University of Minnesota Duluth
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Natural Resources Research Institute

NRRI Now

A monthly newsletter from the Natural Resources Research Institute

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What do you love most about Minnesota's forests? What changes can we anticipate in a warming climate? NRRI is forecasting future impacts of climate change on forests, wildlife and industries.

Greetings!

NRRI continues its focus on delivering impactful, applied science and information to Minnesota.

Our work continues to fulfill the charter given to NRRI back in the early 1980s providing data and tools to support sound, long-term decisions. Even better, it showcases what we can accomplish when our collective research is focused on the future. I'm especially pleased to highlight two such impacts you'll read about in this issue.

ForCAST– a forest climate adaptation web tool – will allow individuals, from industry forest planners to land managers, an ability to evaluate forest management choices and their impacts for more informed decision-making. Another impact is NRRI's collaboration with regional industries to make better products and reduce waste.

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And, of course, all of our work is led by a strong safety culture that has now adopted a preemptive strategy to "safety first."

Enjoy reading!

Rolf Weberg
Executive Director
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Preparing for the forests of 2100

NRRI's ForCAST modeling tool helps resource managers plan for environmental changes and impacts to wildlife and industries

June Breneman
Aug 2, 2022

Trees seem pretty tough. But like all sentinel species – from tiny algae to birds to moose – trees respond to changes in their environment, though on a very slow timeline.

So, as we anticipate an increasingly warmer climate, how will that impact Minnesota's forests? How about the accompanying drier soils? Changes in wildlife? Rainfall intensity?

"For instance, in drier conditions, we know that oak trees will do better than aspen trees, and oak trees grow much more slowly," said John Du Plissis, NRRI Forest and Land Group Manager. "What does that mean for birds and mammals? For our forest products industries? For people who love today's forests?"

Questions like these are very complex. And yet, that's what natural resource managers face as they plan for future forests that meet the needs of today and generations to come. What can we expect of our forests in the year 2100?

Decision Support Tool

To help, NRRI developed the Forest Change Assessment Simulation Tool, or ForCAST. This unique, online decision tool integrates forest productivity, ecosystem services, and economic information to help land managers assess the potential costs, benefits, and tradeoffs between forest management options at a landscape scale over an 80-year planning period. It is a large, multi-disciplinary project, with funding provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

Photo right: John Du Plissis

"Things are changing; we know that," said Du Plissis. "This tool helps us to envision what those changes look like and the investments we might want to make to maintain the things we value about and from Minnesota's forests."

This initial roll-out of ForCAST, launched in July, covers nearly four million acres in northern Minnesota – about 20 percent of the state's forest cover -- spanning four major watersheds and encompassing private, public and tribal ownership. The watersheds are the St. Louis River, Cloquet River, Mississippi River-Grand Rapids and Lake Superior-South.

For Resource Managers

A ForCAST learning session will be held for potential users at the University of Minnesota Cloquet Forestry Center, 175 University Road, Cloquet, on September 29. For details and to register, view the Sustainable Forests Education Cooperative event page.

A resource manager can consider 12 scenarios for their selected area of interest. Among the scenarios, what happens if we increase wood harvest? Or decrease harvest? Or maintain current levels of harvest? What impacts will we see in water quality if harvesting declines t versus increasing harvests?? What changes in species can we expect if carbon emissions continue to increase?

Wildlife Impacts

Black bears, for example, are a common Minnesota forest dweller relying on berries, nuts and acorns for forage. NRRI Wildife Biologist, Ron Moen, found that effects of forest harvest vary in ForCAST modeled scenarios. Bears find acorns in older oak stands, and find berries and nuts in younger stands. When forest harvest levels were maintained or increased in the future, increased harvest of aspen stands and aging of older oak stands that weren't harvested led to an increase in habitat quality relative to ForCAST scenarios with reduced harvest levels.

"One of the valuable things we can learn for wildlife research from the ForCAST model output is the relative impact of forest harvest level compared to the impact of climate change," said Moen. "For black bears in Minnesota, climate change effects are predicted to have less of an effect on habitat suitability than forest harvest."

Photo right: Ron Moen

The modeling is built off the well-known, but highly complex LANDIS-II, an open-source, forest change model developed over the past 30 years. LANDIS-II is a spatial temporal, tree species-level, cell-based forest model that simulates forest growth, succession, and disturbances over large landscapes and allows the developers to model forest change through time based on what we know about how forest changes through natural processes.

