EVERGREEN

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GIANT MINDS, GIANT IDEAS:

The USFS Forest Products Laboratory at Madison, Wisconsin

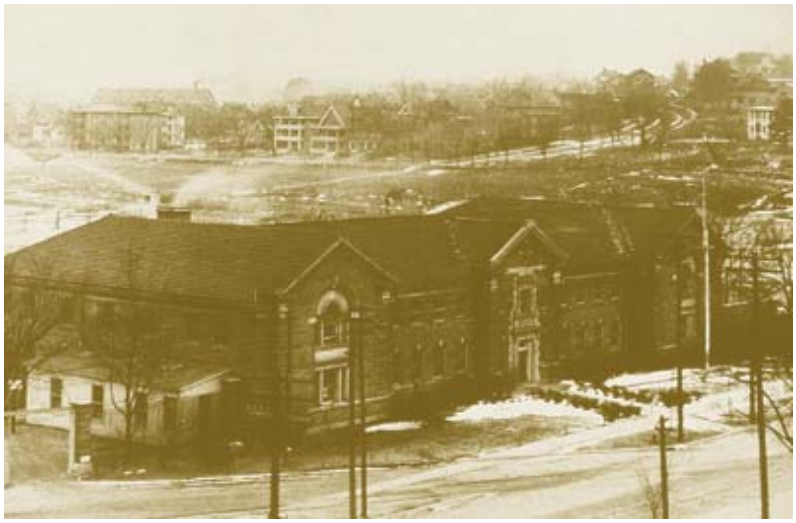
"I cannot say enough good about the Forest Products Laboratory. You don't have to be a Weyerhaeuser or a Georgia-Pacific to get them to return your phone calls. They are customer driven and they clearly recognize that their market has shifted from big companies needing help to small communities that are trying to partner with the federal government to figure out how to solve the West's forest health crisis. Questions that would have taken me months and thousands of dollars to answer they answer free in minutes. We have challenged them and they have met our challenge head-on."

Jim Jungwirth, Jefferson State Forest Products, Hayfork, California, from an August 30, 2003 *Evergreen* Magazine interview

The twin towers of human progress

In this issue we write about the twin towers of human progress: knowledge and inspiration. Both flourish in abundance at the United States Forest Service Forest Products Laboratory in Madison, Wisconsin.

We doubt many Americans have ever heard of the lab, yet so ubiquitous is its contribution to the way we live and work that it rivals that of the National Aeronautics and Space Administration. All of the technologically advanced structural and panel products used in home construction today began as basic research by lab scientists; so too did the impressive array of paper-based packaging materials we use daily.



USFS historic files

The venerable U.S. Forest Service Forest Products Laboratory on University Avenue in Madison, Wisconsin, as it looked following its completion in 1910. Wisconsin taxpayers build the lab next door to the University of Wisconsin after winning a spirited competition involving the universities of Minnesota and Michigan.

But for all of its unheralded contributions to the nation's standard of living, the Madison lab's greatest strength has always rested on its ability to identify practical and often quite timely applications for seemingly unrelated discoveries in chemistry, physics, botany, forestry, pathology, biology and engineering.

It is no accident. Long before the federal government's fledgling "timber physics" program was consolidated in Madison in1910, there was a strong laboratory emphasis on bridging the gap between basic research and its practical application. Credit Bernard Fernow, a fervent conservationist, and his better-known colleague, Gifford Pinchot, the first Chief of the Forest Service and a luminary whose vision and gift for persuasion is still influencing the course of forestry in America.

But it was Prussian-trained Fernow, the first professional forester to immigrate to America and the first director of the Division of Forestry, precursor to the Forest Service, who coined the phrase "timber physics" to describe the government's early work in wood conservation. He used the phrase as early as 1887 to underscore his belief that foresters needed to understand the physical, mechanical and chemical properties of wood "to know what are the qualities for which a special timber is prized and under what conditions it can be expected to produce those qualities."

Fernow and Pinchot were practical men who understood that conservation's theoretical goals, which both championed, would remain a distant dream until early industrialists could be convinced that greater economy in the use of wood, what Pinchot called "conservation lumbering," could be profitable. Given that the nation's wood supply then seemed inexhaustible the task proved to be impossible until a declining supply in cheap white oak crossties caught the attention of price conscious railroad barons who were then buying more than 110 million of them annually. Soaring demand drove tie prices up more than 200 percent between 1887 and 1900. Small wonder then that the railroads, by then transcontinental and still expanding rapidly, finally embraced wood preservatives that Fernow had earlier said would double the service life of a tie.

Despite the high praise of engineers and architects of the day, the timber physics program was abruptly and inexplicable dropped from the Division of Forestry in 1896. Lacking Pinchot's missionary zeal, Fernow had failed to make the case for the practical value of his largely scientific endeavor. He moved on to Cornell University, where he became dean of its forestry school. It remained for Pinchot, who took over the Division in 1898, to reshape the program largely by the sheer force of his own considerable will.

His timing was perfect. Demand for applied science was growing exponentially, driven largely by soaring prices for a diminishing wood supply. By 1906, there were 60 wood treating plants in the U.S. In 1900 there had been only 15. Also by 1906, there were six timber-testing laboratories scattered across the country, from Washington, D.C. to New Haven, Connecticut, from Lafayette, Indiana to Eugene, Oregon. The renamed Bureau of Forestry described their

role, and Pinchot's vision, in Circular No. 28, Practical Assistance to Users of Forest Products, published in 1904:

"In order to promote the more economical land effective use of our forest resources, the Bureau of Forestry offers practical assistance to users of wood in the study of problems relating to the selection, testing, handling, seasoning and preservative treatment of construction and other timbers, or relating to wood products."

The popularity of the labs soared. By 1906, Pinchot had made his case, not just for economy in the use of timber "to get the most out of it," but also for conservation of the nation's standing timber supply by eliminating both waste in manufacturing and plunder in logging, what Pinchot called "lumbering." But by 1906 the timber-testing program had also become a major headache for the Bureau. It was growing too fast to make control or efficient operation possible. Worse, the interdisciplinary approach that was needed to unlock wood's complex chemical and structural codes—codes that both enhance and complicate its usefulness—was impossible to foster in such a far-flung enterprise.

Consolidation under one roof was the only answer. On March 5,1909, following spirited bidding from several universities, Secretary of Agriculture James Wilson, announced that a new laboratory would be built on the University of Wisconsin campus at Madison. It was a fortuitous moment in the history of forest conservation and wood utilization research.

By 1910 scientists knew that when wood was dried its strength increased dramatically. But what could you do with such a discovery? No one knew until wood chemists and physicists, working side by side, decoded the wood-moisture relationship. The resulting drying schedules—charts that told manufacturers how long to dry certain wood species and at what temperature—greatly increased the utilization of wood species that had been thought to be inferior or too weak for structural use. Practical conservation: Pinchot's trademark.

It was the same with the semi-chemical pulping process, another early triumph for Madison scientists. Semi-chemical pulping increased pulp yields, allowing papermakers to use different wood species. Now foresters could turn their attention to the management of multiple species. The quality of forestry—and forests—improved dramatically, all thanks to the lab's new interdisciplinary approach.

