NRRI *Now*

Autumn 2015

Natural Resources Research Institute
University of Minnesota Duluth
Driven to Discover™

Wetlands research continues with $2.4M grant.

See page 3

OUR RESEARCH GOES TO WORK FOR YOU

From the Director: Rolf T. Weberg

After a busy summer in the field, activity at NRRI continues to run at a high rate. NRRI researchers hosted and mentored over 60 graduate and undergraduate students in field studies and engineering projects. Now we're evaluating that work as cooler weather moves in.

In the meantime, there have been a few changes at the Institute. Over the past several months, our Advisory Board has been reorganized to focus on strategic direction and funding. With the engagement of our Board, we have completed a Strategic Plan that will be deployed at the end of the year. This document will be the foundation for the mission-driven applied research organization that is NRRI.

The Institute will focus on six integrated strategic initiatives that define delivery of solutions for Minnesota: (1) Forestry and Land Resource Management; (2) Wood Utilization, Materials and BioEconomy; (3) Renewable Energy; (4) Minerals, Metallurgy & Mining; (5) Water and Water Resource Management; (6) Business & Entrepreneurial Support. NRRI's ability to integrate solutions across disciplines makes it a unique asset to the state economy.

Our Strategic Plan will help NRRI focus on our mission of delivering research solutions that balance Minnesota's economy, resources and environment in support of our resilient and vital communities. We will continue to develop the technologies and understanding needed to provide a "big-picture" view of opportunities and decisions facing Minnesota stakeholders as we seek to help businesses and industry compete and succeed in today's global market. Ultimately, NRRI will focus on support of an evolving economy based upon more diverse and higher value products derived from our natural resources and manufacturing base while preserving our precious ecosystems.

It is an exciting time to be at NRRI. Our dedicated staff has made significant progress on a number of projects and is now at work integrating this knowledge into solutions. Scientists at our Coleraine Labs facility have succeeded in developing several novel approaches to ore processing to help our mining industry enhance efficiencies. Meanwhile, as our Renewable Energy Laboratory nears commissioning, we are engaging the forestry and wood products industries to explore opportunities for the emerging biomass-based "bio-economy." Our water scientists continue to receive national recognition and support for their work and are now traveling the globe in support of the Great Ships Initiative, verifying technologies to control invasive species contamination in ballast water. And our business group is engaging across the Institute to assist in evaluation of business opportunities.

In an exciting global development, NRRI recently signed a Letter of Intent with Metabolon, a research consortium made up of The University of Applied Sciences in Koln, Germany, and the Bergische Waste Association to collaborate on economic opportunities associated with renewable energy. Metabolon's work in waste digestion, biogas energy generation, systems development and public engagement will complement NRRI's biofuels, biochemicals and renewable energy programs. We look forward to engaging with our new colleagues in early 2016.

In response to the growing interest in our e-newsletter and a dwindling subscription to our printed *NRRI Now* magazine, we are moving to an electronic newsletter for Spring 2016. We are thankful for what our printed magazine did to establish our communication outreach and we look forward to the new opportunities offered by electronic media. Be sure to sign up on our website to receive the newsletter in your email inbox!

Thank you for your continued support.

Expanding our knowledge

This October a small team of us at NRRI had the opportunity to tour Lundin Mining's Eagle Mine in Marquette, Mich. We learned about Lundin's mine life-cycle approach to copper-nickel mining, advances in water remediation technologies and proactive community engagement.

Two things that especially impressed me are their corporate approach to collaborate directly with the communities and their integrated planning practices that define and maintain the social license to mine. This additional information will inform our work as the state considers the many different mining opportunities in Minnesota.

Photo: Kristen Mariuzza (left) Eagle's manager of environment, health and safety, leads the tour. NRRI's Dick Kiesel (behind Kristen), Rolf Weberg, Don Fosnacht and Patrick Schoff walk with her on the perimeter of the mine site.

NRRI awarded $2.4M to continue Great Lakes wetlands monitoring

Rolf says . . .

"This award is a great recognition of NRRI's contributions in protecting our Great Lakes."

