Final Report

Safeguarding Rural Communities

Fire Hazard Reduction and Fuels Utilization

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I. Training and Demonstrations

As planned, training workshops were held in three targeted watersheds. Each workshop was advertised well in advance with posters put up at appropriate places (such as bulletin boards) in the watersheds and by phone calls or mailings to residents. Each workshop had a different resource professional who led the training. Each workshop covered the basic topics outlined below with each presenter focused their presentation around their areas of expertise.

The **<u>Seely Creek</u>** workshop was held after a portion of the thinning in the watershed had already begun. This had the advantage of using the already thinned area as an excellent learning tool. After spending the rainy morning indoors listen to workshop Native American restorationist Dennis Martinez and discussing the issues, the workshop adjourned for lunch then carpooled to the project site. The side-by-side contrast of treated and non-treated areas was an effective way to for participants to analyze thinning work already undertaken. See photos 1A and 1 B.

The **<u>Tom Long</u>** workshop was held in March at a household of watershed residents. Community members were notified by telephone and via the posting of a sign on the community bulletin board. Ten of the watershed residents attended. (See photos 10 and 11.) The major presenter at the workshop was local Liscensed Timber Operator Dave Kahan. Dave has extensive experience working as a faller on fire crews, as well as leading crews on significant thinning contracts throughout the region.

The **<u>Woodman Creek</u>** workshop was in early April at the Laytonville Fire Hall. Registered Professional Forester Ken Baldwin led the workshop. This workshop had the fewest attendees. Woodman creek also has a higher proportion of absentee landowners than any other watershed in the project areas, which is reflected the low turnout rate. See photos 2 and 3.

The workshops and field projects are summarized in **table 1.**

The following is an outline of the information that was covered in each workshop:

Fire Hazard Reduction and Fuels Utilization Workshop(s)

I. Introductions
II. The Need for Fire Hazard Reduction
  A. Dwellings in the forest
  B. Fire suppression
  C. Roads in high fuel-density areas
  D. Terrain
  E. Access
III. National Fire Plan
IV. Local Fire History
  A. Fire fighting resources
  B. Local VFD (Equipment, person power, etc)
  C. Ponds
  D. Residents
V. Responding to a Fires
  A. Emergency routes/ fire safe areas
  B. VFD
  C. CDF
  D. Communication systems (phone trees, etc)
VI. Defensible Space
  A. Prioritization and assessment
VII. Benefits of Fire Hazard Reduction Activity
  A. Forest health
  B. Wildlife habitat
  C. Aesthetics
  D. Stand improvement
VIII. Fuels characterization
IX. Potential for fuels utilization
  A. Fuels (Firewood, chips, pellets)
  B. Compost
  C. Structural (Lumber, roundwood)
  D. Mushroom cultivation
X. Schedule watershed work

Fuels Reduction Demonstration Projects

Sites within the targeted watersheds were selected for the demonstration projects based-upon the following criteria:

- Stand composition
- Accessibility
- Visibility
- Strategic location as a legitimate fire break area
- Land owner cooperation
- Usable materials
- Exemptions needed/possible

The thinning work proceeds best when performed in teams of two or three, falling one tree and bucking it up before proceeding to the next tree. Whenever possible, crewmembers should drag slash downhill. Trees are cut as low to the ground as possible. When working in teams of threes, the crew should consist of a sawyer, a swamper (dragger) and fire tender. If working with a chipper, a five-person crew is efficient with one of the crewmembers operating the wood chipper at all times. Using a wood chipper adds as much as fifty-percent time and labor to a project.

Tools for Fuels Reduction:

Chain saws (14 " bar good, lightweight preferable to most people)
Hand saws
McLeod fire tool for fire tending
Shovel
Loppers
Metal bucket for moving coals for next burn piles
Gloves
Safety equipment (Medical kit including poison oak remedies-Tecnu)
Back pack sprayer
Pole saw
Machete
Brush cutter (weed whip with metal blade)
Waxed cardboard for starting fires in winter
Cell phone for emergency calls
Extra fuel, hard hats, ear protection

Limbing-up, the practice of cutting tree limbs as far as possible above the ground, is an effective way to reduce fire hazard of a forest. While it does add extra labor to the project limbing-up with pole saws, either manual or motor driven, is highly recommended. Pole saws can be extended to cut from 10 to 20 feet above normal arms reach above the forest floor.