Between 1910 and 1940 the lab's 60-some scientists strung together a series of quite remarkable advances in wood preservation, strength testing, lumber grading, gluing, pulping, drying, fireproofing and lamination. Though it was a long way from Madison to the front lines, their strategic role on World War II beaches and battlefields was nearly incalculable, particularly the development of lightweight laminated "sandwich" products that could be quickly repaired. General Eisenhower would later say that the battle for control of Omaha Beach might have been lost had it not been for plywood-constructed Higgins supply boats: victory built on the lab's seemingly inconsequential discovery that wood easily formed strong bonds with a wide array of organic chemicals.

But it was in the years after the war that plywood came into its own as the homebuilding material of choice for a fast growing nation. The manufactured housing industry was born - using a low-cost prefabricated housing design the lab had developed before war broke out that relied on easily assembled plywood panels. An entire family of

From U.S. Forest Service historic files

Most of the early research at the Forest Products Laboratory was in wood preservation. The lab's principle customers were railroad barons who, by the late 1880s, were buying more than 110 million crossties annually. Interest in wood preservation techniques was aided by a shortage of white oak timber, which caused tie prices to increase by more than 200 percent between 1887 and 1900. Between 1850 and 1910 U.S. track mileage grew from less than 10,000 to more than 350,000 miles. Each mile required 2,500 crossties.

panel products followed: hardboard, particleboard, flakeboard and insulation board all relied on processing technologies pioneered by lab scientists.

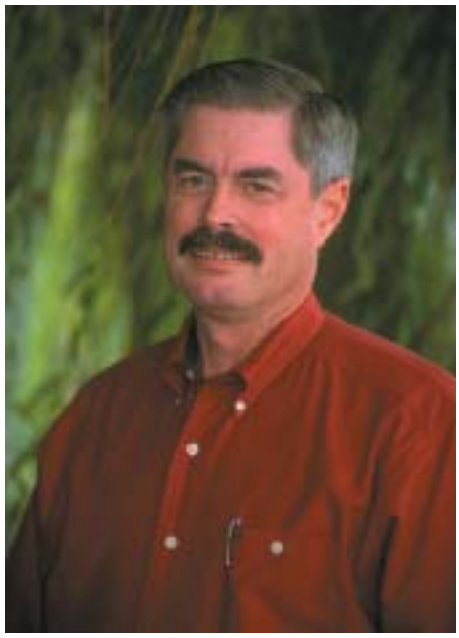
The lab's contribution to the way logs are sawn has also been incalculable. By the 1920s it was clear a tremendous amount of wood was being wasted by unsophisticated sawing systems that relied largely on human eyes. Wood lost was money lost, so with the lab's now formidable research capability in tow, mills readily invested in a series of now seemingly rudimentary advancements that greatly increased the amount of lumber that could be sawn from each log: rudimentary because today lab-developed software programs run computers and optical scanners that have replaced human eyes, making it possible to recover lumber from logs so small they were unusable a decade ago.

But now the lab has turned its attention to the most vexing problem our society has faced since conservation first took root in forestry and wood utilization more than a hundred years ago: what to do with the explosion of small diameter trees that have crowded their way into our national forests over the last half-century, choking the life out of treasured landscapes, both east and west. And what also to do with millions of tons of woody biomass, both green and dead, that, along with millions of dead and dying trees, are fueling the most destructive forest fires scientists have ever witnessed in the West?

In hopes of finding the answers to these questions, or at least the beginnings of answers, we traveled to Madison in July to talk with scientists who are trying to find uses for this fiber. We are pleased to report that we found reason for hope, though it was tempered by a straightforward acknowledgement that until viable markets are identified and appropriate technologies developed, forest restoration, which enjoys remarkably wide public support, will remain a distant dream.

It took us an entire day, walking from one office to the next, to see first hand the enormity of the lab's small-diameter wood utilization research program. It took another three days to garner the earliest beginnings of understanding. And since returning home we've spent another month reviewing and digesting reports.

For a glimpse at the future, be sure to log on to the Madison website: www.fpl.fs.fed.us. But read this special report first. You'll discover, as we did,



Jim Petersen

"We have an obligation to wade into the forestry debate, providing a sound decision making basis for policy makers."

Dr. Chris Risbrudt, Director, Forest Products Laboratory

that lab scientists and engineers have already unearthed some exciting opportunities for small wood and biomass entrepreneurs, opportunities that a Forest Service in desperate search of its once widely admired "can do" attitude should embrace immediately.

The credibility of federally funded forestry research has suffered in recent years, in large part because it has tended to create more problems than it has solved. No better example of this downfall exists than the economic and environmental debacle created by the now questioned decision to list the northern spotted owl as a threatened species. Although the lab had nothing to do with the still to be implemented Northwest Forest Plan, the resulting melee unjustly tarnished its reputation too. But new director, Dr. Chris Risbrudt, appears to have successfully steered Madison away from the fallout.

Dr. Risbrudt is plainspoken by any standard, but most definitely by today's Forest Service standard. And like Pinchot before him he understands that it is not possible for scientists to serve society's interests while ignoring public needs, values and beliefs.

"The idea that scientists are somehow immune to these value-laden debates—and therefore should not defend against the misrepresentation of scientific facts—is bogus," he declared in answer to our question about the role scientists should play in helping resolve the host of contentious forestry issues facing society.

"Yes, we need to be sure our reports are as free of bias as is humanly possible," he explained. "But we have an obligation to society to wade into the forestry debate, providing a sound decision making basis for policymakers. In the years leading to the spotted owl decision we abdicated this role, leaving our on-the-ground Forest Service brethren to fight through a thicket of unanswered questions and ecological concerns, both real and imagined. It won't happen in Madison on my watch."

By all counts, it hasn't happened either. Indeed, high praise is universal among the small businesses and even smaller entrepreneurial ventures that have sought help in Madison. And clearly, no business in its infancy could afford to buy any of the lab's impressive array of free-for-the-asking services: scientific literature searches, engineering expertise, market research, business planning assistance and onsite consultation. And yet it is small businesses, often undercapitalized—not large well-funded companies—that have enthusiastically embraced the small wood bonanza science-based forest restoration will yield if and when the Bush Administration's Healthy Forests Initiative is implemented. In the interim, most of these emerging businesses are simply treading water, waiting for the day when meaningful quantities of federal fiber can finally be purchased.

The list of those we need to thank for their help with this story is much too long to be cited here. But we would be remiss if we did not publicly thank Jean Livingston, communications specialist for the lab's technology marketing unit. Without her help this project would never have gotten off the ground.

We also want to tell you we've entered into an agreement with the Forest Service to host three tours of the Madison small-wood program. We don't normally step out of our research and publishing roles but the opportunity to introduce old friends in the logging and sawmilling industries to this exciting program was simply irresistible. You can learn more about our tours by logging on to our website: www.evergreenmagazine.com.

Onward we go,
Jim Petersen, Publisher

"I'd recommend the Forest Products Lab to anyone. They do a marvelous job. They're problem-solvers. And they have the country's best interests at heart. If you had to go out and buy the professional services the lab offers free of charge it would cost you millions of dollars. No startup venture could get to first base in a small wood utilization business without their help."

