Stream restoration begins

Algae: tiny research tools

Emergency housing launched

Archiving metadata & Life on the rocks

The future of Minnesota ore

NRRI hits the court

International impact

Still on the lynx trail
For the love of

LESTER RIVER

Cover Story

Private donation leads to research, restoration of Lake Superior streams

He grew up fishing the Lester River and now he wants to say “thanks.” Ron Weber, former-Duluthian and generous benefactor of the University of Minnesota Duluth, has donated $100,000 to NRRI to restore and protect the expansive Lester River/Amity Creek system.

NRRI’s scientists won’t start and stop there, however. They’ve put together a proposal to use this funding as seed money to develop an environmental initiative to raise public awareness of everyone’s impact on local tributaries up and down the North Shore.

But it will all start with the Lester, a beloved trout stream that has been designated as “impaired” by the Minnesota Pollution Control Agency due to excessive suspended sediments.

“Water is proving to be the most important resource we have. The sooner we start maintaining its quality, the better,” said Weber. “This river is a tremendous resource for young people to have access to a good, wholesome sport right here in town.”

Duluth does a pretty good job taking care of its 42 streams. Just the fact

UMD Chancellor Kathryn A. Martin publicly thanks Ron Weber for his generous donation.
that 12 are designated trout streams says a lot. Trout are sensitive fish that need cool, clean water. Still, vigilance and education are important watershed responsibilities to keep them clean.

NRRI is particularly talented at building partnerships between agencies and community organizations. NRRI will use this talent to the fullest for this project. The hope is that a successful restoration of the Lester/Amity pilot project will foster support for a comprehensive management plan that will secure the integrity of many streams. The Lester/Amity system is a great starting point.

“The streams wind through urban and rural settings and they get a lot of use. People care about this,” said NRRI aquatic ecologist Dan Breneman, who is coordinating this project. “More importantly, we have great partnership potential in the Twin Ports area, which gives us more possibilities for additional funding to continue this effort on other streams.”

One problem the scientists will address in Lester and Amity is excess sediment. It enters the stream by natural erosion, or runoff of road salt and sand during spring snowmelt. The process often speeds up when natural vegetation along the banks is removed or during road construction or development projects in the watershed.

Sediment is hard on the aquatic life in streams, especially trout. It degrades their spawning habitat and is abrasive to their gills and fins. Excessive sediment also reduces the habitat quality for aquatic insects—a major food source for stream fish.

“The most important thing we can do today to keep the Lester River healthy is to spread the word on how activities, even away from a stream, impact what goes on in the entire watershed,” Breneman said. “There are a lot of people who can make a difference, even when it occurs along a small tributary. It’s really up to them.”

(Left) Best management practices include healthy vegetation along the banks to slow down water. (Below) Poor management practices include stormwater culverts that rush water straight into the stream.
They’re just a fraction of a millimeter long, slimy and sensitive—but what a story algae have to tell.

Algae are one of the indicators ecologists use to understand what’s going on in the waters we live near and play in. Algae are the organisms that make rocks and docks slippery in the water. These microscopic species play an important role in the global ecosystem, taking in carbon dioxide and producing oxygen. But even more, their sensitive nature makes them respond quickly to any disturbances in water quality, making them an excellent warning system for ecological problems.

Which is why Ely, Minnesota—on the border of the lake-laden Boundary Waters Canoe Area—is NRRI’s center for algal research. Housed in Vermilion Community College, the laboratory focuses on aquatic studies, including assessments of aquatic ecosystem health and paleoecology (the study of sedimentary records).

Algae thrive in all aquatic habitats, with each of the more than 20,000 species having an affinity for different environmental conditions. And it’s that affinity that gives scientists clues about water conditions.

“Most algae live a very short life, usually less than a week,” explains Euan Reavie, lead scientist at the Ely station. “If something happens in their environment—the pH balance changes, or the nutrients increase—a new algal community that is tolerant of the disturbance will quickly replace them.”

Although their life is short, algae leave clues behind that scientists can read later—even thousands of years later. Diatom algae have intricate “glass house” cell walls made of biogenic silica, and each species’ cell wall exhibits a unique architecture (see photos). Long after the diatom algae die, those resilient cell walls accumulate in the sediments preserving a sedimentary archive of past ecological conditions.

