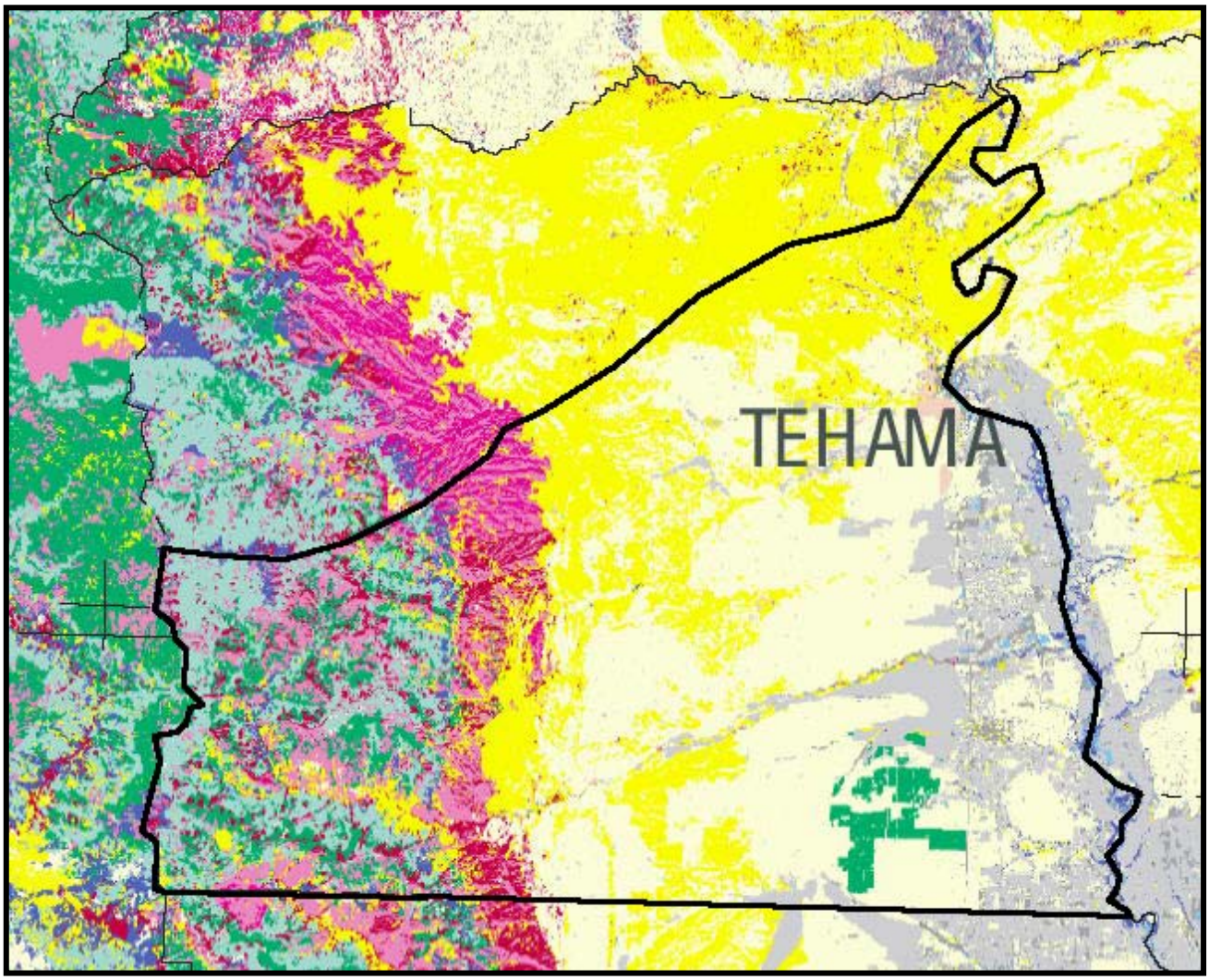
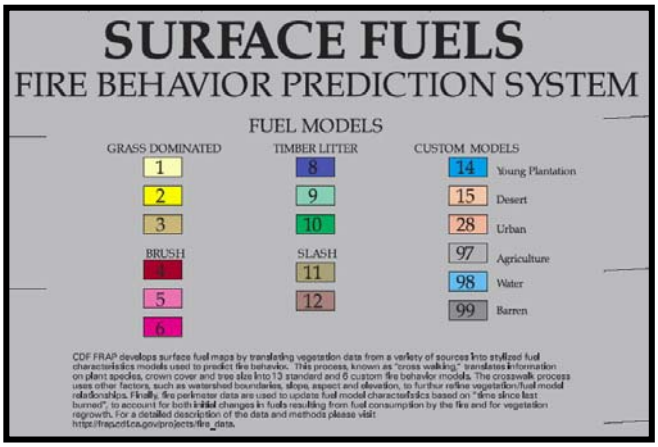
TEHAMA WEST FIRE PLAN AREA
BIOMASS STUDY





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INTRODUCTION

Worldwide, wildfires are increasing in numbers and intensity. With this increase comes a corresponding loss of life and property. Additional impacts include environmental degradation and expenditures of public funds for fire suppression. At one time, wildfires could rightly be considered a natural phenomenon such as earthquakes and hurricanes. Today, large, disastrous wildfires can no longer be considered natural occurrences because of human factors. These include over a century of fire suppression coupled with increasing human populations. A history of aggressive fire suppression has resulted in densities of natural vegetation (fuel or biomass) that exceed pre settlement densities. Human settlements, because of increasing population, are increasingly located adjacent to hazardous fuel types.

It is now generally recognized that significant reductions in the amount of natural vegetation are necessary. This is especially true for lands within the Tehama West Watershed. The public interest dictates that fuel reduction be undertaken in an efficient manner. In many instances, the cost to treat or reduce biomass to acceptable levels exceeds the value of the biomass.

Fortunately, the future for biomass as a resource is bright.

