



NRRI Now

A monthly newsletter from the Natural Resources Research Institute

December 2022 | Volume 07 | Issue 12



Creative Commons Photo Credit NASA/Joel Kowsky

As I was putting this edition together, we got word that Armetis 1 successfully launched on a voyage to orbit the moon. This uncrewed mission is the first step in an ambitious new space campaign with some big goals. In the years ahead, we'll see the first woman and first person of color walk on the moon. They're also planning to establish a lunar space station.

I was a seven-year-old space stick-eating, Tang®-drinking kid whose whole family watched as Apollo 11 made its journey and successfully landed on July 20, 1969. It fueled my curiosity about our planet and beyond.

So imagine my excitement to learn the NRRI is playing a small role in the new Armetis mission. You can read all about it below.

I hope your curiosity is fueled and you're ready for 2023. Happy New Year!

June Breneman
Editor, Marketing & Communications Manager
nrriinfo@d.umn.edu

NRRI is 'crushing it'



NRRI Process Mineralogist Lysa Chizmadia is managing the project to crush scoria for Michigan Tech.

June Breneman
Nov 17, 2022

High Pressure Grinding Rolls provide perfect technology for interplanetary impact

Unique rock crushing capabilities at NRRI's Coleraine labs will help NASA build structures on the moon.

The space agency wants to know how lunar regolith, a variety of pulverized minerals coating the surface of the moon, could be used to eventually build structures to support a moonbase – landing surface, roads and foundations for livable structures.

Using lunar resources for construction materials will be more efficient than trying to haul material in a spaceship -- as well as extracting water from lunar ice and oxygen from minerals to create rocket propellant. But the researchers, based out of Michigan Technological University's Planetary Surface Technology Development Lab, need to develop the robots and processes to find, extract and process the lunar resources on earth.



To mimic the moon material – very small and angular particles that behave very differently than sand – they are mixing crushed earth-sourced minerals, anorthite and basaltic scoria. But to get the right particle size, the scoria has to be crushed. Eight metric tons of it was shipped to NRRI's labs in Coleraine, Minn., from New Mexico in early November. The rocks will be crushed in NRRI's unique, pilot-scale high pressure grinding roll (HPGR) so that the mixture will simulate lunar highland samples brought to earth on the Apollo space mission.

Image left: Scoria as it arrived to NRRI for crushing.

“Remember when Neil Armstrong and Buzz Aldrin walked on the Moon and left those footprints in the surface? That’s the material they need. It’s very fine, like flour,” said NRRI Process Mineralogist Lysa Chizmadia, lead researcher on NRRI’s portion of the project.

NRRI’s unique grinding equipment – the only large scale HPGR dedicated to research in the U.S. – is the perfect scale to tackle the scoria crushing. High pressure grinding rolls reduce particles by compressing and crushing the material between two counter rotating, parallel rollers with a small gap between them. This forces the rocks against each other. Compared to rod or ball mills typically used in iron ore processing, the HPGR substantially reduces water consumption and there are no rods or balls that need replacing. And depending on the rock type, is about 30 to 40 percent more energy efficient than traditional grinding technologies.



Image right: Lysa Chizmadia

“Our HPGR is in that sweet spot where we can process much larger quantities than what an average research lab can do,” explained Kevin W. Kangas, Director NRRI Coleraine Labs. “And ours is the only one available in the U.S. for research on this scale.”

Image below: MTU’s lunar rover



NASA’s goal is to build an Artemis Base Camp that will allow robots and astronauts to explore more and conduct more science than ever before. A portion of the lunar simulant material will be mixed with crushed ice and used to fill a trench with layers of varying compaction level and ice content, according to Paul van Susante, MTU principal investigator of the NASA Lunar Surface Technology Research (LuSTR) grant. Using a field test rover on Earth, the researchers will collect information about the geotechnical properties and ice content of the material with their test instruments (a percussive hot cone penetrometer and ground penetrating radar) to identify and quantify

the ice and methods for extracting the ice as well as future exploration on the moon.

“The goal of extracting ice is to create rocket propellant and open up the rest of the solar system to much easier access,” van Susante explained. “The crushed basaltic scoria and anorthite mixture, called ‘lunar simulant,’ will be used to perform integrated system testing between January and May, and hopefully the cone penetrometer and ground penetrating radar will fly on a future lunar lander mission.”