Five more years of funding from the federal Great Lakes Restoration Initiative will allow NRRI to continue assessing the condition of vital wetlands. The EPA's Great Lakes National Program Office announced in October that $10 million is awarded to the Great Lakes Coastal Wetland Consortium, of which NRRI will receive $2.4 million to work on the western end of the Great Lakes.

NRRI Aquatic Ecologist Valerie Brady is the lead researcher on NRRI's portion of the project which will take her field crew from Thunder Bay, Canada, to Green Bay, Wisc. They will gather data, evaluate wetland condition, identify high functioning wetlands that need protection and gauge restoration efforts. Brady is also coordinating the four other field teams across the entire Great Lakes project. Over the next five years, 1,000 wetlands will be visited and precise protocol will be followed to gather data. NRRI is charged with sampling 200 of those sites.

"The challenge is in getting all the teams to gather the same data in exactly the same way at each location, basically getting a snapshot of wetland condition," said Brady.

In the Duluth area, NRRI is collecting data in the St. Louis River estuary where restoration efforts are underway. Information gathered before the restoration will show the success of the effort.

Wetlands in the Great Lakes' coastal areas play an essential role as habitat for unique plants, insects, birds and other animals. Wetlands also filter pollutants, reduce coastal damage during high water years and provide important spawning and nursery areas for fish.

"Each of the Great Lakes has a unique variety of marshes, swamps, bogs and wet meadows," Brady explained. "The overall goal of this project is to keep watch on the wetlands so that if there's degradation, we can fix it before it's too late."

Launched in 2010, federal funding of the Great Lakes Restoration Initiative is accelerating efforts to protect and restore the largest system of fresh surface water in the world.

"The Great Lakes are a natural treasure that we should be protecting so everyone can enjoy their beauty," said Senator Al Franken. "Continuing this important funding will help the Natural Resources Research Institute and the University of Minnesota Duluth keep the Great Lakes clean and safe for generations to come."

Central Michigan University is leading the overall project. Other institutions involved are SUNY Brockport, University of Wisconsin campuses of Green Bay and River Falls, Lake Superior State University, University of Notre Dame, Grand Valley State University, University of Windsor, Michigan Department of Environmental Quality, the U.S. Geological Survey, Environment Canada and Bird Studies Canada.

Rolf says . . .
"We are gearing up to deliver biomass energy that also helps our forestry industry."

ENERGIZING ALTERNATIVE FUELS

Grant will help NRRI advance biofuels industry

NRRI received $1.9 million in funding from Xcel Energy's Renewable Development Fund to demonstrate the potential for distributed power from converted biomass. Working with industry partners, SynGas Technology, LLC and the Coalition for Sustainable Rail, NRRI will test processes that can convert biomass into renewable, local replacements for coal and petroleum-based fuels.

Using SynGas' proprietary technology, NRRI will produce three tons of solid biofuel daily. The short term goal will be to generate electricity at NRRI's Renewable Energy Lab in Coleraine, Minn. Raw biomass will be converted into a coal-like product with a roasting technique called "torrefaction" and then pressed into a variety of shapes to fuel an advanced boiler-generator system. The torrefied biofuel is largely free of mercury and sulfur and can reduce carbon emissions in flue gas. As a direct replacement for fossil coal, biofuel has potential for use at power plants or in advanced boiler-generator systems to produce distributed energy in remote, rural systems. With additional processing, this biofuel can also be gasified and chemically converted into diesel fuel.

"We think this will help advance power companies' goals to meet their Renewable Portfolio Standards," explained Don Fosnacht, NRRI associate director and the project's principal investigator. "Utilities wouldn't have to replace their current capital assets and they'll improve their environmental footprint."

The Coalition for Sustainable Rail will work with NRRI to manufacture and install a prototype advanced steam boiler-electric generator to create up to 100 kilowatts which will be provided to the electrical grid. This demonstration-scale research will allow future commercial units to be rapidly designed and implemented. NRRI's Renewable Energy Center is expected to be operational by early December.

This project helps advance NRRI's mission to deliver research solutions to balance Minnesota's economy, environment and resources and economy for resilient communities.

NRRI researcher Jonathan Utecht shows volunteers how to use a stream thermometer.

Rolf says . . .

