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Natural Resources Research Institute

NRRI Now

A monthly newsletter from the Natural Resources Research Institute

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Rolf Weberg (right) welcomes John Kettle of Finland's Natural Resources Institute to NRRI on May 30.

Greetings!

NRRI welcomed a special international visitor from Finland on May 30. John Kettle, director of Sales and International Relationships for Luke Natural Resources Institute (sound familiar?) flew into Duluth for a whirlwind tour of NRRI's facilities, led by NRRI Executive Director Rolf Weberg.

The visit marks the one year anniversary of the initiation of a research relationship to identify programs of mutual interest.

"Both organizations have strong capabilities in climate change and natural resource management," said Weberg. "We're just getting started, but we hope that together we can generate programs larger in scope than we could do separately."

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This connection was initiated by Governor Walz' letters of understanding signed with Finland's foreign trade minister in late 2021 to collaborate on developing sustainable technologies.

Bonus fun fact: NE Minnesota and the Upper Peninsula of Michigan have the most residents of Finnish descent in the United States.

Terveisin [Best wishes],

June Breneman
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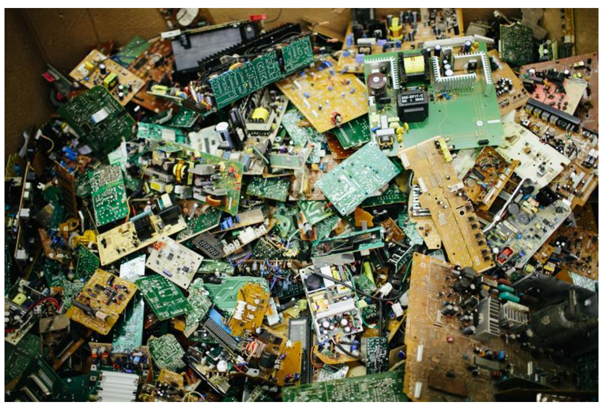
NRRI looks into urban mining



June Breneman
Jun 1, 2022

Report explores the challenges and research opportunities in electronic waste recycling.

Look up this fun fact on your smartphone: There's about 100 times more gold in a ton of mobile phones than in a ton of gold ore, according to the World Economic Forum. There's also lithium, rare earth elements, silver, copper, platinum, palladium, cobalt and more. Much more.

Above ground or below, ores and metals are a finite resource. Recent studies published by the Royal Society of Chemistry indicate that traditional supplies of many mineral elements that are vital for low-carbon technologies (electric vehicles, batteries, wind turbines, solar panels, etc.)

will be consumed in less than 50 years if we continue the current extraction and consumption rates. At the same time, new legislation and growing social pressure to mitigate climate change are driving demands for even more of these technologies.

One way to balance these supply and demand challenges may be mining electronic waste resources. In addition to smart phones, e-waste includes 3-D printers, medical devices, spent solar panels and old electric car batteries. Compared to mining virgin ores, it is more energy efficient, reduces carbon emissions and there's money to be made. A study published in 2019 estimates that the raw materials in electronic waste were worth roughly $57 billion (United Nations University, International Telecommunication Union, and International Solid Waste Association). The study also indicated that 53.6 million metric tons of e-waste are generated each year globally, of which only about 17 percent is formally recycled.

In the U.S. a small percentage of recycled electronics are simply dismantled into component parts and the materials are sent to other countries for refining and reuse, according to the Minnesota Pollution Control Agency. And that global 83 percent that isn't recycled? There's little data, except that it predominantly ends up in landfills.

E-waste contains metals critical to high-tech products including cobalt, lithium, rare earths, gallium, germanium, tantalum, tungsten, platinum and palladium. It also contains valuable bulky materials such as copper, iron, and aluminum, along with plastics, ceramics, fillers and glass. And while it's true that recycling rates for copper, iron and aluminum are high – more than 50 percent – recycling rates for 35 critical elements is below one percent. And plastics recycling? Zero to 20 percent.

The potential in e-waste recycling is huge, but so are the challenges.

Exploring the Horizon

NRRI Engineer Shashi Rao prepared an internal summary report in 2021 as an initial step to outline the innovation gaps that NRRI may be able to help address. In preparing the report, he conducted "voice of customer" interviews from across the metals recycling industry during the first half of 2020. The data cited were published in 2019 and 2020.

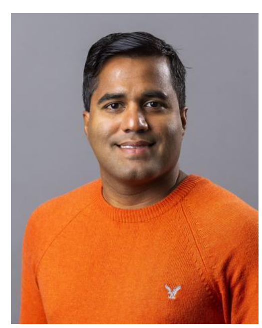


Photo right: NRRI Engineer Shashi Rao

NRRI is now considering updating the report and identifying projects to address the barriers and opportunities associated with accessing the value in electronic waste.

"NRRI is always exploring new opportunities to sustainably meet Minnesota's resource needs," said Matt Mlinar, NRRI Interim Mineral Processing & Metallurgy Research Group Manager. "This report generated some interesting internal discussions and we're hoping to extend the conversation and find partners in this arena."

