Forest Products Laboratory

Conserving Our Forests Since 1910

1932–present

1910–1932

1910

USDA United States Department of Agriculture

Forest Service

Forest Products Laboratory

From the Director

Since 1910, our mission at the Forest Products Laboratory has been to conserve and extend America's wood resources through the use of science and technology.

Think about that for a moment. It is a daunting challenge. And through over 90 years of research projects—ranging from preserving railroad ties to building better homes to improving wood and paper recycling rates—the Forest Products Laboratory (FPL) has had a profound effect on shaping our Nation's landscape.

Our purpose is not to promote the use of wood simply because it is an excellent building material, or because its chemical composition makes it useful for a wide variety of uses, such as paper. It is because sound conservation practices that promote the long-term sustainability of our forests include efficient utilization. We provide tools to forest managers so that they can properly care for and maintain our Nation's forests.

Illustrious names surround our beginnings. FPL was created through the efforts of Teddy Roosevelt and Gifford Pinchot, the first Chief of the Forest Service. Aldo Leopold served as FPL Assistant Director from 1925 to 1927 and helped define our mission. His legacy lives on in FPL research. Through improved efficiency and technological innovations, we continue to sustain forest ecosystems and the communities that depend on them.

For instance, our Western States have recently suffered catastrophic losses due to wildfires. One reason is the buildup of dense undergrowth in our forests resulting from years of successful fire suppression. When fires break out, this undergrowth serves as fuel, feeding fires and making them burn hotter and more destructively.

In the past, the small-diameter material that makes up most of this undergrowth had little value. FPL researchers are addressing that problem by creating products and uses that make it economically feasible to take this small-diameter material off the land. The result makes our forests healthier, provides economic opportunities for rural communities, and saves money for the taxpayer.

Chris Risbrudt, Director
USDA Forest Service
Forest Products Laboratory

Or our Advanced Housing Research Center. What does housing have to do with Forest Service Research? Well, when you consider that there were more than 1.5 million housing starts in the United States last year, you begin to realize the impact housing has on our forests. Promoting the efficient use of wood and using recycled material save trees. We are also developing environmentally sensitive preservatives and promoting the use

of wood salvaged from large deconstruction projects, such as closing military bases.

Practical, commonsense solutions to conservation problems like these have been the cornerstone of FPL for over 90 years.

We are also working to prevent invasive species from taking over our land. In the past, the careless transport of unprocessed forest products has introduced devastating exotic fungi and insects into the United States. The fungi that caused Dutch elm disease reached the United States on raw logs in the early 1900s. Insects such as the gypsy moth, Asian gypsy moth, and the recently discovered Asian longhorn beetle are other examples. The disastrous results of these pest introductions demonstrate the need for caution when importing unprocessed forest products.

Clean water is another vital area we are working on. Roosevelt and other visionary conservationists realized early on that forests serve an important role by cleansing our watersheds. It is one of the primary reasons that they established our National Forests. Still, much of the water available for human use today is polluted. An estimated 90% of all Americans live within 10 miles of a body of contaminated water. FPL researchers have learned that filters made from wood and agricultural fibers can remove significant levels of contaminants such as heavy metals, oils, pesticides, and agricultural run-off from water. In the near future, communities might be able to use locally available and cheaply produced fibers in their filtration systems.

These are just a few of the many things we are working on at FPL that affect your daily life. The Forest Service motto is “caring for the land and serving people.” We at FPL have been doing our part now for close to a century and very much look forward to the next 100 years.

The New Century of Service is the Forest Service ideal that combines past traditions and core values with new thinking and a fresh spirit of service. It offers a forum to encourage and share new ways of doing our work and building relationships so we can improve the health and vitality of the land. The Forest Products Laboratory is working toward the future with the goal of providing a New Century of Service.

Research Initiative: Housing

Improving Our Nation's Housing: The Advanced Housing Research Center

The Forest Products Laboratory knows there's no place like home. And homeowners and builders alike are always looking for new ways to make their homes more comfortable, durable, and energy efficient. To reach that goal, the Forest Products Laboratory established the Advanced Housing Research Center, where researchers will continuously study new ways to make America's housing the best it can be.

Research at the Center evaluates and develops cutting edge technologies for all types of residential structures. The goal is to develop practical technologies that can be readily adopted by homebuilders for high-quality, affordable home construction. Emphasis is placed on the following areas of research:

- Improved use of traditional wood products
- Use of recycled and engineered wood composite materials
- Durability and moisture control
- Energy and sound efficiency
- Indoor air quality
- Improved living environments
- Natural disaster resistance

The Center is also evaluating the latest theories and ideas in water conservation and recovery.

In addition to being recognized as a world leader in these housing-related areas, the Forest Products Laboratory also conducts research in areas such as material design and performance, coatings and finishes, preservatives, adhesives, biodeterioration, and composites.

Many of the materials used in housing today were developed through basic research at FPL in coordination with academia and industry. FPL has also played a very active role in technology transfer and the development of codes and standards to move new technologies into use.