> *"Looking ahead, some analysts have begun to talk about a "carbohydrate economy," in which plants would be a major source of electricity and fuels, as well as construction materials, clothes, inks, paints, synthetic fibers, pharmaceuticals, and industrial chemicals. According to studies by the Shell International Petroleum Company and the Intergovernmental Panel on Climate Change, biomass could satisfy between one-quarter and one-half of the world's demand for energy by the middle of the 21st century. This projection implies a world full of biorefineries, where plants provide many of the materials we now obtain from coal, oil, and natural gas".*
> http://www.eere.energy.gov/consumerinfo/refbriefs/nb2.html

In this light, the biomass within the Tehama West Watershed should be considered an asset. Not only will appropriate management reduce fire hazard, it will also serve as the raw material for an impressive array of valuable products. It is the objective of this report to assemble known studies for biomass utilization and to review innovative uses for biomass especially from the chaparral zone.

BIOMASS UTILIZATION: KNOWN STUDIES AND RELEVANT INFORMATION

The term "biomass utilization" was inserted in the Google Search Engine. The search resulted in over 3,500 "hits". The following is a summary of the most relevant information. The summary includes web links, where available, to enable the reader to explore the information in greater detail.

University of California Forest Products Lab Biomass Utilization Web Site: http://www.ucfpl.ucop.edu/ERBiomass.htm. This is by far the best web site with respect to biomass utilization issues within California. Per their web site, the Overview & Objectives of the UCFPL Biomass Utilization Program are:

> *"Woody biomass makes up more than 60% of California's total biomass resource. It includes the tree-based and shrub-based materials that accumulate to hazard levels in timberland, woodland, rangeland, and urban forest environments. This material often creates high fire risk, ecosystem health, and forest productivity concerns; but its removal creates a disposal problem. The goal of this program is to develop knowledge and disseminate information on the material properties and utilization opportunities of woody biomass. Projects are currently focused on small-diameter trees, forest thinnings, underutilized hardwoods, and urban trees."*

This web site covers all aspects of the problem and contains many useful links to other publications. Of particular relevance is the report: Utilization Options for Woody Biomass, John R. Shelly, Frank C. Beall, Dorothy E. Mockus Lubin, 2000. http://www.ucfpl.ucop.edu/I-Zone/XX/izbiomas.htm This publication is a volume of the I-Zone Series, a Strategic Resource Planning Guide Project sponsored by the Federal Emergency Management Agency (FEMA), the California Department of Forestry and Fire Protection (CDF), the Governor's Office of Emergency Services (OES), and the University of California Forest Products Laboratory (UCFPL). The report can be downloaded as a PDF document.

Biomass Utilization: Energy

The next several sources are related to biomass utilization for production of energy products.

1. Biomass Feasibility and Utilization Study within the Northern Sacramento Valley, Williams, Hansen, and Bates, September 2002

This report was prepared for the Central Sacramento Valley Resource Conservation and Development Area Council. The objective of the study was to consider the feasibility of utilizing bio-wastes from forest and agricultural sources to comply with environmental regulations and provide economic benefits to the communities of Tehama, Glenn, and Colusa Counties. No copy of this report has been found on the Internet but an electronic version can be obtained from the Tehama County RCD.

Biomass considered in this report includes agricultural waste from orchards and rice harvest as well as forest fuels. Current and potential uses are considered for this biomass.

Current uses included electricity generation using conventional steam/turbine technology. The Wheelabrator Plant in Anderson, California uses this technology. The following information was gleaned from their web site: http://www.westbioenergy.org/lessons/les05.htm

"Wheelabrator Shasta Energy Company Inc., or "Shasta" as it will be referred to here, was formed to manage one of Northern California's most modern independent wood-fired power plants. Engineering and equipment procurement started in June 1986, and construction started at the site near Anderson, California in November 1986. The plant became operational in December 1987. The project owner and operator is Wheelabrator Environmental Systems Inc. The owner's engineer was Rust International Corporation. Construction financing was provided by Ford Motor Credit Lease, and long-term financing was provided by Citicorp USA.

The 49.9 MW (net) plant processes about 750,000 tons/year (350,000 to 400,000 dry tons/year) of mill waste and forest residues from Shasta County and surrounding areas. Redding is the main milling center for timber produced in Northern California. Unmerchantable wood wastes from Shasta-Trinity and Lassen National forests, as well as from private lands in the area, are selectively removed and processed in the plant to improve remaining standing timber.

The plant produces over 400 million kWh of electricity per year for sale to Pacific Gas and Electric Company (PG&E) under a long-term (Standard Offer #4) contract. The plant design includes three independent wood-burning units, comprised of three state-of-the-art wood-fired traveling grate furnaces with utility-type high-pressure boilers. The highly automated wood yard design includes capabilities to accept mill wastes, chips, and unmerchantable whole logs (culls) up to six feet in diameter, which are chipped onsite for fuel.

The Wheelabrator Shasta plant has shown excellent performance. On-peak availability has been 100% since January 1, 1989, and overall availability exceeded 99% in both 1995 and 1996. The annual capacity factor in 1996 was 95%. The net plant heat rate is about 17,200 Btu/kWh (about 19.9% thermal efficiency based on HHV). The furnaces are specially shaped and have staged overfire air to reduce NO_x emissions. Particulate emissions are controlled by high-efficiency electrostatic precipitators.

Like the other California biomass power plants with Standard Offer #4 contracts, Wheelabrator Shasta Energy Company receives special payments collected from electricity customers and distributed by the California Energy Commission during the four-year transition period to a restructured electric industry (1998 through 2001). The California

legislation (AB 1890) that established this support system for existing renewable energy power plants also tasks the state Solid Waste Management Board with developing a fuel "cost shifting" strategy that would place the cost burdens more equitably on those who receive the direct benefits (e.g., the farmers and foresters who produce biomass residues and sell them as fuel). Through these programs, the owners of biomass plants in California hope to make a successful transition to the new world of competitive electricity markets."

The only other current use addressed was erosion control structures made from rice straw.

Potential uses discussed include panel construction products fabricated from rice straw and energy products. The specific energy products were ethanol and syngas. The report discusses both small scale and large scale power plants.