The report highlights key issues related to plastics and metal recovery from end-of-life electronic and electrical equipment, and challenges in creating circular supply chains for these materials. It also identifies opportunities to improve the recycling rates of "difficult to recycle" materials and creating secondary markets for electronic waste materials. Rao also outlines opportunities to define recycling methods for newer materials that are introduced into new electronic gadgets.

Research Opportunities

Research opportunities with high potential for significant impact, and that fit in the University of Minnesota research enterprise, include:

- Develop techniques to upscale e-waste plastics into higher value-added products.
- Develop characterization techniques to measure recycled plastic content in newer electronic products.
- Develop super-polymers that have superior functionality and recyclability compared to today’s polymers.
- Develop recycling methods for next generation EV and energy storage batteries (solid-state and lithium-iron-phosphate batteries); along with methods to characterize waste battery materials.
- Develop multiple avenues to improve the recyclability of wind turbine and solar panel components.
- Understand deficiencies of current recycling technologies to recover materials from future electronic products.
- Investigate how complex products can be dismantled so that relevant components can be channeled into appropriate metallurgical end-processes.

The NRRI report identifies critical research equipment, skillsets, collaborators, and funding opportunities required to support and sustain a regional research facility. Next steps include soliciting feedback from stakeholders, finding funding, identifying partners and obtaining necessary equipment.

“Improving the recyclability of electronics is a win scenario all around,” said Rao. “More research is needed to evaluate the feasibility of a regional program to maintain economic competitiveness and improve Minnesota’s environmental stewardship.”

NRRI focuses on minimizing waste and environmental impact, maximizing value from all resources, and maintaining/restoring ecosystem function. As part of its strategic initiative, NRRI conducted this exploratory project to understand the innovation needs of the electronics waste recycling industry. This effort is an essential step in promoting resource efficiency, improved materials recycling, and life cycle thinking.

NRRI wildlife research experiences launch young biologist's career

June Breneman
Jun 1, 2022

Northwoods bobcats and fishers research leads recent graduate Nate Weisenbeck to sea turtles on Florida beaches.

Nate Weisenbeck's 8-year-old self couldn't be happier. Now at age 23, he's headed to Florida to live out his dream as an intern in the field of marine biology.

"From my earliest memories – the very first time anyone asked me – 'What do you want to be when you grow up?' I said, 'marine biologist'," said Weisenbeck. "As I got older it expanded to all animals and nature. I couldn't do anything else."

And with that easy decision made, he launched a career trajectory that started at the University of Wisconsin-Stevens Point. His degree in Wildlife Ecology and Management included a trip to Africa to study the sex and age ratios of Savannah elephants using digital photogrammetry in the Okavango Delta region of Botswana. The last safe haven for these elephants.

“One of my professors had a project there, and he gave me the opportunity to lead part of a larger research project on elephants in Botswana,” he said. “That was life-changing, to say the least.”

During his junior year, Weisenbeck met NRRI Wildlife Ecologist, Michael Joyce, at the Midwest Fish and Wildlife Society conference. Joyce’s presentation on the agenda caught his eye.

“He was the only one in the whole conference talking about fishers, one of my favorite species – I had to go to his talk,” Weisenbeck said. They chatted afterwards and exchanged emails. Upon graduation, Joyce invited Weisenbeck to come to NRRI to be a summer research technician.

Wild Ride

He arrived in June 2021 and immediately started analyzing data collected from trail cameras aimed on fisher den boxes to gain understanding of their effectiveness and look for reproduction events. By the end of October, Weisenbeck accepted a full-time position at NRRI as a Wildlife Technician

“Having Michael as a mentor, sharing everything he knew with me, was invaluable. I will take everything I learned with me and hope to make a big, positive impact on our wild places,” said Weisenbeck.

His favorite project involved getting close to animal scats. Joyce is leading a project to understand the relationship between small forest mammals and dispersal of fungal spores – like, truffles that fruit underground. As mice, voles and other critters eat mushrooms, the spores are dispersed throughout the forest in their droppings. Forest fungi are important forest health partners, with an incredibly complex, symbiotic relationship with trees.

“Small mammals play a really big role in forest health, but this research is pretty new,” said Weisenbeck. “It was exciting to learn about Michael’s research on the cutting edge of mammal-mediated fungal spore dispersal research.”

During the winter of 2022, Weisenbeck also helped with bobcat and fisher trapping to outfit the carnivores with radio-collars. Bobcats are a significant predator of fishers, and this project aims to understand bobcat impacts on Minnesota’s fisher population. The carnivore project is funded by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

“We went out on snowmobiles in the Superior and Chippewa National Forests and ran trap lines. It was all new to me and super fun,” said Weisenbeck. “This project also taught me a lot about how legislative funding works and all the facets that go into it.”

Weisenbeck also had the opportunity to learn about other NRRI wildlife research projects taking place, from long-term bird monitoring to wood turtle habitat. He is amazed at the broad diversity of research and how NRRI is right at the intersection of the economy and sustainability.