Phil Archuletta, P&M Signs, Mountainair, New Mexico, from an Evergreen Magazine interview, August 30, 2003

Giant Minds, Giant Ideas

An essay by Jim Petersen

Phil Archuletta is a man on a mission. He aims to return New Mexico's high country to its former glory, but first he needs 100 good workers, about a million pounds of wood a day and most of the used plastic milk jugs in Albuquerque. Oh yeah, he needs $5 million too. See, there's this used extruding machine in Chicago that turns junk wood and recycled milk cartons into really nice all weather road signs.

So, pretend for a moment that you are a bank loan officer. Would you lend Mr. Archuletta the $5 million he needs? Or would you suddenly have to take an urgent phone call from a customer in Cleveland? Before you put Mr. Archuletta on hold consider this: He is already a very successful sign maker. Moreover, he has the full technical support of the federal government's Forest Products Laboratory, the oldest and most respected forest laboratory of its kind in the country. In fact, Mr. Archuletta and the lab jointly own patents on both the process and the product. Now, about that $5 million.

Welcome to the dead-serious high stakes world of forest and rangeland restoration. The faint of heart should not enter. But if you can stomach considerable financial risk and can cope with the uncertainties of the bare-knuckles political brawl for control of the West's fire-ravaged forests, there is probably money to be made here if, as Mr. Archuletta counsels, you are patient and do your homework. For those interested in following his lead, this story is your first homework lesson. Study hard.

Stephanie Steck, Northern Lights, Bigfork, Montana

This laminated beam is constructed from curved, low-value, small-diameter lodgepole pine harvested from Wyoming's Bighorn National Forest. It is the end product of a joint venture between the Forest Products Laboratory, Wyoming Sawmills, Sheridan, Genesis Laboratories, Batavia, Illinois and the University of Wyoming. Wyoming Sawmills is marketing the beam as a door and window header. The Forest Service estimates that a mill using this process could consume between 8.5 and 17 million board feet of low value wood annually.

Much has been written and said about the West's wildfire crisis over the last decade. The science here is pretty straightforward: there are too many trees in our forests and they are dying by the millions. The listed causes of death are drought, insects, diseases and nutrient starvation. But in truth they are victims of a head-on collision between two conflicting government policies — a policy to preserve forests in no management or minimum management reserves and, concurrently, a policy to exclude wildfire from forests the public loves.

What we have failed to recognize is that preserving forests requires that we care for them. As an old Tennessee forester friend once observed, "The problem with leaving forests to nature, as so many seem to want to do, is that we can't control the outcome. We get whatever nature serves up, which can be pretty devastating at times. But with forestry we have options, and a degree of predictability not found in nature."

Between 70 and 90 million acres of federal forestland in the West are now in Condition Class 2 or 3, meaning the risk of catastrophic wildfire is moderate and getting worse, or the acres in question are ready to burn. It is worth noting that most of the acreage in ready-to-burn Condition Class 3 includes critical habitat for salmon, steelhead, bull trout, grizzly bears, northern and Mexican spotted owls and marbled murrelets, species listed as threatened under the Federal Endangered Species Act.

Of the dozens of scientists who sense the urgency of the West's wildfire crisis, none seems to feel it more keenly than Wally Covington, a soft-spoken, self-effacing Ph.D. fire ecologist whose credentials and research have thrust him into the forefront in the debate over what—if anything—to do about the West's wildfire crisis.

"The current rate of acceleration in the severity and size of in the West indicates that average annual losses over the next two decades will be in excess of five to ten million acres per year," Dr. Covington told

members of the House Subcommittee on Forests and Forest Health at a March 7 field hearing in Flagstaff, Arizona. "Using the reasonable assumption that preventive restoration treatments should at least be at the pace and scale of losses to severe stand replacing fire, one would conclude that we should be treating five to ten million acres per year. Our current pace and scale is woefully inadequate given the scope of the problem."

No kidding. Only about 3.26 million acres were treated last year. At this rate, the government will never get ahead of the wildfire crisis. Worse, a good deal of 2002 and 2003 allocations for hazardous fuels reduction were sucked up to subsidize a woefully inadequate firefighting budget, leaving too little money for the kind of preventive action Dr. Covington and other scientists have been urging for years.

But the political landscape is beginning to change in ways that favor a more scientific approach to caring for the West's beleaguered national forests. Polling and focus groups results from six major cities reveal strong bi-partisan support for the forest thinning and fuels management initiatives President Bush proposed during a visit with firefighters near Medford, Oregon in August 2002. Last March, a Memphis focus group composed of 12 Gore voters, 12 Bush voters and one independent voted 23-2 for the President's forest restoration strategy.

Small wonder then that in May the House of Representatives ratified the Administration's Healthy Forests Restoration Act on a bi-partisan 256-170 vote, giving Mr. Archuletta reason to hope that he will eventually recoup his 10-year half-million dollar investment in a unique blend of composite and biomass technologies he says hold great promise for federal agencies now confronting the reality of the West's forest health crisis. And the reality is simply this: minus huge infusions of public and private capital, that can be used to develop new infrastructures and markets able to profitably absorb significant quantities of small diameter wood fiber and biomass, restoring the West's desperately ill national forests will remain an impossible dream. That possibility does not set well with a public that has no tolerance left for stand-replacing wildfires that continue to sweep the West's national forests, polluting watersheds, wiping out fish and wildlife habitat and filling normally blue summer skies with thick yellowish smoke that has hospitalized hundreds from Arizona to Montana.


Jim Petersen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Phil Archuletta, P&M Signs, Mountainair, New Mexico, makes about 70 percent of the highway signs in New Mexico. He credits the lab with helping him develop a wood-plastic composite that makes an excellent sign material. Mr. Archuletta's initial interest was in making posts, but testing revealed the material made a much better sign. To help spur federal interest in the process, he makes Forest Service ensigns using an extruded blend of finely ground juniper and recycled plastic milk jugs. P&M will open a new manufacturing facility in Mountainair next summer.

Yet at this writing political observers aren't sure the Senate will ratify its version of the House-passed forest restoration bill. Proponents of the measure are still a few votes shy of a filibuster-proof 60 votes. But assuming the Senate bill is approved and conferees are able to reconcile the two bills in committee, it will take a year, maybe two, for the Forest Service and the Bureau of Land Management to ramp up forest and rangeland restoration strategies that have rested largely on a string of pilot projects and scientific experiments, some of which date back nearly 30 years.

Phil Archuletta knows the sign business very well. His company makes 70 percent of the road signs you see on New Mexico's highways. But he will tell you point blank that he could not have come as far as he has with his latest innovation without the able assistance of a cadre of scientists, engineers and marketing specialists based at the Forest Service's Forest Products Laboratory in Madison, Wisconsin. So will several other entrepreneurs who, like Mr. Archuletta, are pioneering innovations that rest on converting small-diameter trees and woody biomass into marketable products, laying new economic cornerstones in rural western communities devastated by the collapse of the federal timber sale program ten years ago.

"Had it not been for the lab's help I would probably still be trying to make sign posts out of a blend of ground wood and cement," Mr. Archuletta recalls of his decade-long quest to find uses for juniper and pinon pine that clogs New Mexico's forests and high chaparral. "When the lab saw what I was trying to do they recommended an extrusion process that blends ground wood and recycled plastic, then they helped me engineer the process, free."

