

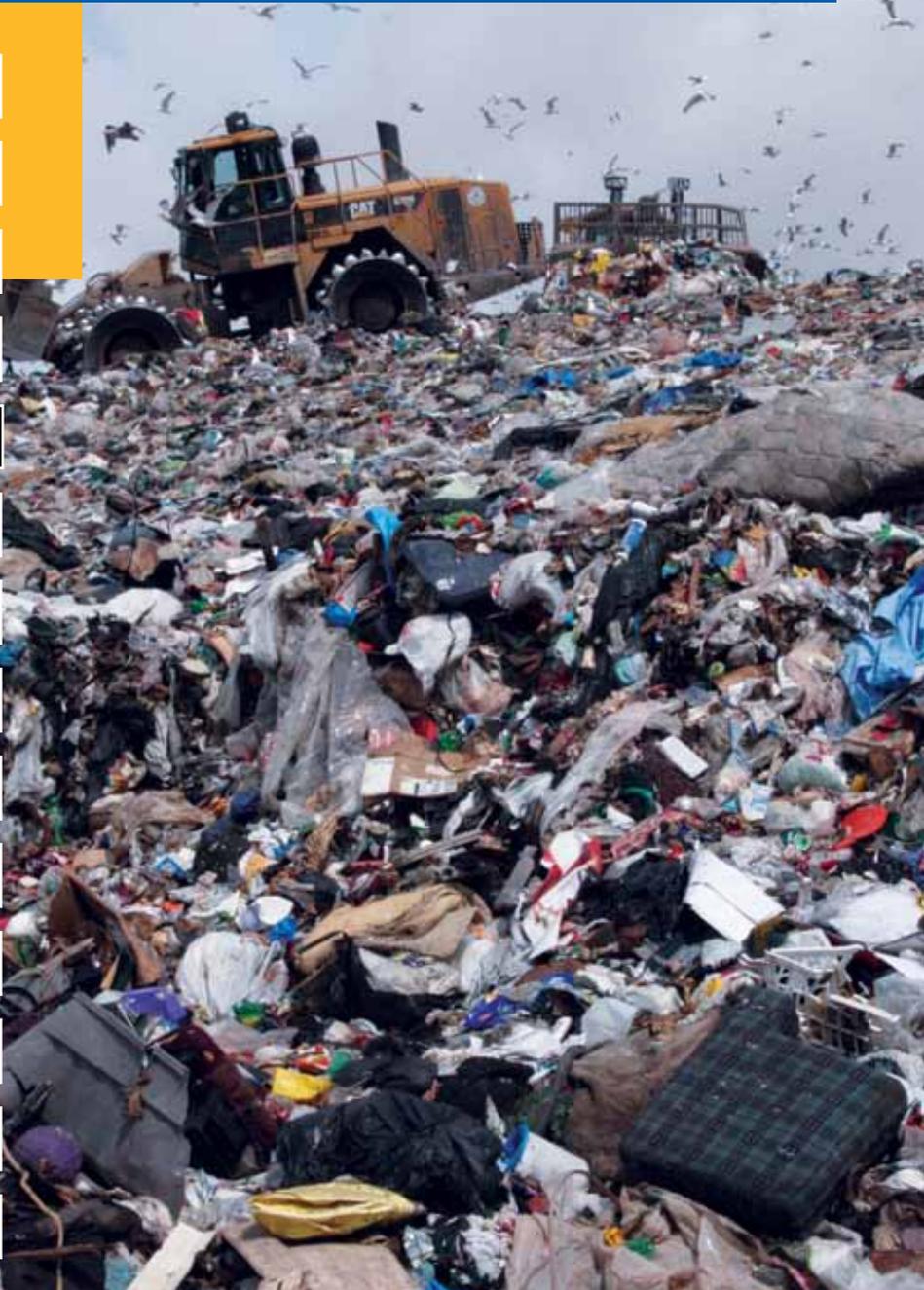


NATURAL RESOURCES RESEARCH INSTITUTE

NRRI *Now*

Autumn 2012

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Focus on the future! NRRI research for sustainable communities

Across the University and throughout NRRI, the focus is sustainability

By Mindy Granley

Paper or Plastic? The answer to this simple question we hear at grocery stores can sometimes divide families and friends. Some people may cite the amount of energy and water used for production of a paper bag as they chose the plastic option. Others conjure up an image of a large vortex made up of plastic bits floating in our oceans, as they chose paper. Others think of regional forestry jobs, or using fossil fuel as a raw material. Often times, the answer to the question is easy: bring your own bag. (Assuming one doesn't leave their reusable bags at home!)

But, what is sustainability? That question can't be answered with one single viewpoint or one simple choice. The answer is more complex, and can be shaped by each person's individual experience. Some might view sustainability as limiting our choices. But, it is actually about making choices available for not just us, but for future generations. How can we leave the world a better place? How can we save natural and economic resources for future generations? Finding answers to some of these difficult questions is part of what NRRI does.