Forest Value

Understanding the value people place on our forests is important to decision-making. To quantify the value, NRRI Resource Economist Saleh Mamun conducted a "discrete choice" experiment to evaluate residents' willingness to pay for forest ecosystem services across 11 counties in northern Minnesota. What hypothetical amount of money would they be willing to pay for ecosystem services provided by forests? They were asked about their preferences for forest harvest, timber production, water quality, wildlife habitat and carbon sequestration.

"We learned that people value some increase in timber production – just 10 percent – but increasing timber production a lot shifts their preference toward other forest-based ecosystem services, like wildlife habitat and recreational use," explained Mamun.

The Natural Resources Research Institute's mission is to deliver integrated research solutions that value our resources, environment and economy for a sustainable and resilient future.

Innovation is risky business

June Breneman
Aug 3, 2022

Businesses large and small reduce risk with NRRI minerals R&D.

Across the dirt road from a small town high school football field, the work of NRRI engineers, geologists, metallurgists and technicians reaches around the globe.

The NRRI Labs in Coleraine, Minn., currently have about 20 applied research projects underway that help companies innovate – from Fortune 500s with a 100-plus year history to growing start-ups. And there's another 20 projects in the project development pipeline as potential opportunities.

"Companies at every level need innovation, but that takes time and money," said Kevin Kangas, NRRI Coleraine Site Director. "Our diverse research capabilities offer dedicated, talented expertise to drive process efficiencies and better products."

Photo right: Kevin Kangas

NRRI metallurgists help steel industry manufacturers get the best iron ore feedstock or understand the composition of metallic core samples. NRRI engineers work with companies to test new equipment against a variety of ores for processing. NRRI technicians perform tests to deliver the data companies need to improve their processes and products.

"It's much more cost effective for companies of any size to engage our staff for research and development because we have the infrastructure and talent already in place," said Kangas. "It would be very expensive for them to build out this capability. And we can engage them to fit their specific needs."

NRRI Coleraine is also situated in the heart of Iron Country – Minnesota's Mesabi Iron Range – where taconite pellet producers are transitioning their products to higher value iron that meets evolving steel industry needs.

"What's really unique is NRRI's ability to take a new idea from the lab bench to large pilot scale," said Tim White, NRRI Director of Business Development. "We know that the scale-up process is tricky, so our work can help reduce risk in innovation."

Photo right: Tim White

Industries of the Future

One example of a large industry impact is supporting the steel industry's efforts to decarbonize by finding substitutes for fossil coal-based coke, a nearly pure carbon product necessary in steelmaking. NRRI is working with several companies to evaluate a variety of ways the steel industry can transition to renewable and climate friendly sources of carbon, such as biocarbon, and using alternative reductants, such as hydrogen.

NRRI's unique capabilities include the ability to characterize different sources of biocarbon, make biocarbon at different scales and test how it performs metallurgically as a substitute for coke in iron ore pelletizing, sintering, and steelmaking. Once done, NRRI can also evaluate changes in energy use, environmental impacts and reclamation efforts in support of industry life cycle considerations.

"Working side by side with our partners, NRRI is uniquely positioned to create impact through advancing ideas to commercial success." said White.

Start-up companies need a different set of expertise. Developing a new project and securing financing often requires concept validation studies. MagIron, LLC, for example, is restarting operations in the former ERP Iron Ore Plant 4 near Coleraine to produce high quality, lower carbon iron units for domestic steel production. NRRI is currently conducting flowsheet validation, along with bench and pilot-scale mineral processing test work in support of MagIron's efforts.

UMN Partnerships

When companies or entrepreneurs come to NRRI for assistance, it's often their first time working with a University entity. White and Kangas walk customers through complex topics like intellectual property, confidentiality and licensing up front.

"NRRI takes its role in technology demonstration and economic development seriously, striving to provide applied research at the speed of business," said Executive Director Rolf Weberg. "It's a unique role within the university system. Our goal is to meet the business world where they are."

Proactive program puts safety out front

Jean Cranston, right, and intern Haleigh Reindl test air monitoring equipment used to detect airborne chemicals associated with adhesives in NRRI's Materials Testing Lab.