"In the small project range, are two processes that are similar but approach the energy conversion by different means. Chiptec Wood Energy Systems has been in the energy business for over 16 years and offers off the shelf" systems rated from 12-300 boiler horsepower. Their process combusts the conditioned syngas in a conventional furnace to create thermal energy (steam) which can then be converted via steam turbine to electrical energy. The system cannot boast the thermal efficiencies of a direct fired turbine, but their systems are reliable and commercially available."[a]

Figure 6, Chiptec A series Gasifier

"Using a direct firing gasification system, Community Power Corporation (CPC) has been working with Shell Oil and the US National Renewable Energy Laboratory (NREL) to develop small modular biopower systems to offer affordable and environmentally friendly means of using local biomass resources to generate electricity and thermal energy needed by most off-grid communities in developing nations. In 2001, a prototype was installed in the Philippines to convert coconut shells into energy. CPC will distribute an additional six (6) units in cooperation with the U.S.F.S. later

this year. Their small modular system, the BioMax 15, currently combusts the conditioned syngas in a standard internal combustion engine genset for conversion to mechanical, electrical, and thermal power. Working at full power for an 8 hour shift, the 15 kWh genset would consume approximately 550 pounds of wood chips (~ 6-55 gal. barrels full). Future models are planned to incorporate solid oxide fuel cells and microturbines. Though in the developmental stage, CPC plans to offer "off the shelf" commercial modular systems within two years."

Figure 7, Community Power Corp. BioMax 15

"Both systems allow for flexible raw material sources and have closed loop controls of all components including gasifier, gas conditioning and genset. The waste stream consists of ash (~2% by weight), which is easily disposed of as a soil amendment. Currently, research and development is being conducted on the
coupling of Chiptec's gasification process to direct fire microturbine technology (Capstone C30 Microturbine) at the Washington Ridge Youth Authority Camp located northwest of Auburn, CA. R&D work is progressing towards cleaning and conditioning the syngas adequately to resist pitting and tar buildup on the turbine blades. Both parties believe that they are close to solving the problem."[a]

A Biomax 15 unit has been installed on the Hoopa Reservation. "The Biomax 15 pictured here will supplement the power needs during business hours of a cooperative silvicultural nursery, operated by the Hoopa tribe. The field trial will be completed by December, 2001, and the Biomax 15 will undergo a series of re-engineering and re-design steps during January and February 2002."
http://www.fs.fed.us/psw/programs/snrc/research_emphasis_areas/socioeconomics/currentstudies/community_wb/potential.shtml

A BioMax 50 is planned for the Siskiyou Opportunity Center in the City of Mount Shasta. This power plant will consume 1 BDT of wood chips per day and produce 50 Kw of power…enough to light 40 homes. However, the power will be used to provide energy for the Opportunity Center with the surplus energy being

fed into the Pacific Power Grid. The project is funded with Forest Service and California Energy Commission grant money.
http://www.redding.com/news/stories/20031009lo035.shtml

Large Scale Projects: Through a process known as acid hydrolysis, ethanol can be produced by chemically converting cellulose into sugars. The sugars are then fermented and distilled to produce ethanol. The report states that ethanol plants are designed to a minimum scale to produce 20 million gallons per year. Using a conversion rate of 100 gallons of ethanol per bone dry ton of biomass, the "minimum" size plant would require 200,000 bone dry tons of biomass per year. From the report:

> *"One such example of a two-stage dilute acid conversion facility was proposed by Boston based BC International Corp. to be constructed in the Oroville-Gridley area and expected to open by 2001. Due to the lower than forecasted price of vehicle fuels and higher than hoped for cost of delivering raw material, investors backed out of the program, and the plant was never constructed."*

> *"Ethanol has the potential to become a very large market in the future. It can be used as a vehicle fuel or as an additive to gasoline to serve as an octane enhancer and oxygenate in reformulated gasoline and diesel. Ethanol as a vehicle fuel shows promise as an alternative to petroleum based fuels, but currently only contains 80-85% of the energy value of gasoline. Until such time as ethanol cost per gallon is less than 85% of gasoline, there is not expected to be a significant increase in its demand. As a fuel oxygenate, ethanol can be converted to ethyl tertiary butyl ether (ETBE) and used as an environmentally safer replacement of the much maligned methyl tertiary butyl ether (MTBE) that is currently produced from petroleum and used in California reformulated fuels. Federal law has mandated that California complete its phase out of MTBE by the end of 2002, but by executive decision, Gov. Davis extended that phase out until Dec. 31st, 2003, citing expected fuel shortages and adverse economic impact upon the state.[b] The adverse economic impact is due to the fact that we would have to annually import 750-900 million gallons of ethanol per year."*

Syngas is produced by burning vegetative material in an anaerobic (airless) environment. The collected syngas is further conditioned to remove impurities. Once conditioned, the syngas can be burned directly to produce electricity or further refined to produce ethanol and other products.

> *"The City of Gridley, in partnership with TSS Consultants and Pearson Technologies has started a pilot plant to convert rice straw into ethanol. According to Bruce Vantine of Pearson Technologies, The theoretical yield of ethanol is approximately 285 gallons per ton of biomass, though their planned operational output would be about 214 gal./T. This alone*

represents over a 100% increase in gallons per tons of raw material over the conversion rate in the previously proposed acid hydrolysis process that was being considered just a few years ago. According to Thomas Sanford, City of Gridley Energy Commissioner, the projected cost of development is estimated to be ½ to ¾ of the BC International project." "The facility will nominally produce 23 million gallons per year of ethanol and will utilize 300,000 Bone Dry Tons (BDT) of biomass feedstock per year."
http://www.cdfa.ca.gov/exec/aep/aes/rs_grant_program/grants/gridley_ethanol.htm

The Pearson process converts the syngas into ethanol, and other "higher alcohol's" using a proprietary chemical catalyst. At this time, they plan to process ethanol for sales into the vehicle fuels market, however, if they found that the fuels market did not support their conversion costs, by re formulating their catalyst they could instead produce combustible syngas for use in a turbine."

The information in the report with respect to ethanol produced per bone dry ton is not consistent. The following table presents a summary of existing and proposed energy-producing facilities that could use biomass from the Tehama West watershed.