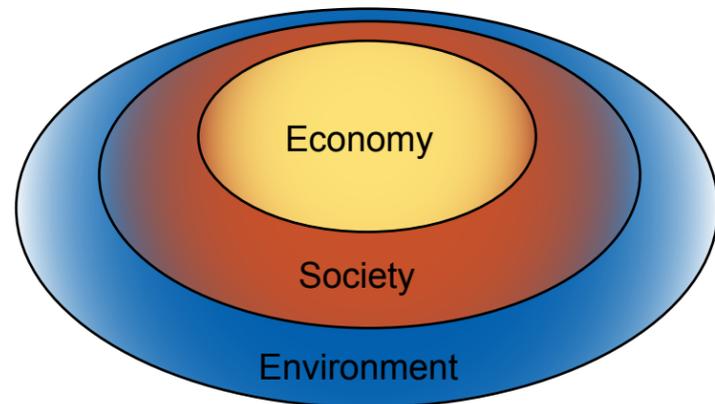
The University of Minnesota Board of Regents policy on Energy Efficiency and Sustainability defines sustainability as "a continuous effort integrating environmental, social, and economic goals through design, planning, and operational organization to meet current needs without compromising the ability of future generations to meet their own needs." Integrating environmental, social, and economic goals was the reason NRRI was created almost 30 years ago, and it continues to be their mission today. The stories in this newsletter are inspiring. By finding new uses for the wasted stems of a soybean plant and unearthing new markets for reclaimed old-growth wood, NRRI is helping both the economy and the environment. By sharing results of research on invasive mussels and indicators of coastal health, NRRI supports decision-making for both the economic and environmental bottom line.

As part of UMD, NRRI is a key contributor to the campus core value of sustainability. The UMD Strategic Plan also includes goals to infuse the concept of sustainability across the curriculum, reduce campus greenhouse gas emissions, and revise the master plan for the future of our campus. Whether educating future leaders, conducting research, modeling sustainable operations, or being a leader in adopting new technologies and techniques, UMD strives for sustainability. By sharing our progress (and setbacks) with our students and our community, we can promote adoption of environmentally, economically, and socially sound choices.

To sustain our society we'll have to transition from our gift of fossil fuels and look for alternatives and local resources. We'll have to embrace the idea that there is no real "waste," and that most everything can be recycled or repurposed, including "waste" from industrial processes. We will have to study how various species are responding to changes in our world. We'll have to find ways to improve the environment while creating and sustaining jobs. Through their research, NRRI is working on these - and many more - critical issues for Minnesota.



Mindy Granley



The economy is dependant upon the environment and the society which built it, not the other way around. Remove the economy, even the society, and the environment will survive. In this region, we are intimately aware of our dependence on the environment. NRRI is focused on maintaining a balanced relationship between society's economic needs and the environment.

On the cover: The landfill in Superior, Wisc., summer 2012.

NRRI business partner shines as leader in green manufacturing

By Greg Benson

As the owner of Loll Designs and Epicurean I am often asked why we strive to be a sustainable company and what that means to me. We take a very holistic approach to this. Environmental health, a healthy exterior and interior work space, energy efficiency, manufacturing process efficiencies to reduce waste in all forms, especially pollution, are all considered. The core principals of sustainability are profit, environmental consciousness, and a commitment to bettering our community.

Profit simply means the business is economically viable. Profit allows us to invest back into the company and continue to grow which in turn allows us to hire more employees. Profit also enables us to invest in projects that help our community and employee welfare. Loll Designs and Epicurean have an inherent dedication to creating local jobs. Being based in West Duluth, we draw employees from as far up the shore as Two Harbors, into Northwestern Wisconsin, and of course the Duluth metro area. Creating jobs stimulates our local economy which helps to build a stronger community. Most of our products are sold outside of the local area so we bring money into our local economy that can be spent here by our employees.

Our environmental commitment is at the center of what we do. We built a new office and manufacturing facility in 2005 that

we call Hawks Boots Sustainable Manufacturing Facility. Our mission was to create a modern, sustainable manufacturing plant from an existing brownfield building - an abandoned industrial



Gregory A. Benson

facility. Our goals on the project were clear; low impact land use, energy efficient design and construction, reduced water consumption, reduce all forms of pollution, and it was very important that we do this with community support. Our approach to this project was simply a mind set on how we approach our business. Our entire business model has been to make products from what most people see as waste. I would like to think that Hawks Boots offers a sound model for forward-looking industries in our community.

When I speak about bettering our community I include our employees since we are all part of it together, whether at work or not. Continuing to offer better benefits and higher pay will directly have a positive impact on our employees and, in turn, help the community. We focus locally by donating money to environmental organizations based in Duluth and Minnesota. We have also donated a considerable amount of products each year for educational fund raisers in our community. This "give back" model has helped us in so many ways as a business, as a powerful recruitment tool, and a cohesive marketing strategy. It also gives our company stability and efficiency that gives Loll Designs and Epicurean staying power in a global economy that has a lot of competition.

Green Results

Goodwill Mattress Recycling

Since June 2004, 110,659 mattresses have been recycled.

15.5 tons of steel are recycled monthly.

Loll Designs

Recycled 5.9 million plastic milk cartons in 2011.

Epicurean Cutting Surfaces

Recycles about 90,000 pounds of paper and cardboard a year for their products and also uses Forest Stewardship Council certified material.

Peatland Restoration

334 acres of drained peatlands restored to sphagnum bog and another 126 acres are on their way to complete restoration in Zim, Minn.

Moose Research

One million moose locations were gathered to help researchers understand forest management practices.

Taconite Tailings in Road Projects

Tens of millions of tons of iron mining waste rock are produced on Minnesota's Mesabi Iron Range every year. NRRI is exploring new uses for these abundant resources, like road surfacing compounds, pothole patch materials, and construction aggregate.

wow.org & Iss.org

300,000 web users learned about water science and the Lake Superior watershed in 2011.