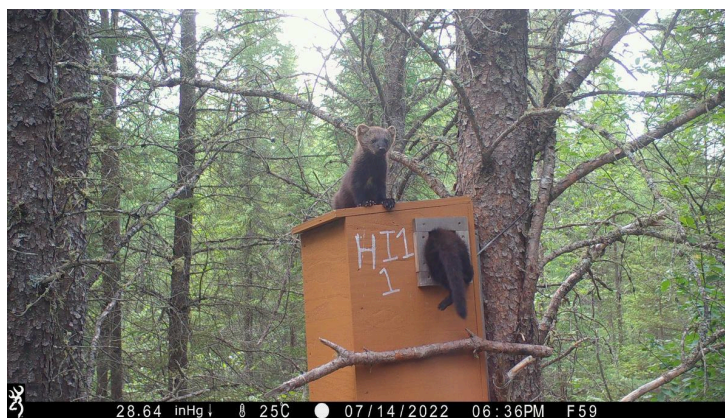


Image right: Paul van Susante

For NRRI, this an opportunity to showcase unique capabilities for new collaborations.

“Personally, this is exciting because my research background and my research interests have always been space science and geology,” said Chizmadia. “That’s how I ended up studying meteorites for my masters and doctorate degrees.”

Finicky fishers bypass boxes for raising kits



One fisher kit sits on top of a large wooden box attached to a tree while the tail end of another sticks out the door.

June Breneman
Nov 21, 2022

Research effort to provide artificial tree cavities attracted some fishers, other wildlife; expanded project will study predators

Carrying a 55-pound wood box deep into the forest and attaching it seven feet up on a tree was no easy task for wildlife biologist Michael Joyce. And he – with the help of field technicians – did this over 100 times throughout 2019 and 2020.

“I figured this would either break me or make me stronger,” he said with a laugh. “I’m happy to report that we all survived.”

The boxes were designed specifically to meet the denning needs of fishers, the largest mammal in Minnesota’s weasel family. Joyce used them to research whether the boxes would provide habitat for female fishers to safely give birth in and raise their kits. Fisher populations in northern Minnesota have dropped to about 7,000 from a high of 16,000 in the year 2000.

The decline spurred this study to evaluate whether den boxes could be a valuable management tool to improve fisher habitat and balance wildlife needs with forest industry needs. It is part of a larger effort to

understand what factors have caused the recent fisher population decline and provide management solutions to boost fishers in Minnesota.



Photo left: An adult fisher sticks its head out the door on a large fisher den box attached to a tree.

Female fishers' preferred denning sites are in wide diameter aspen that have rotted inside to form a cavity. The research hypothesis was that, due to logging and other factors, there is a shortage of this habitat (forest surveys show fewer than two percent of the landscape) and the den boxes could provide artificial cavities where natural cavities are rare. To monitor wildlife activity, each box had a motion-sensor camera aimed at it. The camera cards – collected a few times a year – provided more than 3 million images.

Photo right: Two bears climb on a wooden box attached to a tree

“We haven’t looked at them all yet, but it’s been really fun seeing all the other forest animals – bears, moose, bobcats – that visited the boxes,” said Joyce. “Martens and tree squirrels also used them for resting, storing food, and escaping predators – and they used them way more than fishers did.”



Thermometers were put in each box to record box temperature and sticky tape applied to the den box entrance to gather hair for DNA sampling providing the researchers with additional data.



Photo left: A moose rubs their face against a large wooden box attached to a tree.

Study Results

Female fishers used the den boxes for protection from male fishers during mating season – the opening on the box was sized specifically for females; males are almost twice their size – allowing females to be selective in choosing their mating partner. This is similar to how female fishers use natural tree cavities for mate selection. Females also used the boxes for resting, sometimes with their kits, and cached food to collect later.

Photo right: A red squirrel with a mouth full of leaves climbs up to the entrance of a wooden den box.



But fishers were detected at less than half of the boxes, and Joyce didn't see any indication of females giving birth nor raising kits in the boxes. He speculates that several factors may have deterred them.