"Volunteers needed to help our trout streams. Join us!"

Angling for cool streams

Volunteers recruited to collect stream temperature data

After 30 some years as a North Shore angler, John Lenczewski is actually worried.

"My concern is the prospect of what a warming climate might mean for our north shore streams," he said. "I think it's affecting fish populations."

Lenczewski is also Executive Director of Minnesota Trout Unlimited, an organization that is keenly involved in stream restoration efforts. With funding from the Legislative-Citizen Commission for Minnesota Resources, NRRI is working with his group to get a better understanding of which streams have the best chance of staying cool enough for game fish to thrive. With many north shore streams in need of attention, this will focus efforts where Trout Unlimited and its volunteers can do the most good.

As a first attempt in that direction, NRRI Associate Director Lucinda Johnson led a project that used computer models to predict brook trout distribution in changing climate scenarios. But the computer wasn't precise enough for the Department of Natural Resources.

"And they were right. It was 75 percent correct and they knew the models could be improved with better knowledge of where cold groundwater exists," Johnson explained. "To fill in the knowledge gaps, it takes boots on the ground and in the stream."

What trout fishermen have noticed is that steelheads seem to have a harder time reaching the spawning areas. There's less physical habitat for the fish. Their food systems have decreased. The populations just don't seem as robust as they used to be.

"But we have to fight the urge to think fishing was just plain better back in the day," Lenczewski added with a laugh.

The people-power it will take to map the groundwater resources in 100 stream segments over the next three years is daunting and expensive. That's why recruiting volunteers for the project is so important. They are hoping to get enough people into the streams – via canoes or in waders – with custom-made thermometers to document stream temperature and where the cold water is coming from. Is it a seep from underground? Is it a spring? From a bank? Maybe a tributary?

With more accurate information put into the computer models, the researchers can do a better job of predicting the relationships between landscape features – geology, land use, vegetation, etc. – and the location of groundwater inputs. They'll also identify where they're actually seeing fish and document fish barriers, like beaver dams or waterfalls. Ultimately, the data will lead to a better understanding of streams that are worth the time and expense to restore as opposed to streams that don't have the cold water inputs that can fend off effects of a warming climate.

"We want to be sure we're protecting the high value resources," said Johnson. "That's the key."

The winter of 2015-16 will include a flurry of activity designed to catch the interest of anglers and entice them to help with the project next spring. Johnson is working on this project with NRRI Aquatic Ecologist Valerie Brady and NRRI Statistician Meijun Cai as well as William Herb from the University of Minnesota's St. Anthony Falls Lab.

ENERGY & TIMBER SET FOR WIN-WIN

Consortium to brainstorm how to turn excess biomass into fuels

Watch the news and you'll understand why the U.S. Forest Service is actively seeking uses for timber. This year was record-breaking for wildfire danger and damage in the U.S. Add to that 1.5 million acres of beetle-killed lodgepole pine in Colorado and Wyoming that are a tinderbox poised for flame. Fire is a potential danger wherever timber and slash stand too long in dry, hot environments.

But there are ways to turn that situation into a win-win-win scenario. A group of stakeholders [see list] is funding a new Consortium for Advanced Wood to Energy Solutions. Yes, it's CAWES with a cause – to turn under-utilized wood species and slash into biomass energy resources. Organized in 2014, the group has already identified seven tasks to move forward [see sidebar]. NRRI is leading two of those – a commercial-scale demonstration of the use of advanced biofuel in power plants and development of methods to densify the biomass material – as well as participating in finding ways to use low value wood.

"An important driver for this effort is to use the post-harvest tops and limbs of trees and underutilized species to prevent forest fires," explained Dick Kiesel, NRRI Coleraine Laboratory director. "The Forest Service spends half of its annual budget, roughly two billion dollars every year, fighting forest fires."

So, reducing fire danger is one 'win.' Another is the potential to provide a very low polluting, renewable partial replacement for coal in power and industrial plants.

Minnesota has set renewable electricity mandates on the state's power providers. Xcel Energy has set the most stringent goal: to produce 30 percent of its energy from renewable sources by 2022. All other utilities are required to achieve 25 percent by 2025. Minnesota Power has already passed that goal.