Following the algal trail, Reavie and research fellow Amy Kireta can piece together the history of a lake to prehistoric times, noting when changes occurred and the likely causes of any disturbances. Reavie has used this method many times to reveal human impacts in lakes, and define pre-impact conditions to help determine appropriate rehabilitation measures.
Diatoms are biological ‘tools’ for NRRI’s Ely scientists

Sometimes, what is assumed to be a human-related disturbance is simply a lake’s natural condition.

“We can save folks a lot of money and headache trying to fix something they believe is human impact when that’s not the problem at all,” said Reavie.

Often, however, the algae tell them that detergents (especially phosphate-based soaps of the 1960s and 70s), acid rain, mine drainage or septic system leaks are the cause of water quality problems. In such cases, changes need to be made.

The Sportsmen Club of Lake Vermilion initiated a study to see if the taconite tailings basins in Mountain Iron are having an effect on the lake’s water quality. Reavie found elevated levels of iron, magnesium, lead and sodium, but thinks it’s likely these increases are the result of air pollution and local activities. Increases in sodium, from non-detectable levels in sediments from before European settlement to 45 parts per million (ppm) in the top layers of sediment is almost certainly from road salt runoff, Reavie said.

The research also indicated that the level of phosphorous—the number one contributor to algae growth in Minnesota lakes—has nearly tripled since European settlement of the area. Tests also indicated that mercury levels in the sediments are extremely low (only about 0.1 ppm) far below some other known contaminated lakes in the region.

The goal of this project is to develop a set of tools for understanding the Great Lakes coastal water quality. Algae are one such tool and were sampled at over 200 sites for the study. Algae allow researchers to forecast the effects of trends like increased nutrient loads and other impact on the watersheds.

What’s going on in this busy waterway on the south side of Lake of the Woods? The Ely research team is looking at causes for sediment build-up and algal blooms. By studying the paleoecology of two streams that feed into the bay, they are able to evaluate the effect of the resorts and agriculture that hug its shores. A plan for rehabilitation will follow.

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It took a lot of careful thought, planning—and just plain sweat—but the first demonstration model of NRRI’s rapid response housing was unveiled this spring.

Representatives from the Federal Emergency Management Agency, American Red Cross, Economic Development Administration, and Department of Defense came to NRRI to see this efficient and portable emergency housing concept.

The idea to transform a shipping container into emergency relief housing isn’t new, but NRRI’s system is unique. Other systems rely on a steel super-structure, which is costly and specialized. NRRI’s solution is wood-based, which could stimulate the development of renewable natural resources industrial clusters in Minnesota. The end result is more cost effective and immediate.

The NRRI containerized house is a self-contained 8-by-20 foot unit that partially disassembles and reassembles into a 20-by-24 foot, two-bedroom home. The house can be assembled on site in about four hours. All construction materials for the home (including electrical and plumbing systems) are built to HUD-code standards and are embedded in the container unit.

NRRI’s rapid response housing system can be deployed for refugee housing, military shelter, homeless mitigation, and disaster relief.
The craggy, crashing North Shore of Lake Superior is beautiful to look at, but difficult to study. The rocky surface that makes up more than 50 percent of the lake’s near-shore area renders typical sampling methods for bottom-dwelling critters—a special scoop called a ponar—impossible to use. And divers sent underwater to collect samples are very expensive.

NRRI received an $80,000 grant from Minnesota Sea Grant (along with funding for a graduate student) to develop a more cost-effective method for monitoring the macroinvertebrate communities living on those rocky surfaces. They’ll test the effectiveness of putting artificial substrates—woven bags full of rocks that will mimic the rocky habitat—into the water at various sampling points at 15 to 30 foot depths. They’re hoping the “cobble bags” will attract enough species to provide a reasonable sample of what is making its home along the shores.

“Too much information!” has become a modern catch phrase. We all live with information overload. But data is especially valuable information—a collection of facts from which conclusions can be drawn. And scientists can’t get enough of it.

