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NRRI Now

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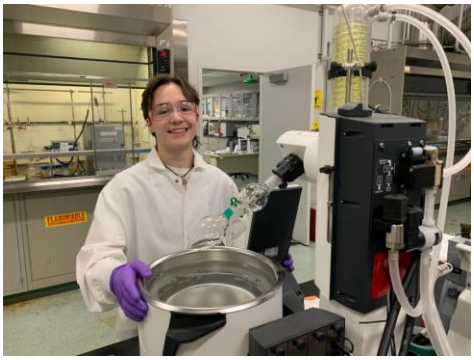

Emelyn Beaster works in NRRI Duluth's chemistry lab analyzing trace contaminants.

Next Gen Scientists

For many years, I've coordinated a small team of NRRI researchers who volunteer their time to judge local middle and high school science fair projects. We sponsor our own NRRI awards in three categories -- Chemistry, Ecology and Earth Sciences. It's always inspiring to see the enthusiasm and effort put forth by these young people.

So imagine my thrill when we hired a two-time NRRI award winner -- Emelyn Beaster -- as a summer technician. After high school she went to Lawrence University in Appleton, WI, set to graduate in 2027. She's all in on continuing studies in natural sciences, especially water systems and water geochemical cycles.

This summer at NRRI she's helping with contaminants analysis for the Great Lakes Sediment Surveillance Program (see story below) and working with a post doc researching PFAS in food waste.

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"I was amazed to learn about the amount of research underway at NRRI, spanning such a wide variety," Beaster enthused. "Even just in one lab, I am impressed by the sheer number of projects."

Let's all do what we can to encourage the next generation of STEM students.

June Breneman
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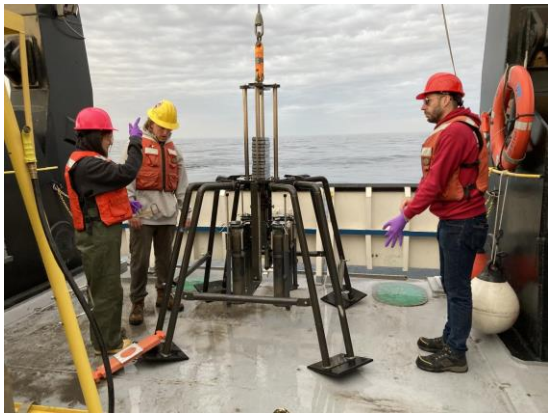
What chemicals are lurking (and where) in our Great Lakes?



NRRI Scientist Elizabeth Alexson points as she watches a core sample being lowered into the research vessel during the 2023 field season on Lake Huron. (Credit: D. Edge)

June Breneman
Jul 31, 2024

NRRI's early data analyses show surprising concentrations in the deep middle of lake, not just near shore

Understanding how pollutants flow through watersheds is well studied. We know that nitrogen fertilizers, for example, flow off lawns when it rains into nearby creeks and lakes. Plenty of contaminants also flow from our streets into water systems.

So scientists expected to see concentrations of contaminants near tributaries when they started the Great Lakes Sediment Surveillance Program in 2020. This massive effort, funded by the Environmental Protection Agency and led by NRRI, is identifying and analyzing legacy and emerging contaminants in surface sediments and deep sediment cores collected throughout the lakes. They are now getting results from data collected on Lake Superior and Lake Huron.

Interestingly, high concentrations of contaminants were found in the deep, middle of the lakes, rather than just the near shore areas. So now the team is looking closely at, not just the watersheds, but the airsheds, too. Pollutants get into the atmosphere and are moved with the wind and deposited when it rains. Some will attach to sediment which move with currents to deeper parts of the lake.

“We're seeing large changes in the concentrations from near shore to offshore, especially with some of the heavy metals I've been looking at,” said Chris Filstrup, principal investigator on the project. “They are more highly concentrated in the center of the lake rather than near most, but not all, tributary sources.”

What and Where?

The goal of the five-year study is to understand the extent of contamination in the lakes – from legacy chemicals to emerging pollutants – and how they move through the system.

The findings will lead to improved management strategies that more effectively target potentially harmful contaminants to protect the ecosystems and human health.

Photo left: Chris Filstrup

“We want to know more about the sources. Are they coming off the landscape or from wetlands or from where in the atmosphere?” said Filstrup. “And once the chemical gets into a lake, is it taken up by algae and then eaten by fish? Or does it settle out and stay undisturbed in the lake bottom?”

