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ISF's *Safeguarding Rural Communities: Fire Hazard Reduction and Fuels Utilization*
M. Straka, 2002
http://sustainablehardwoods.net/biomass

III. Utilization

Ultimately the success of fire hazard reduction on a region wide basis will result from the ability of landowners to offset the costs the thinning projects by marketing wood products from their land. This is challenging for small landowners due to the costs of filing harvest plans, which cost thousands of dollars. The undeveloped markets for small-diameter wood also makes the current prospect of paying for fire hazard reduction through selling wood not particularly good, though not impossible.

A multi-year project in Hayfork California finds that "… for a small diameter utilization operation to be technically and economically feasible, it must first be able to rely upon a supply of from 3-6 million board feet of reasonably sound small diameter trees per year".3 This volume level is necessary to maintain 10 – 12 employees at a time and supplies high volumes of material for wholesale customers. Hayfork's diversified forest products include furniture, custom cabinets, counter tops, posts, poles, lumber and flooring.

This project suffered when we learned last summer that the Dimmick family decided not to resume operations on their property due to the depressed market for timber. The Dimmick's had a THP and they were written into the grant to be the source of material that was to be utilized for various wood products and then test marketed. We were unable to locate a property owner with a THP with whom we could conduct such trials. However we were successful in fulfilling the aims of this aspect of the grant through sponsoring the Economizer demonstration/workshop, our mushroom cultivation project, gathering data from the work in the woods on biomass utilization and other potential products.

Economizer Small Timber Utilization Demonstration

The economizer demo was a big success. The first date was cancelled because of heavy rain. At the rescheduled December 6th event, more than forty people showed up to watch the economizer in action. The machine, mounted on a trailer and enclosed in an 8' x 16'shell, was very impressive as it was fed whole logs and, in a single pass, mills each log. In total two thousand board feet of high quality lumber was cut that morning. There was a lot of excitement generated from the demonstration and it has gotten people thinking about how the economizer could fit into a regional fire hazard reduction plan.

At the workshop 2000 board feet of Douglas fir lumber were milled. The lumber came from seventy logs of 8.5-feet in length each. It took less than four hours for the wood to be milled, including time for questions and discussion with the attendees. The vast majority of logs were in the largest size classes of least 7-10 inches in diameter. The material was cut in full dimension and ranged from 2x4's to 6x6's. It required 2.5 hours for two men to physically set up the sort piles once the logs were delivered to the workshop site. Because we were using equipment designed for bigger trees, yarding time in the field took a total of two days.

There was a lot of culling of logs before transport to the mill, mostly due to sweep (curve) in the tree. The Economizer does not tolerate any sweep whatsoever as the mill is designed for straight logs only. Most of those logs should be 8-foot lengths (8.5' is best), though longer is theoretically possible. Trees are cut to 17-foot or 25.5 foot or 34 foot lengths for loading, depending upon the hauling equipment being used. At full production, two people working the Economizer can mill up to 8000 board feet in a day.

While log volumes are typically calculated using scaling systems such as Scribner, those scales are not applicable for use with small diameter timber such as the Economizer uses. For example, the amount of lumber we realized from the Economizer was many times greater than the Scribner Log Rule indicated we had.

Since the mill seems to prefer eight-foot lengths it might be best to cut lumber to nominal dimensions (for commercial application) rather than full dimension. That is because eight feet is a common size for framing lumber and most builders use nominal lumber as it interfaces with fasteners and other materials used in construction.

To make the economizer an economically viable option, according to Hayfork's Watershed Research and Training Center, it takes about 1000-acres to provide enough material per year. This is a very rough average though, as that acreage would also be dependent upon the stocking of the forest and the rate at which the forests were thinned.

Locals are considering if the machine might be part of a cooperative venture amongst landowners, if it could be owned by a local non-profit, or if perhaps it may be part of an individual private enterprise undertaking.

If an economizer were to be purchased, other materials would have to be included in the package, including:

- A large truck to haul the mill around-or alternatively a permanent location for the mill and a large truck to transport logs to it;
- Harvesting equipment, either an atv with skidding arch or draft horses;
- An efficient loader (on and off load);
- A forklift on-site to load the logs onto the economizer's processing deck.

Mushroom Cultivation: Mushroom Production as a Fuels Reduction By-Product

Materials generated as a result of the Seely Creek Fire Hazard Reduction project provided for the creation of a pilot project to determine if cultivation of mushrooms can generate income and potentially defer the cost of required forest/fuels management actions. Utilizing tan oak (Lithocarpus densiflorus) logs felled during thinning a mushroom farming operation is currently raising primarily shiitake (Lentinula edodes) mushrooms on over 56 logs.