Stephanie Steck, Northern Lights

Jim Petersen

This beautiful softwood floor sample is made from small diameter suppressed growth Douglas fir. Jefferson State Forest Products, Hayfork, California, made it from wood fiber purchased from a private landowner in southern Oregon. The lab helped company owners Jim and Lynn Jungwirth perfect a drying technique that keeps the wood straight and prevents cracking. The West's federal forests contain millions of acres of suppressed growth Douglas fir that need to be thinned soon. Thinning reduces insect and wildfire risks while stimulating new growth in residual trees.

As it turns out, the process Mr. Archuletta pioneered with the lab's help isn't much good for making sign posts, but it yields an all weather sign that impresses testing laboratories that have put it through its paces. If everything goes according to plan, P&M Signs new 16,000-square foot extrusion facility will be hiring next July.

Mr. Archuletta's story repeats itself in small businesses scattered all across the West, from Ruidoso, New Mexico to Hamilton, Montana and Hayfork, California, a remote logging community west of Redding hard hit by the collapse of the federal timber sale program and the subsequent loss of its last sawmill, also its largest local employer.

"I remember going to Madison to talk with Sue LeVan in 1994," recalls Lynn Jungwirth who, with husband Jim, founded the Watershed Research and Training Center and later Jefferson State Forest Products, a maker of hardwood fixtures for Whole Food stores and suppressed-growth Douglas-fir flooring. "For the first time I saw hope in someone who understood that Hayfork wasn't going to become a mecca for tourists and that we needed to find a way to put economic legs under ecosystem management."

Praise for Ms LeVan—a chemical engineer and program manager for the lab's Technology Marketing Unit—is universal among entrepreneurs and small business people for whom she is a tireless and devoted cheerleader. "Without the creativity and energy of innovative small businesses we cannot begin to address the forest health crisis in the West," she said when we interviewed her in her Madison office.

Ms. Jungwirth agrees. "Hayfork is a tiny town on the road to nowhere. No big company is going to come here and solve the environmental problems wildfires are creating. We have to do it on our own. The lab has been a patient and faithful provider of technical services that are priceless. No one has ever said to us, 'Gee, sorry, we'd like to help but we can't.' To the contrary, they've been with us every step of the way."

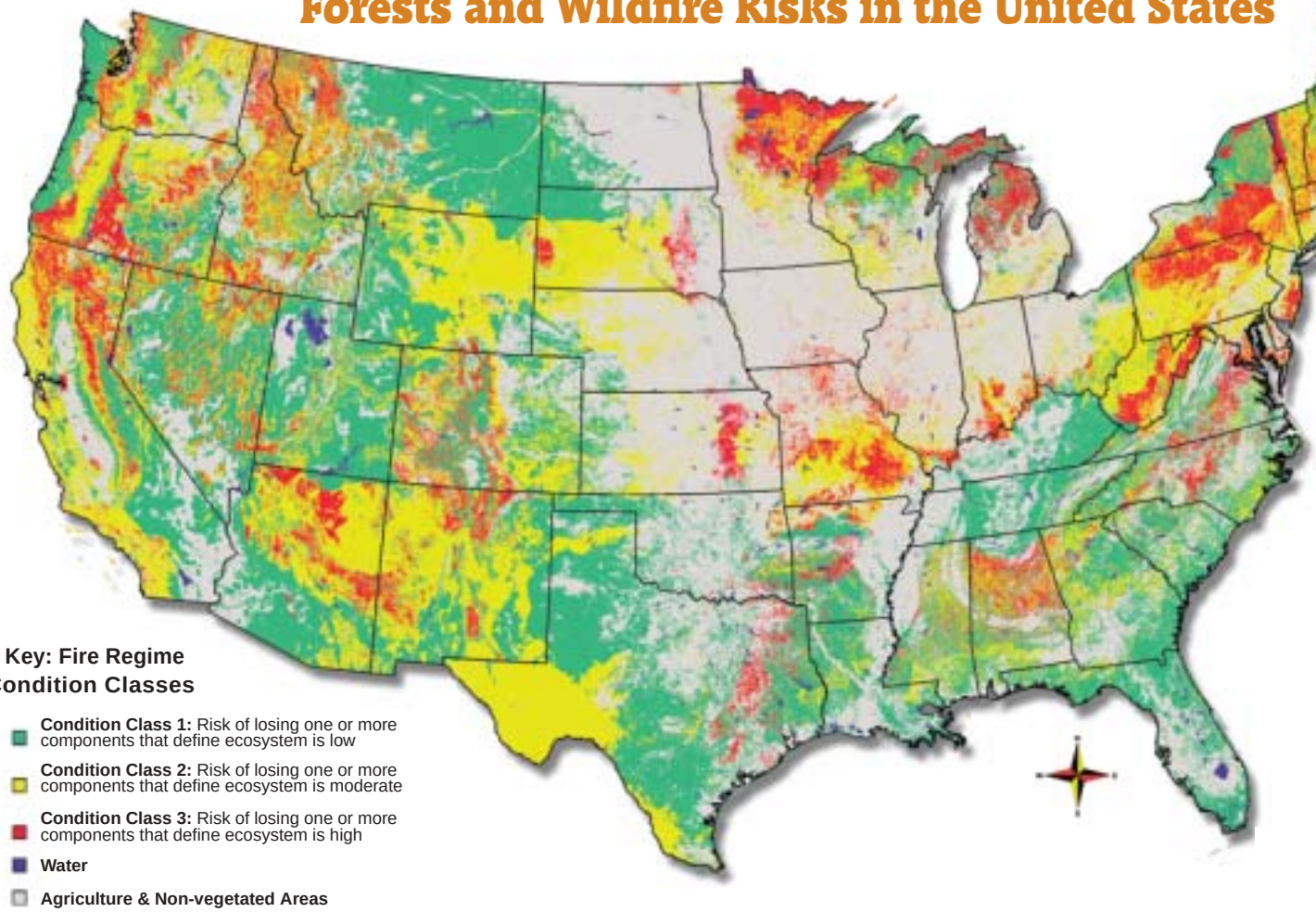
Mr. Jungwirth concurs. "We're trying to add value to wood species that frankly aren't worth very much. The lab has helped us find solutions to a host of pretty complex problems concerning twisting and discoloration, product imperfections we can't tolerate. No one from the lab has ever laughed at a question I asked or failed to find the answer."

Since the Jungwirth's set sail Jefferson State—a for-profit consumer of low grade wood fiber—and the Watershed Research Center—a non-profit that teaches locals how to contract with federal agencies for ecosystem-based monitoring and forest restoration services—have created nearly a hundred new jobs in the Hayfork area. That they have been so successful under such tenuous circumstances is a tribute to the quality of the wide array of services the lab offers: grant writing assistance, help writing business plans, market research and a long list of engineering solutions that have been the hallmark of the lab's commitment to applied science for nearly a century.

If the venerable Forest Products Laboratory looks remarkably like a university classroom building it is probably because Wisconsin taxpayers picked up the tab for the building's construction after the University of Wisconsin, which is located just down the street, won out in a spirited three-way competition that also involved the universities of Minnesota and Michigan. The Forest Service selected Madison because they believed their best shot at growing a practical wood science program rested in nurturing a lasting relationship with Wisconsin's faculty. As testament to the accuracy of that vision, many of the lab's present day Ph.D. scientists also teach and lecture undergraduate and graduate level classes at the university—in microbiology, plant physiology, chemistry, bio-chemistry, mycology, forestry, economics, physics, statistics, botany and structural, chemical, mechanical and general engineering.

