$ 200.00	$ 600.00	
	Mileage	500	$ 0.325	$ 162.50	
	Meals	8	$ 25.00	$ 200.00	
	Lodging	3	$ 80.00	$ 240.00	
					$ 5,152.50
Forest Service ASV					
	Low-boy	14	$ 40.00	$ 560.00	
	Machine Time	3	$ 360.00	$ 1,080.00	
	Meals	4	$ 25.00	$ 100.00	
	Lodging	3	$ 80.00	$ 240.00	
					$ 1,980.00
Total for Okanogan/Wenatchee Trial					**$ 18,207.50**

Idaho City Trial, May 29-31

Vendor	Activity	Hours/Days /Miles	Rate	Subtotal	Total
Unnamed Mastication System					
	Low-boy	20	$ 65.00	$ 1,300.00	
	Machine Time	3	$ 1,000.00	$ 3,000.00	
	Support Personnel	9	$ 200.00	$ 1,800.00	
	Mileage	1000	$ 0.325	$ 325.00	
	Meals	16	$ 25.00	$ 400.00	
	Lodging	6	$ 60.00	$ 360.00	
					$ 7,185.00
Fecon					
	Low-boy	60	$ 95.00	$ 5,700.00	
	Machine Time	3	$ 1,160.00	$ 3,480.00	
	Mileage	500	$ 0.325	$ 162.50	
	Meals	8	$ 25.00	$ 200.00	
	Lodging	3	$ 60.00	$ 180.00	
					$ 9,722.50
C. Richard Nordstrom					
	Low-boy	28	$ 95.00	$ 2,660.00	
	Machine Time	3	$ 1,800.00	$ 5,400.00	
	Support Personnel	6	$ 200.00	$ 1,200.00	
	Mileage	500	$ 0.325	$ 162.50	
	Meals	12	$ 25.00	$ 300.00	
	Lodging	6	$ 60.00	$ 360.00	
					$ 10,082.50
Kemp West					
	Low-boy	20	$ 65.00	$ 1,300.00	
	Machine Time	3	$ 520.00	$ 1,560.00	
	Mileage	500	$ 0.325	$ 162.50	
	Meals	4	$ 25.00	$ 100.00	
	Lodging	3	$ 60.00	$ 180.00	
					$ 3,302.50
Wesspur					
	Low-boy	30	$ 65.00	$ 1,950.00	
	Machine Time	3	$ 800.00	$ 2,400.00	
	Support Personnel	6	$ 200.00	$ 1,200.00	
	Mileage	500	$ 0.325	$ 162.50	
	Meals	12	$ 25.00	$ 300.00	
	Lodging	6	$ 60.00	$ 360.00	
					$ 6,372.50
Total for Idaho City					**$ 36,665.00**

Blue Mountain Trial, June 5-6

Vendor	Activity	Hours/Days /Miles	Rate	Subtotal	Total
Unnamed Mastication System					
	Low-boy	14	$ 65.00	$ 910.00	
	Machine Time	3	$ 1,000.00	$ 3,000.00	
	Support Personnel	9	$ 200.00	$ 1,800.00	
	Mileage	1000	$ 0.325	$ 325.00	
	Meals	16	$ 25.00	$ 400.00	
	Lodging	6	$ 60.00	$ 360.00	
					$ 6,795.00
Future Forestry Products					
	Low-boy	14	$ 35.00	$ 490.00	
	Machine Time	3	$ 280.00	$ 840.00	
	Mileage	700	$ 0.325	$ 227.50	
	Meals	4	$ 25.00	$ 100.00	
	Lodging	3	$ 60.00	$ 180.00	
					$ 1,837.50
Kemp West					
	Low-boy	14	$ 65.00	$ 910.00	
	Machine Time	3	$ 520.00	$ 1,560.00	
	Mileage	700	$ 0.325	$ 227.50	
	Meals	4	$ 25.00	$ 100.00	
	Lodging	3	$ 60.00	$ 180.00	
					$ 2,977.50
Hakmet USA					
	Low-boy - Excavator	10	$ 65.00	$ 650.00	
	Low-boy - Cat	10	$ 65.00	$ 650.00	
	Machine Time – Exc.	3	$ 400.00	$ 1,200.00	
	Machine Time - Cat	3	$ 440.00	$ 1,320.00	
	Mileage - Excavator	500	$ 0.325	$ 162.50	
	Mileage - Cat	700	$ 0.325	$ 227.50	
	Meals	8	$ 25.00	$ 200.00	
	Lodging	3	$ 60.00	$ 180.00	
					$ 4,590.00
Grouse Mountain Tractor					
	Low-boy	3	$ 65.00	$ 195.00	
	Machine Time	3	$ 520.00	$ 1,560.00	
	Mileage	100	$ 0.325	$ 32.50	
	Meals	4	$ 25.00	$ 100.00	
	Lodging	3	$ 60.00	$ 180.00	
					$ 2,067.50
Total for John Day					**$ 18,267.50**
Total for All Trials					**$ 88,736.00**