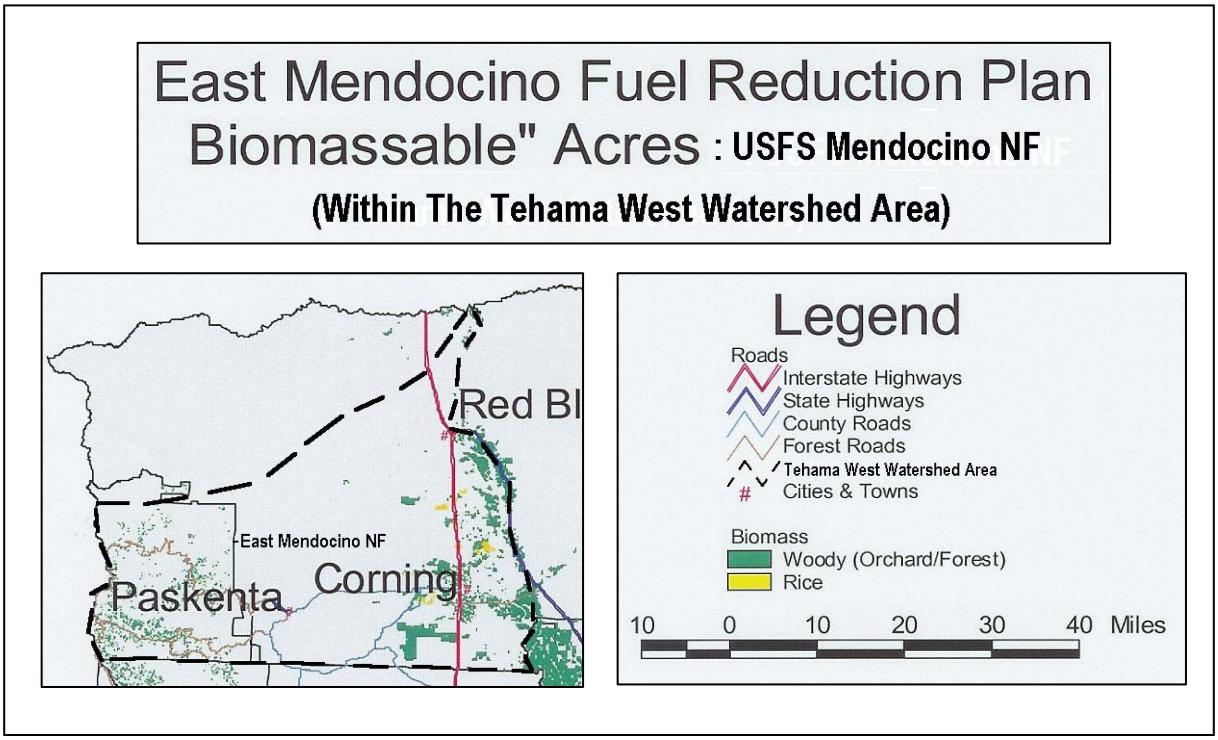
Facility & Location	Status	BDT Biomass/Yr	Energy Product
Wheelabrator, Anderson	Existing	375,000	400 million kWh
BC International, Oro-Gridley	Proposed	200,000	20 Million Gal. Ethanol
City of Gridley	Proposed	300,000	20 Million Gal. Ethanol

2. East Mendocino Forest Fuels Reduction Plan – Analysis of Fuel Availability, Williams, Hansen, and Bates, March 2002

This report was completed as a "stand alone" product and was also included as an appendix item in the subsequent report, Biomass Feasibility and Utilization Study within the Northern Sacramento Valley, Williams, Hansen, and Bates, September 2002.

The purpose of the East Mendocino report was to identify available forest fuel within the eastside of the Mendocino National Forest. The total size of the study area was 536,000 acres. Of this acreage, 102,000 is private. The study area included portions of Colusa, Glenn, and Tehama Counties. The remaining 434,000 acres of Forest Service land is subject to regulatory and economic constraints that preclude harvest of biomass. Administratively constrained acreage include wilderness, inventoried roadless areas, designated back country, wild and scenic rivers, and research natural areas. The acreage was also reduced to eliminate all topography over 35 percent slope and areas not having sufficient fuel volume to support mechanical harvesting of biomass.

Of the remaining 100,000 acres, 34,000 are within Tehama County. Virtually all of this acreage is within the Tehama West Watershed. See the map below.



Of this 34,000 acres, further reductions are made for Riparian Preserve and Late Seral Reserve. The study assumes no harvest within Riparian Preserve and 60 percent harvest within Late Seral Reserve (LSR). The study assumes a twenty-year re-entry and an average fuel harvest of 5.64 bone dry tons (BDT) per acre.

Crane Mills owns approximately 67,000 acres within the Tehama West watershed Area. According to Frank Barron of Crane Mills, approximately 40% of this acreage would be available for biomass utilization. The following table indicates acreage reductions and available fuel volume for the Forest Service and Crane Mills in Tehama County.

	Gross Acres in Western Tehama County					Available Per Year	
Land Owner	**Riparian**	**LSR**	**Other**	**Total**	**Available**	**Acres**	**BDT's**
USFS	16,000	11,000	6,600	33,600	13,200	660	3,722
Crane Mills				67,000	26,800	1,340	7,558
Total				**100,600**	**40,000**	**2,000**	**11,280**

To summarize: the combination of available National Forest land and Crane Mills land within the Tehama West watershed could furnish enough biomass to produce about 1.5 MW of electric power or approximately 3 percent of the annual fuel needs for the Wheelabrator plant.

3. Ag Biomass Council – Thorson Bailey: www.agbiomasscouncil.org

A discussion of the relationship between the natural fuel problem and its relationship with agricultural fuels was discussed with Thorson Bailey of the Ag Biomass Council. The mission of the of the Ag Biomass Council is to

> *"Support its members by providing collective expertise, interpretation and services, also recommend public policy regarding the development, use and practical application of by products through sound agronomics and science"*.[c]

Mr. Bailey would like to see natural fuel producers and agricultural fuel producers develop a co-op relationship where energy is produced for the benefit of co-op members. Excess energy produced would be sold to utilities. Mr. Bailey envisions strategically located small power plants producing between one and five megawatts of power with the ability to pay fuel producers a minimum of $40 per bone dry ton and to sell power to co-op members for $0.10-$0.12/KWH.