Just down the lab's front steps—and looking very much out of place in a university setting—stands a two-story

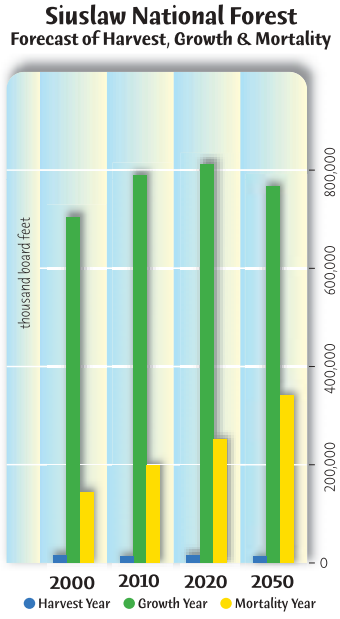
Forests and Wildfire Risks in the United States

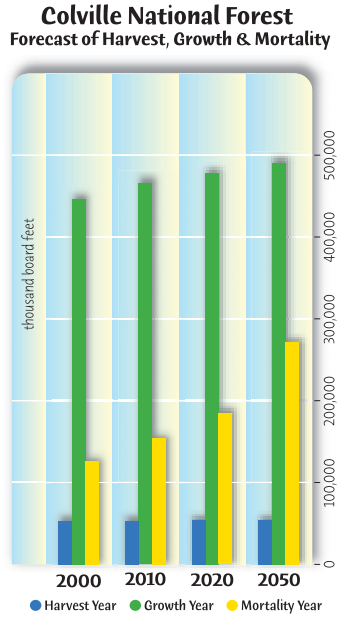


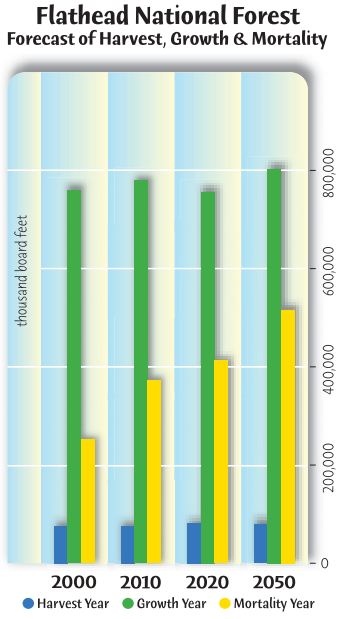
Map Color Key: Fire Regime Current Condition Classes

- **Condition Class 1:** Risk of losing one or more components that define ecosystem is low
- **Condition Class 2:** Risk of losing one or more components that define ecosystem is moderate
- **Condition Class 3:** Risk of losing one or more components that define ecosystem is high
- **Water**
- **Agriculture & Non-vegetated Areas**

This map was developed by the Fire Modeling Institute and the U.S. Forest Service Fire Sciences Laboratory Missoula, Montana, in collaboration with USFS Fire and Aviation Management. www.fs.fed.us/fire/fuelman/curcond2000/maps/cc2000.pdf







Growth exceeds combined harvest and mortality by a wide margin in many western national forests, among them Oregon's Siuslaw, Washington's Colville and Montana's Flathead. But as these Forest Serviced charts reveal, mortality will also increase through time because such outsized growth is not naturally sustainable. In Montana, nearly 40 percent of all non-wilderness non-roadless national forest acres are in Condition Class 2 or 3, and on one forest, the Kootenai, mortality exceeds growth by a 3-1 margin. The situation is even worse in the Southwest. Mortality exceeds harvest by more than 4 to 1. Picture a solid block of wood the dimensions of a football field stretching a mile into the sky. That is the amount of new wood fiber the Forest Service says nature is adding to forests in Arizona and New Mexico every year.

Are These Maps The Roadmaps To Opportunity?

Are these maps—a Forest Service map illustrating the risk of wildfire in the nation's forests—and a Pulp and Paper Workers Resource Council map depicting mill closures across the nation—actually maps to future economic opportunity? Some people think so, for two reasons. First, the wildfire map color codes the locations of forests that are ready to burn [red] and those that will burn in the near future [yellow] if forest density is not reduced before catastrophic disease and inevitable wildfire strike. And second, the mill closure map shows where there is little or no milling infrastructure for processing the millions of small diameter trees [and biomass] scientists say must be removed if wildfire catastrophe is to be averted.

For more information concerning mill closures, log on to the PPRC website at: http://usconservation.org/dam/millclosures.htm.

Saw Mill and Paper Mill Closures, 1989–2003

three-bedroom home most any family would be pleased to own. But the unoccupied structure's walls, roof, flooring systems and foundation contain a maze of electronic probes for monitoring and studying moisture movement, age-old homeowner challenges. Also under observation: engineered I-joists and beams. Though stronger and more easily assembled than dimension lumber they are less forgiving if used improperly. Also on display, a softwood floor cut from suppressed-growth Douglas-fir, a carpet made of ground up soft drink containers, attic insulation from ground newspapers, panelized roof shingles made from natural fibers and recycled plastic and an inexpensive, handicap-accessible playground surface made from compressed wood fibers.

There is a substantial gee-whiz factor in the growing list of wood-based product innovations and manufacturing processes lab scientists and engineers have turned out under the auspices of the Forest Service's small-diameter and under-utilized wood species program: the composites Mr. Archuletta is using; inexpensive water filters that show great promise for absorbing agricultural and mining wastes; a system for sending sound waves through trees to detect decay, or through logs to measure yield and quality or through old timber, to test for strength; a new family of connectors that make it possible to use small diameter round-wood in structural applications; a fungal treatment for wood chips that should save pulp producers 30 percent on their energy bills while increasing the strength properties of paper; an adhesive for postage stamps that doesn't gum up the works in recycling; promising exploratory work on a new non-toxic pulping process that will allow pulp producers to utilize a mix of small-diameter wood species; bio-fuels and chemicals to replace non-renewable petroleum-based fuels; a three-dimensional, sandwich-like panel that displays such strength and stiffness that manufacturers think it can be used to make at least a dozen products ranging from pallets to wall panels to office furniture; and an entirely new approach to studying decay in wood, allowing us to speed decay in bone dry forests and, in the reverse, disrupt the decaying process in building materials and systems. And now the final frontier: the quest to disassemble wood at the molecular level, a feat of almost unimaginable importance in a world that consumes as much energy and wood fiber as ours.

"On a weight basis, cellulose molecules are stronger than steel," observes lab director Dr. Chris Risbrudt. "But we've never taken full advantage of their strength. Since the Stone Age humankind's quest has been limited to various attempts to modify what nature gives us. Now we believe we can compel nature to give us what we need in cellulose form with the right properties for the intended job."

Many genes carry the information needed to assemble atoms into cellulose molecules. Once researchers figure out how they interact it will be possible to get nature to do much of the costly engineering now done in manufacturing: to grow fiber that possesses the physical properties most desired in a particular product: a piece of paper that doesn't tear as easily, an unbreakable wood beam, a truss that doesn't twist.