The third 'win' is for Minnesota's timber industry. With a slowdown in the forest products industry (reduced demand at paper mills and loss of oriented strand board plants), timberland owners, loggers

and truckers also feel the pinch. Using Minnesota's sustainably available resources for alternative energy keeps the money local.

"Minnesota currently spends around $18 billion each year on energy," said NRRI Director Rolf Weberg. "That's money that's going out of the state. We can do more to diversify the local economy, make better use of our resources and reduce polluting emissions."

NRRI's laboratory on the Iron Range is now equipped to produce 12 tons of solid biofuel a day – an output that can be used for full-scale trials at local power plants. It's one of four facilities in the U.S. capable of making this renewable fuel at this scale.

"And we have flexibility that some others don't to customize the biofuel in a variety of shapes, depending on what the energy plant needs for their equipment," Kiesel explained. "We can make torrefied pellets or briquettes, custom shaped fuels."

NRRI is also working to develop a process to make the biofuel water resistant, even more coal-like, to improve handling and outdoor storage capabilities. A fuel cost analysis is also being planned. This fully-instrumented pilot facility will also allow NRRI to make critical measurements needed to determine energy balance and economic feasibility.

To better understand the needs of potential customers, NRRI is developing a questionnaire that will be sent to targeted utilities. Variables like storage facilities, bin and conveyor sizes, feed mechanisms, fuel requirements, and boiler systems will determine their differing fuel needs.

"Our ability to supply trial lots of advanced biofuel to our state-owned utilities and to others in the region, will help facilitate the potential use of our forest resources as a direct coal substitute and help us better manage our forests," said NRRI Associate Director Don Fosnacht, who is the project's principal investigator. "We also have some complementary technologies that can be used with torrefaction to produce energy products that will help reduce the state's need for coal at existing coal-fired power plants."

The Consortium is an open-platform collaborative of public and private sector institutions with a variety of interests in bio-based fuels.

WHAT IS TORREFACTION?

Torrefaction is a process that converts biomass into a high-grade, solid biofuel. The process involves thermally treating the biomass between 260-320°C (500 – 608°F) in an oxygen-poor environment. Moisture and volatile organics are roasted out of the material and much of the hemi-cellulose is decomposed. In a solid form, this fuel has significant advantages over common biomass fuels, such as standard wood pellets or chips, containing 95 percent of the BTU energy content of hard coal. Once torrefied, the biomass is easily ground and shaped as needed. It has a higher energy density than raw biomass and resists moisture.

CONSORTIUM PARTNERS

Herty Advanced Materials Development Center at Georgia Southern University, Savannah, GA

USDA Forest Service, Forest products Laboratory, Madison, WI

U.S. Endowment for Forestry and Communities, Greenville, SC

UMD Natural Resources Research Institute, Duluth, MN

Integro Earth Fuels, Greenville, SC

University of Louisville, Conn Center, Louisville, KY

Global Bioresources, Inc., Destin, FL

Terra Green Resources, Greenwood Village, CO

Airex Energy, Laval, QC, Canada

HM3 Energy, Gresham, OR

Michigan Technical University, Houghton, MI

University of Georgia, Athens, GA

SEVEN TASKS FOR WOOD-TO-ENERGY DEVELOPMENT

Task 1: Overall Project Management. Lead: Herty

Task 2: Identify coal-fired utilities that can use biofuel, secure biomass resources and conduct commercial scale demonstration project. Assess mass and energy balance to identify best strategies to integrate biofuels into existing power plants. Lead: NRRI

Task 3: Demonstrate torrefaction at pre-commercial scale on clean wood. Lead: Integro & HM3

Task 4: A complete study of densification processes with an emphasis on natural binders to make solid fuels that maintain water resistance. Lead: NRRI

Task 5: Optimize integration of torrefier within manufacturing platform. Lead: Herty

Task 6: Parameters developed for feedstock selection and collection, ash-removal operations and possibilities for use of ash by-product. Lead: Herty

Task 7: Develop cost model for densified torrefied product production in targeted regions. Lead: Forest Products Lab

FUNDING STAKEHOLDERS

USDA Forest Service – Forest Products Laboratory

U.S. Endowment for Forestry and Communities

Herty Foundation

Advanced Material Development Center

Georgia Southern University

The ballast battle

NRRI develops quick 'n' easy protocol to check ship holds

Too many happy microorganisms are not a good thing in ship ballast tanks. In fact, killing off critters that are hitchhiking to new ports is something NRRI Scientist Euan Reavie has been working on for some time. He even has a device that measures algae "happiness" – or how vibrant and healthy the little buggers are in the ballast water.