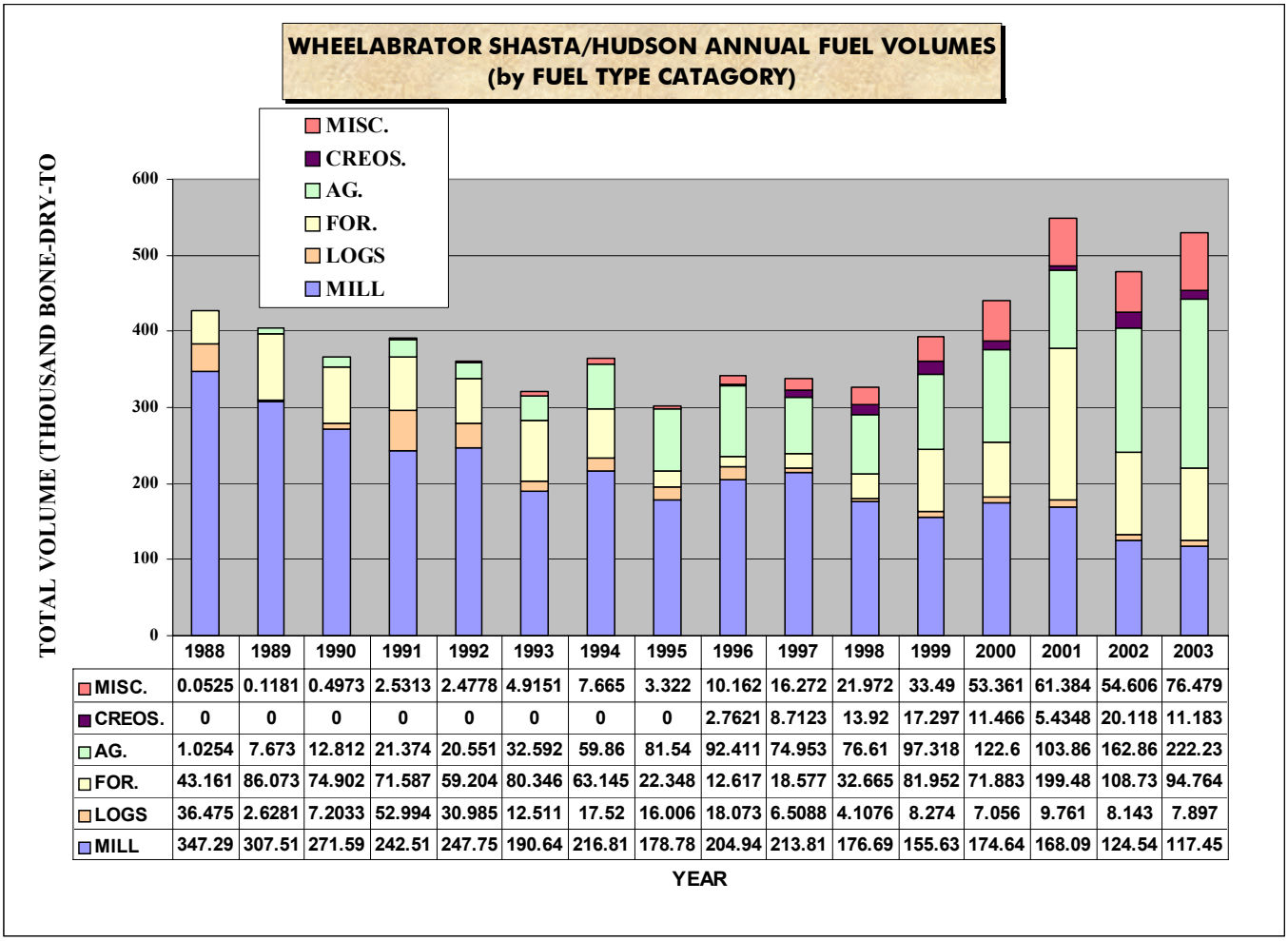
The concept of natural fuel producers cooperating with agricultural producers is sound. However, it is unlikely that natural fuels within the Tehama West Watershed Area could pay their way to the power plant for $40 per BDT. Since the amount of agricultural fuel dwarfs the available natural fuel, power plant locations would logically be located on the valley floor. In addition, fuel collection and distribution is a much more homogenous operation for agricultural fuels than it is for natural fuels. Finally, with the exception of large timberland owners, the majority of natural fuel owners would not be harvesting on an annual basis.

Biomass and Energy Economics

Based on stated capacities and available fuel, it is obvious that all forest fuel that could be harvested could be converted to energy. Efficient utilization of biomass generated from wildfire hazard reduction projects is compromised by a variety of factors. Natural biomass fuels must compete with other sources of fuels. These other sources include orchard prunings and rice straw.

The State of California recently addressed the problem of agricultural fuels by enacting Senate Bill 704 (SB 704, Florez, Statues of 2003, Chapter 480) September 22, 2003. It directs the Energy Commission to design and implement a program to help improve the air quality in California's agricultural areas by reducing the amount of agricultural fuels that are open-field burned. SB 704 directs the Commission to provide $10 per ton for purchases of qualified agricultural biomass from July 1, 2003, through June 30, 2004. Only facilities whose qualified agricultural biomass purchases exceed by at least 10 percent their five-year average of qualified purchases prior to July 1, 2000, are eligible to receive any funding.

According to Steve Jolley, fuel buyer for Wheelabrator[d], this legislation applies only to the San Juaquin Valley. However, it is logical to assume the same constraints will be placed on the Sacramento Valley. This legislation prohibiting burning of orchard prunings will reduce the ability of natural fuels to compete in the market place. The following table, provided by Steve Jolley, presents the break-down of fuel sources for the Wheelabrator plant.