The problem with data is that it’s often just numbers. Metadata holds the details about the numbers—what they mean, why they’re important, how they were gathered and the goal for gathering them. This detailed information is crucial to other researchers who want to use the data for further study.

Another problem is that once it’s used for its specific purpose, scientific data is often improperly archived, making it inaccessible for future researchers. Valuable sets of facts are easily lost if the original creator of the dataset retires or dies, or new computing platforms move in, or it decays from improper storage.

“A straightforward discovery and retrieval system for datasets will greatly expand the availability of research results to the public and other researchers,” said NRRI Aquatic Ecologist Valerie Brady, who is coordinating this project. “That means more usage of, and benefits from, the work that went into gathering it.”

NRRI will build an archiving system that will be tested on the Environmental Protection Agency’s expansive STAR Estuarine and Great Lakes Coastal Initiative that reaches from coast to coast. The project is generating impressive amounts of datasets that need safekeeping.

The EPA’s Environmental Information Management System is being designed to be as simple as possible for both data submitters and data retrievers. Most importantly, the data will be stored in a way that will be stable across computing platforms for at least 20 years.

Researchers archiving their data will have to submit metadata with it, but the extra effort will be well worth it. One readily apparent benefit is having a safe, offsite backup of all their data in case of a computer crash. The system will link the power of the Internet with the power of really big databases. How big? Approximately one terabyte (1,000 gigabytes) of data. And all of that information will be made available through the system Web portal to researchers and the general public after it has been published in peer-reviewed journals.

Brady is also coordinator for the EPA’s Estuarine and Great Lakes Coastal Initiative, the “guinea pigs” for this metadata and archiving system. NRRI database manager Terry Brown is redesigning metadata creation software for this project.

UMD graduate student Matt Gearhiser tries several different styles of cobble bags in the lab. He placed three species of aquatic invertebrates in the bags to see if they would attach themselves to the rocks.
More people mean more buildings. More buildings mean more steel. More steel means more markets for iron ore.

China’s recently purchased interest in—and start up of—the United Taconite plant is certainly a boon to the Iron Range economy. But what does the future hold for Minnesota ore in the world economy?

It depends how we play the global market. The Mesabi Range is no longer the only source for iron ore in the United States—and certainly not for countries half-way around the world. Still, steel consumption continues to grow. The question is, who is best suited to supply the ore to feed the hungry steel mills?

“The fact is, there’s no shortage of global resources for iron ore,” says NRRI center director Donald Fosnacht. “But not everyone can mine it effectively. Whether or not a deposit can be developed into a commercially viable mine depends on a number of economic and geopolitical factors.”

The competition is tough. Minnesota’s taconite pellet quality is excellent with high iron values and low phosphorus content, even though our mill grades are generally much lower than competitive mines on a world-wide basis. The big players in the merchant iron ore trade are Brazil and Australia, accounting for over 67 percent of the total world commerce in ore. Their iron ore resources are enormous and the quality of the ore is excellent.

Understanding that Minnesota is a small player in the world ore marketplace brings the challenges into focus—our cost to produce pellets is higher because of the low-grade ore and extra costs associated with crushing and separating our ore to make the final products used by the steel mills. To stay in the game, Minnesota’s taconite operations need to be as efficient as possible, find uses for the by-products that we routinely generate and add value to the products we do produce.

NRRI’s expertise is critical to maximize the utility of Minnesota ore. NRRI has been instrumental in helping the mines produce very high quality iron ore for blast furnaces. Now, NRRI is developing new technology that will allow the mines to serve the electric arc furnace sector with oxygen- and gangue-free iron metal. NRRI has also been busy finding markets for the rock by-products of the taconite industry. Our research shows that various rock by-products can be used for high quality aggregate, road patching compounds and new building materials (for example, inorganically bonded wood fiber panels).