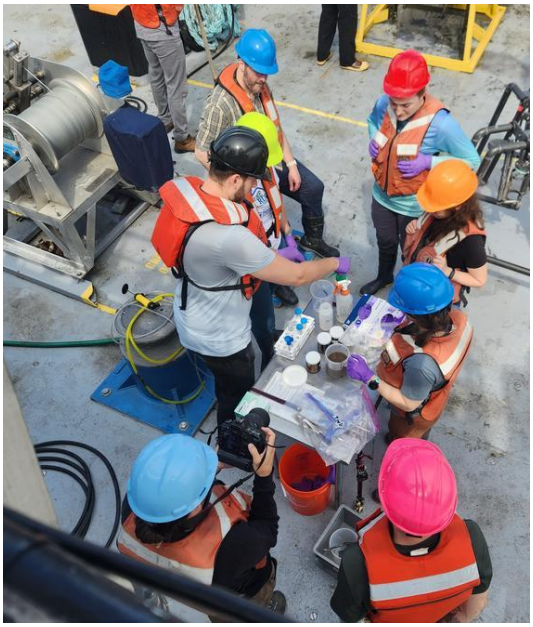
There are many questions to be answered, confounded by the depth and breadth of the Great Lakes and the 250 target contaminants – including 40 different PFAS ‘forever chemicals’ – being investigated for this study. And while a similar study was done some 10 years ago, the data collected then doesn’t compare well with the data collected today because of the finer details newer technologies can gather, and updated analytical methods.

“We’re adapting and adding new analytes – pesticides, for example – and we are also looking for new PFAS,” said NRRI Environmental Chemist Bridget Ulrich. “Some estimates say there are over 10,000 of these per- and polyfluoroalkyl substances, but we’re only measuring the concentrations for 40 that are included in standard methodologies. So we are also using non-target screening methods to identify new PFAS that could potentially be included in targeted measurement methods for future surveys.” Ulrich is also a Co-Principal Investigator for this program, leading a team of four scientists to perform the trace organic contaminant analyses for the sediments.

Sediment Collection

The core samples are collected from three sites on each of the five Great Lakes and shallow surface sediment samples at about 30 sites per lake. Going to the deepest sediment deposits allow scientists to go back some 200 years in the depositional record to see when concentrations of certain contaminants peaked and if the amounts entering the lakes are decreasing over time. Scientists will use the surface samples to identify contaminated hotspots – areas of the lake where contaminants are accumulating.

Photo right: Processing sediment samples on Lake Ontario 2023.



According to Ulrich, they're finding that legacy contaminants that have been regulated are being buried deeper within the sediment as time passes and new sediments settle on the surface. A new Gas Chromatography Triple Quadrupole Mass Spectrometer was installed to analyze legacy organic contaminants like polychlorinated biphenyls (PCBs) used widely in electrical equipment and polycyclic aromatic hydrocarbons (PAHs) from coal, crude oil and gasoline.

In addition to measuring emerging contaminants such as PFAS and neonicotinoid pesticides, the scientists are also performing nontarget analyses to detect new unknown contaminants. This required onboarding a new Liquid Chromatography Quadrupole Time-of-Flight High Resolution Mass Spectrometer. It can both measure contaminant concentrations and detect unknown contaminants, such as those that form in the environment due to degradation of other contaminants, and unknown chemical mixtures present in commercial products.

"At the beginning of the project it was challenging to comprehend the amount of effort it would take

Photo left: Bridget Ulrich

to implement this portion of the program," said Ulrich. "We not only had to onboard and train new scientists on these highly sensitive technologies, we also had to develop our own in-house protocols that align with new EPA standard methods that had just been released."

Katie Schreiner at UMD's Large Lakes Observatory is leading the effort to understand how the contaminants are transported within the lakes, which chemicals bind to what resources in the lakes – like organic matter or clay – and if it will cause bioaccumulation in the food web.

"Inorganic ions with a negative charge, such as dissolved phosphorus, bind to clays, which contain aluminum with a positive charge," said Filstrup. "Once it binds, the contaminant is transported wherever that clay goes."

Multidisciplinary

This extraordinary effort requires expertise from many science disciplines. (Team leads are listed in this 2020 grant announcement.) A paleolimnology team is charged with coordinating the surface sediment and sediment core sample collection and initial processing and physical analyses. Bulk analysis of the sediments and composition of organic compounds and how they influence contaminant transport will be done by a team from UMD's Swenson College of Science and Engineering. A civil engineering team will characterize the lakes' microbial communities and how the microbes may affect contaminant movement

from the sediments back into the water. A collaboration with the U.S. Geological Survey Mercury Lab in Madison, WI is providing additional expertise in mercury and methyl mercury concentrations.

“People hear about this effort and are astonished by the amount of contaminants we’re analyzing,” added Filstrup. “In the end, we’ll have a really comprehensive chemical fingerprint at each site and better understand how these contaminants move in the lakes.”

Being able to predict where known and emerging chemicals are in the valuable freshwater resources of the Great Lakes will inform efforts to protect the environment and keep humans from being exposed.