	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
MISC.	0.0525	0.1181	0.4973	2.5313	2.4778	4.9151	7.665	3.322	10.162	16.272	21.972	33.49	53.361	61.384	54.606	76.479
CREOS.	0	0	0	0	0	0	0	0	2.7621	8.7123	13.92	17.297	11.466	5.4348	20.118	11.183
AG.	1.0254	7.673	12.812	21.374	20.551	32.592	59.86	81.54	92.411	74.953	76.61	97.318	122.6	103.86	162.86	222.23
FOR.	43.161	86.073	74.902	71.587	59.204	80.346	63.145	22.348	12.617	18.577	32.665	81.952	71.883	199.48	108.73	94.764
LOGS	36.475	2.6281	7.2033	52.994	30.985	12.511	17.52	16.006	18.073	6.5088	4.1076	8.274	7.056	9.761	8.143	7.897
MILL	347.29	307.51	271.59	242.51	247.75	190.64	216.81	178.78	204.94	213.81	176.69	155.63	174.64	168.09	124.54	117.45

- Mill waste
- Logs
- Forest (whole tree chips from forest operations)
- Agriculture (whole orchard take-out, nut shell, pits, etc.)
- Creosote (railroad ties)
- Misc. (land clearing, urban, paper

The table below indicates the relationship between the amount natural fuels and agricultural fuels available on an annual basis in Tehama County. The amount of natural fuels is based on fuels available from Forest Service and Crane Mills lands within the Tehama West Watershed Area. The estimate for agricultural fuels is countywide.

Annual Available Fuels (Bone Dry Tons)		
Orchard	**Rice**	**Forest 1/**
36,201	2,065	11,280

1/ No estimate of natural fuel from other private sources within the Tehama West Watershed Area has been made. Based on the relatively dispersed nature of assets at risk within the watershed area, it is assumed that the available fuel is less than 5%.

Power Plant Economics: Large wood-fired power plants derive their income from utilities that pay wholesale rates based on contracts negotiated between the utility and the power plant. The utilities take this power and sell it to consumers. The table below indicates the relationship between delivered fuel costs, other costs, and income for a typical large wood-fired power plant.

Fuel Cost $/BDT	Fuel Cost $/kWh	O&M 1/ $/kWh	Ownership 2/ $/kWh	Total Cost $/kWh	Receipts 3/ $/kWh	Return $/kWh
$ -	$ -	$ 0.015	$ 0.016	$ 0.031	$ 0.064	$ 0.033
$ 5.00	$ 0.005	$ 0.015	$ 0.016	$ 0.036	$ 0.064	$ 0.028
$ 10.00	$ 0.010	$ 0.015	$ 0.016	$ 0.041	$ 0.064	$ 0.023
$ 15.00	$ 0.015	$ 0.015	$ 0.016	$ 0.046	$ 0.064	$ 0.018
$ 20.00	$ 0.020	$ 0.015	$ 0.016	$ 0.051	$ 0.064	$ 0.013
$ 25.00	$ 0.025	$ 0.015	$ 0.016	$ 0.056	$ 0.064	$ 0.008
$ 30.00	$ 0.030	$ 0.015	$ 0.016	$ 0.061	$ 0.064	$ 0.003
$ 35.00	$ 0.035	$ 0.015	$ 0.016	$ 0.066	$ 0.064	$ (0.002)
$ 40.00	$ 0.040	$ 0.015	$ 0.016	$ 0.071	$ 0.064	$ (0.007)
$ 45.00	$ 0.045	$ 0.015	$ 0.016	$ 0.076	$ 0.064	$ (0.012)
$ 50.00	$ 0.050	$ 0.015	$ 0.016	$ 0.081	$ 0.064	$ (0.017)
$ 55.00	$ 0.055	$ 0.015	$ 0.016	$ 0.086	$ 0.064	$ (0.022)
$ 60.00	$ 0.060	$ 0.015	$ 0.016	$ 0.091	$ 0.064	$ (0.027)
$ 65.00	$ 0.065	$ 0.015	$ 0.016	$ 0.096	$ 0.064	$ (0.032)
$ 70.00	$ 0.070	$ 0.015	$ 0.016	$ 0.101	$ 0.064	$ (0.037)
$ 75.00	$ 0.075	$ 0.015	$ 0.016	$ 0.106	$ 0.064	$ (0.042)
$ 80.00	$ 0.080	$ 0.015	$ 0.016	$ 0.111	$ 0.064	$ (0.047)
$ 85.00	$ 0.085	$ 0.015	$ 0.016	$ 0.116	$ 0.064	$ (0.052)
$ 90.00	$ 0.090	$ 0.015	$ 0.016	$ 0.121	$ 0.064	$ (0.057)
$ 95.00	$ 0.095	$ 0.015	$ 0.016	$ 0.126	$ 0.064	$ (0.062)
$ 100.00	$ 0.100	$ 0.015	$ 0.016	$ 0.131	$ 0.064	$ (0.067)

1/ Operation and maintenance costs

2/ Ownership costs (debt service, return on investment etc.)

3/ Receipt from utility: Includes %0.01/kwh capacity payment

The data in the table indicates that today's electrical power payments will not support fuel costs over $30/BDT. **Some plants no longer have debt service and can pay more for fuel.**

Fuel must be gathered, turned into chips, and loaded on a truck. This operation for the harvest of traditional natural biomass fuel from thinnings and logging slash costs between $25 and $35/BDT. While there is little cost experience with harvesting non-traditional natural fuels such as small hardwoods and chaparral, its logical to assume the cost would be much higher than harvesting traditional fuels. Once the chips have been loaded on a truck, they have to be delivered to a power plant. A chip truck can haul about 13 BDT/load. Hauling costs are estimated to be $5/BDT/Hour. The trucking cost is extremely sensitive to the distance the chips must be hauled.

After considering the cost and income stream for a large plant and the costs associated with getting fuel to the plant, it is obvious the majority of hazardous fuels will not pay their way out of the woods. **A support level for turning natural fuel into energy should be considered because of the economic benefits of cleaner air, reduced fire suppression costs, and decreased reliance on imported fossil fuels.** Two recent major fires, the Fork and Trough, burned a combined 108,000 acres and cost a combined 37 million dollars to suppress.[e] This amounts to $343 per acre. Assuming an average yield of 6 BDT per acre, the suppression cost was approximately $57.00 per BDT. From a different source: *"In 1994, over 4 million acres burned in the West and the suppression cost to the US Forest Service alone was over $1 billion."* http://www.westbioenergy.org/lessons/les05.htm This amounts to $250 per acre. With fuel loads within the Tehama West Watershed Area estimated to be 6 BDT/Acre, fire suppression costs would be over $41 per BDT. It's probably safe to assume that fire suppression cost savings alone can be valued between $40 and $60 per BDT.