Ongoing modernization of Iron Range taconite plants will enhance the recovery of the value of iron oxide components and help keep costs down. NRRI research has shown that the typical taconite processing
flowsheet can be improved with new minerals separation and crushing techniques. Some of these concepts are being used now in Minnesota plants. The other players in world iron ore trade continue to install new plants for ore processing and also have greatly enhanced the logistical capabilities of moving their products to market. In the near future, both Australia and Brazil will be routinely shipping over 250 million tonnes each (one tonne equals 1,000 kilograms) of ore to world markets. China is importing significant quantities of Australian and Brazilian ore for their burgeoning steel market. Expanded highways, airport construction, manufacturing plans and city modernization are driving China’s demand, which is good for all. If the Chinese consumption were to ease, the world market could be flooded with iron ore from these sources to the detriment of Minnesota’s iron ore industry.

“If Minnesota is going to continue to be an active iron mining area, we must continue to enhance our current capabilities and get the most out of the rock we mine,” says Fosnacht. “Alternative uses must be part of our future economic equation, as well as value-added iron. These things will continue the economic success that has come back to Northeast Minnesota during the current steel industry boom.”
Underneath Shaq’s size 22 shoes

Wood products ‘dream team’ helps basketball floor manufacturer

They may be too short to make a dunk shot and too slow to take on Kevin Garnett, but NRRI’s forest products researchers were still able to play a highly visible (but, let’s say “supporting”) role in this year’s men’s NCAA basketball tournament...and the women’s tournament...even the NBA All-Star game. In fact, working with the researchers at the USDA Forest Products Laboratory in Madison, Wisc., they’ve had a major “impact” at just about all the big basketball venues.

Though it doesn’t get as much attention as the breathtaking athleticism on court, the wooden floor underneath the action is an important part of the game. To say it must be durable is an understatement.

The floor must withstand endless pounding (imagine having Shaquille O’Neal jump up and down in your living room 50 times a day for a few years), and it must be versatile with a surface that’s quick to set up and take apart—it’s not unusual to have a hockey game, a rock concert, and a basketball game at the same venue in the same week.

One of the oldest and most successful wood floor manufacturing companies is the Horner Flooring Company of Dollar Bay, Michigan. Horner has been around since 1891, the same year James Naismith invented basketball. The company specializes in making high-end portable hardwood flooring surfaces for many NBA and NCAA venues. Since 1983, every NBA All-Star Game and NCAA Final Four has been played on a Horner floor.

As with the rest of the wood products industry, Horner Flooring feels the economic pressure of the global market. The company employs more than 100 people at its headquarters in Northern Michigan and is an important outlet for the hardwoods from Michigan’s Upper Peninsula. However, many small companies often lack the resources to implement the technological and manufacturing advances of their larger competitors. So, like life on the competitive basketball court, it’s the teamwork that counts. In this arena, NRRI Forest Products Program Director Brian Brashaw is the head coach. Facing especially tough overseas competition, NRRI is boosting the wood industry’s regional defense by creating a team of experts, like the talent at the USDA Forest Service, who can help companies like Horner improve their bottom line to stay in the game.

NRRI’s game plan is to work from the inside. Brashaw says his team is unlike typical consultants who inspect a business from the outside and offer recommendations without really engaging the company.

“We truly work hand-in-hand with them,” he says. “We start with folks in the company doing ground level work, who have ideas about how to improve the process, but don’t necessarily have ways to get them to upper-level management where the change can occur. We also support their ideas with needed technical and engineering expertise.”

So while NRRI focuses on improving the manufacturing process, the USDA Forest Products Lab works to improve the product. Together, the dream team helps Horner at the tip-off.

“We were able to come up with an improved flooring system that was easier to manufacture,” explains Bob Ross, a researcher at the USDA Forest Products Lab. “We improved the connectors that hold the floor together. We looked at the base and structure—which is usually plywood or oriented-strand board—products that got their genesis at our Forest Products Lab. We also looked at finishing and drying schedules as well as moisture absorption and vibration characteristics.”

Ross also says that getting to work on a project like this was a thrill he won’t soon forget.

“You watch some of these games being played, and you think, wow, I had a hand in that,” he quips. “It’s a good feeling. And I also realize this was probably the only way a middle-aged guy like me was ever going to get on the same basketball floor as Shaq.”
NRRI's connection with Horner Flooring made the front page of The Wall Street Journal on April 1, just in time for the NCAA Final Four basketball games. The story was picked up across the country—from Florida to Alaska. Reporter Kris Maher started the story with this lead:

"DULUTH, Minn.—In a tan, cube-shaped building here, where Strategic Air Command personnel once guarded against missiles from Russia, a team of researchers labored on a new secret project. Their mission: build a better basketball floor."