Tiff's Tips #2: 5 Tips for Road Trip Foods

Tiff's Tip #2 Review!
Jul 2, 2021

Introducing a new monthly series by NRRI’s Tiffany Sprague, Sustainability Program Coordinator: Sustainability at NRRI: Tiff's Tips for Eco-Living.

After last month’s Tiff’s Tips I imagine you are now bursting with eco-friendly BBQ tips. Maybe so many tips you are exploding at your organic cotton seams (the bursting sensation may also be the result of a few too many carrot hot dogs, but #SelfLove, my friends). Perhaps so many tips, you just have to share your newfound wisdom with your friends and family. Unfortunately, not everyone you know lives nearby...

So honey, pack up the car -- it’s time for a road trip!

After you do all the boring adult things -- filled the gas tank, topped off the windshield wiper fluid, checked your tire pressure -- comes the #1 car trip priority: the snacks. Tiny humans in tow or not (thank gosh for third row seating, amiright? Shove them as far back there as possible), car snacks can make or break a successful trip.

Cut the Plastic-Wrapped Car Snacks

After the allowable store-bought goods of cheesy crackers and gummy worms, consider what you can prep in advance, store those items, and reduce single-use plastic as you sing Wilson Phillips' "Hold On" for the 300th time (wait, we're only an hour from the house? Well, what else are we going to listen to?!).

We all have our guilty (fast food and convenience store) pleasures (#SelfLove), but it actually isn't our only option. I know this may sound bananas (which, btw, is a great snack to pack for your trip), but the food currently in your fridge and pantry can exit your property and be placed into your vehicle!

It's not about the quality or "healthiness" of the food I am harping on here, but rather the packaging. Beverages in plastic bottles, or in throw-away cups with plastic straws; burgers wrapped in throw-away film paper; sandwiches packaged in those odd little single-use triangular containers; string cheese in single-use plastic wrap (freakin' string cheese).

Okay, calm down, Tiff, they get it; now give them some helpful hints. Whew! Sorry. I just get a bit riled up about single-use plastics.

1. **Pack as many meals as you realistically can.**

- The trusty PBJ
- Mason jar salads (all the cool kids are eating them)
- Cut and peel a regular ol' carrot; put in a container with a bit of water
- Straight-up apple, not pre-sliced
- Block of cheese, not plastic wrapped string cheese

Face it, you're all going to make just as big of a mess if the snack was in a tiny single-use bag or in a reusable container. You can even make your own granola bars! If that feels terrifying, here's Tiff's favorite recipe for an introduction to granola bar making: Peanut Butter and Jelly Bars.

2. **Pack your meals and snacks in recycled containers.**

- Reuse sour cream and yogurt containers (not making homemade yogurt? Then you're buying it in a gigantic container, not tiny single-use containers… correct?).
- Mason jars work great for snacks you buy in bulk (because of course you're buying all your snacks in bulk).
- Plastic peanut butter jars also make great storage containers.

3. **Containers too bulky? Use the plastic zip-top bag. But…**

- Re-use those bags as much as possible. Rinse 'em out, let them dry, and use them again and again.
- Recycle! Cut off the zip-top and discard, and put the clean bag in your plastic bag recycling (most grocery retailers collect plastic bags).
- Do not put in your plastic bags in your mixed curbside recycling.

- Can't bother to clean them out, let them dry and cut off their zip-top? Well, then unfortunately, toss 'em. Just know you had choices.

4. **Napkins and silverware (no travel kits required).**

- Pack what you use at home or thrift some neat-o secondhand forks. Wipe them off when you're done, spritz with some alcohol (if germs are a thing for you) and you're ready to go.
- Cloth napkins travel just as well...well...as your clothing. Throw them in your towel load when you get back from your trip and they're ready for your next adventure!
- Bring a tiny cutting board and a knife (wrapped up in a towel or sporting a blade cover, of course).

5. **Water supply - fill the containers!**

- Fill up the orange Igloo and throw it in the trunk.
- Refill individual reusable water bottles, kept on hand.
- Travel-sized orange Igloo?! Yep. It is epically adorable. Like its big brother, our travel one is 2.5 gallons and stows away perfectly next to our first aid kit and jumper cables.

Small effort. Big impact.

Remember, the convenience of single-use bottled beverages does not outweigh the expense -- both to your wallet and to our environment.

Yep, this requires pulling over to cut up the apple and big ole block of cheese, and filling up reusable water bottles from the adorable travel-sized orange Igloo. Break at a rest stop! Many of them are quite wonderful and feature playgrounds, picnic tables, bird feeders, walking trails and dog areas. Picnic at a scenic overlook or historical marker. You might be surprised by what you see and learn along the way. Don't get so hung up on what you are going to do once you reach your destination that you don't enjoy the process of getting there.

Well, until next month, the environment thanks you for dealing with some minor inconveniences and minimizing your consumption of foods wrapped in single-use packaging.