To continue this successful trend, the Advanced Housing Research Center will build on the following areas of current housing research:

- Improved designs for housing in high wind areas
- Effects of moisture on engineered wood panel products
- Durability of hardboard siding
- Development of wood/nonwood composites using recycled materials
- Use of recycled lumber for construction
- Improved utilization of secondary wood species for engineered wood products

Our Research Demonstration House: A Showcase of Proper Building Practices

Built on the grounds of the Forest Products Laboratory, this unique house is a laboratory in itself. The house will be used to study the effects of moisture (page 6) and other building-related concerns for the next several years.

Open to the public…
The Research Demonstration House is the showcase piece of FPL's Advanced Housing Research Center. This 2,200-square-foot house is a center for continuing research on important issues—such as moisture intrusion and mold—that concern today's homeowner. Also on display in the house are technologies designed to improve the safety, affordability, durability, and energy efficiency of America's housing.

The four-bedroom, 2,200-square-foot house demonstrates moisture-resistant construction techniques and proper building practices.

The demonstration house also features the latest innovations in wood product technologies:

- **Permanent Wood Foundation:** In place of concrete walls we installed a wood foundation. The advantages of this method include the ability to install the foundation under any weather conditions, shortened construction time, ease in changing wiring and plumbing, and enhanced design flexibility.
- **Small-Diameter Wood Floors:** We used flooring made from small-diameter Douglas Fir to showcase how a low-value material can be made into a high-value product. Thinning these trees from the forests is necessary to reduce the risk of catastrophic fires, but it is also very costly. Finding profitable uses for this material helps make thinning forests an economically beneficial option for rural communities.
- **Engineered Wood Products:** Products such as finger-jointed studs, oriented strandboard, I-joists, and glued-laminated beams are all featured in the house. Because they are produced from underutilized materials, these products make the most of our wood resource and save a great deal of material from being landfilled.
- **Wood-Fiber–Plastic Composite Shingles:** These locally produced composite shingles were made from recycled plastic milk jugs and sawdust, yet they resemble hand-split wood shakes. This product is unique because it uses waste products to produce a heavy, durable roof cover. These shingles require no special fasteners or unusual installation procedures, and they are expected to last 50 years.

Our Research Demonstration House is just the beginning of an extensive educational outreach program, which was designed to demonstrate better building practices and will continue as a research facility for housing-related issues.

Conservation in Your Backyard

The grounds surrounding our research demonstration house are as much of an innovative learning tool as the house itself.

With the help of the Natural Resource Conservation Service, the landscaping around the house was designed to demonstrate a variety of backyard conservation methods.

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These various practices can improve the environment by increasing food and shelter for birds and other wildlife, controlling soil erosion, conserving water, and improving water quality. They also simply make your yard more attractive and enjoyable and even improve safety.

You don't have to be a major landowner to practice conservation. This landscape plan done by the Natural Resource Conservation Service for FPL's Research Demonstration House reflects the latest landscape techniques in backyard conservation. The plan shows simple steps you can take to improve wildlife habitat and save water and energy.

Whether you have acres of land or a small lot in the city, you can do your part to protect the environment and add beauty and interest to your surroundings. Take a look at some of the features of our landscaping to get ideas for yours!

Moisture in Homes: A Priority for the Advanced Housing Research Center

Mold has become a top concern in housing-related issues today. Stories of toxic mold in homes and other buildings have flooded the news and become a widespread topic of discussion.

The Forest Products Laboratory plans to do its part in solving this growing problem by monitoring moisture movement in the Research Demonstration House and also building a new test facility with the following capabilities:

- Measure water intrusion into typical residential walls
- Measure how quickly the walls dry out under various indoor and outdoor conditions
- Monitor any mold growth and determine species of mold
- Determine the potential for structural damage
- Determine the potential damage to paint surfaces
- Assess the potential for reduced indoor air quality due to mold

This unique test facility would enable researchers to measure the effects of wetting and drying cycles under controlled, but realistic, conditions. Researchers will be studying the effects of rain, wind, sun, temperature, and humidity on different designs and construction techniques.

Moisture research has already begun in our demonstration house, where the walls are wired to instruments designed to measure moisture movement.

Multi-billion dollar problem: Water damage or moisture intrusion if left untreated can result in mold growth. Although there are more than 100,000 species of mold, only a handful are toxic, and most that are routinely found are not hazardous to healthy people. But overexposure or certain types of mold can cause allergic reactions, asthma, rashes, and respiratory problems. Due to escalating claims and costs, many insurance companies are now limiting mold coverage. In Texas alone, the top five insurance carriers paid more than $1 billion in mold settlements during the past 2 years, according to the Texas Department of Insurance.

A Useful Alternative to Demolition: Wood-Frame Building Deconstruction

An estimated 245,000 buildings are torn down each year in the United States. Imagine the debris that results from this practice…and where does it all go?

Unfortunately, much of it goes to landfills. Millions of board feet of lumber are thrown away each year, so it's not surprising that construction and demolition materials now make up 25% of our Nation's landfill waste.

Researchers at FPL have been looking into ways to ease this disposal problem. One potential solution to this problem is the deconstruction of buildings scheduled to be demolished.

Deconstruction is the careful dismantlement of structures in order to recover valuable building materials for reuse and recycling.

If building deconstruction and lumber salvage were to replace demolition and landfilling, over a billion board feet of high-quality lumber could be reclaimed for reuse each year.

A promising market for these reclaimed materials is in structural framing and millwork for new construction and remodeling.