The Seely Creek Hazard Reduction project did significant thinning in December 2001 and February 2002 which resulted in numerous logs produced that were suitable for shiitake mushroom production. Tan oak is one of the preferred genera for cultivation of shiitake and the most preferable logs are grown in dense stands.

A total of ninety-eight four-foot long tan oak logs ranging from 5 to 9 inches in diameter were collected and transported from the project site to the nearby town of Redway. Usable logs are defined as possessing intact bark, no signs of illness or rot and no visible insect infestation. In an effort to minimize topical competitors the logs were scrubbed with a brush and water and rinsed with water. During this procedure over 30% of the logs were culled because of revealed defects resulting in 67 logs for inoculation.

A group of community volunteers worked to complete the labor-intensive process of inoculating the logs with mushroom spawn in late February and early March 2003. The shiitake spawn arrived on 1/4-inch diameter dowels or plugs which are driven into holes drilled in a 5-inch diamond pattern on each log. After a dowel was driven in to the log, hot wax was applied to seal the hole in an effort to deter contamination by undesirable fungi. A total of sixty-seven tan oak logs were inoculated with shiitake plugs at a cost of $190 for plug spawn and sealing wax.

Following the completion of inoculation the logs were crib stacked (see illustration) off the ground on two separate pallets for the duration of the spawn run. During this period the shiitake mycelium colonizes the log and hopefully evolves into the fruiting run the following winter. This incubation period from initial inoculation until bloom of the mushrooms typically lasts from 10-18 months.

During the spawn run logs need sufficient moisture to prevent the excessive drying of the logs (ideal wood moisture content is 35-70%). Without adequate moisture, the microscopic fungal organisms relying upon the wood as their food source and growth medium die. A drip irrigation watering system was set up for the logs. In this trial the logs were watered every 3-5 weeks depending on weather conditions. The logs were shaded under a dense deciduous and conifer canopy.

Following inoculation the only labor required labor is for restacking the logs at the beginning and end of each fruiting run to maximize yield and watering. No materials costs are anticipated.

Early Harvest Results

During the spawn run another 11 logs were culled from production over concern of possible contagious competitor infestation, including the potential shiitake-killing Hypoxylon fungus. No lethal competitors have been apparent since the suspected logs were removed in summer and fall 2002.

The first flush (fruiting), of shiitake came in November after a mere 9 months from inoculation which was several months sooner than expected. Shiitake are reported to fruit seasonally for 2 to 6 years. Depending upon management regime the yield in second and third years are often substantially greater than the first year of production.

Over 26 pounds of shiitake mushrooms have been harvested, from all 56 logs, since first flush in November through mid-March 2003. Based on the consistent local retail price for Shiitake of $12.99 per pounds the total yield thus far is valued at $337. This compares favorably to the $190 expense for plug spawn and wax.

The return on the first year of production is encouraging. Since most mushroom logs are productive over successive years it is too soon to evaluate the success of these projects.

Simultaneous with the operation described above three variations on this project were undertaken. Three Tan oak logs were inoculated with maitake (Grifola frondosa) and four Douglas fir logs with Phoenix oyster (Pleurotus pulmonarius) mushrooms.

An additional twenty-six logs were inoculated with Shiitake spawn and stored on a property close to the thinning project. These logs have been managed in a far less controlled environment in an attempt to minimize labor, transport and water , and overall expenses. The cost for plugs and wax for these three variations was $153. Yields have been virtually nonexistent with total volume for these projects less than one pound total.

Observations about Mushroom Cultivation

It is too early to draw definitive conclusions regarding the success of the shiitake cultivation project. Given that potentially several years of production are to follow there is inadequate information to conclude whether the project is commercially viable. However, a meaningful return has already been realized and production is continuing as this report is drafted in March, 2003.

Some authors have suggested that the minimum size for a profitable mushroom farm is one hundred logs. While this cannot be confirmed from this project at this time it is readily apparent that in order to increase the size of the operation, labor input must be reduced to make the operation viable.

This whole process has been very labor intensive with each of the logs requiring nearly one hour of labor just to inoculate and process. There is room for significant improvement in inoculation efficiency based on professional estimates of 40-80 logs inoculated per hour. Most likely novice crews, a production station that was intermittently inundated by torrential winter rains, and under-powered drills hampered productivity.