June Breneman
Aug 2, 2022

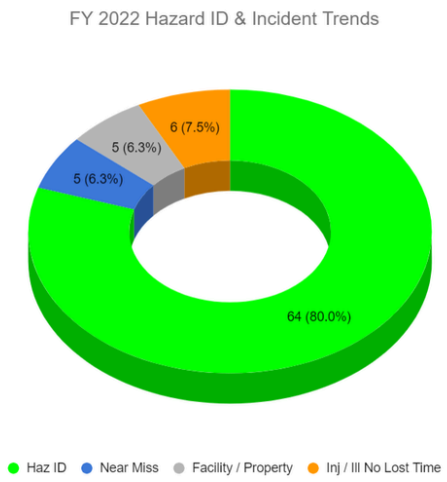
Industrial safety programs often focus on counting up safety incidents, hoping the numbers go down instead of up. But NRRI is taking a different approach – stop the incidents before they happen.

"When the focus is on tracking safety mistakes, people hesitate to report them," said NRRI Safety Manager Jean Cranston. "That's not what we want. So, we put a positive spin on it."

In July 2021, Cranston initiated a hazard reporting incentive program. She's asking all employees to report something amiss – a cord on the floor, a wobbly ladder, a vent system not working – before there's an incident. Each quarter, the employee who reports the most "hazards" receives an award.

"By reporting hazards, we raise awareness and prevent accidents," said Cranston. "We're working to instill proactive behaviors that create a safe working culture."

Green Donuts



Cranston produced a circular graph that challenged employees to "fill the donut green" by finding and reporting hazards at the Duluth and Coleraine facilities, and out in the field. In the course of a year, the "donut" was 80 percent green, reflecting 64 reported hazards. Staff efforts were celebrated with real green donuts, of course.

Cranston is a certified industrial hygienist and a certified safety professional, but she is still challenged by the unique and diverse labs that go from the microscopic scale to full pilot-scale. Researchers often work with hazardous materials, such as peroxide formers and combustible dusts.

"NRRI scientists take on projects that have never been done before," she said. "With no historical data to help prepare, the start of a new project can feel like we're trying to predict the unpredictable."

But by working with the researchers and brainstorming together, they can make predictions. They break down projects into specific steps and evaluate the components in great detail. Sometimes they conduct mock-setups and studies before they start. This allows the team to use science to predict the outcomes and control them appropriately.

Safety Intern

In the spring of 2022, Cranston hired a recent UMD graduate, Haleigh Reindl, as an intern to help organize the fast-accumulating piles of data and documents. Reindl graduated with a bachelor's degree in Public Health and is enrolled in the Master of Environmental Health and Safety Program this fall.

"I like community health issues and helping people, so this major is a good fit," said Reindl. "And Jean Cranston will be one of my instructors in the master's program, so this internship will help me get ahead next year."

Working to revamp an outdated and confusing chemical inventory system, for example, has taught her more than she ever thought she'd know about chemicals and chemical reactions. And visiting the Coleraine Labs after entering a lot of Management of Change documentation was eye-opening.

"It was really interesting to see the new equipment and get a better understanding of what pilot testing research is all about," Reindl said. "I'm learning a lot."

Future Efforts

Cranston is preparing the NRRI facilities to be accepted into the Occupational Safety and Health Administration (OSHA) MNSTAR program. This volunteer program recognizes workplaces that go beyond basic compliance with OSHA standards, resulting in immediate and long-term prevention of job-related injuries and illnesses. She's hoping to be ready for review in fiscal year 2024.

"This is a big goal for us," said Cranston. "We'll be inviting regulators onto our sites for audits and to review our injury rates, investigations and policies. It will be a very real test of our safety program."

Meet the Researcher - Igor Kolomitsyn

Igor Kolomitsyn works in his NRRI Duluth office.

June Breneman
Aug 2, 2022

‘Green chemist’ travels from Ukraine to U.S. to solve complex environmental problems in Minnesota.

When Ukraine declared independence following the collapse of the Soviet Union in 1991, Igor Kolomitsyn was two years into his organic chemistry degree at the National Technical University’s Kyiv Polytechnic Institute. His focus was on “green chemistry” with an interest in developing products and processes that minimize the use and generation of hazardous chemicals by using chemicals manufactured from renewable sources like biomass.

But paying his bills suddenly got very complicated. The Ukraine economy collapsed as the Soviet ruble was replaced with the Ukrainian karbovanets. (In 1996, it was replaced again by the hryvnia.) And amid the upheaval, Kolomitsyn enrolled in the University’s PhD program.

“The economic situation in Ukraine motivated me to search for opportunities while studying,” said Kolomitsyn. “I collaborated with industry and several research groups from Poland and Netherlands that led to my first Ukrainian patent related to green chemistry.”