The possibilities for capitalizing on cellulose's enormous strength are absolutely endless.

"It will take a decade, maybe two or three," Dr. Risbrudt says. "But we are starting to see and understand the possibilities. In wood, this is the final frontier."

Giant minds. Giant ideas.

Yet for all their firepower, Madison's scientists owe much to a long line of foot soldiers who have championed their work where the rubber meets the road: on sawmill floors, in paper mills and, more recently, in communities in search of a future and across kitchen tables where a new generation of dreamers readies itself for a smaller-is-better era that seems destined to again reshape the way forests are managed and wood is used.

Stephanie Steck

Community Power Corp.

U.S. Forest Service

Jim Petersen

Because its quality is high, virgin animal bedding made from forest thinnings by SBS, Ruidoso, New Mexico, is a hot item on the horse breeding and racing circuits. With technical and marketing assistance of the Forest Products Lab SBS owners Glen and Sherry Barrow have also invested in a micro-power system that will consume wood waste. Such systems are thought to hold great promise for rural communities trying to breathe new life into their forests and economies.

Jim Petersen

U.S. Forest Service

Jim Petersen

Jim Petersen

Ron Porter [top] is an old hand at figuring out how to keep the door open at his post and pole business in the Bitterroot Valley south of Missoula, Montana. But even he concedes he never thought he'd be building kiosks for the 2002 Winter Olympics. But he did it in answer to a call from Sue LeVan, Technology Marketing Unit manager at the Forest Products Lab. With lab technical assistance Mr. Porter has developed several new products made from small diameter trees.

"We are the spokes in the wheel, research is the hub," explains Sue LeVan, program manager for the lab's technology marketing unit. "We go anywhere, anytime to work with landowners, sawmill owners, entrepreneurs, community groups, literally anyone interested in learning more about the product innovations that are the result of basic and applied research in small diameter wood utilization."

There is an enormous amount of hand holding in the work that Ms LeVan and her well-traveled staff do. Hope is in very short supply in most of the rural western towns on their call list. The economic devastation wrought by the collapse of the federal timber sale programs goes well beyond mill closures. Teacher layoffs, Main Street business failures and the loss of essential social and medical services are commonplace.

"It can be pretty challenging," she concedes. "But the human spirit is very resilient. And we are solution driven. So when we find communities, entrepreneurs or sawmill owners unwilling to accept defeat we go right to work."

The information infrastructure at Ms LeVan's disposal is vast: the lab's library, which holds most of the research done in Madison since 1910, the world's largest wood species and mold collections, a forensics paradise; Internet links to university scientists, libraries and research stations around the world, plus a network of field professionals representing every aspect of forest products manufacturing and energy development.

Despite these impressive resources, Ms LeVan concedes her job can be a bit overwhelming at times. "It's easy when all we have to do is function as a clearing house or a facilitator of small meetings involving a customer and one or two scientists or engineers. But when dealing with entire communities searching for ways to create new employment in forest restoration and small-wood utilization we often start with a blank sheet of paper and try to narrow hopes to a realistic list of possibilities. Though we are charged to solve problems, we often find that our first task involves restoring lost trust."

It is not easy. But Ms LeVan and her colleagues have made some significant breakthroughs despite the nearly incapacitating cynicism that grips timber towns pushed off an economic cliff when the federal timber sale program imploded a decade ago. The Jungwirth's and Mr. Archuletta are but the beginning of a pattern that offers reason for hope. So too are Glen and Sherry Barrow. Likewise, Ron Porter.

Mr. Porter is an old hand at figuring out how to keep the door open. He's been in the post and pole businesses in the Bitterroot Valley south of Missoula, Montana for more than 35 years. But he became something of a celebrity during the 2002 Winter Olympics by answering Sue LeVan's call for someone out West to build kiosks the lab could display in Salt Lake City as examples of small wood put to good use.

"It seemed like a worthwhile project," Mr. Porter says, "so we did it for the chance to get acquainted with the lab. We haven't sold any new kiosks yet but we've certainly learned a great deal more about what we can make from small diameter trees. Their knowledge has become a real asset in our business."

Indeed, Mr. Porter hardly recognizes his old fencepost business. Today his 11 employees and five contractors make everything from engineered roof trusses, fashioned from abundant lodgepole pine logs, to an impressive line of rustic, custom crafted furniture that includes desks, bed frames, wine cabinets, china cabinets, chests, rockers and dining room sets.

"After 35 years I thought I knew most of what there was to know about this business, but the lab opened my eyes to a multitude of small-wood possibilities I'd never considered," Mr. Porter concedes. "Add in their technical assistance and help with design engineering and you've got a package of services few small businessmen, including me, could ever afford on their own. I'd recommend them to anyone interested in starting or expanding a small-

wood utilization business."

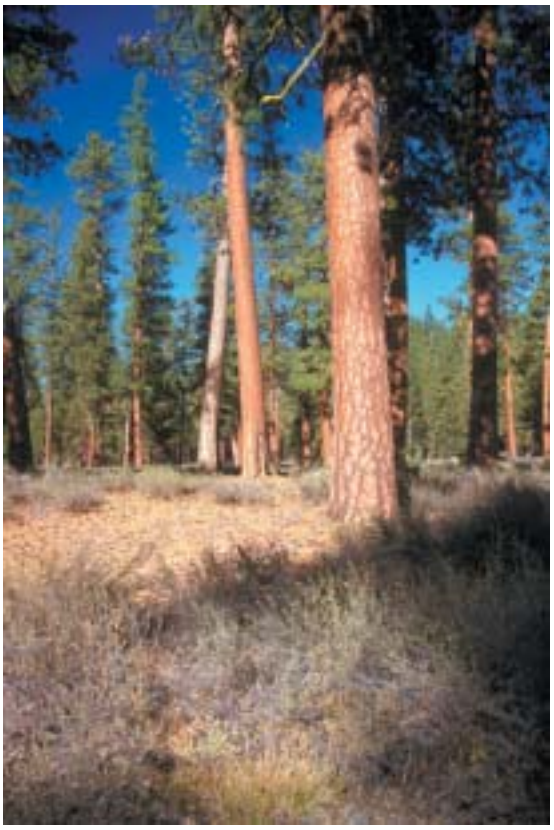
So would Glen and Sherry Barrow. The New Mexico couple spent a year analyzing the possibilities for marketing fiber the Forest Service hopes to remove from dying forests that abut Ruidoso, a town nearly overrun by wildfire several times in recent years. In the end they settled on livestock bedding and micro biomass power technology the Barrow's believe holds great promise.

"We're new at this, Ms Barrow says of the couple's backgrounds in marketing and horseracing. "Without the lab's research, engineering and marketing expertise we'd still be at square one. With their help we walked backwards from the market to the stump and identified 12 product possibilities. Now we are moving forward but I have to tell you we have taken a huge financial, emotional and personal risk to make this work."

Indeed they have. Although the couple won't say how much they've borrowed from lenders, Ms Barrow concedes that amount is "well beyond" the $400,000 in grants their company has received from various federal sources including the Forest Service and the Four Corners Initiative, a multi-state forest restoration coalition pioneered by Toby Martinez, former New Mexico State Forester.