Conserving our forests and helping families in need
An estimated 1 billion board feet of lumber from demolished wood-frame structures is disposed of each year in our landfills. Carefully dismantling buildings and reusing the wood minimizes landfill waste and saves our forest resource. Here Americorp volunteers disassemble buildings at Fort Campbell, Kentucky. The sale of these materials at Habitat for Humanity ReStores raises money to build houses for needy families.

Currently, FPL researchers are addressing the technical barriers to reusing wood. They are testing factors such as strength and stiffness in order to develop standards that will allow the reclaimed lumber to be reused in home construction.

The advantages of deconstruction are many:

- Environmental benefits—Less material is being sent to landfills.
- Economic benefits—Reselling salvaged materials can offset the cost of deconstruction, often making it less expensive than demolition.
- Increased employment—Deconstruction can be linked to job training programs where workers can gain experience in construction and material recovery.
- Quality materials—Recovered materials are often of higher quality and less expensive than new materials.

A Prime Example

FPL researchers have been focusing their attention on Badger Army Ammunition Plant near Baraboo, Wisconsin.

The 7,300-acre plant is being abandoned by the U.S. Army and is a promising candidate for deconstruction.

The timber in these structures is some of the last of our Nation's once vast old-growth forests. Badger Army Ammunition Plant likely contains a wealth of high-quality lumber that has great potential for reuse.

We estimate that of the 1,500 buildings at Badger, the largest 77 could contain 4 million board feet of usable lumber. As many as 300 new homes could come from this reclaimed wood and it would save the harvesting of more than 17,000 trees on 600 acres of forest land.

A prime example in Wisconsin…
Millions of board feet of high-quality lumber reside in some of the 1,500 buildings at the Badger Army Ammunition Plant near Baraboo, Wisconsin. (These pictures are from various military bases around the country.) Reusing this lumber will save trees and decrease the amount of waste going to our landfills.

Research Initiative: Clean Water

Improving an Invaluable Resource

Water is essential to life. In the United States alone, we use about 400 billion gallons of water each day. Although we have an abundance of water in America, the quality of this resource remains a problem.

According to the Environmental Protection Agency, 90% of Americans live within 10 miles of a contaminated body of water. It is also estimated that 40% of America's streams and lakes are not clean enough for common uses such as fishing and swimming.

In response to this startling problem, the Forest Products Laboratory is conducting several research programs aimed at improving the quality of our Nation's water.

Wood-Fiber Water Filters: One Product, Numerous Benefits

The development of wood-fiber water filters is one way the Forest Products Laboratory is helping clean America's water.

Researchers have learned that filters made from readily available wood and agricultural fibers can remove significant levels of contaminants from water.

Contaminants such as heavy metals, oils, pesticides, herbicides, and phosphates can be removed with the use of low-cost wood-based fiber mats. These filters can be used for watershed restoration, land reclamation, soil remediation, and cleanup of pollution.

Recently, wood-fiber filters have been placed in Ohio's Wayne National Forest to remove heavy metals from a stream contaminated by an acid mine. Preliminary test results showed that the filters are able to remove most of the iron and aluminum from the stream.

Amazingly, these fiber mats have several other benefits as well. The wood fiber for the filters can be processed from materials that need to be cut to improve forest health. For example, juniper fiber needs to be cleared from land in the West, and juniper appears to be one of the most effective fibers for removing contaminants.

But the benefits don't stop there—along with having a positive environmental impact, wood-fiber water filters can provide an interesting economic opportunity for many rural communities.

Creating a marketable product for fibers such as juniper will increase the demand, giving local communities an opportunity to profit from this once useless and overabundant tree. Also, communities with polluted water can manufacture and use their own locally produced, low-cost wood-fiber filters to clean their water.

Cleaning our water and improving forest health
Wood-fiber filters are very effective at removing many types of pollutants and can be made cheaply from a variety of locally available species. They are also recyclable and biodegradable.

High-Quality Paper From an Earth-Friendly Process

Although the paper industry continues to comply with increasingly tougher environmental regulations, papermaking processes such as bleaching can still affect our water supply.

Traditional methods of bleaching pulp for paper are chlorine based and use large amounts of water. The process also generates chlorinated hydrocarbons and large volumes of wastewater.

In response to this concern, researchers at the Forest Products Laboratory have developed a new bleaching method that reduces the impact on our water supply. The method uses polyoxometalates (POMs), an inorganic enzyme, to bleach pulp. POMs have the ability to remove lignin (the "glue" that holds wood together) without damaging the cellulose needed to make paper.

The benefits of POM bleaching are numerous:

- POM bleaching is not chlorine based, so it creates nothing more than carbon dioxide and water as by-products.
- POMs are reusable and have the ability to bleach pulp without damaging the fibers.
- POMs give paper mills the ability to bleach small-diameter and mixed species pulp, which hasn't been possible with other methods.
- POM bleaching requires only 0.2 cubic meters of water per ton of pulp, compared with the 20 to 40 cubic meters used in traditional bleaching. This new method of bleaching produces paper with the same properties as that produced by traditional chlorine-based bleaching, and it does so in a much cleaner way.

Richard Reiner of the University of Wisconsin assembles a reactor in preparation for a test run of the POM bleaching process. Polyoxometalates mimic naturally occurring enzymatic processes to bleach pulp, removing lignin from wood without damaging the cellulose (fiber). FPL research has proven that POM technology works on an industrial scale. Our research is now focused on improving the economics to make the technology even more attractive to industry.