Biofuels for the future

Targeting turkey farms could launch renewable fuel in Minnesota

It's hard to have a conversation about sustainable resources without addressing the fact that fossil fuels simply are not. And our collective dependence upon that finite resource is indisputable.

That's why NRRI is doing what it can to promote biomass – wood or agricultural residue – as a renewable heating/cooling option. When pelletized for use in specially made furnaces it is cost efficient for residences and businesses heated with propane, which continually fluctuates in price. But beyond cost savings, it makes even more sense for poultry producers.

Why? Minnesota is the largest turkey producing state in the country and keeping those birds warm requires a lot of propane fuel. Propane generates moisture in the air and that moisture mixed with animal feces is a potential health hazard to the workers and the birds.

"To burn one gallon of propane you're putting 6.3 pounds of water on the feces, and they're not burning one gallon. They're burning tens of thousands of gallons," said Jim Eiyneck, owner of Advanced Bioheat in Becker, Minn. "The bedding is always wet which increases the ammonia by 60-70 percent. The key to healthy turkeys and workers is dry bedding."

Biomass pellet furnaces produce a very dry heat which is proving to be beneficial to a local turkey producer, Park Hill Turkey Farms, who installed wood pellet forced air furnaces in their barns in 2009.

"It's much better for the animal because it keeps the litter dryer. They seem healthier," explained Ryan Dahlgren, poultry manager at the farm.

NRRI researcher Tim Hagen thinks that starting to move biofuel furnaces into the Minnesota poultry industry will showcase its value to other businesses and homeowners currently on propane.

"Right now propane costs a bit higher per million BTU than wood pellets, but propane is starting to be exported from the U.S. and that will drive the price up," said Hagen. "Heating oil is another volatile commodity. Wood is renewable, clean and stable. We can source it locally and that keeps the money local, too."

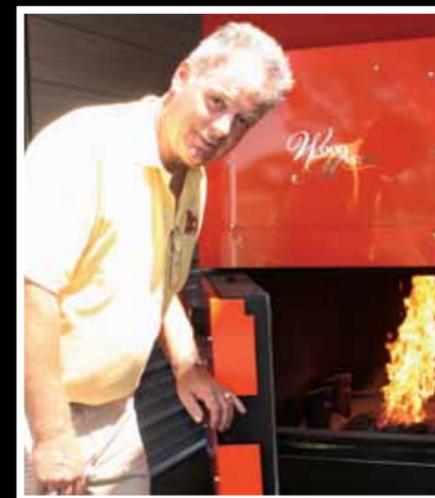
Eiyneck has the sole distributor license to sell a commercial forced-air pellet furnace that houses Scandinavian technology and is built in Red Lake Falls, Minn. Northern Minnesota pellet furnace users include Wolf

in this area, we'll get overrun," said Seger. "There will be a need for other local pellet plants. That means local jobs and another fuel source that's not fossil fuels... and more productive turkey farms. It's good for everyone."

NRRI is part of a larger effort to move biomass pellets to market. The Agricultural Utilization Research Institute (AURI) developed and published an extensive Minnesota Biomass Heating Feasibility Guide that outlines fuels and

technologies and also provides information about requirements to set up and operate such a system. The group is also planning a scientific study of pellet heat on poultry health to quantify anecdotal information. Lastly, demonstration heating trials in poultry operations are needed.

"Our goal at NRRI is to help create markets for Minnesota wood," said NRRI Program Director Brian Brashaw. "This could be a great opportunity to increase biomass fuel consumption in highly efficient, commercial thermal systems. With very low emissions, these new biomass boilers and furnaces are a big improvement over older units."



Jim Eiyneck of Advanced Bioheat in Becker, Minn.

Full steam ahead for biocoal!

Research at NRRI helps fuel first green locomotive

NRRI Researcher Tim Hagen describes torrefaction as roasting – similar to what happens to coffee beans. And whether you're roasting coffee beans or biomass, the result is increased energy. Now, NRRI's research on torrefied biomass is on track to fuel the first and the fastest carbon-neutral passenger locomotive.

Project 130 is the brainchild of the Coalition for Sustainable Rail, a collaboration of Sustainable Rail International and the University of Minnesota's Institute on the Environment. The plan is to turn a mothballed 1937 locomotive into proof-of-concept for using this biocoal. The project has been nominated for the 2012 Katerva Award, considered the "Nobel Prize" of sustainability.

Torrefaction makes processed wood into a higher quality fuel source for combustion or gasification applications. The darkened and pelletized renewable resource is easily densified, grinds easily, repels water and does not rot, making it easier to ship and store than unprocessed wood. It basically becomes a renewable, coal-like fuel with net zero carbon emission, and reduced ash, sulfur and mercury.

NRRI's research included testing 10 different Minnesota tree species for their responses to torrefaction and to select densification processes.

"Different tree species respond differently to the processing," explained Hagen. "We had to test how much pressure and at what temperatures they would each hold together while still being water-repellent."