Also, these labor estimates do not include the significant effort required to remove the logs from the dense hilly forest littered with downed trees and shrubs nor the truck transport to the processing site. In order to become a viable undertaking the labor associated with handling and inoculation needs to be greatly reduced by addressing the issues stated above.

In an effort to minimize water use in the summer alternate stack and watering techniques are being explored. More efficient humidity control could cut water use at the driest time of the year, improve log condition and mycelium health, resulting in more bountiful harvests and less labor effort.

Biomass

Biomass refers to organic material from living things such as trees, shrubs, grasses and other plants. The temperate forests of the Pacific Northwest contain the highest amounts of biomass per-acre of any forests in the world, far exceeding tropical forests. Biomass is commonly used as lumber, firewood and paper. Biomass can also be used for energy production. It is estimated that if just 6 percent of the continental United States were utilized for biomass production we could eliminate entirely our use of fossil fuels. Biomass utilization is considered carbon dioxide neutral and therefore will not significantly contribute to global warming.

Gasification

Gasification is a process of using woody material (biomass) as a source of energy to produce methane and hydrogen gases which can then be used as fuel to power an engine which produces electricity. That electricity can be connected to the utility grid or used to directly power homes and businesses. Currently 4 to 6% of US electrical supply comes from biomass.

Gasification technology for extracting usable non-heat energy from woody material has existed for at least 100 years. Before and during WWII Germany, Japan, and many Scandnavian countries used gas generated from wood to fuel vehicles and power machines. Today, small-scale gasification systems from fire hazard reduction projects could theoretically provide electrical power for a household or an entire community while residual heat from biogas generators can be used for heating a kiln, greenhouse or for space heating.

One possible biogas scenario combining community fire-hazard reduction and community electricity generation uses a mobile generator of 15 to 50 kilowatt capacity. This generator can be located in the vicinity of the fire hazard reduction projects where the material can be gathered and accumulated near the existing utility grid. The generator could have the ability to interface with the grid and generate electricity that the municipality (or other owner) could use in its energy distribution. This would reduce the costs associated with transport of the materials to the generator and help to offset the cost of thinning forests 50 in the high-risk urban/wildland interface zone. Other technologies such as co-generation have been commonly used for creating heat and electricity to power sawmills where high supplies of biomass materials exist. Sawmills are often able to supply 75% of their power needs through co-generation.

The closer the biomass source is to the generator, the more efficient and cost effective the operation. Before combustion the wood must be first chipped then dried to a low moisture content of between 6 and 15 percent which reduces the particulates in the emissions. Inexpensive passive solar drying chambers can accomplish this level of drying.

Work in the woods in Seely Creek has shown that for every acre thinned there are approximately 60 cubic-yards of material generated (assuming the same silvicultural prescription is followed). If the thinning takes place within 50-feet of the roadway (on both sides), 12 acres of forest are thinned for every mile of road. We can project that the initial yield of biomass would be approximately 720 cubic yards per mile of roadway thinned (60 cubic yards/acre, x 12 acres/mile). In the Seely Creek watershed there are approximately 15 miles of roads suitable for a thinning project. Assuming that this forest type is typical for the Seely Creek watershed, we could expect that the entire watershed would yield in the vicinity of 10,800 cubic yards of biomass. Expressed in wet weight the yield is 4.5 million pounds or 2268 tons. More discussion of this issue and a table is included in the appendix. Alternatively, using the data from the management simulation expressed in the table in part I, the 15 miles of roads in Seely Creek could produce roughly 300 tons of chips annually through establishment and ongoing maintenance of the fuel break.

The tables in section one show the expected annual yield of biomass over a 25¬year period. Actual harvest levels at a given time would be much greater than the amount shown for the average annual yield per acre. Using the gasification unit designed by Community Power Corporation, four pounds of dried chips will generate 1 kwh of usable electricity. Therefore 11.7 tons of dried chips, the amount a “typical”5 mile of road would yield annually, would potentially yield 6 Mw of electricity if thinned to 50-foot width on either side of the road.

The industry break-even price for delivered woody biomass is estimated to be in the range of $30 per ton. This delivered price could be reduced if some of the costs of biomass removal associated with fuel reduction projects are shouldered by government agencies (or landowners) as an incentive to reduce fire hazards while producing a public benefit and reducing future fire suppression costs.