Small power plant economics are based on replacing consumer priced power with the power generated by the facility. At this writing, consumer-priced electrical power is approximately $0.15/kwh. Compare this with the $0.064/kwh the large power plants receive. Obviously, a small plant could pay much more for fuel. In addition, as previously noted, grant funding is being used to pay for a portion of the construction cost for some of these plants. The potential for small-scale power plants should be explored for isolated communities within the Tehama West Watershed Area.

Biomass Utilization: Livestock

While it is not practical to use livestock to reduce existing heavy fuel loads, they can be used to maintain a fire safe vegetation type. On the surface this appears to be a “win-win” solution. Wildfire hazard is reduced while biomass is converted to protein and other livestock products. The best web site found that treats the subject of grazing is Grazing Management, an Ecological Perspective, Edited by Rodney K. Heitschmidt and Jerry W. Smith.
http://cnrit.tamu.edu/rlem/textbook/textbook-fr.html.

Managed grazing and browsing (especially sheep, cattle, and goats) of wildland fuels is a common practice. Grazing and browsing live grassy or brushy fuels can reduce fuels prior to burning or reduce the burn frequency. Goats will sometimes consume even small, dead woody biomass. However ungulates are selective, favoring some plants over others. The cumulative effect of this selectivity can significantly change plant species composition and long-term ecological processes of an area eventually converting a grass dominated area to brush. On moderate to steep slopes, high populations of ungulates contribute to increased soil erosion. http://fire.r9.fws.gov/ifcc/smoke/fuel_exclusion_techniques.htm

A commonly recognized fact is that fuel reduction must be maintained to remain effective. Over the years, maintenance by use of grazing livestock has been proposed as a panacea. In reality, economic and environmental factors severely limit the potential for grazing to provide any meaningful large scale maintenance of fuel reduction projects in the chaparral and timber fuel types. However, if opportunities arise to test grazing projects, these opportunities should be exploited.

An organization within the watershed, the Sunflower CRMP, is proposing such a project. A Coordinated Resource Management Plan (CRMP) is a landowner driven process established by the California Legislation in the late 1970's. The purpose of a CRMP is to do environmental enhancement on a landscape basis. A series of meeting with landowners and agency representatives develop the specific objectives of the CRMP, followed by a Memorandum of Understanding (MOU) signed by all involved parties.

The Sunflower CRMP consisting of 65 landowners, along with other partners listed and signed an MOU in the early '80's to continue the objectives. http://www.sunflowercrmp.com/scrmp.html Their proposed project involves raising livestock (goats and sheep) in the brush belt. The idea is that the animals would manage the brush and their offspring would then be sold for income to the livestock owner. The proposed project will require some funding for research.

Contact with Glenn Nader, livestock and natural resources advisor, for Sutter, Yuba and Butte counties is recommended. His areas of expertise include livestock, forage crops, range and natural resources. Nader has extensive experience working with citizens and agencies on post-fire rehabilitation, such as the devastating Williams Fire that destroyed more than 100 homes and 5,000 acres, and two fires in the Concow area of Butte County. He has assembled information on what communities can do in post-fire response, and worked with communities in the formation of two "fire safe" councils that earned more than $1 million in grant funding to create evacuation plans, shaded fuel breaks and fuel treatments, hand clearing, goat grazing and biomass harvesting. Glenn Nader is located in the Sutter/Yuba County Cooperative Extension office at 142-A Garden Highway, Yuba City, CA 95991. Phone (530) 822-7515. Email: ganader@ucdavis.edu

According to Glenn Nader, Soper-Wheeler, a large timberland owner, participated in a study to use goats to manage vegetation. The results of the study[f] were published in the 20th Forest Vegetation Management Conference, an annual conference sponsored by the University of California Cooperative Extension. The study contains important information relevant to anyone contemplating a similar project.

Finally, a commercial web site was found that advocates the use of goats to manage vegetation. http://www.livingsystemslandmanagement.com/website_lslm_001.htm

Summary: Biomass and Livestock

Goats are particularly suited for management of fuel loads when compared to other livestock species. Soper-Wheeler abandoned their grazing project because herbicides were cheaper.[g] Also, it appears that manzanita is rated fair to poor in browse value for goats. Many of the brush fields in the Tehama West Watershed run heavy to manzanita. The best opportunities for use of goats is to maintain existing shaded fuel breaks where herbicides and prescribed fire are not possible and manzanita is not the primary target species.

Innovative New Uses for Biomass

For the purposes of this report, new uses for biomass will include non-traditional uses within the context of the Tehama West or adjacent watersheds. Traditional uses include sawtimber, utility poles, firewood, paper chips, and hog fuel chips.

Since the focus of this report is innovative new uses for biomass from the chaparral zone, products from that zone will be discussed. The discussion will include an estimate of the existing use, expansion potential, and conflicts with traditional uses.

1. Barbecue Wood

Barbecue wood is sold in chunks, chips, and pellets. Chunks are generally 2' x 2" pieces while the chips are manufactured using chippers having knives that differ substantially from the knives used for hog fuel chips. The resulting product is a cleaner, more attractive chip. These products are used for cooking and smoking food.

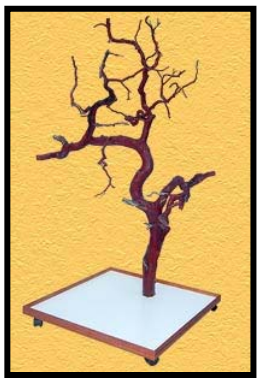
According to Colin Postance, from Barbecuewood.Com in Selah, Washington, http://www.barbecuewood.com, they sell between 4 and 5 million pounds (dry weight) of chunks and chips per year. This equates to between 2,000 and 2,500 bone dry tons. He estimates his other significant competitors sell an additional 5 to 12 million pounds per year. Most of his raw material is fruitwood such as apple, cherry, and grape and comes from orchards in the local area or, in the case of hickory and mesquite, is shipped to Washington from the southeast. Manzanita has not been tried by Barbecue.Com.

Leon Cody, a Licensed Timber Operator from Weaverville, attempted to market a similar product made from native oaks but discovered that marketing, labor and transportation were too costly. [h] Mr. Postance from Barbecue.Com already has a viable marketing infrastructure. The Tehama County RCD should consider shipping manzanita chunks to Barbecue.com to test within his established market.