USDA Forest Service Chief Dale Bosworth gets briefed about FPL pulp and paper research in our pilot plant by FPL assistant director Ted Wegner. The large wooden beams (called “glulams,” meaning glued and laminated) you see in the background have supported the roof of the pilot plant since 1967. FPL research was instrumental in establishing the use of glulam beams.

Research Initiative: Biobased Products

Creating Healthy Forests and Healthy Economies With Biobased Products

Our country's forests are a highly valuable, renewable resource. Biotechnology and biobased products are two ways in which the Forest Products Laboratory is looking to extend this resource.

With the help of FPL research, our Nation's forests have the potential to become major sources of valuable materials, such as chemicals, liquid fuels, and pharmaceuticals. They also present the opportunity for economic growth through processes that restore forest health while creating new businesses and employment opportunities in rural communities.

FPL is working toward creating biobased products that benefit the forests and the economies that rely on them. These products include bioenergy, solid wood, composites, and wood-fiber products that can be produced from the small-diameter timber that needs to be removed from our forests to restore their health. Using this wood for value-added products will offset the cost of removal and give rural communities the opportunity to develop businesses based on these materials.

More than 70 million acres of our National Forests contains small-diameter trees that need to be thinned to reduce the risk of fire and disease. Depending on the type of treatment used, thinning costs can range from $200–500 an acre or more. Finding high value uses for this thinned material can offset some of the cost. This is just one way that FPL research benefits the American taxpayer.

Ethanol: An Alternative Fuel Source

Ongoing research in the United States has been aimed at developing alternative energy sources to reduce our dependence on foreign oil and nonrenewable energy.

The use of ethanol has increased in recent years as an alternative energy source. Ethanol is derived mostly from the fermentation of corn starch, but as the demand for ethanol increases in coming years, it will greatly exceed the supply that can be economically produced from corn starch.

To address this increased demand, FPL is researching ways to derive ethanol from biomass other than corn starch. Biomass includes materials such as agricultural wastes (such as corn hulls and corn cobs) and other woody materials.

Researchers at FPL will also need to focus on making the process economically feasible and highly productive.

Alternative energy sources such as ethanol can decrease our dependence on foreign oil. Most ethanol now comes from corn. In the near future, the demand for ethanol will exceed what can be supplied form corn, so FPL research is focusing on other sources for ethanol, such as wood.

Currently, researchers are studying the conversion of sugars to ethanol. The key to converting wood to energy is converting five- and six-carbon sugars to ethanol. The process for converting six-carbon sugars is well established, but five-carbon sugars, which make up about 30% of the sugars in wood, have presented a problem.

FPL has developed the capability to ferment the once-problematic five-carbon sugars to ethanol and is working toward a process that will convert five- and six-carbon sugars simultaneously. This capability will make it possible for a much wider variety of materials to be converted to ethanol.

Researchers estimate that ethanol from wood can make a significant contribution to the liquid fuels market, replacing as much as 30% of the petroleum used.

Taking Pressure off Our National Forests Using Tree Plantations

FPL researchers are exploring the potential for short-rotation tree plantations as a source of wood for our Nation's use. These planted trees would free large areas of natural forests from pressures to supply industrial wood, which helps preserve their natural diversity and wildlife habitat.

Tree plantations would consist of fast growing species and could be customized to meet production needs. For example, hybrid poplars could be planted for production of wood products such as pulp and oriented strandboard panels, and coppice willow could be planted for energy or chemical uses. Plantations would increase the availability of wood and therefore lower the costs of wood and wood products.

Tree plantations can alleviate some of the pressure for wood from our National Forests, allowing National Forests to retain their natural diversity and wildlife habitat.

Photo courtesy of Biltmore Estate, Asheville, North Carolina.

Gifford Pinchot, the first Chief of the Forest Service, summed up the mission of the Forest Service—

"To provide the greatest amount of good for the greatest amount of people in the long run."

FPL research helps us meet our need for wood products while conserving our forests and minimizing environmental impacts.

Research Initiative: Environmental Technologies

Working To Keep America's Forests Healthy and Their Users Happy

People demand a lot from our forests. Jobs, recreation, and a strong economy are desired, but so is a clean environment that includes healthy and diverse forests. Unfortunately, environmental health can be jeopardized by the need to use the forests for other means.

FPL is developing new technologies to resolve this conflict between market demand and environmental concerns. These cost-effective environmental technologies are aimed at meeting the needs of both people and forests.

FPL research focuses on conserving forest timber and fiber resources while reducing environmental problems associated with the production, conversion, use, and disposal of forest products.

Preserving our forests
FPL research helps our forests in a variety of ways—whether it's designing stronger, more durable buildings, looking at more effective ways to recycle paper, studying how fungi decay wood, or creating high-value products from undesirable wood that needs to be thinned to improve forest health.

Extending Our Forest Resource With Composites

Composites are an effective way to achieve sustainable forestry. Whether using under-valued small-diameter timber, fire- or disease-prone timber, or paper and wood wastes to make these composites, they are always an effective way to extend the forest resource. The process keeps waste out of landfills, helps add value to under-used timber, and saves additional trees from being harvested while creating jobs and economic opportunities.