"But maybe the biggest thing I gained for my professional career here was seeing and taking part in a larger part of the full research cycle," he said. "I was able to help draft initial protocols, collect field data, and help enter and analyze the field data… seeing the full breadth of what research is and how it gets done was just awesome."

Life's a beach

And now he's hoping he can apply the skills he learned in the Northwoods to the beaches of Florida. Weisenbeck will join a team of U.S. Geological Survey researchers studying sea turtles. During nesting season when the mother turtles come up on the beach, the crew will check those with movement transmitters and put more on those who need them.

The transmitters help the researchers understand the sea turtle migration through the gulf. He'll also be involved in capturing sharks, the sea turtle's main predators, to put transmitters on them. The research aims to understand how sharks move through the Gulf and in which areas shark movement is overlapping with the tagged turtles.

"I grew up in central Wisconsin boating on the Wisconsin River, so being on the water feels natural for me. This is exactly what I want to do," Weisenbeck said. "And I'm looking forward to the warmer temperatures and lots of reptiles and amphibians to find and learn about."

He realizes how fortunate he is to have had a clear vision for what to study in college and for his career. For college students struggling with picking a major, he says to look inward.

"What do you truly love? When are you happiest? And if that's not clear, just try a bunch of new things, see what feels right and trust yourself," he said.

Meet the Researcher: Steve Kolbe

June Breneman
May 31, 2022

Wandering bird lover settles at NRRI's Avian Ecology Lab to grow understanding of bird migration and habitat

For a while there, it seemed Steve Kolbe might just make a career of being a roving field technician. Upon getting his bachelor's degree from Miami University, he spent five years travelling North America – from Maine to California and Alaska to Jamaica – doing 20 different field research jobs related to birds.

The year 2015 brought him to Duluth to work for Hawk Ridge Bird Observatory and he enrolled in UMD's Integrated Biological Sciences master's program. Throughout his time at UMD, he worked as a summer field tech doing breeding bird point counts for NRRI's Avian Ecology Lab. Upon completion of his degree in 2018, Kolbe was hired at NRRI as a full time Avian Ecologist.

"My major area of interest is in bird movements," said Kolbe. "Everything from the movement of fledgling birds within their breeding territories to the migratory movements of birds that are heading to different continents."

Wetland Wildlife

Kolbe is currently focused on helping to determine the habitat needs of Black Terns and Forster's Terns in Minnesota wetlands – but not just any wetlands. These terns breed in high-quality wetland habitats – clean water, diverse vegetation, high-quality insect or fish prey – throughout the western portion of the state. That means they are excellent indicators of water quality and wetland health, which is important to other wildlife and humans.

Photo right: Steve Kolbe

"Surprisingly, there's no current effort to understand the status of their populations in Minnesota," said Kolbe, "even though there appear to be range-wide declines."

With funding provided by the Minnesota Environment and Natural Resources Trust Fund, Kolbe is digging into understanding what habitat features are important to provide recommendations on how to create higher quality wetland habitat. This information will also provide critical information about the status of tern populations in the state.

"Black and Forster's Terns are amazing species that deserve a place to live here – like all native species," he said. "As great indicators of habitat health, stabilizing or increasing their populations would mean we have increased quality wetland habitat as well."

In addition to wildlife habitat, wetlands provide a wealth of benefits to humans and the environment including water filtration and carbon sequestration.

Collaboration

Connecting birds and other wildlife to fields such as hydrology, silviculture, carbon and minerals within NRRI and the University taps into the expertise of a wide variety of disciplines and supports sound, long-term decisions regarding how we manage all of our natural resources.

"We also strive to stay current with the latest technologies and always think about how they could be used to study wildlife," said Kolbe. From camera and video technology, to using tracking technology to better understand movement and behavior of birds, the Avian Ecology Lab works with collaborators across North America to improve understanding of birds and ecology.

Central Support

Following NRRI’s carefully crafted procedures and the University’s many protocols can be confusing. Kolbe says he’s especially grateful for the assistance of Central Administrative Specialist Tammy Thomasson-Ehrhart, Jenna Ballard and Lisa Paczynski.

“They are always willing and able to help with any problems that arise, and do it cheerfully and capably,” said Kolbe. “They will either know the answer or point me to the person who can help me. And they all make me feel very welcome at NRRI.”

Not Enough Birds

In his off-work hours, Kolbe still enjoys time with his feathered friends. He is an experienced photographer specializing in pictures of flying birds.

“I spend much of my off time watching birds! Most of my hobbies relate to this,” he said. “Even while out riding my bicycle, I’m listening to and looking for birds.”

Side Note

NRRI's Rolf Weberg and NRI's John Kettle also visited the labs in Coleraine, Minn. on May 31. This 27-acre site is focused on scaled-up minerals and bio-based energy research.

From left: George Hudak, Patrick Schoff, Rolf Weberg, John Kettle and Kevin Kangas

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