Appendix I: Specific Recommendations for Future Trials

The following is a list of recommendations for future trials compiled after each of the four field trials:

- Media should have one key contact - the Public Affairs Officer (PAO). We found from the Deschutes trial that this worked very well considering that the Site Liaison (SL) needs to be in the field during the trial and may not be able to address media questions (calls to the office). Close coordination between the SL and the PAO is important.
- Consider inviting high profile public officials (county commissioners, local congressional reps, etc.) to attend the trial. This will not only provide a higher profile, but will also maximize the opportunity to secure media attention. Also consider contacting state and region-wide media.
- Require that trial participants walk (not drive) through the trial site, this keeps congestion to a minimum and allows participants to view operations and pre/post treatment areas up close.
- A tent or gathering structure is helpful to provide cover to the participants and as a central location facilitate sign-in, safety discussions, participant input, etc.
- Make sure that the following duties are assigned daily:
    - Monitor the sign in sheet to assure that legible addresses (preferably email address) are secured from those seeking study results from the trial.
    - Dispatch/First Aid duties – monitor radio traffic to coordinate communications and first aid – safety efforts.
    - Greet incoming participants and interview outgoing participants.
    - Issue hard hats to any participants that need them.
- Acknowledge those (primarily vendors) that volunteered time and expense to carry out the trial. Coordinate with COIC to generate a thank you letter and/or a certificate of appreciation to selected people and organizations.
- Set aside one full day for time and motion studies. During the trials operations are constantly interrupted with visitors, which is as it should be.
- Consider creating a large trial site map to post on an easel or on the tent wall, near the sign in station.
- Post signs at each treatment system explaining what participants are viewing.
- Provide sanitation station(s) (port-a-potties) that are in plain view of the participants.
- Consider using radios to facilitate communication between the implementation team members. This will also allow improved reaction time in case of an emergency.
- Consider supplying coffee or other refreshments.
- At the Okanogan/Wenatchee trial we experienced an equipment fire that appeared to be caused by an equipment failure such as a fuel line leak or hydraulic line failure. Due to quick thinking operators, agency personnel and Keith's masterful snowmobile piloting skills, the fire was brought under control within 15 minutes (4 fire extinguishers were utilized to get the job done). For trials occurring during the fire season it might be prudent to station an engine (500 gal minimum) on site.

- Need to convince the equipment vendors that they must show up on the scheduled date.
- Sending participants out in organized, guided groups worked very well.
- Assign equipment to treatment blocks based upon projected site impacts and ability to treat site-specific fuels.
- Other equipment sponsors (example – OSU extension) need to be involved early in the process of setting up the trial, for example at least 120-day lead.
- Sending participants out in organized, guided groups worked very well.
- Train group facilitators to address the issues that many participants are keyed into – fuels, equipment capabilities, treatment impacts, etc.
- Need to attract more line officer and specialists.
- More specialist – biologist, hydrologist, soils specialist, fisheries biologist, etc. in attendance. Should consider having ID teams attend trial as a group.
- Have RAC's attend as a group. Conduct a RAC field meeting in conjunction with trial.
- USFS members of the implementation team were not clear on the time commitment required to conduct the trial. Need to better define responsibilities and time commitment.
- Attract more Economic Development folks – county EDC, RC+D's, etc.
- Forests should consider developing a comprehensive decision tree that would (target USFS field personnel) facilitate fuels treatment equipment selection based on soils, stand condition, objectives, etc.
- Actively engage local and statewide preservationist group representatives.