"We never intended to apply for government grants, but getting them validated our business plan," Ms Barrow explained. "Without federal or state grant monies in the mix no private lender would have touched us. Believe me, it takes a lot of capital to get a business like ours started." Ms Barrow's husband, Glen, concurs.

"I don't want to take anything away from the forest products laboratory because they have been very helpful, but without a tremendous amount of public financing there is little hope for addressing the West's forest health crisis on scales that are economically and environmentally meaningful," he says. "Our state's sawmilling infrastructure is gone so, despite our very small size, we've become log buyers where, in the past, we probably would have built a less capital intensive business that purchased residues from sawmills."



Jim Petersen

Jim Petersen

If ever two photographs told the story of the benefits of forest management these two do. They were taken five miles distant from one another, in southern Oregon, along Highway 138 between Diamond Lake and Diamond Lake Junction. Although the decadent stand looks like a total loss, it still holds many trees that would survive and grow following thinning. Thinning would also reduce the risk of wildfire and disease in healthier nearby forests, while yielding some usable wood fiber.

Adding to the challenge, the Barrow's are already experiencing the same log shortages that plagued the area's sawmills for many years. But the problem facing SBS Shavings, which needs only 65 cords of wood weekly, isn't the result of timber sale appeals or litigation. In fact, there is quite strong local support for their company and, more broadly, forest restoration. And Ms. Barrow reports local national forest officials have also been very supportive, but in September the forest's entire restoration budget was transferred to the Forest Service's under-funded firefighting budget. Even the lab lost $5 million in already allocated funds.

"At some level the government does not seem to understand there are certain basic costs associated with owning forestland, one of which is the cost of thinning and stand tending," Mr. Barrow observes. "If we don't get some logs by winter, we'll be out of business. Federal logs are our economic lifeblood."

But the Barrow's remain confident this latest crisis will pass as the others have. Market response to their bedding has been good among horse fanciers across four states. And, Ms. Barrows adds, "Around Ruidoso we are all painfully aware of the need for science-based prescriptive forest restoration. There is a group will—a passion shared by the Forest Service, the lab, townspeople and us—to do this work in a way that will win wide public and congressional support. We'll never get rich at this, but we hope to make a decent living and provide some much needed employment in our community,"

So ends Lesson 1.

It is time to finish the job, time for Madison to again soar on the wings of its rich history.

"Our mission is targeted fundamental research. We are not a university. We are a public agency. Our customers are other government agencies, industries and, probably most important of all, our grandchildren. Our job is to look a generation into the future, determine what we will be doing and how it may adversely impact the environment, then design new processes that minimize the anticipated impacts."

Rajai H. Atalla, Senior Scientist, Chemistry and Pulping Research, Forest Products Laboratory, July, 2003 *Evergreen* interview

The United States is falling further and further behind in forest product research. Canada, Finland, Sweden and the European Economic Community are setting the global standard now. The economic and environmental implications for America's forests and forest industry are serious and poorly understood.

Last year the Canadian government unveiled a $75 million science and technology initiative "that will ensure that Canada's forest products industry remains prosperous and competitive." Finland is investing $35 million in "Wood Wisdom," a program "to promote the competitiveness of Finish forestry and forestry-based industries in today's changing operating environment."

Meanwhile, Sweden is funding a research center it says will keep the country's forest products sector abreast of competition through development of knowledge that enhances creation of new products, renews production processes and optimally utilizes the industrial potential of wood fibers produced in Swedish forests. Not to be outdone, the 34-nation European Economic Community has committed $1.5 billion to 16 sectors including agriculture and forestry, which will get about ten percent of the fund.

Here at home our federal government budgets about $26 million a year for research work underway at the Forest Service's Forest Products Laboratory at Madison, Wisconsin. A pittance for a country worried about keeping good paying manufacturing jobs here at home. But the symbiotic relationship that links Canadian and European governments to forestry and forest product manufacturers doesn't exist here. So to remain competitive in cutthroat global markets U.S. lumber and papermakers are shelving their own domestic research laboratories in favor of offshore investments, mainly in the Southern Hemisphere where land, labor and regulatory costs are much lower.

Stephanie Steck

One of the lab's most exciting innovations is a fiberized structural panel made from low quality, underutilized wood fiber. In their various designs, these panels exhibit high levels of strength and stiffness meaning that they can be used in myriad ways. Among the uses for these panels: bins, pallets, shipping containers, heavy-duty boxes, wall and roof panels, furniture, cement forms and doors

Let's be clear here. America's big lumber and paper outfits can take care of themselves. They always have. But the fact that our federal government is apparently surrendering its century-old role as the global leader in forest product research is very disturbing. So too is the not unrelated fact that we have become net importers of wood products manufactured in Canada, Brazil and Europe. A country that consumes nearly 350 million tons of wood annually—as we do—ought to be a lot more self-reliant. Have we learned nothing from decades of reliance on foreign oil?

The long-term environmental implications of our miserly approach to forest product research are even more profound than the more immediate economic impacts. How can we possibly pull treasured national forests back from the brink of ecological collapse if we do not find and develop viable commercial markets for the countless millions of tons of small trees scientists tell us must be removed as a first step toward reducing the ever-worsening risk of catastrophic wildfire?

Small landowners—the caretakers of most of our nation's privately owned forest acreage—face the same problem. Minus more robust markets for annual thinnings good forestry yields, the quality of these habitat-rich forests will begin to decline very soon. But the greatest burden is falling on entrepreneurs who are risking their capital—and taxpayer money—in vitally important efforts to commercialize small-wood product innovations perfected by the Forest Products Laboratory. But these

investments are all predicated on a yet to materialize flow of wood fiber from lands needing restoration. That's because the Forest Service has had to rob its restoration budget two years in a row to shore up its grossly underfunded fire fighting budget. Worse, lawyers representing special interest groups that oppose publicly popular forest restoration are using poorly written or conflicting environmental laws to block the work. This situation will change for the better if the Senate approves its version of the House-passed Healthy Forests Restoration Act. Until then our national forests will continue to burn, restoration will remain the exclusive domain of judges and business investment in small-wood technology and markets will lag far behind where it should be.

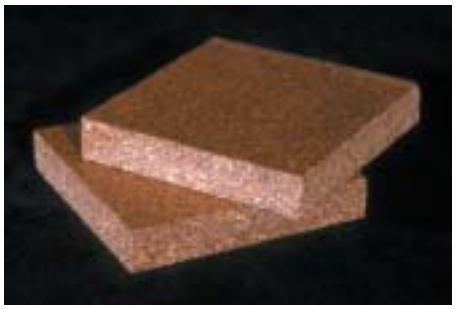
Meanwhile, countries that are serious about forestry and forest products research are eating our lunch. It's clear the Madison budget should at least match those of competing labs in Europe and Canada. But simply adding more scientists to the payroll won't solve anything. What's needed is a Marshall Plan for forest products research: one that encourages private sector reinvestment in domestic primary and secondary wood and paper plants, keeps us competitive in brutal global markets, solves the biomass-to-energy riddle, shelters impoverished millions in sturdy houses fashioned from molded corrugated waterproof paper, and creates more good paying jobs here at home—all while solving our country's most vexing environmental problem: what to do with millions of acres of trees grown so dense they are sucking the life out of the same forested landscapes they occupy, fueling uncommonly destructive wildfires.