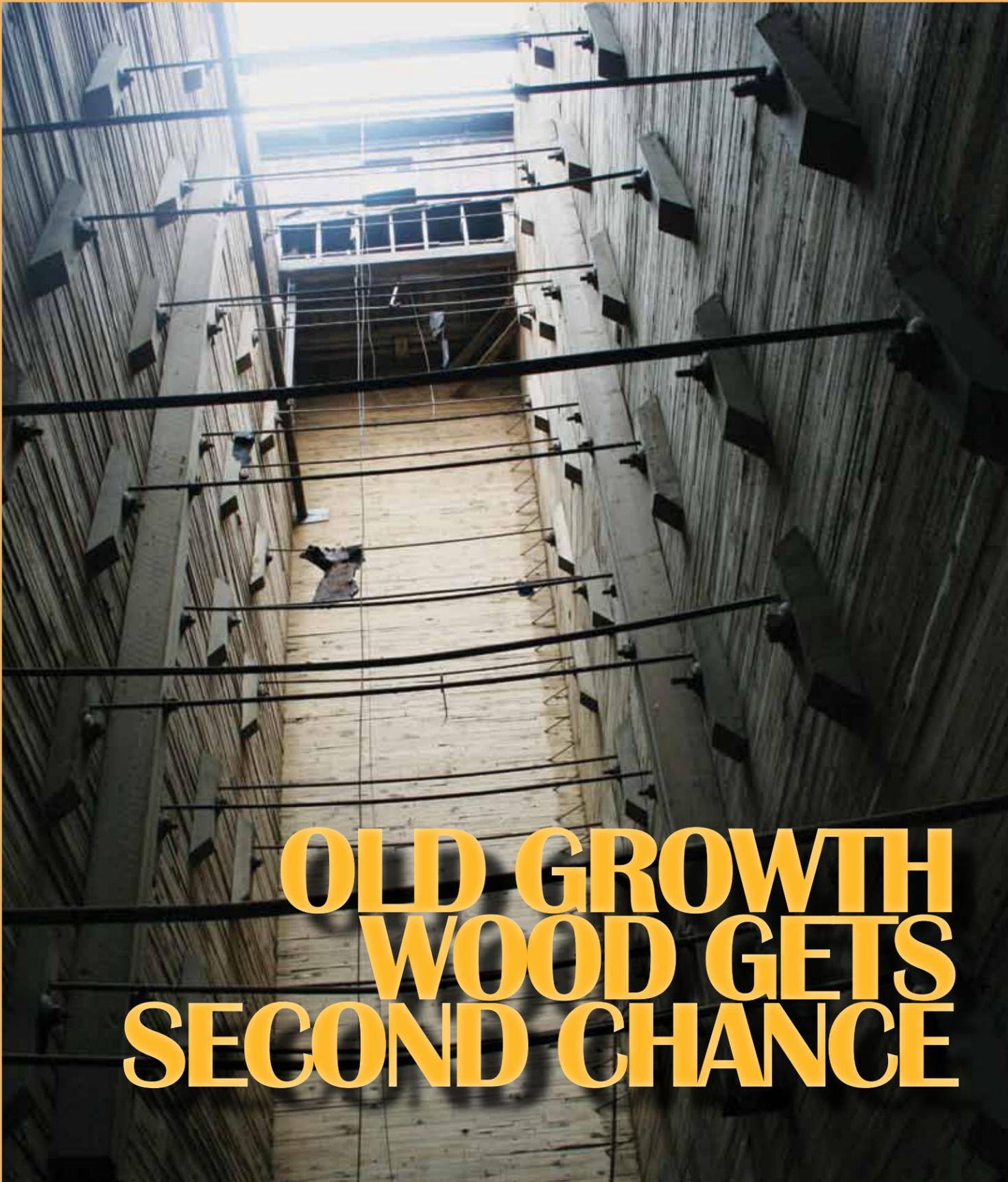
Regular and torrefied pellets.

NRRI's pilot scale facility is now working with Project 130 in categorizing and developing a body of torrefaction research to support its goals. One long term research goal is to develop a facility capable of providing the hundreds of tons of biocoal needed to fuel the locomotive and other end users that have been identified by NRRI.

Davidson Ward, president of the Coalition for Sustainable Rail, explained that these efforts aim to draw attention to the promise of torrefied biomass not only as a sustainable transportation fuel, but also as a potential source of carbon-neutral, renewable combined heat and power in developing countries.

The Katerva Award recognizes and rewards "paradigm-busting ideas" that create change toward a more sustainable world. Project 130 is among some 300-plus projects worldwide nominated for this year's award. Learn more about Project 130 and keep up with the project's progress at www.csrail.org.

Institute on the Environment writer Mary Hoff contributed to this article.



OLD GROWTH WOOD GETS SECOND CHANCE

Company reclaims white pine in 125 year old grainery

“There’s a whole forest in those buildings. The idea that it would get plowed under or go to a landfill was just hideously unacceptable.”

Judy Peres remains optimistic at the task in front of her – dismantling the remaining five million board feet of old growth white pine in the walls of the Globe Grain Elevators. Built in 1887 and sitting idle since 1998, the gigantic structures rendered the Superior, Wis., harbor property useless. But Peres and her partner David Hozza saw the vast wood resources as a thing of beauty and hoped that others would agree.

Hozza started Wisconsin Woodchuck in 2005 and started taking down Building One: the Head House. Eventually Peres joined him and started Old Globe Reclaimed Wood Company, the marketing end of the business. Unfortunately, the work was not as straight-forward as taking down the wood and selling it.

“Every time we turned around there was a new problem to solve,” said Peres. “We thought we’d sell the timbers as they hit the ground and then pay the crane contractor. But after three months and a hefty bill, there was still no wood on the ground. We had to get our own crane and work on our own timeline.”