"We call it a 'happiness' scale," he said. "Are they on a high growth curve or on their way out?"

To reduce invasive species impacts, discharged ballast water must have fewer than 10 live cells – happy or disgruntled – per milliliter. While it's too late to stop invaders like zebra mussels and spiny water fleas that are already in the Great Lakes, this project aims to stop further invasions.

So with the compliance bar set at 10 cells per milliliter, Reavie and his team are developing processes that will determine if ship-borne treatment systems are meeting that goal. The process has to be quick and easy so that a ship crew member – a non-scientist with no microscope – can add it to his or her routine.

Working at the Great Ships Initiative laboratory the NRRI scientists are using advanced instruments, such as high-power microscopes, to measure the activity of tiny organisms in the ballast water. The results are then compared with measurements from easy-to-use devices, some even hand-held. The simple devices can't provide the detail of a microscope and an experienced analyst, but they may be good enough for a rapid compliance check.

"The goal is that someone could simply take a water sample from the ballast, throw it into the machine and look at the number," said Reavie. "They could check any time, even before they get to port, to know if their ship meets the discharge standard."

The instrument manufacturers – YSI Instruments, BBE Moldaenke and Turner Designs – were on board (pun intended) with the project. It helps vendors know what their device readings actually mean for the end users.

"There's been a lot of progress with reducing the spread of invasive species through ballast systems," Reavie added. "This is another step to ensuring we prevent future invasions of the lakes."

The Great Ships Initiative Laboratory was established in 2006 in Superior, Wisc., by the Northeast-Midwest Institute. NRRI has been a project partner from the beginning, helping to accelerate research, development and implementation of effective ballast water management systems, and to end the problem of ship-mediated invasive species in the Great Lakes-St. Lawrence Seaway System and globally.

NRRI scientist Andrew Bramburger lowers a sampler into the harbor to collect water for testing in the lab.
(Inset) Euan Reavie pours water into tubes.

Turtle Telemetry

Researchers study life of threatened wood turtles

Rolf says . . .

"High-tech backpacks to follow our reptilian friends."

Biologist Ron Moen calls being co-investigator on a turtle project "different." His past research subjects have been cute and iconic furry beasts – Canada lynx and moose.

"Turtles are a lot easier to catch though," he said. "We just find them and pick them up. No box traps. No drugs."

Riverine Wood Turtles, once common along the riverbanks of eastern Minnesota, are listed as a threatened species. Moen's research project uses small GPS units glued to the turtle shell to track the species for the state's Department of Natural Resources. The resource managers need to know how the turtles are responding to conservation efforts and threats to their reproduction.

"They are different from other turtles in that they're very terrestrial," Moen said. "Wood turtles spend most of their time in the summer on the land and go back to the water in the fall."

Studying this species is also unique in that they live more than 50 years. That means reproductive rates are more difficult to follow and problems might not be detected until it's too late. But just six months into the two-year project, Moen and his graduate student researchers are already getting some preliminary insights.

Nests in areas well known to predators – skunks, raccoons, badgers, bears – are not producing a lot of turtles. Nests that the researchers put cages over or nests well hidden from predators were more successful. The researchers are also monitoring how far the turtles move away from the water in the summer and when they go back to hibernate in the fall.

The data will be used to inform decisions about whether intervention is necessary, or even desirable, for the wood turtles.