Silvicultural Prescription

In all demonstrations the distance being thinned was fifty-feet back from the roadway, on either side of the road, when possible. Calculated on a per-mile basis it adds up to 12.2 acres per linear mile of roadway or 432 linear feet of road for each acre. Data collection plots were 1/100th-acre plots or 11.7 foot radius. The plots were 50’ or 66’ apart. The data collected was:

- Number of stems/plot
- Canopy class
- Species
- Diameter at breast height (dbh)
- Avg. height
- Dominant vegetation
- Percent canopy

All tan oaks under 4-inch dbh, suppressed firs, brush and limbs within easy arms reach were recommended for cutting. Other “take” trees were marked and cut as a part of stand improvement and landowner goals. Trees were also noted for their firewood, mushroom and saw log, potentials.

Chip volume was measured in two separate samples at the Seely Creek demonstration site. This was accomplished by chipping all materials from a known area, including brush, limbs, and whole trees when possible. Next, the mound of chips was estimated. Then a sample of the chips was collected and weighed to determine the wet weight of the materials for possible use in biomass utilization schemes.

Project	Dates	Notes	Person Hours	Area Treated	Outputs
Seely Creek	12-01, 4-02, 11-02	Chipper 3 days,	133 volunteer, 213 total	2.5 acres	38.5 cu. yds. Chips, 5 cords fire wood, 62 – 20' fir poles 130 mush logs
Tom Long Creek	3-02	Hand tools only	62.5 volunteer 137 total,	1.5 acres	6 cords fire wood 61 – 10' fir poles
Woodman Creek	4-02	Hand tools only	24 vol, 65 total	1.0 acre	18 – 10' fir poles 2 cords fire wood
Ettersburg	12-02	No workshop	131 total	2.0 acres	2.0 cords fire wood, 20 fir poles

Table 1. Fire Hazard Reduction Projects

Ettersburg Fire Hazard Reduction

Between torrential rainstorms in December, a *thinning from below* fire hazard reduction project was completed near Ettersburg. Unlike the other demonstration projects, this fuel break lies along a busy county road where many locals can see what a project of this type actually looks like. Approximately 1/3 of a mile was thinned. This work supports a Southern Humboldt Fire Safe Council proposed project to create an extensive five-mile long shaded-fuel break on Telegraph Ridge along the Ettersburg Road[1]. Photos 12 and 13 show the before and after thinning in Ettersburg.

Ettersburg was chosen for the project for several reasons. First, the location of the fuel break is along a busy traffic corridor along Telegraph Ridge, which lies just east of the Kings Range. Secondly, this region has a history of fire starts including the Findley Creek fire of 1973, which burned more than 14,000 acres. Additionally, the Telegraph Ridge/Ettersburg community was considered to be one of the target watersheds in the original version of this grant and there is an active volunteer fire department. The owner of the land, Dawna Blair, is a single mother who would be unable to conduct such a thinning project on her own.

What was learned from conducting the trainings and demonstrations

• It became apparent that once sawyers became familiar with the work that they began to exercise their own judgement when choosing which trees to take or leave. With experience it actually seemed that the best way to proceed was to let a skilled sawyer cut without marking the trees. In trainings, however, it is best to mark the trees to be cut, at least in the beginning. It is also important to clearly flag the road from either direction to

[1] This project initiated an agency to agency grant submitted in March 2003 by CDF to BLM on behalf of the Southern Humboldt Fire Safe Council and local contractors. If granted, it would award $100,000 to a local contractors to begin work on a five mile fuel break along the Ettersburg road! This break would continue, essentially, the fuel break that was kick-started through this grant

warn motorists when and where the projects are taking place. Even on backroads, traffic can move at high speeds and be a hazard to all.