In our continuing efforts to promote sustainability of forests, composites are desirable because they can be engineered to possess specific properties and serve specific functions. Unlike conventional lumber, composite products can be molded to finished dimension, be curved or edged as needed, or improved with performance-enhancing treatments.

These characteristics allow composites to be used for a wide variety of products. Pallets, automotive parts, window and door profiles, exterior signs, roofing, siding, and decking can all be made from composites.

Jim Muehl, FPL Forest Products Technologist, demonstrates the process of creating a composite panel by blending the wood fiber and plastic together, forming a mat from the blended materials, pre-pressing the mat prior to hot-pressing, and loading the formed mat into the hot press to create the finished panel.

The three primary composite types are wood-based composites, wood-fiber–thermoplastic composites, and inorganic bonded wood composites (wood cement). FPL research has already determined that wood-fiber–plastic composites can be produced from recycled materials. Continuing research will increase the compatibility of recycled fibers and extend their range of use.

Wood–plastic composites are strong yet lightweight, making them ideal for the automotive industry.

These signs are made using juniper fiber mixed with plastic. Juniper is a problem species that needs to be removed from many areas in the southwestern United States.

Finding Uses for Juniper: One Success Story

The vast grasslands of the southwestern United States are being invaded by juniper, a troublesome tree for the environment there. The trees have made their way onto the rangelands as a result of overgrazing of cattle and fire suppression, and they currently cover an estimated 60 million acres.

The presence of juniper is contributing to a number of ecological problems for these lands. The tree's wide, deep roots lower the water table, preventing the native shallow-rooted grasses from surviving. This situation also contributes to severe erosion and pollution of streams and lakes.

Unfortunately, although there is plenty to go around, juniper is not a very useful wood. The labor-intensive harvesting and costly processing have limited its use to firewood and fence posts.

FPL researchers have discovered that juniper can be made into an excellent composite when mixed with recycled thermoplastics. Researchers used this composite to make a product that helps solve the environmental and economic issues as well as another prickly problem:

Porcupines have an appetite for plywood. They devour highway signs and route markers and cause extensive damage. Researchers made new signs out of juniper composite and placed them in the Cibola and Kaibab National Forests. Thus far, the signs remain untouched, and juniper has a new use. That's good news all around…except, of course, for the porcupines.

Advancing Recycling Techniques

Although paper recycling rates are relatively high, the most commonly used types of paper—printing and packaging grades—have the lowest recycling rate. This low rate is a result of problems that develop during the recycling process.

Common problems include low brightness, high contaminant levels, and low paper strength. Because of these defects, recycled materials are often made into low-grade products such as newsprint, tissue, and boxboard.

Several of the environmental technologies that FPL is developing address the technical barriers of paper recycling. Advanced technologies are being developed to more easily remove inks and adhesives from recycled paper and retain paper strength, improving its overall quality.

Once determined, these technologies will help make recycled materials into all grades and types of paper and paperboard.

A Recycling Breakthrough

Commonly used items such as stamps, labels, and "sticky notes" wreak havoc on recycling processes. The pressure-sensitive adhesives (PSAs) used on these products lower the quality of recycled paper and gum up recycling equipment.

FPL and a team of adhesive manufacturers, printers, and paper manufacturers teamed up with the U.S. Postal Service, a significant user of these adhesives, to work on a solution to this problem.

FPL researchers worked with PSA suppliers to develop a new pressure-sensitive adhesive that can be recycled without causing problems in the machinery or affecting paper quality. This innovation will allow up to 20 million more tons of mixed office wastepaper to be recycled annually in the United States.

No more licking!

The U.S. Postal Service Tropical Flowers stamp was the first issued with a new pressure-sensitive adhesive that FPL helped develop.

Using Fungi to Improve Pulping

The papermaking process is often a topic of discussion when it comes to environmental concerns. Despite the paper industry's continuous adherence to environmental regulations, there is always room for improvement.

The most widely used pulping method for making paper is Kraft pulping, which uses chemicals to soften the wood chips. This process produces sulfonated hydrocarbons and other by-product wastes that must be treated before being released into surface water.

Mechanical pulping is an alternative chemical-free pulping option, but it is not as commonly used as Kraft pulping. And although the process does not use chemicals, it does use a great deal of electrical energy.

In a search for a more environmentally sound pulping method, the Forest Products Laboratory has come up with a way to make the nonchemical mechanical pulping process more efficient and less energy intensive.

The newly developed process is called biopulping. This natural process works in conjunction with mechanical pulping and reduces energy consumption by 30%.

What's the secret? Wood decay fungi are used to soften the wood chips before mechanical pulping, making the pulping process easier and requiring much less energy. Amazingly, biopulping produces nothing more than carbon dioxide and water as by-products, so it is very environmentally friendly. As an added bonus, the biopulping process results in paper with greater strength than that produced by conventional pulping processes.

Wood chips are inoculated with naturally occurring wood decay fungi to soften them before mechanical pulping. This treatment reduces energy consumption in the pulping process by 30%.

Access Board: Creating Safe, Accessible Playgrounds

America's playgrounds are meant to offer a good time for all who enter. One of FPL's newest projects is working to ensure that everyone is able to participate in the fun.