Still working toward his doctorate in 1997, Kolomitsyn learned of an opportunity in UMD’s Chemistry Department and he accepted the temporary six-month position as a junior scientist with every intention of returning home to Ukraine.

“But I was also determined to finish my PhD thesis, publish and patent,” said Kolomitsyn. “My workdays were long, including Saturdays and holidays… fun time.”

But first he had to convince the Department of Organic Chemistry in Kyiv that he could execute the research independently and pass all necessary exams. He was awarded the doctorate degree in 2001, the year his daughter was born in the United States.

Home away from home

By late 1999, NRRI built its Chemical Extractives Laboratory and moved the research from UMD to the new lab. Kolomitsyn and other organic chemists continued development of proprietary processes to extract valuable natural chemicals from waste stream birch bark. Kolomitsyn and his family settled into life in the U.S.

“Naturally occurring organic chemicals, their structural complexity and their ability to be used by living organisms fascinates me,” said Kolomitsyn. “NRRI gave me the tools to research natural substrates like peat, peat lignin, wood and grass lignin and more, to develop a new generation of wastewater remediation materials.”

PFAS and peat

A current project – with industry partner American Peat Technology, LLC in Aitkin, Minn. – is developing a set of new natural anion exchange materials that selectively removes toxic Per- and Polyfluoroalkyl Substances (PFAS) from wastewater.

“It’s exciting to work on a solution that uses Minnesota resources wisely while tackling a complex environmental problem,” Kolomitsyn said. “If successful, it will lead to a new manufacturing facility to deliver this new technology and remediate impacted water resources.”

He appreciates NRRI’s diverse scientific expertise – chemists, metallurgists, engineers, biologists, ecologists – all within the organization. As Kolomitsyn develops new, natural materials he can often find a colleague with the expertise he needs to advance his project.

Central Support

Ordering chemicals is much more complicated than ordering standard office supplies, so Kolomitsyn relies on Purchasing Specialist Tammy Thomasson-Ehrhart to keep tabs on orders, especially important with the current supply and distribution challenges. And NRRI’s front desk team, Lisa Paczynski and Jenna Ballard, make sure that once the chemicals arrive, they get refrigerated, frozen or otherwise properly stored.

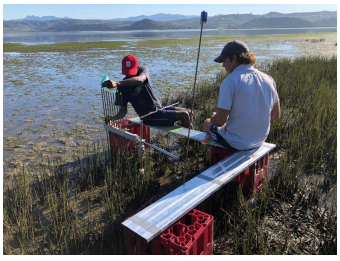
“We get a lot of help to keep my group on schedule,” said Kolomitsyn.

For Fun

When away from reaction flasks and analytical instruments, Kolomitsyn enjoys woodworking projects, challenging himself to build something he’s never tried before. He also has a large garden with prolific cucumber plants.

“So, every year I make pickled cucumbers using a Ukrainian recipe,” he said. “It’s very tasty and crunchy with garlic, dill flowers, horseradish leaves and black currant leaves.”

Research Highlight: Rising sea levels and tidal marshes



NRRI's Katya Kovalenko is co-author on research to study tidal marsh adjustment to accelerating sea level rise. It was published in Science.

Read the UMN Research Brief here.

About NRRI

The Natural Resources Research Institute was established by the Minnesota legislature in 1983 as an applied science and engineering research organization to inform state citizens and decision-makers while leveraging the power of the University of Minnesota. **The forward-looking charter provided by the Legislature is to *foster the economic development of Minnesota's natural resources in an environmentally sound manner to promote private sector employment.*** We are a mission-driven, project-focused team working to create opportunities for natural resource stewardship.

As part of the University of Minnesota system research enterprise, the Natural Resources Research Institute (NRRI) employs over 140 scientists, engineers, technicians, staff and students in two industrial research facilities.

Two Industrial Research Facilities

NRRI has extensive laboratory capabilities to discover and deliver at the bench-to-pilot scales, reducing risk inherent in commercializing innovations. NRRI Duluth has 19 labs to meet the needs of land, wildlife, water and minerals research. There's also an additive manufacturing lab and several technology development labs. NRRI Coleraine is a 27-acre site focused on minerals and bio-based energy research.

NRRI Mission

Deliver integrated research solutions that value our resources, environment and economy for a sustainable and resilient future.

NRRI Vision

Discover the economy of the future.

Find out more: NRRI website / Facebook / Twitter / Instagram / YouTube / LinkedIn