The wood products industry is one of the primary economic drivers for the Western Great Lakes region of Minnesota, Michigan, and Wisconsin, employing more than 300,000 people.

If you have a forestry-based business and are looking for advice, visit NRRI at www.nrri.umn.edu or call 218-720-4294.
UNE, India—International relations have never been better. NRRI was at the heart of this year’s Indo-U.S. Workshop on Mathematical Chemistry held at the University of Pune in Maharastra, India, in January. All corners of India and the United States were represented, as well as Canada, Slovenia, Turkey, Colombia, Japan, Taiwan, Russia, France, Germany, Australia and Poland. Their goal was to share knowledge—not a small undertaking for this gathering of the brightest minds in mathematical chemistry.

NRRI’s Subhash Basak and Calcutta University’s Dilip Sinha, co-chaired this fourth workshop which brought the world together to understand the intricacies and possibilities that lie in computer-based chemistry and biology. Back in 1988, Basak and his colleagues at NRRI developed one of the key computer programs to predict chemical properties (see NRRI Then).

Here’s how it works: computational chemistry takes the search for information out of the laboratory where chemicals are tested on animals (in vivo) or in test tubes (in vitro) to computer models where structures and their derivatives are more quickly deciphered in silico (literally, in silicon—in the computer). This powerful computer tool is being used to understand the toxicity of chemical mixtures at Superfund sites or in fuels, for drug discovery, to understand gene sequences or to find more effective chemical compounds.

“In silico is really a decision-support system,” explained Basak. “Using the computer, we decrease the cost by decreasing the size of the problem, sifting through millions of possible chemical structures to find the best ones for what we need.”

What’s particularly exciting for the workshop participants are the seemingly limitless applications for this software, which leads to sharing between disciplines. Mathematical chemistry and theory is a general framework that can be applied to many sciences that deal with an overload of data. The unraveling of the human genome revolutionized genetics research—even beyond the study of DNA sequences. Proteomics (the study of proteins encoded by a genome) and metabolomics (the analysis of small molecules generated inside the body during metabolism) are producing scads of new data every day. These branches of research broaden our understanding of human biology, environmental protection and the search new drugs, but the large numbers of chemicals are becoming unmanageable. So while the computer sorts and manages information about hundreds of thousands of chemical and gene structures, it’s the mathematicians who make sense of it all.

“NRRI has become the hub for the international connection of scientists in this field,” said Basak, president of the International Society of Mathematical Chemistry, which sponsored the workshop. “We bring all the best people in the world together to collaborate. That gives us knowledge leverage—and everyone benefits.”
MATHEMATICAL CHEMISTRY AT WORK

For many people, the white lab coat world of mathematical chemistry seems far removed from everyday life. It is, however, a helpful tool for solving many everyday concerns—environmental protection, affordable health care, even a new mosquito repellent. Want lower priced prescription drugs? Developing new drugs—from the chemist’s first discovery to a pill on the pharmacist’s shelf—takes about 10 years and approximately $1 billion. Using mathematical chemistry software, however, computers can simplify the search for new and more effective drugs, significantly lowering the cost.

NRRI Then

In 1988, Subhash Basak was a young research associate who led the development of a computer program that predicts chemical properties. The program was named POLLY and written in Pascal to calculate 90-plus factors that compare and order molecules in a database. Upjohn pharmaceutical company was one of the first to use the new program.

The Spring, 1988 edition of NRRI Now reported that each year “pharmaceutical and chemical companies develop many new chemicals for use in medicine, industry and society, in general. However, the cost of developing these new agents is increasing because of an increase in toxicity testing requirements. According to a recent American Pharmaceutical Manufacturers Association report, the average cost of developing a new drug is $125 million in 1986, compared to $54 million in 1976.”

Since then, the cost to develop new drugs has grown exponentially. Basak’s research in computational chemistry has expanded since then as well.