Traditionally, playground surfaces have been covered with loosely piled wood chips called engineered wood fiber (EWF). At a cost of just $1.00 per square foot, EWF is a cost-effective way to improve playground safety. However, as playground designers begin to incorporate accessibility features into their designs, traditional EWF does not meet their needs.

The loosely piled chips are difficult for wheelchair and walker users to navigate. The shifting and uneven surface makes it difficult to roll or move across.

Alternative products, such as bonded rubber or synthetic foam, increase playground accessibility, but at a cost of $8.00 to $15.00 per square foot they are an expensive option.

So researchers at FPL started looking for ways to make a more cost-effective, accessible playground cover. They came up with a variation of the original EWF that makes all the difference.

Scientists bonded the top layer of wood chips with binders such as silicone, polyurethane, and latex. This bond forms a resilient, yet flexible, mat that allows for easy navigation of wheelchairs and walkers. Underneath this layer, the loose chips still provide cushioning for falls and excellent rainwater drainage.

Preliminary tests show that the stabilized EWF is successful as a low-impact, high-safety surface that is wheelchair and walker accessible. Cost estimates indicate that this new surface will add only $1 to $3 per square foot to the price of traditional EWF, making it a viable option for many more communities

Safer playgrounds
Wood fibers bonded together can make an accessible, safe, and affordable playground cover.

Nondestructive Evaluation: Assessing Wood in Use

A common way of testing the strength of a piece of wood is to break it and then measure how much pressure it was able to withstand before it failed.

Often this is a perfectly suitable testing method. But what if the piece of wood that needs testing is contained within, say, a 200-year-old ship?

That's the challenge that FPL scientists were met with when they were asked to help with the restoration of the historic USS Constitution.

Old Ironsides, as the ship is referred to, is the oldest floating commissioned ship in the world, and it is still a part of the U.S. Navy. When the ship was brought in to dry dock for restoration in honor of its 200th birthday, FPL was called upon to determine the condition of its solid wood hull.

Researchers used a technique called nondestructive evaluation (NDE) to determine the condition of the ship's wood.

NDE is a technique that uses sound waves to assess the quality of wood. An ultrasonic pulse is sent through the timbers, and depending on the speed of the sound wave, the location of decay can be detected.

For the USS Constitution project, NDE was able to determine which pieces of wood needed to be replaced without dismantling the entire ship.

NDE has also been used for other historic renovations. This technique was used in the restoration of Grey Towers, the home of Gifford Pinchot, who was a conservation pioneer and the first chief of the Forest Service.

NDE is useful in other applications, as well. It is often used to evaluate in-service bridges and other highway applications.

Even live trees can be evaluated with this method. NDE can be used to determine the quality of wood in standing timber, and thereby determine what management practices are best for growth rates of trees and the wood that results.

Saving our historic treasures
Nondestructive evaluation techniques have been used to test wood in many historic structures, including Grey Towers, the home of Gifford Pinchot, the first Chief of the Forest Service and the USS Constitution (Old Ironsides).

Little Fungi Take on Big Responsibilities

The mycology unit at the Forest Products Laboratory is putting decay fungi to work for our environment. These fungi may be small, but they have the potential to play a huge role in improving several aspects of our environment.

One way these fungi can be helpful is by easing the impact that treated wood could have on our environment. Treated wood is not easy to dispose of. Whether burning or landfilling, strict regulations must be followed so that harmful contaminants are not released into the environment. Researchers are studying decay fungi that can degrade waste wood and remove the preservatives from treated wood before it goes to landfills. This eliminates the possibility of preservatives leaching into groundwater.

Preservatives and treated wood
FPL research evaluates preservatives used in sensitive ecosystems, such as this wetland. We're always looking for effective treatments that will minimize environmental impacts. The disposal of treated wood is another problem we're tackling. Our research shows that naturally occurring fungi can help metabolize some of the potentially harmful chemicals found in treated wood before disposal.

Another big job that decay fungi may be able to tackle is decreasing the amount of fuel for forest fires. After logging or thinning forests, leftover slash covers the forest floor, creating a perfect fuel for a raging fire. Scientists at FPL are looking at ways to use fungi to make the slash decay faster. Decayed wood is helpful to forests, and this would reduce the amount of fuel in a fire.

Technology Transfer

Putting Our Research to Work for You

The Technology Marketing Unit (TMU) plays a key role for FPL by getting the results of our research to people who can use them. This unit works with many partners to transfer wood-based technology to the public.

The Technology Marketing Unit is a part of State and Private Forestry, one of the three main branches of the Forest Service. The TMU improves the use of wood through technology transfer, which links forestry and conservation with people.

The many duties of the TMU range from technical assistance, communications, and networking to patent and licensing, marketing, and technology marketing.

For the past three years, the TMU has concentrated its efforts on providing technical assistance to rural communities. This work helps to restore our Nation's forests and energize the economies of rural, forestry-dependent communities.

(Left) Workshops and demonstrations at the SmallWood 2002 Conference in Albuquerque, New Mexico, informed participants of the many potential uses for small-diameter wood.

(Above) John "Rusty" Dramm, FPL Forest Products Technologist, gives technical advice to the operator of a post and pole peeler. Technical assistance is just one way that the Technology Marketing Unit puts FPL research to use.