• Often there arise *conflicting values* or outcomes from a particular demonstration thinning project. The goals of fire hazard reduction may be at odds with a landowner's goals or people may have other feelings that are contrary to what a forester may believe. For example, some people love madrones and want to save them all while another may want to convert their forest into mostly conifers for later harvest. Sometimes landowners want to maintain privacy between the roadway and structures. This can disrupt the continuity of a fuel break, but has to be considered.

• Protecting biological diversity is also important. We occasionally left "islands" or pockets of plants that were uncommon in the area being treated. These islands add habitat and/or forage for insects, birds, and other animals. One rule of thumb we observed was to never take all of any species in a given area (invasive exotics excluded). Species such as ceanothus are important for insect forage and nitrogen fixation but their growth form lends itself to fire risk. The end result must reflect the goals of the project, which is always influenced, by landowner goals and objectives.

• Burn piles are the easiest and most economical way to deal with slash removal and offer comfort for the crew when working in cold, rainy conditions. They can be spaced about 50-feet apart on the downhill side, away from large stumps. The roots of old stumps can harbor embers over winter and combust in dry weather and start a wildfire. (See photos 5A and 5 B).

• Wood chippers are valuable because they allow for dry season work and give the options for higher use (compost, mulch, biogeneration, etc.), of residues. However, chippers add a higher cost to projects and their noise is deafening. (See photo 4).

While a team of two hard working people (sawyer and swamper) can treat an average of 1/4 of an acre in a day, volunteers add substantial amounts of time to that equation as the data shows. The workshops are summarized in table 1.

Data Analysis & Management Projections

Data from Seely Creek & Tom Long Creek was used to simulate growth and harvest of the fuel break area over the next 25 years. Simulated harvests were thinnings from below at year 0, 10, and 20 aimed at creating, over time, a park-like stand of big trees with a high canopy and no understory. After stands reach this condition, only much lighter harvesting or brushing out will be needed to maintain them. Roadside forest stands which are intended to remain as permanent fuel breaks will continue to produce some biomass for thinning, but they are not appropriate for long-term production of commercial timber because this would require allowing new age classes of trees to establish in the fuel break zones.

When interpreting and extrapolating from these results, some important things to consider are:

- Biomass produced from thinning would yield both firewood and chips in varying proportions depending on available markets and landowner needs.
- The weight of the chips and timing of their delivery significantly affect the financial viability of a project - prices are usually paid by the ton and chips can lose at least half their weight in a season of drying in the woods.
- Harvest of saw timber and pole wood should be interpreted as a one-time harvest with little or no added harvests over time.
- Biomass production is an average yearly yield from the managed fuel break - actual harvest levels from a given stand would be much greater than the amount shown for the average yield per acre over time.

Traditional Burning in Seely Creek

The fourth workshop that was conducted as a part of this project was in Seely Creek where residents were so impressed with workshop leader Dennis Martinez that they asked for him to come back for a workshop focused on traditional/prescribed burning. Dennis is a noted restoration ecologist, the chair of the Indigenous Peoples Restoration Network of the Society of Ecological Restoration and has practiced restoration forestry for 32 years based on a Native American - reference ecosystem approach. Twelve people and five dogs attended the workshop. See photo 8.

Notes from the Traditional Burning Workshop

Pre-fire site preparation to include:

- Thinning oak clumps and improving stand by removing some trees
- Thin-out small firs crowding oaks and encroaching on edges
- Remove moss from base of oaks approximately 1-2 feet above fuel
- Remove poison oak
- Scratch a line around burn area

Ecological

- Fire ecology,
- Fire and nutrient cycling,
- Hydrological function,
- Primary and secondary productivity (of ecosystem as associated with fire)
- Have a control area adjacent to burn to monitor effects of fire
- Oaks are a sub-climax species (fire arrested)

Cultural

- Collect local/native seeds to scatter in ashes after site cools
- Traditional burning was mostly conducted in autumn while prescribed burns, as often practiced today, take place in the spring.
- Fires traditionally occurred every 5-20 years in this area
- Acorns, especially tan oak, were a major food source for Indians
- White oak is best for making implements
- Fire helped keep the forest understory open, aiding hunting and travel
- Fire functioned as natural pest control for misletoe and other pathogens
- Sixty-percent of local Native economy was based upon fire adapted plants

In addition to the talk by Dennis, the workshop participants evaluated various sites for their suitabilty for a future prescribed burn. A site was selected and it is estimated that costs for preparing the 2-4 acres for a burn would be between $1500 and $2000.