Tiff

Meet the Researcher - Lysa Chizmadia

NRRI Process Mineralogist Lysa Chizmadia works at a microscope to image iron pellets for a project.

June Breneman
Jul 31, 2024

Mineralogist finds ways to keep learning and growing at NRRI

Geeking out over cool new tools is just one perk of her job. Another is breaking out of her comfort zone in the rocks and minerals world to forests and biomass.

Lysa Chizmadia is a process mineralogist at NRRI's Coleraine lab on the Iron Range. And she's ready to onboard a new cutting-edge microscope – the only one of its kind in Minnesota – with what she calls "nearly unlimited possibilities."

The Craic vitrinite imaging system uses reflectance and fluorescence to measure the thermal maturity of coal or biocarbon so that it can be fully characterized. Vitrinite is one of the primary components of coals and most sedimentary kerogens (organic material compressed and heated by geological processes).

And this imaging technology is going to make her research much easier. For example, distinguishing the difference between two similar polymers under a microscope is notoriously difficult, but this instrument defines what bonds are in the polymer, even if they have the same composition, so the researchers can tell them apart.

Photo left: Lysa Chizmadia

"This equipment is perfect for NRRI because it will be useful to researchers in various fields, including geology, metallurgy, biomaterials, forestry, and more," said Chizmadia. "And a better understanding of surface chemistry can lead to more efficient processing, saving water or saving energy."

Chizmadia came to NRRI in September 2022, fresh off a gig as a geology professor at Bemidji State University in northern Minnesota. She also taught at the University of Puerto Rico for 11 years. She holds a master's degree in geochemistry from the University of California Los Angeles (UCLA) and a doctorate in Earth & Planetary Sciences from the University of New Mexico.

"As a professor, I oversaw research for undergraduate and graduate students, so research is not new to me," she said. "But now I have more uninterrupted time and don't have to grade papers all the time."

Minerals to Biomass

So while she's gearing up to microscopically dig into complex iron- and manganese-rich ores, Chizmadia is also turning her attention to the world of wood.

NRRI received Department of Energy funding to develop biomass-based carbon fuels to reduce carbon dioxide emissions in the iron-making process. Chizmadia is part of the team that will identify the properties the biocarbon needs to replace fossil coal in the process.

"I have experience and expertise with using electron microscopy to characterize complex solid materials," she said. "But my background is more in inorganic chemistry, so biomass characterization is new to me."

The biocarbon project is also expanding her work circles within NRRI to forestry researchers, giving her a lot of new things to learn. She also appreciates the administrative support that helped her settle into the University system, writing and submitting grant proposals and dealing with financial paperwork.

"Robin Oberton, Megan Gorder and Julie Christopherson are great administrative assets to helping us get our work done on time and on budget," added Chizmadia.

Off Hours

When she needs a break from "geeking out" Chizmadia gets on her bike and rides the Mesabi Trail, listening for tree frogs in the spring.

"I didn't know Minnesota had tree frogs!" she exclaimed. "I thought they were only tropical or subtropical species."

One Last Thing

Watch for deer!

NRRI Wildlife Biologist Ron Moen shares information about his study of deer-vehicle collisions with the Star Tribune. His findings will help inform Dept. of Transportation efforts to reduce accidents.

Don't swerve

NRRI Organization Overview

NRRI was created by the MN Legislature in 1983 to deliver applied research informing environmental stewardship and economic development of the state's natural resources. It is a nationally unique model for integrated research focused on three strategic initiatives: Ecosystem Resilience, Future Forest Industries, and Iron and Minerals of the Future.

As part of the University of Minnesota system research enterprise, NRRI employs over 140 scientists, engineers, technicians, staff and students in two industrial research facilities. Through collaborative partnerships, we deliver the innovative tools and solutions needed to utilize and sustain Minnesota's valuable natural resources.

Find out more: NRRI website • Facebook • X • Instagram • YouTube • LinkedIn

NRRI Facilities Overview

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 that address the needs of land, wildlife, water and minerals research, as well as several technology development labs and the LP Innovation Center, developed in partnership with LP Building Solutions.

NRRI Coleraine, a former U.S. Steel R&D facility, is a 27-acre industrial-scale site that was acquired in 1986. The minerals processing and metallurgy labs provide bench to pilot-scale research to broaden the state's portfolio of ore resources while impacting process efficiencies and improved production of taconite. The engineered biocarbon product development lab tests processes for converting a variety of biomass into fuel and carbon materials up to commercial demonstration scale.

NRRI Fens is a 425-acre property near Zim, Minnesota, was acquired in 1986 to restore its function as a valuable peatland and fens bog after being drained in the 1950s for farmland. Decades of effort have restored the peatland - nature's most effective carbon sequestration solution - and the restoration credits were sold to state agencies. Ongoing research on the site will continue to inform successful peatland restorations across the nation.

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.