We'd like to see Madison's scientists be given a leadership role in formulating and implementing this plan, not just because it is their tradition but equally because, despite meager funding, they are already making significant progress on all these fronts, including the final frontier: deciphering the gene codes that link cellulose molecules. It is time to finish the job, time for Madison to again soar on the wings of its rich history.

– Jim Petersen

Flooring for a dance floor made from western larch thinned from a privately owned forest in western Montana's Bitterroot Valley

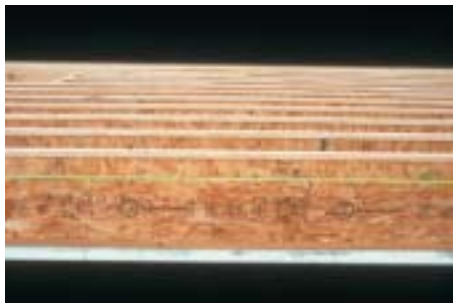
Lab scientists made this inexpensive fiber mat made from juniper. It is capable of filtering many contaminants from water.



Lab scientists have perfected a wide variety of composite manufacturing technologies including this one: 50 percent ground juniper and 50 percent recycled plastic.

Lab scientists are conducting a series of tests to improve drying techniques for low quality ponderosa pine, which often twists when dried.

So-called "demolition wood" salvaged from old buildings is another lab specialty. Here, re-sawn flooring recovered from an old military depot.



Engineered floor joists made from Douglas fir harvested from Tree Farms in Oregon and Washington are products of ongoing Madison research

Editors note:

We asked professional photographer Stephanie Steck to photograph several prototype products developed by the Forest Products Laboratory. Our only instruction to her was to "do something that will focus reader attention on the fact that it is possible to make useful products from useless trees." The quite striking black-lit close-ups you see here are the result.

We suppose some readers will object to our referencing "useless trees." It's true all trees serve some useful purpose, however small. But reducing the risk of wildfire in fire-prone forests rests on finding and developing efficient and viable markets for small diameter, low quality trees that are fueling increasingly frequent and ferocious wildfires.

These photographs leave no doubt about the fact that it is possible to develop prototype products from the trees scientists tell us must be removed. The question is will communities, entrepreneurs, investors and existing forest product manufacturers step to the plate. If they don't the public's forest management objectives—clean air, clean water, abundant fish and wildlife habitat and year-round recreation opportunity—cannot be met.

Jim Petersen

Arizona logger Jerrold Reidhead is dwarfed by a sea of trees he thinned from a Forest Service urban interface project near Alpine, Arizona in 2002. Mr. Reidhead qualified for a $75,000 matching federal grant to purchase a mechanical harvester more suited to the kind of thinning work nearby forests require, but with so much political uncertainty and nearly non-existent markets for this kind of fiber, he isn't sure he'll take the money. Mr. Reidhead's dilemma—and that of other loggers and sawmill owners—makes the lab's research all the more important.

"We will go anywhere anytime to work with landowners, sawmill owners, entrepreneurs, community groups, literally anyone interested in learning more about the product innovations that are the result of basic and applied research in small diameter wood utilization."

Sue LeVan, Program Manager,
Technology Marketing Unit

Jim Petersen

These logs from western Montana's Clearwater Stewardship Project will find their way into furniture markets throughout the West

"The presumption that low quality, small diameter trees harvested from federal lands—or any forest for that matter—are worthless simply is not true. The fact that we can take trees apart and reassemble them in different ways, forming different products, has changed everything. Now we have a basis for answering three very important questions: what is the quality of the wood that is available to us, what can we make from this wood and how can its quality be improved through better engineering."

David W. Green, Ph.D.
Project Leader, Engineering
Properties of Wood

Jim Petersen

There are no sawmills left in Arizona interested in coping with the uncertainties of the federal timber sale program, so it took months to find a market for these trees harvested from a restoration pilot project on the Coconino National Forest just west of Flagstaff

"This desk is not wood. It is a three-dimensional biopolymer composite commonly called wood, a word that greatly understates its value and potential. We've learned how to use it and how to work around the physical and dimensional limits we've imposed on its use. But by altering its chemistry, capitalizing on the fact that the tensile strength of cellulose is greater than steel, you can make a great many more things. You can even make a pretty good composite out of lawn clippings. I know. I've done it."

Roger Rowell, Ph.D.
Project Leader, Modified
Lignocellulosic Materials

"Improving the quality of forests, both east and west, rests on finding ways to process, utilize and market low value wood, which is growing in abundance in forests from coast to coast to coast. We are in an interesting transition period in this quest. Our ability to design and engineer high performance wood products from small trees has fundamentally altered the relationship between wood product manufacturers, architects, building code writers, builders and homeowners."

Robert J. Ross, Ph.D., Project Leader, Wood Engineering and Drying Systems Design Criteria

The Evergreen Foundation: Exploring the art and science of forestry

The Evergreen Foundation is a nonprofit forestry research and educational organization dedicated to the advancement of science-based forestry and forest policy. To this end, we publish Evergreen, a periodic journal designed to keep Foundation members and others abreast of issues and events impacting forestry, forest communities and the forest products industry.

In our research, writing and publishing activities, we work closely with forest ecologists, silviculturists, soil scientists, geneticists, botanists, hydrologists, fish and wildlife biologists, historians, economists, engineers, chemists, private landowners and state and federal agencies responsible for managing and protecting the nation's publicly owned forest resources.

All statistical information appearing in Evergreen is taken from publicly supported federal and state forest databases in place since the 1950s. Industry information is also used, but only when it can be independently verified.

All Evergreen manuscripts are reviewed before publication to ensure their accuracy and completeness. Reviewers include those interviewed as well as scientists, economists and others who are familiar with the subject matter. While not a peer review, this rigorous process makes for strong, fact-based presentations on which the Evergreen Foundation stakes its reputation.

Evergreen was founded in 1986. Initial funding came from a small group of Southern Oregon lumber companies interested in promoting wider citizen involvement in the federal government's congressionally mandated forest planning process. In the years since its founding, Evergreen has assumed a much wider role, providing public forums for scientists, policymakers, landowners, federal and state resource managers and community leaders across the nation.

Support for our educational mission comes from Foundation members and other public and private sector organizations that share our commitment to science-based forestry. We also generate revenue from reprint sales - and from "Our Daily Wood," a hand-finished four-pound wood block that is the volumetric equivalent of the amount of wood fiber consumed ever 24 hours by every person on Earth.

The Foundation operates under Internal Revenue Service 501(c)(3) regulations that govern the conduct of tax-exempt organizations created for charitable, religious, educational or scientific purposes. As such, we do not lobby or litigate. Forestry education is our only business. Contributions to the Foundation are tax deductible to the full extent the law allows. There is a membership application card in the centerfold of this magazine. For more information, contact Kathleen Petersen, Development Director, The Evergreen Foundation, P.O. Box 1290, Bigfork, Montana or log on to our website at www.evergreenmagazine.org

Jim Petersen

Lookout Pass on the Idaho-Montana border: the Great 1910 Fire started near here. It destroyed more than three million acres of old-growth timber in less than 48 hours. Across much of the West, the threat of another 1910-scale wildfire looms large.