Manzanita chips have been marketed nation-wide from the Redding area. They are being marketed by Barr Brothers, Inc., BBQ Tools - The Tool Wizard, 1540-B Charles Drive, Redding, CA 96003. http://www.toolwizard.com/store/moreinfo.cfm?Product_ID=47 The product was discussed with Patrick McCabe. In their best year to date, they sold 6,600 five pound bags of chips nation-wide. This amount is equal to 16.5 bone dry tons or slightly more than one standard chip van. According to Mr. McCabe, they no longer have a nation-wide market and the volume of chips sold is substantially less than in former years.

With appropriate promotion and partnership agreements, I believe the Tehama West watershed area can provide manzanita cooking products, both chips and blocks, to the market place.

2. Novelty Products



Other uses for manzanita worthy of note include branching and perching structures for bird cages. The picture is of a product for sale at http://www.mountainmanzanita.com/perchess.htm The product is a four foot a Bonsai Tree Perch that retails for $235.00. Manzanita is also used as tree base material for artificial trees.

Manzanita burls are sold to woodworkers for turning into beautiful products. http://www.righteouswoods.com/manzanita_burl_pics.html

It is important that land managers be aware of the types of novelty products in the market place and take advantage of opportunities to merchandise wildland biomass that is suitable for these products. However, it must be realized that these products can never amount to more than a niche market.

2. Small Coniferous Roundwood Products

Traditionally, coniferous roundwood material less than 6 inches in diameter on the small end was considered waste and was left in the wood as a by-product from logging. Recently, with the advent of large scale wood fired energy plants such as Wheelabrator, a portion of this "waste" is being converted to energy. Several recent studies and projects have been undertaken to explore alternative uses for sub 6-inch diameter coniferous roundwood. The two most significant and relevant to the Tehama West Watershed will be discussed.

The first of these is the Feasibility Study for Recreation Play Structures Small Wood Utilization, by Greg Bates (Williams, Hansen, & Bates, Inc.); Charles Schoendienst, (CDF); and Joshua Pierce (CSU-Chico). Small roundwood is a significant contributor to fuel loading in over-stocked coniferous timber stands. The specific product size constraints were stump diameter ranges from 4 to 8 inches that would yield a pole diameter of 2 to 8 inches.

The study demonstrates an opportunity to use this material in the construction of recreational and gardening structures.

> *"…it is the intent of the cooperators of this study to provide a planning document to some entrepreneur(s) that will eventually establish a small business that will convert wood waste, now a fire hazard, into a commercial product."* [i]

The majority of this material lies in the commercial conifer zone above the chaparral belt. No estimate of the total volume of wood available that meets the size constraints was made as a part of the study. However, it is clear to most resource managers dealing with this size material that the amount of material available is not a limiting factor. To date, according to Chuck Schoendienst, no one has initiated a business using this wood.

In Trinity County, The Watershed Research and Training Center (WRTC) in Hayfork, CA manufactures lumber as part of a program to develop economic opportunities in the community area. Hayfork is a remote, rural community with high unemployment resulting from the closure of the Sierra Pacific sawmill in town. The source of the lumber is the Hayfork watershed containing numerous stands of densely spaced, slow-growing Douglas-fir trees that contribute to a significant fire hazard in the region. This suppressed Douglas-fir, is the result of past harvesting practices and fire suppression efforts in the Trinity National Forest. Similar stands of timber can be found within the Tehama West Watershed. [j] With respect to producing high quality sawn products, the study found significant issues with warping.

Roger Jagel of the WRTC states that there is a good market for Douglas-fir sawn products with a small end inside bark diameter from 5 to 10 inches and for poles but there is less interest in other species.[k]

Summary: Innovative New Uses for Biomass

It does not appear that the collective utilization of biomass for cooking wood or small coniferous roundwood products will ever contribute to a significant reduction in existing fuel hazard. However, it is important to exploit opportunities to convert hazardous fuel into these products when these opportunities arise.

Summary and Conclusions

1. The cost to society of wildfires and our dependence on foreign oil are two compelling reasons to convert as much excess wildland biomass to energy as possible.

2. Wildland biomass alone is not sufficient to maintain the existing demand for energy plant feed stock for Wheelabrator.

3. Small-scale power plants should be considered for specific locations within the Tehama West Watershed Area. Rancho Tehama is a suggestion.

4. Subsidies should be established that reflect the cost savings of reducing wildfires, improving air quality, and a decreasing dependence on foreign oil.

5. Maintenance of appropriate fuel loads with livestock should be considered wherever alternative maintenance methods are unacceptable.

6. The opportunity to convert wildland biomass into building materials and other non-energy products should be explored with appropriate entrepreneurs.

7. Where wildland biomass is suitable for building materials or other non-energy products, the market place will favor these products over energy production uses.

Sources Not Cited Directly in Text

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[a] Biomass Feasibility and Utilization Study Within the Northern Sacramento Valley, Williams, Hansen & Bates, September 25, 2002
[b] "Fearing $3 Gasoline, Davis delays MTBE Phase-out". Sacramento Business Journal, March 15, 2002
[c] Ag Biomass Council Brochure
[d] Phone conversation, February 20, 2004
[e] East Mendocino Forest Fuels Reduction Plan – Analysis of Fuel Availability, p. 1-2
[f] Using Goats to Control Understory Vegetation, Dustin Lindler, Jason Warshawer, Darrin Campos
[g] Glenn Nader, phone conversation, December 30, 2003
[h] Leon Cody, phone conversation, December 10, 2003
[i] Feasibility Study for Recreation Play Structures Small Wood Utilization, by Greg Bates (Williams, Hansen, & Bates, Inc.); Charles Schoendienst, (CDF); and Joshua Pierce (CSU-Chico), page 3
[j] Analysis of Warp in Lumber Manufactured from Suppressed-Growth Douglas-Fir, John R. Shelly, University of California Forest Products Laboratory
William T. Simpson, USDA Forest Service Forest Products Laboratory
January 5,2000
[k] Roger Jagel, phone conversation, December 2, 2003