Now one million board feet have been sold to venues such as Whole Foods regional headquarters

in Chicago, the University of Wisconsin-Eau Claire’s new student center, and Amsoil Arena at the Duluth Entertainment & Convention Center. And with some experience behind them, the next five million feet should go more smoothly. So the next hurdle is developing more markets for the antique wood. The couple turned to NRRI to help with product development.

“We brain-stormed with them about how to best utilize the wood, how to dismantle most efficiently and what products would have the most market value,” said Patrick Donahue, director of NRRI’s Market-Oriented Wood Technologies program..

To increase its performance as a commercial floor product, for instance, NRRI tested a process of infusing the wood with acrylics. They also researched product ideas that wouldn’t require so much dismantling, like table tops and large wall pieces.

At the heart of the operation is the labor of love for the Eastern White Pine forests that were once so plentiful in this region, and saving the forests we have today.

“If people can use this wood, then there are trees that don’t have to be cut down,” said Peres. “This is the kind of thing that you would never do if you knew how hard it was going to be. But the wood is gorgeous.”





From land to harbor to land again

Dredged sediment from shipping channels proving to be inexpensive local soil

The summer of 2012 offered Duluth an exaggerated display of something that's been happening quietly for decades... largely unnoticed by most. The steep hillside, streams and tributaries regularly send soils from the land into Lake Superior. This was painfully obvious after the Flood of the Century turned the harbor water brown with mud.

Watershed erosion occurs whenever water flows, just not as dramatically as recently witnessed. And as the soils settle to the bottom of the harbor, some also settles in the navigation channels maintained by the U.S. Army Corps of Engineers, making them too shallow for the heavy tonnage traffic. To keep the ships moving, the Corps dredges the channels and, historically, dumped the sediment into the deep waters of Lake Superior. The Clean

Water Act of 1972 put an end to this practice.

In response, the Erie Pier Confined Disposal Facility was created in 1979 as a storage area for sediment dredged from the bottom of the channels. But now Erie Pier is nearing capacity. New solutions are being sought by the Corps and NRRI is helping to recycle the material.

"Thanks to the Clean Water Act, the dredged soil is cleaner than it was decades ago and it has a higher nutrient content after being in an anaerobic environment," explained Richard Price, research agronomist at the U.S. Army Engineer Research and Development Center. "But it can be put right back on the land for a lot of uses. I call it Dredge 360, it's a complete cycle."

Lack of space for dredged soils is a problem in many harbor towns. Recycling the soil on the land is one solution. Other sustainable options include minimizing watershed erosion on the source or creating wetlands with the dredged sediments in the lake's near shore zones.

Last summer, with project funding support from the Corps, dredged material from Erie Pier was trucked to the Moccasin Mike Landfill in Superior, Wisc., for a pilot scale demonstration. An area measuring about 100 by 400 feet that had been disturbed by a sewer installation project was covered with 1,100 yards of the dredged material. In July, Price and colleague Michelle Bourne toured the site to see how well the new top soil performed. NRRI Senior Research Fellow

Larry Zanko and the NRRI project team organized the demonstration project, coordinated the logistics and have been monitoring the progress.

"This is a significant accomplishment for showing a beneficial reuse of dredged soils," Zanko explained. "It's Wisconsin's first permitted upland use of dredged materials and the first time we've crossed a state border with this material. It can open a lot of doors for recycling these soils."

The researchers checked the site for any invasive plants that might have travelled with the dredged soil. Purple Loosestrife is the most noxious but is being controlled with herbicides, mowing or hand-pulling. The site is performing well and the team talked about future uses of dredged soils at the landfill, including topping filled waste sites.

Northland Country Club in Duluth also agreed to try the dredged soil on a trial basis. When three large trees were uprooted by a storm, the gaping holes were filled with dredge material and seeded. Chief

Groundskeeper Chris Tritabaugh said he's pleased with the results and will use it again as projects come up.

The soils are tested for contaminants, assessed for possible risks and then designated for appropriate uses. The goal is to find local, large scale uses for the dredged material, like the 30,000 cubic yards used to provide topsoil cover for a portion of a 6,000 acre mine tailings basin at a U.S. Steel site in Keewatin, Minn. The site was covered in the fall of 2010 and today native trees and grasses have reclaimed the area for wildlife habitat. It's being monitored and treated for invasive plants and additional mine land uses are being planned.

"We're basically reclaiming top soil, getting it out of the harbor and back on the ground," said Zanko. "And if we can extend the life of the Erie Pier site by removing and beneficially re-using the material, that's better for everyone."

SEDIMENT REMEDIATION

Near the end of 2010, about 30,000 cubic yards of sediment were sent to Keewatin Taconite (Keetac) by the Corps; NRRI has been monitoring growth.

NRRI's recent/current demo projects with the Corps included:

1. Moccasin Mike landfill, Superior, WI: 1100 yards (turf restoration)
2. Atlas Cement site, Gary-New Duluth, 2000 yards (pilot test for mitigating high pH in surface water runoff).
3. Northland Country Club, Duluth: 500 yards (for various golf course construction needs, such as re-establishing turf in disturbed areas and for maintenance projects)

Additional mine land uses are being planned. The goal is to establish vegetation on disturbed sites, tailings areas, etc. Up to 10,000 cubic yards of sediment could be used.

The canary in the coal mine

A variety of species help scientists measure environmental impacts



Piles of zebra mussel shells along the shores of Lake Ontario.