Constraints with this source are primarily based upon transport issues. First the material must be cut and transported from the forest floor to the roadside where it is cut to size for loading or immediately chipped and fed into a dump truck for transport to the generation site. For economic feasibility the distance for the biomass to travel should not exceed 25-50 miles (based upon the cost of fossil fuels). In remote private forestlands, access to biomass is further complicated by inadequate infrastructure such as poorly constructed roads and undersized bridges which create impediments for larger dump trucks to haul large loads.

Pellet Fuel Manufacturing

There exists an opportunity for the creation of a pellet fuel facility in Northern California. Bags of pellets offered for sale in local shops come from facilities in Idaho, West Virginia and Colorado with some retailers offering pellets from Canada! Capital costs for the construction of a fifteen to twenty-thousand ton processing facility are between $2.5 - 3 million.

Pellet fuel is preferable to burning firewood because it produces only 1/8th of the particulates of cordwood and one cubic-foot of pellet fuel contains 357,000 BTU’s or about 4.5 times the content of green wood. Many urban areas have banned the use of wood stoves due to air quality concerns yet, pellet stoves are not banned due to their relatively clean burning characteristics. Pellets are typically made from sawdust and ground wood chips. The annual consumption of pellet fuel in North America is more than 230,000 tons.

Other Markets

Firewood: Retail costs of firewood in Humboldt County average $200 per cord for hardwood and $175 for fir (delivered cost). San Francisco Bay Area prices are 25% (or more) higher ($250 in March) The Sacramento area market has lower prices than San Francisco and at the time of this writing that market appears saturated. Wood splitters can be rented for $50/day.

Lumber:

Providing that a thinning project complies with regulations, landowners can cut and use lumber for personal use. For larger diameter trees, portable sawmills such as a Lucas Mill or Woodmizer can be hauled to remote locations and cost $250-300 for 1000 board feet of lumber milled. Logging and yarding of materials are other added costs. A simpler but cruder method is to use an Alaska Mill which converts a chainsaw into a small sawmill for milling larger posts or slabs, from fallen trees.

Poles:

Many of the fir poles harvested during fire hazard reduction have characteristics that provide an opportunity for utilization. Often the poles have tight growth rings due to their growing conditions in the understory and likewise they tend to grow straight. Demand for use in construction is limited. The USFS Forest Products Lab built a series of round wood gazebos that were used at the 2002 Olympics in Salt Lake City. The Lab especially designed the fasteners that connected the round wood joints of the gazebo.

There is also a limited market for logs suitable for furniture, teepees, vigas (southwest) and other specialty markets (see photos 8a and 8b). Use of poles for fence posts is constrained by the need for preservation of the wood, often a toxic process.

Non-Timber Forest Products

Some plants which contribute to fire hazard may be harvested for non-timber uses such as the floral market. Some of the plants which make their way into the florist's boquets which cold be gathered in the forests of the northcoast region include Evergreen huckleberry, salal, and broom. However opportunities to gleen revenue from gathering plants from the forest are minimal. One local marketer, West Coast Evergreen of McKinleyville, no longer purchases plant material from new collectors but instead relies upon long-term suppliers. However the company claims that there may be an opportunity for landowners to make arrangements with pickers who would pay to gather on their land.

Summary

The sustainable solution for reducing the wildfire threat within the urban-wildland interface is comprised of a matrix of responses that are varied according to unique social, economic and environmental conditions. Current work suggests that a sustained and diverse mix of private and public efforts will be needed to adequately reduce the fire hazards currently existing in California's forest lands.

There is no doubt that reducing fire hazards on wildlands requires a tremendous amount of work. The labor involved is strenuous, hazardous and expensive. It is not really the type of work that can or should be done alone. Often community members organize work parties to thin along roadsides. Sometimes landowners choose to hire professionals to conduct the thinning for them. While the hours needed to effectively thin forests and reduce fire hazards vary widely according to terrain, the type of vegetation, and accessibility, an average cost for treatment is in the range of $1000 per acre. Organizations like Fire Safe Councils have been formed in some areas to help coordinate large-scale planning of fire hazard reduction efforts.

Transporting the trees remains the most critical part of the puzzle. Our terrain is steep, many of the roads are narrow and bridges are often inadequate for heavy logging equipment or. These same impediments also exist for efficient biomass utilization. These obstacles are more easily overcome with logging mature trees which, due to lower per unit costs and higher market value of the product, produce revenues that can cover the costs of infrastructure upgrades.

Small diameter timber must often overcome barriers to efficient and economic utilization of the resource, including the writing of timber harvest plans, undeveloped markets, limited demand for products and high costs of handling materials. Small-diameter harvesting technology isn’t locally available on a scale, which makes it economically available for use.