Expected outputs from a pre-fire site preparation include fir poles, oak poles. After the burn native grasses such as *Festuca Californica* and *Elymus glaucus*, could be encouraged to grow and their seeds collected for future propagation and restoration efforts. Indian potatoes (yampa), blue dicks, and basketry materials are other among many other possible outputs from a traditional burning.

II. Planning

Formation of the Southern Humboldt Fire Safe Council

As work progressed on the demonstrations and trainings it became apparent there was something missing in the preparedness of the community to protect itself and respond to a wildfire. Fire safe councils utilize "the combined expertise, resources and distribution channels of its members, the Fire Safe Council fulfills its mission to preserve California's natural and manmade resources by mobilizing all Californians to make their homes, neighborhoods and communities fire safe."[2]

The Southern Humboldt Fire Safe Council was founded through this grant. Since the founding meeting in July of 2002, there have been monthly meetings which have brought together diverse parts of the community into a group that is forming a coherent strategy on reducing our wildfire threat. There is no doubt that accomplishing regional fire-hazard reduction takes a community effort. The core members of the SHFSC reflect this diversity with representation from 6 volunteer fire departments, CDF, BLM, watershed associations, non-profit organizations and other community members.

As the founder of the SHFSC, Mishka Straka of ISF has functioned as the group's facilitator of meetings which involves creating and distributing agendas among other tasks.

The following is a synopsis of the SHFSC:

October, 2002

Southern Humboldt area residents concerned about the potentially devastating effects of wildfire upon our families, homes, businesses and community have recently formed the Southern Humboldt Fire Safe Council. It is because we enjoy living and working in our beautiful natural environment, and that this wonderful community could be destroyed in a wildfire that we are motivated to form this council which will help protect ourselves from this threat and minimize our potential losses. The public safety issues we discuss may even extend beyond fire safety, to earthquake preparedness, emergency medical response, etc.

The council had its first meeting July 2nd 2002 and has continued to meet on a monthly basis. Participation has been widespread with more than forty individuals including representation from the following volunteer fire departments: Beginnings, Telegraph Ridge, Sprowel Cr., Palo Verde, Whale Gulch, Shelter Cove, and Salmon Creek. Additionally the California Department of Forestry and Fire Protection's Garberville Battalion Chief and other personnel from CDF's Humboldt-Del Norte Unit based in Fortuna have worked with us. Organizations that have thus far participated in the SHFSC include Beginnings Inc., the Institute for Sustainable Forestry, Ancient Forest

[2] www.firesafecouncil.org)

International, Sanctuary Forest, and the Humboldt Fire Chiefs Association. Additional networking is being done with BLM and the California Conservation Corps. To coordinate our activities (i.e. fuel breaks) with other fire prevention efforts.

Mission Statement:

The mission of the Southern Humboldt Fire Safe Council is to protect the region's natural and manmade resources by mobilizing our community to make their homes, neighborhoods and communities fire safe.

Goals

- Reduce the risk and effects of wildfires
- Increased community preparedness and fire planning
- Create jobs through fuels reduction and utilization of fire hazard reduction materials
- Protect natural and manmade resources
- Improved forest health and ecosystem function

Objectives

- Extensive fuel breaks (demonstration projects)
- Education about fire hazard reduction and fire safety
- Neighborhood and road associations participation
- Increased communication between chiefs (VFD's) and within neighborhoods
- Initiate prescribed burning program
- Improved training for emergency response teams
- Capital investments for equipment to manage vegetation
- Increased fire department training and equipment

To accomplish the established goals and objectives, the council plans to seek funding to enable:

- Work on creating fuel breaks in strategic places in the community;
- Creating defensible space around homesteads in the urban-wildland interface;
- Funding a coordinator position;
- Creation and distribution of educational materials;
- Developing a fire plan that will identify needs and prioritize projects;
- Funding capital investments in equipment to accomplish the above tasks.