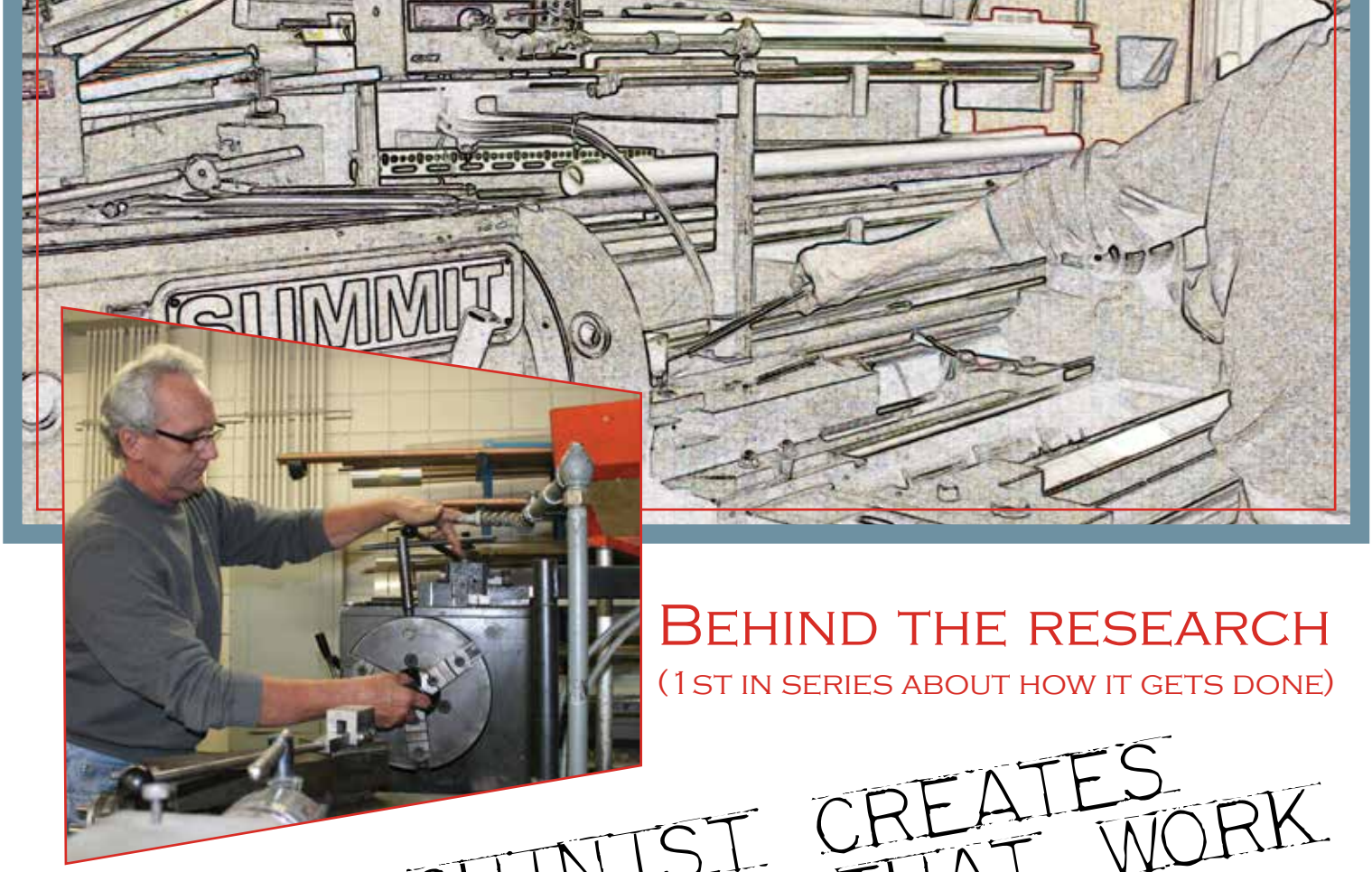
"If predation is the problem, we can build cages and protect the nests," said Moen. "In Europe, they've gone as far as building turtle hatcheries, the way we have fish hatcheries here."

This project is part of a multi-state non-game research effort also being conducted in Iowa, Wisconsin and Michigan where the stressors may be different than in Minnesota. The researchers will meet for a wood turtle symposium in 2016 to compare data.

Photos by Maddy Cochrane.