Working to Restore the Balance

In the interior West of the United States, more than 61 million acres of National Forests and millions more in public and private forests are in critical need of restoration.

These forests are declining in health because of major changes over the years in forest composition. These changes are a result of past management practices and fire suppression. The forests have become much more dense, with fewer large diameter trees and more small, tightly spaced trees and underbrush.

This trend has negatively impacted the growth of native trees and plants and diminished the quality of wildlife habitat and watersheds.

The new forest composition also has other, more devastating results, such as catastrophic wildfires. The densely packed material on the forest floor creates a ladder-type fuel that can lead to high-intensity crown fires, which spread quickly and result in total loss of entire stands of trees. Such loss can cause major alterations to forested landscapes and watersheds. Densely packed forests are also prone to epidemic insect infestation and disease.

Restoring these forests, through mechanical thinning or prescribed burning, will remove most of this small-diameter material and reduce the risk of disastrous fires or infestations. However, thinning is extremely expensive, costing much more than the current value of the thinnings. If new, value-added uses for these thinnings could be developed, forest restoration would cost less.

In addition to improving forest health, removal of small-diameter material offers another major benefit: Forest-dependant rural communities are currently faced with diminishing timber supplies, loss of jobs, high unemployment, and declining community vitality. The Technology Marketing Unit can help these communities find business opportunities in forest restoration.

The TMU is helping many of these rural communities with programs that are exploring the value of small-diameter material and evaluating new technologies that could improve its use. These technologies could be the basis for new businesses in the communities.

Finding profitable uses for this material will restore our Nation’s forests while rejuvenating the economies of forest-based communities.

Tech Transfer in Action

The Technology Marketing Unit's work with forest-based communities gave FPL a chance to shine at the 2002 Winter Olympics in Utah.

The TMU helped several small businesses with the engineering plans and technical assistance needed to construct two visitor information kiosks out of small-diameter material.

These kiosks were built in hopes of building market acceptance for using small-diameter round timbers as a structural building element.

One kiosk, built by Wallowa Resources and Bronson Log Homes, located in Enterprise, Oregon, served as a visitor center for the America's Public Lands Coalition. The other structure was built by the Bitterroot RC&D Council and Porterbilt Post & Pole. These businesses are located just south of Hamilton, Montana, a forest-based community hit hard by the devastating forest fires of 2000. This kiosk is located in the mouth of Ogden Canyon and will continue to serve as an information center for recreation opportunities in the area.

By working with businesses in forest-based communities, the TMU hopes to promote the use of the small-diameter resource, which would aid in the restoration of our forests and boost local economies.

Information on how to obtain engineering plans for the kiosks can be found on the TMU website (www.fpl.fs.fed.us).

FPL at the Olympics
These information kiosks built for the 2002 Winter Olympics demonstrate the structural capability of small-diameter timber. Finding high-value uses such as this can offset some of the cost of forest thinning.

Turning Wood Into Energy

Rural communities may be able to diversify and expand their economies by turning wood into energy.

The TMU has been working with the National Renewable Energy Laboratory (NREL) to demonstrate the use of small-scale biopower units burning waste wood chips to create electricity.

The units being developed by NREL hold tremendous opportunities for both offsetting some local energy needs and using forest residue. However, the units are still in the pre-commercial phase, and more work needs to be done to bring down the cost of the units and to gain a better understanding of their operation and maintenance.

To determine the extent to which these units could benefit communities, TMU and NREL are conducting a nation-wide demonstration program. Units will be set up in six communities for up to two years.

This program will help determine the capability of these units to offset energy needs for a single operation, such as a school or community center.

These units have the potential to become a new source of energy, making good use of forest thinning residue and reducing our dependence on foreign oil.

Turning waste wood into energy
New technologies being tested by FPL and the Department of Energy can help rural communities meet energy needs, improve forest health, and boost local economies.

Our Strategic Plan

The mission of the Forest Service is to:

"Sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations."

The mission of the Forest Products Laboratory directly supports the mission and goals of the USDA Forest Service:

To identify and conduct innovative wood and fiber utilization research that contributes to conservation and productivity of the forest resource, thereby sustaining forests, our economy, and our quality of life.

Some Interesting Facts About Forest Products Consumption in the United States

With a current population of approximately 280 million, the annual harvest of roundwood in the United States is on the order of 350 million tons. Three hundred million tons are used for forest products and 50 million tons are used for energy. Annual consumption of all forest products in the United States is approximately 225 million tons. By 2050, consumption of forest products is expected to reach over 330 million tons per year.

In 2000, approximately 1.8 million housing units were constructed in the United States. These housing units used about 21 billion board feet of lumber, 20 billion square feet of panel products, and 641 million lineal feet of I-joists. It is estimated that over 3 trillion board feet of lumber has gone into structures over the past 100 years.

Currently annual paper and paperboard consumption is approximately 100 million tons. Nearly 90% of all consumer and industrial goods shipped in the United States include some form of corrugated container or solid fiber partition or cushion made from wood-derived fiber. In 46 of the 50 states, the forest products industry ranks among the top 10 manufacturing employers.

These figures show that forest products are essential to our daily living and the health and functioning of our economy. They also demonstrate that the consumption of forest products has a big impact on forests, forest resources, and the environment.