“We want to live near aquatic resources without overly harming them. That’s sustainability,” said NRRI Aquatic Scientist Valerie Brady. “And if we want to know how well we’re taking care of these resources, one way is to ask the critters how they are doing.”

Those “critters” would be the bugs, birds, frogs, and fish that live in or near the water, and the plants that they rely on. NRRI turns to these flora and fauna as bioindicators of the condition of the near-shore regions of the Great Lakes. Coastal sampling done in the early 2000s allows the scientists to monitor changes over time. NRRI also uses bioindicators to monitor water quality in northland streams.

“Remarkably, the Great Lakes’ coastal areas haven’t been well-monitored in the past, and those are the areas where we interact most with the water... where we fish and play and swim,” said Brady. “And 75 percent of fish use coastal wetlands at some time during their lives. Coastal areas are extremely important ecosystems.”

NRRI’s crew of 24 spent the summer travelling from the north shore of Lake Superior to the far eastern end of Lake Ontario. They collected water and sediment samples, noted aquatic communities,



and updated information on invasions by non-native species. The northern Minnesota crews also saw things they don’t normally encounter.

“Further east we were seeing shores with zebra mussel shells piled high and green blobs of decaying algae along the shore,” said Brady. “The shells are sharp and it really smells bad. Nothing we’ve seen on Lake Superior looks like that, and we want to do what we can so it never does.”

With some 1.7 million documented species on Earth, it’s important to understand which species are most effective as bioindicators. Birds, for example, are especially useful because they live in every environment – from forests to grasslands to cities – and they’re easy to count, according to NRRI Ornithologist Jerry Niemi.

“We can easily monitor their population trends and then tie that to specific habitats,” Niemi explained. “And habitat loss is one of the major reasons for population decline. That’s well-known.”

NRRI scientists have built up a rich understanding of the biota of the freshwater resources of the Great Lakes. Invasive plants and fish tend to speed up the degradation process by reducing the biodiversity of an ecosystem. When they take over, the habitat changes along with the life it can sustain.

“With bugs we sometimes have to look at the extremes – the most sensitive creatures or the most tolerant,” Brady explained. “The others can be harder to interpret. We call them the ‘muddle in the middle.’”

NRRI’s Great Lakes Environmental Indicators II and Great Lakes Coastal Wetland Monitoring projects are funded by the Environmental Protection Agency under the Great Lakes Restoration Initiative.



Starting over with soy-straw



NRRI helps company launch new business with ag-waste

Soy-straw is the woody stem of the soybean plant, an agricultural byproduct that’s plentiful in southern Minnesota and Iowa. This summer Agristrand Mankato, LLC began making the straw into particleboard for core material in doors and other products in a previously moth-balled manufacturing facility. This new use for the straw is resulting in new jobs, a market for ag-waste and something many manufacturers are striving for – a green product.

“The facility, under different ownership, manufactured wheat straw particleboard primarily for the door industry,” explained NRRI Program Director Brian Brashaw. “But they had to ship in the wheat straw from several hundred miles away. Using soy straw is much more efficient. It’s a sustainable resource close to Mankato.”

Brashaw started working with Agristrand in 2005 and the company purchased the Mankato facility in November 2011. NRRI produced and tested the soy-straw boards for comparison to traditional wood particleboard. And while the facility was being renovated, NRRI developed their marketing prototypes. Agristrand also got assistance from the Agricultural Utilization Research Institute (AURI) and the Forest Products Laboratory in Madison, Wisc. But

the bulk of the start-up effort fell to the business owners.

“They did a major clean-up and renovation of the bankrupt manufacturing plant, inside and out,” said Brashaw. “They hired an excellent management team with a lot of industry experience and purchased some new equipment... an impressive effort to get things going again.”

According to company President Tom Neel, it’s finally all systems go. He anticipates adding employees to his staff of 55 and sending out as many as 120 trucks a week with product, as long as he can get the manpower.

“We have tremendous demand for the product,” said Neel. “It’s sourced locally within a 500 mile radius of our customers so they can get LEED [Leadership in Energy and Environmental Design] points and it’s formaldehyde-free. We’re not competing with the big particleboard plants. We’re very much a niche product.”

Everyone’s fingers are crossed that the business thrives. Three previous manufacturing businesses have shut down at that plant. But Brashaw and Neel are optimistic for a few reasons.

“Their strong management team is key,” said Brashaw. “They’ve also partnered with their customers,

door manufacturers and other specialty producers in the Midwest, and soybean straw is more cost-competitive than wheat straw because of its availability.”

Neel added that it’s a revenue stream for the farmer that did not previously exist. It is also market-driven with no subsidies necessary. “The neat thing is that it truly is a value-added ag product with no special equipment needed,” he said.

The Agristrand boards are a welcome product for the Midwest’s robust door, cabinetry and other specialty manufacturers. Tight product supplies, the lack of regional production and a desire for green products have created new opportunities for Agristrand.

“We anticipate that the unique ‘green’ nature of the product will fit high-value niche products in cabinetry, countertops and other industrial markets now using traditional density particleboard,” said Brashaw.

In 2011 alone, the U.S. furniture and building trades used more than 2 billion square feet of particleboard. Agristrand will do well once it has positioned itself as a player on that large field.

Photos: (left) NRRI strength testing of soy-straw particle board. (right) Workers at the Agristrand Mankato plant.