FUN FACTS:

- Wood turtles mature between 14 and 18 years of age.
- The females lay only one clutch of eggs per year, and not necessarily every year.
- The pet trade is a threat to this species, even though it is illegal to capture and sell wood turtles.
- Wood turtles eat berries, leaves, mushrooms, insects and earthworms.
- Wood turtle age is determined by growth rings on their shells, similar to how tree age is determined.



Behind the research

(1st in series about how it gets done)

NRRI machinist creates research tools that work

As a journeyman tool and model maker, Steve Johnson is often compared to TV's fictional do-it hero MacGyver with his cobbled together tools. It's a bit of an insult, though Johnson realizes it's meant as a compliment.

Johnson doesn't cobble. His three years of training for tool and model certification at IBM – heavy on math, geometry, trigonometry and metallurgy – taught him precision. His year of apprenticeship added geometric dimensioning, estimating, injection molding and more. If he had his way, everything he makes would be chiseled perfection. But that takes time and time is money.

"My job is to give our researchers the tools they need to get their work done," Johnson explained. "And I have to make the tools as quickly and affordably as possible."

That means he uses a variety of materials, from PVC pipe and creative repurposing of ready-made items to his favorite material: aluminum. He can work a lathe, mill, welding torch and anvil with the best of them. It takes imagination, experience and confidence to pull off his job. Like the oil that keeps machines running smoothly, Johnson's work is both unseen and ubiquitous. And from Monday to Friday (and often weekends, too) he never knows what will be asked of him.

Take, for instance, a recent request to replicate the movement of a moose. A researcher was getting data from moose telemetry collars that was difficult to interpret given the limited information supplied by the collar manufacturers and software developers. To improve the study, the researcher needed to make the collars move like they do on a moose but in a controlled, replicable environment.

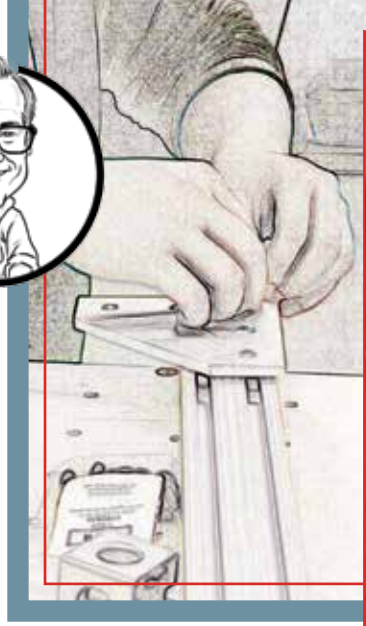
Johnson gathered up some PVC pipe and a couple of motors and, with help from a UMD engineering student [see sidebar], built – as far as they know – the world's first moose collar articulator. After eight hours of replicating the ambling movements of a moose in the wild, they had more accurate data to understand how the collars were reading the range of movements. The researchers are using the information to build a computer model about the behaviors of moose. The apparatus could also be useful for future deer and wolf research.

To build a research tool, Johnson first boils down the request to the simplest solution possible – what the researcher needs, not necessarily what they want. If a simple solution works, he's done. If not, he ramps it up.

"If you start with an elaborate plan that takes months to develop and then it doesn't work, you've got nothing," he explained. "Maybe some things I make could be fancier. But if it works and it's safe, they're on their way."

But his "old school" precision machining skills also get well-used. For a biomass fuels project, a researcher needed to be able to form fine, roasted material into solid

Rolf says . . . "Here is a great example of our staff that keep the Institute humming."



convex "pucks" of a certain size. Johnson went to his trusty radius cutting tool and made a precise concave aluminum form for the press. It worked great.

"I have the opportunity to make people happy and keep this lumbering research behemoth moving forward," said Johnson. "My job is great because it's different every day and I get to interact with a variety of highly intelligent people."

Working on the St. Louis River estuary, an NRRI researcher needed to collect vegetation and soil samples for a restoration project. But the size of the samplers needed was not readily available. Johnson found the right size plastic tube, fitted them with a plug used for plumbing and added a snowmobile trailer tie-down as a handle. He also added a valve at the top that could be plugged to form a vacuum to hold the material as it's pulled up. The project was a success.

Johnson's skills also save the university a significant amount of money.