Currently only about 21% of all forest products consumed in the United States are being recovered for recycling and reuse. Almost 50% of all postconsumer paper and paperboard is recovered for recycling. However, the two largest volume types of paper produced utilize very low amounts of recycled fiber. Solid-sawn wood and composites recycling is negligible despite over 30 million tons of construction and demolition waste wood being readily available for recovery.

Linking and reconciling sustainable management of forests with sustainable utilization of forest resources is critical. This is the goal of the Forest Products Laboratory. We can make significant contributions to maintaining and improving the health, condition, and sustainability of our forests.

Our Vision

To be the world leader in innovative wood utilization research that improves our quality of life while conserving wood and fiber. In reaching our vision, we will help create a future in which people throughout the world will benefit from healthy forests and grasslands that provide roundwood, solid-sawn wood, composites, fibers, chemicals, energy, and other renewable materials in a sustainable manner.

The Forest Products Laboratory is

- dedicated to scientific excellence, problem-solving research, innovative technology development, and proactive technology transfer,
- an unbiased source of relevant technical information,
- responsible and accountable for efficiently conducting quality research and development, and providing well-documented, reliable results, and
- a diverse organization committed to honesty, integrity, fairness, teamwork, and public service in its organizational culture.

Institutional Strengths

The Forest Products Laboratory draws strength from its

- freedom to carry out innovative and collaborative research,
- strong national and international connections to academic institutions, related research institutions, forest resource managers, and the forest products industry,
- ability to conduct utilization research on all major wood uses, including roundwood, solid sawn, composites, pulp, paper and paperboard, and energy,
- historical reputation for unbiased high-quality scientific and technical information,
- ability to address all aspects of wood use questions with a broadly experienced, highly trained, and well-educated work force, and
- connection to the Nation’s National Forest System and forestland management.

Our Laboratory has distinguishing features in that we

- are the only national Federal wood utilization research laboratory in the United States,
- collaborate with a broad spectrum of interested parties,
- have strong ties to the forest products industry and academic institutions,
- are able to maintain continuous expertise on a broad range of mission-related wood utilization issues,
- are able to address problems with broad interdisciplinary expertise,
- relate our research closely to the needs of the American public,
- have a long history of accomplishments and problem solving, and
- have a worldwide reputation as a source of independent, impartial information.

Forest Products Laboratory Long-Term Strategic Research Objectives

- Advance fundamental science
  - Develop novel technologies that allow new and emerging utilization issues and problems to be addressed effectively and efficiently
  - Improve our knowledge of wood's chemical, mechanical, and biological properties
  - Provide economic market models to evaluate the impact of prospective changes in technology and market conditions
- Conserve the wood resource
  - Develop technologies to improve recovery efficiency, recycle and reuse, and extend the service life of wood and wood-based materials in all major end uses
  - Develop and promote technologies for economic use of underutilized material
  - Obtain greater raw material conversion yield, improve end-use performance, increase durability, and overcome reuse and recycling problems associated with existing and projected supplies of wood fiber
- Promote forest-related ecological, economic, and social sustainability
  - Develop technologies that increase product recovery from traditional wood supplies
  - Develop new and improved technologies to use low-value, underutilized forest resources (for example, thinnings, small-diameter timber, unmerchantable species, mixed species) in roundwood, lumber, composites, chemicals, energy, pulp, paper, and paperboard
  - Develop standards for design, fabrication, and testing of structural components from low-value timber
  - Link economic wood use to sustainable forest management options

- Provide information that supports natural resource policy development
  - Project current and expected future wood supply and demand
  - Link economic wood use to sustainable forest management options
  - Analyze current and expected changes in wood processing technologies
- Assure safe, reliable, durable, and disaster-resistant performance of wood in structures
  - Develop information, as needed, on performance and properties of wood and wood-based materials
  - Promote the use of wood in conjunction with other materials whose strengths complement those of wood
  - Develop empirical data and predictive methods to estimate the in-service behavior and performance of construction
  - Develop technologies to promote wood durability
  - Develop technologies to protect and restore wood structures subjected to natural disasters
- Help solve critical problems facing the U.S. forest products sector related to wood-based environmental issues
  - Develop clean and efficient processing technologies and evaluate their market prospects
  - Provide technologies for use of “low-value” timber
  - Identify and promote technologies that improve water quality
  - Assess and improve materials used for wood preservation
  - Provide an expanded renewable energy source
- Provide a high level of service to the public
  - Use innovative techniques to transfer new technologies, provide timely and accurate responses to inquiries, and communicate new information
  - Promote advances in science and technology by participating in scientific societies, publishing groundbreaking research, and establishing performance standards

For more information:

www.fpl.fs.fed.us

FPL at a Glance

The long-term health of our Nation's forests depends on sound conservation practices, including utilization. Founded in 1910, the Forest Products Laboratory in Madison, Wisconsin, uses science and technology to conserve and extend our Nation's forest resources. Our mission is to promote healthy forests and forest-based economies through the efficient, sustainable use of our wood resources.

Some Annual Statistics (Approximate)

Employees: 250

Publications: 275

Presentations & Speeches: 250

Information Requests: 2,500

Site Tours: 150

General tours of FPL are available Monday to Thursday at 2 p.m. If you have a specific interest, please call to coordinate a tour.

How To Contact Us

For more information, visit our website (www.fpl.fs.fed.us) or contact us at

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