Adding value to local wood supplies

A European way to keep it local with modified wood

prone to damage by many insects. In Finland, for example, thermally modified aspen often replaces cedar for sauna construction – that’s extreme exposure to temperature changes and moisture.

“This process is in its infancy in North America, but it’s starting to take hold,” said Pat Donahue, NRRI program director in Market Oriented Wood Technology. “It would be great if we would protect wood species that don’t regenerate well here, like Northern white cedar.”

In order to launch a thermally modified wood market in the U.S., Donahue is working to build the base of knowledge. Wood is complex and each species has its own characteristics. The physical and chemical changes of thermal modification affect each species differently.



NRRI's new pilot scale kiln being manufactured in Spain.

In early autumn 2012, a specially designed pilot scale kiln arrived at NRRI from Denmark-based Moldrup. It’s big enough to modify wood for actual window and door components, but also allows for experimentation of the process on a variety of species.

“Our native trees, especially hardwoods, have a problem with durability,” Donahue explained. “Basswood, for instance, would never be used as siding, but thermal modification can change that.”

Working with Mathew Leitch at Lakehead University in Ontario, Canada, Donahue is developing industrial measures and standards for modified North American wood production. The standards will be a resource for manufacturers who need to know the performance they can expect from a variety of thermally modified wood species for a wide variety of applications.

What if Lake States Lumber, a Minnesota and Wisconsin regional wood supplier, didn’t have to truck in western red cedar from California for their siding and decking customers? What if they could use regional woods like basswood, ash or red pine – wood species that aren’t considered durable enough for outdoor applications? It would obviously save on transportation costs. And using local resources keeps the money local, too.

This scenario is possible with a process of thermal wood modification that has been rapidly expanding in Europe. It makes any wood species dimensionally stable, water repellent and less



Peat deposits are plentiful in Minnesota and could possibly provide a unique solution to remove pollutants from industrial wastewater. NRRI is partnering with a small company to develop products that will hopefully lead to a healthier environment for all.

NRRI Chemist Igor Kolomitsyn and American Peat Technologies (APT) in Aitkin, Minn., have developed a patented product is called APTsorb III that is ready for commercialization as a high performing, peat-based product that removes heavy metals from wastewater. The team also has research underway to develop a product that removes sulfates.

With financial backing from the Iron Range Resources and Rehabilitation Board, APT plans to begin full-scale production within the next two years at an estimated cost of \$250,000. NRRI’s Product Development Fund also helped to fund Kolomitsyn’s expertise to develop the new product.

In simple terms, the active centers of the peat bond with the heavy metals and other compounds. These bonds are so strong that it is safe to discard the used material without the fear of renewed dissolubility. In fact, the loaded granules pass the U.S. Environmental Protection Agency’s Toxicity Characteristic Leaching Procedure testing, allowing for disposal at landfills.

“We used our product in dozens of test sites for the past five years and worked very closely with one mining company,” said Mark Krezowski, APT executive advisor. “This summer we implemented a full-scale use of our product designed specifically for their needs.”

Peat is the decomposed organic matter that has formed over the last 6,000 years in shallow, anaerobic wetlands. The APTsorb product requires reed sedge peat – decomposed peat that contains 30 to 60 percent plant fibers. It is less acidic with higher nitrogen content than sphagnum. The company is currently harvesting 160 acres of peatland and has a permit to harvest 320 acres. Depending on production levels, the company anticipates a 50 to 100 year supply of peat.

APT is also experimenting with a process to make their own peat by replicating the natural environment in which the bacterial process takes place.

“Ideally, we want to produce peat as fast as we’re using it and therefore make our company truly sustainable,” said APT President Doug Green.

Mining peat for industrial discharge solutions

Business North writer Manja Holter contributed to this article.

Slow the flow

Duluth neighborhood learns how to keep stormwater on the land

If we were to start all over again, building homes and streets and businesses on the steep bedrock and clay soils of Duluth, we'd do it differently. We'd build streets with large rain gardens and underground storage tanks to keep our trout streams from taking the burden of the excess stormwater flowing off our streets, houses and driveways. We'd plan ahead to keep dirt, salt, leaves and soaps from getting washed into the storm sewers.

But we're not starting over again. We simply have to do what we can with what we've got. Luckily, Duluth has residents who will do what they can.

With more than 500 gallons of water flowing off one small house rooftop during a typical rain, it's no wonder that a standard 58 gallon rain barrel just can't keep up. But with a few barrels on each house, and many houses collecting water, it can make a difference.



Workers build a rain garden

"It's like public TV, one person can only give a little bit, but everybody together keeps it going. We need to think like this about stormwater" said NRRI Aquatic Scientist Valerie Brady.

Working with the City of Duluth and Minnesota Sea Grant, NRRI monitored stormwater runoff from two streets that drain into Amity Creek. The creek is impaired with excess sediment caused, in part, by erosion due to high amounts of stormwater runoff. By installing rain barrels, planting trees and building rain gardens, could one street prove that stormwater can be controlled better?

Twenty homes participated in the study and they did make a difference in the measured run-off, but even better, the homeowners were able to fix their own water problems on their personal property.

"The residents learned that they can do things that help streams, and the whole project helped them think about rain and where it goes," noted Brady. "The whole neighborhood now thinks about what is getting washed down the street and into the stream."

Through the course of the project, 250 trees and shrubs were planted, 22 rain barrels installed along with five rain gardens, two swales and 12 rock-sump storage basins. A failing stormwater ditch was also re-dug.