An example is a mount he designed for two infrared cameras that were to be attached to a communications tower. Johnson had to be absolutely sure it would not fall off the tower. Had NRRI contracted with the tower climbing company, the result would have been very expensive with reduced quality.

"It couldn't shake or wobble, but also easy enough to install by a guy hanging from a rope 70 feet in the air. It had to go on a tower of a specific size, holding a specific size camera that also needs a certain range of motion," said Johnson. "All this on a shoestring budget with time constraints."

Ultimately, Johnson's projects come down to turn-around time, the tools purpose, how tight the tolerance needs to be and the budget. Getting the job done – and done well – is always the goal.

NRRI lab experience leads to job for UMD graduate

When UMD Chemical Engineering Senior Richie Vang interviewed for internships, twice he was offered the job on the spot.

"They were all really interested in my machine shop projects because I could offer both mechanical and chemical engineering perspectives," said Vang. "I was blown away by the offers!"

Vang interviewed at four companies and accepted the internship that will provide the most opportunity to innovate, the best location and a good vibe. In the summer of 2016, Vang will be a manufacturing engineer intern at Graco in Minneapolis, a leading manufacturer of pumps and spray equipment for many industries. The recruiter told Vang about their CNC machines and robots... "and I thought, sweet. I'd love to work with that, in a place where interns' ideas are heard," he said.

Starting at NRRI as an Undergraduate Research Assistant in 2012, Vang was working with microscopes on moose and wolf research and using Arc GIS to assess moose habitat. By 2014 he was a Manufacturing Process Development Intern in NRRI's Machine Shop to work on a large project helping a local business develop a new manufacturing procedure. Engineering students don't typically get the hands-on CNC (Computer Numerical Control) programming and trouble-shooting experience that Vang got on that project. He also created a Standard Operating Procedure and Job Safety Analysis for the process.

"All the companies I interviewed with loved that experience," he said. "Safety is number one, everywhere."

By July 2015, Vang was a Machine Shop Apprentice assisting in prototyping and fabrication of sophisticated research equipment, including the moose collar articulator and the tower camera mount. He used AutoCAD (2D and 3D software for computer-aided design) to audit the NRRI building for energy use and designed parts using Autodesk Inventor.

Before he graduates he'll have a new experience to add to his resume in developing a less expensive hardening binder to coat products in the rapid prototype center.

"Steve (Johnson) was always accepting my ideas and challenging me to think things through and find ways to be more efficient," said Vang. "I could really be involved and that's the way it is at Graco, too."

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The Natural Resources Research Institute was established by the Minnesota Legislature in 1983 to foster economic development of Minnesota's natural resources in an environmentally sound manner to promote private sector employment.

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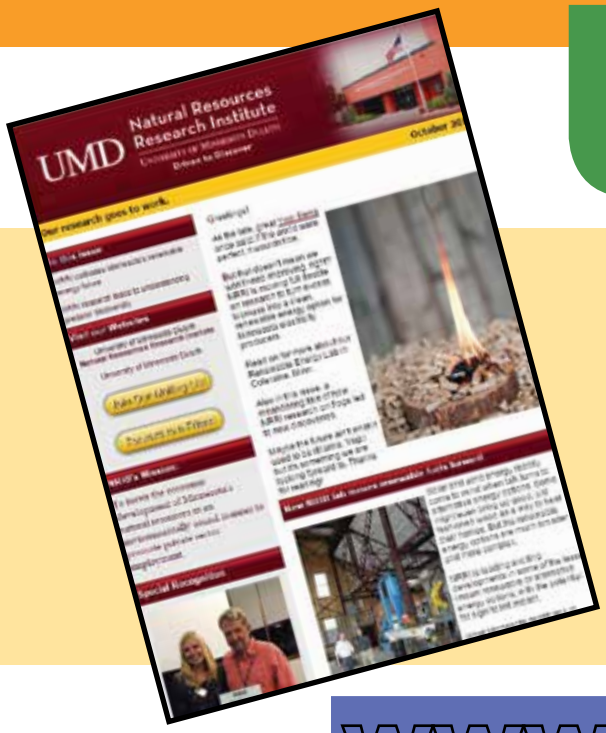

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