The appendix contains more information specific to the Southern Humboldt Fire Safe Council.

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.

[3] A Multi-Year, Multi-Site Demonstration Project for the Utilization of Small Diameter Forest Thinnings, May 1999 – June 2000, Annual Report , Year Two. By the Watershed Research and Training Center, Hayfork, California for the James Irvine Foundation.

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 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.[4]

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.

[4] The Use of Biomass Energy from Hazardous Fuel Reduction Projects, National Community Forestry Center, SW Region Working Paper 6, August 2002

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

[5] In this case ""typical refers to the average of the Seely Creek and Tom Long vegetative data with the numbers derived from the tables in part 1.

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. (Pellet Fuel Institute) 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 regulattions, 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 more crude 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 Council*s 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.

References and Resources

Non –Profit Organizations

The Institute for Sustainable Forestry, PO Box 1580, Redway, CA 95560 (707)923-7004 email: Info@isf-sw.org
Lower Mattole Fire-Safe Council, POB 20, Petrolia, CA 95558 email: firesafe@mattole.org
Mattole Restoration Council, POB 160, Petrolia, CA, 95558 (707)629-3514 www.mattole.org
Redwood Community Action Agency (707)269-2065
Southern Humboldt Fire Safe Council 707- 923-7004
The Watershed Research and Training Center, Hayfork, CA (530)628-4206 email: wrtc@hayfork.net

Government Organizations

California Department of Forestry and Fire Protection, www.fire.ca.gov
Headquarters: 1416 Ninth Street, P.O. Box 944246, Sacramento Ca 94244-2460 (916) 654-5412
Forestry Assistance Program (916)653-8286 Jeff Calvert
Forest Stewardship Helpline (800) 738-TREE
Coast Region: 135 Ridgeway Avenue, PO Box 670, Santa Rosa, CA 95402 (707) 576-2275
Humboldt Del Norte Unit: Fortuna (707)725-4413;
Rich Elliot, Forestry Assistance Specialist (707)946-1961
Hugh Scanlon, Vegetation Management (707)726-1206
California Forest Stewardship Program http://ceres.ca.gov/foreststeward/html/financial.htm
Humboldt County Cooperative Extension, Forestry Advisor, Yana Valakovich (707)445-7351
Mendocino National Forest, Rural Development, 825 N. Humboldt Ave, Willow, Ca 95988 (530) 934-1148
Six Rivers National Forest, Rural Community Assistance, 1330 Bayshore Way, Eureka,CA95501 (707)441-3549

University of California Forest Products Laboratory, http://www.ucfpl.ucop.edu/

John Shelly, Biomass Advisor email: john.shelly@ucop.edu

Natural Resources Events Calendar, http://danr.rcop.edu/ihrmp/nrn.html

Fire Safe Councils WWW.fiesafecouncil.org

California Fire Alliance www.cafirealliance.org

Fire Effects Information System www.fs.fed.us/database/feis/welcome.html The site has a comprehensive data base of plants and gives full descriptions of how fire interacts with each species and much more.

Forestland Steward web site http://ceres.ca.gov/foreststeward/

Environmental Quality Incentives Program http://www.fs.fed.us/spf/coop/eqip.htm

References

Przybylowicz, Paul *Cultivation of Shiitake Mushrooms*, Northwest Mycological Consultants, Inc., 702 Northwest 4th St., Corvallis, OR 97330
Przybylowicz, Paul and Donoghue, John *Shiitake Growers Handbook : The Art and Science of Mushroom Cultivation*, 1990, Kendall/Hunt Publishing Co., Dubuque Iowa
Stamets, Paul *Growing Gourmet and Medicinal Mushrooms, 3rd Edition*, 2000, Ten Speed Press, Berkeley, California