More efficient monitoring

GIS lab and satellite technologies go the extra mile

The irony is not lost on the scientists. In order to protect and restore the watery environs of the Great Lakes coastal zones they have to load up 20 field research teams in



as many trucks and drive many miles.

For perspective, a drive around all five Great Lakes in one boat-towing truck would be well over 5,000 miles which would burn an optimistic 333 gallons of gasoline, releasing 6,660 pounds of carbon dioxide.

So while the data gathered is vital to the long-term environmental monitoring of these valuable freshwater resources, the need for efficiency is equally vital. NRRI's Geographic Information Systems team uses satellite data and project web sites to do the upfront leg-work.

NRRI studies have collected detailed information about various sites around the lakes such as development, population density, and ecosystem type. This allows selection of appropriate research sampling sites ahead of the crews' visits.

"Teams also log into the project web site and update the status of their work for a particular site with a single click on a Web 2.0 interactive table," NRRI GIS researcher Terry Brown explained. "They can leave comments for each site so that other teams can decide if they should go there. Usually, smaller car-based teams visit the sites first and can report to the other teams."

The field crews also carpool when they can, but each center has a bird team, amphibian team, vegetation team, and the largest, a bug/fish/water quality team. Each is sampling to gather different types of information, usually at different locations and times, so that doesn't often work out.

The concentration of CO₂ in the Earth's atmosphere has reached 395 parts per million and is rising. Reducing emissions in every way possible is valuable on the personal level... and especially for environmental researchers.

Concerned about the quagga

Invasive mussels are collapsing food web in Great Lakes



photo credit: Minnesota Sea Grant



photo credit: National Park Service

There is a critter about the size of your thumbnail that is striking fear in the hearts of the hale and hearty fishermen of the Great Lakes. The invasive quagga mussel has completely invaded Lakes Michigan and Huron to the point of crashing the fish population. Of course, this has the fishing industry extremely concerned. Sustainability of regional food resources should have everyone concerned.

"Pick anywhere in Lake Michigan; you can't sample the sediment without getting a half-pound of mussels," explained NRRI scientist Euan Reavie. "They're feeding on everything that makes up the bottom of the food chain."

The quagga are similar to the familiar invasive zebra mussels that are causing similar problems. But quagga have adapted to be able to sit on the mud, unlike zebras that must attach to a hard surface. That has allowed them to proliferate throughout the lakes, well beyond the coastal zones.

"Because of the long-term monitoring research that's been going on in the Great Lakes, we can study changes in the lakes," said Reavie, whose team has been part of the Environmental Protection Agency's monitoring efforts since 2007. "Fifteen years ago, many would have said the lakes were in pretty good shape. The Great Lakes Water Quality Agreement, first established in the 1970s, went a long way to deal with problems. But look at Lake Michigan now; compared to a decade ago, fish are in a serious decline and it's likely to get worse."

Much of what is being gobbled up by the quagga are algae (phytoplankton) which are at the start of the aquatic food chain. Reavie and his team at NRRI's Ely Field Station have long been studying algae as indicators of water quality and other changes that take place over time because of human disturbance. Aboard the Environmental Protection Agency's research vessel, Lake Guardian, they collect samples from the deep, open waters of the lakes. He has observed remarkable declines in these important food organisms.

"We're trying to figure out the trajectory of these changes, and when we can expect things to stabilize," said Reavie. "As far as quagga impacts, it hasn't stopped proliferating yet."

This invasive mussel hails from far away Eastern Europe and made its way to the U.S. via ballast water on international ships. Reavie is also involved in efforts to test technologies that can reduce or eliminate non-native species in ballast water. The Great Ships Initiative is a collaborative effort managed by the Northeast-Midwest Institute with a research lab in the Duluth-Superior harbor of Lake Superior.

"Our goal is to stabilize the freshwater food web by preventing these recurring problems with invasives," Reavie said. "Every potential treatment has special considerations and varies in its effectiveness. With strict scientific and regulatory considerations, and all of the stakeholders involved, you realize how complicated it is. There's still a lot to sort out."

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June Kallestad, editor/writer

Trish Sodahl, graphic design

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Natural Resources Research Institute
University of Minnesota Duluth
5013 Miller Trunk Highway
Duluth Minnesota 55811-1442

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Doing the numbers

How many non-native species are too many?

The Duluth area flood of June 2012 was a setback for many people in many ways. For UMD student Meagan Aliff it means she has to wait for the Duluth-Superior harbor to heal itself before she can begin her master's thesis project in Water Resources Sciences.

"The flood waters pretty much washed everything out of the harbor," said Aliff. "So that makes it pretty hard to collect representative biological samples from the water."

Aliff's project addresses the problem of ballast water discharge ordinances set by the United Nations and other agencies. Under current criteria, ships will be permitted to discharge ballasts containing fewer than 10 phytoplankton organisms per milliliter of water.

"But ecologically that is an arbitrary number, and it is not certain any treatment will consistently meet that criterion," said Euan Reavie, principal investigator on the project. "We need to figure out if that number is realistic and can be tested."

So once the harbor returns to pre-flood conditions, Aliff will add non-native species in varying concentrations to several "mesocosms," a series of tubs set up to replicate natural conditions in the lake. Her goal is to determine how many critters it takes to make an ecological impact.

"Perhaps less than 10 per milliliter is still enough to be a real problem, or maybe 100 per milliliter is not a problem at all," said Reavie. "That's what we'll find out."