Back in ’88, Basak called POLLY “the Model T” version. “This is a continuous program and we will be developing new software with more models and increased accuracy,” he said then.
Just three years ago, it wasn’t clear if Minnesota had a breeding population of Canada lynx, or if lynx were simply visiting from Ontario. NRRI’s study, using the newest technologies, is starting to turn up interesting answers.

“This spring and last, we found lynx dens with kittens in Minnesota,” says NRRI biologist Ron Moen, who is leading the Canada lynx research project. “And at least one kitten from all three of last year’s litters is still alive. Whether or not they’ll continue to live and breed here will take more time to answer.”

This spring 13 lynx kittens were found in four separate dens in northeast Minnesota. Like the kittens found last spring, they were ear-tagged so they can be kept track of from year to year. Last year’s kittens will be of breeding age next year. If they do, this is the next step to documenting the continued existence of the lynx population in Minnesota.

Meanwhile, the scientists are learning more than ever about these fascinating felines, thanks in part to public sightings reported to NRRI or the Department of Natural Resources. Rich Baker, DNR non-game research coordinator, says these sightings help the scientists know how far the cats are wandering.

“Five years ago we would have said there are very few lynx in Minnesota,” Baker said. “But today our Web site map shows 291 sightings. We appreciate all the information about lynx we can get.”

Much of what biologists have learned since then has been gathered through the efforts of scientists at NRRI and the U.S. Forest Service in a radiotelemetry project which began soon after the Canada lynx was listed as a threatened species under the Endangered Species Act. Resource managers needed to know how many lynx there were, where they lived and hunted, and what they ate.

Since the project began in 2003, 32 adult lynx and 21 kittens have been handled, providing interesting data about their life—and death—in Minnesota’s woods. Last winter 25 lynx with radio collars were monitored. Most of the males visit Ontario for a few days or for several months each year. Adult females, with or without kittens, tend to stay within a 20 square mile area. Seven monitored
NRRI biologists are still on the trail

lynx died over the past two years—six deaths were probably related to humans and one by a hungry fisher.

“We have almost 10,000 locations from the GPS collars that some of the lynx in this project are wearing,” says Chris Burdett, a graduate student working on the project. “I will be using the GPS locations from collared animals to develop a habitat use model for lynx in Minnesota.”

In Minnesota, as elsewhere, lynx prefer living in young forests with a conifer understory that attracts their favorite food, the snowshoe hare. Lynx have also been seen feeding on road-killed deer. Lynx can be active any time, but they are most active in the early morning and late afternoon according to data from the GPS collars worn by lynx in this project.

Pictures and more information on the Canada lynx research project can be found at www.nrri.umn.edu/lynx. If you see a lynx, this web site also tells you how to report the sighting.

“Minnesota once had the largest lynx population in the Midwest,” said Moen. “Ultimately, people will decide whether lynx continue to survive here. How we manage our forests, our daily activities, even climate change, will all affect Minnesota’s lynx population.”
NRRI partners appreciate 20 years of results!

“NRRI’s scientists can take complicated science, and make it user friendly. The data is local, cutting-edge information. NRRI has helped us by taking bird monitoring data and constructing a journal on bird populations. They helped us build maps from their data in a way that children can understand. Congratulations NRRI, and thanks for working with us.”

Peter Harris
Science Coordinator
Wolf Ridge Environmental Learning Center

“The NRRI and their Coleraine Laboratory have been especially beneficial in helping our taconite mines remain competitive during some very difficult years. Their achievements include research, testing and implementation of better process flow sheets, help in handling lower grade ores in the plants, material handling solutions, environmental improvements and help in day-to-day operating problems, to mention a few.”

Jim Swearengen
Retired General Manager U.S. Steel
Minntac Operations

“NRRI has been a tremendous resource to Northern Contours and played a significant role in our success. From product testing and evaluation to R&D and lean manufacturing assistance, the professionals at the NRRI have kept in step with our needs and a step ahead of the industry. We’re very pleased with the results we have achieved through our association with the NRRI.”

Lary Skow
National Sales Manager
Northern Contours

Check us out: www.nrri.umn.edu

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