"Maybe the box location wasn't where the fishers wanted them, or they had better natural cavities available," Joyce said. "We put the boxes in areas with recent presence of fishers, but with their population decline they might not have been there anymore."

Another outcome of the study will improve data gathering for this species going forward. The thermometers picked up a unique temperature fingerprint for fishers in the boxes. That means researchers can determine if fishers are using the boxes by visiting the sites just once a year and collect data that is much easier to analyze than millions of photos.

Predator Problem?

Another theory for the recent fisher decline is that their number one predator, the bobcat, might be winning. Research by the Minnesota Department of Natural Resources has shown that this wild feline population has increased to about 7,000 from a low of 2,000 some-40 years ago. Joyce received additional funding to capture both bobcats and fishers to outfit them with GPS collars and track their overlapping movements for further study.



Above photo: A bobcat sits atop a wooden den box attached to a tree attempting to enter a small doorway.

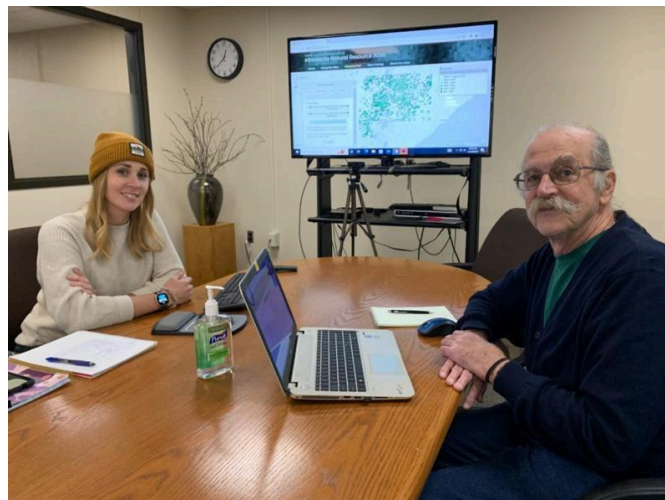
"Bobcats tend to do well in young forest, while fishers prefer old forests – but there are forest conditions that they both use, especially where they are hunting for shared prey," said Joyce. This project to gain more insight into fisher and bobcat interactions is underway and the project will continue through 2024.

Group Effort

Partners in the NRRI Fisher Den Box project include the Leech Lake Band of Minnesota Chippewa, the 1854 Treaty Authority, Vermilion Community College, Carlton County, Cloquet Forestry Center, and Hubachek Wilderness Research Center.

Funding is provided by grants from the Legislative-Citizen Commission on Minnesota Resources as recommended by the Minnesota Environment and Natural Resources Trust Fund.

Historical logging data in state forest goes high-tech



Megan Quade provides a training session to retired geologist and data enthusiast Peter Jongewaard for access to state forest information on MNAtlas.org.

June Breneman
Nov 29, 2022

Intern project gives data the GIS treatment for easy access to pine estimates and logging harvest activities

Weekly ATV rides through the Cloquet Valley State Forest inspired a new quest for retired geologist, Peter Jongewaard. As he and his friends in the Reed's Riders ATV group explored this 366,000 acre forest, he wondered about the early loggers on this land – when they came and what they found.

So, he started digging into the archives in the Gale Library at the Minnesota Historical Society in St. Paul.

Jongewaard was surprised to learn about when and how much of this forest was cut for industry. Now, NRRI is helping him share the reams of data he collected, by converting his spreadsheets into online maps.

“I’ve always been a map guy,” said Jongewaard. “I was the kid in the back seat on family road trips with the map on my lap.”

The project was turned over to NRRI Geographical Information Systems Intern, Megan Quade. She was very impressed by the massive amounts of data Jongewaard collected from a dozen research trips to St. Paul. He went through stacks of land records going back to the 1880’s, when Cloquet-based sawmills began logging in the area.

And then he entered the data he wanted – land ownership, original stand estimates, logging harvest information, dates and details – into a spreadsheet that ended up 9,217 lines long.

“It took some critical thinking on my part to figure out how to join the data into GIS format,” said Quade. “After that, it was just a matter of cleaning up the data, generating symbology, creating static maps, and prepping the data to be shared on the Atlas.”

The tricky part was figuring out how to create a unique ID in both the historic pine spreadsheet and public land survey GIS dataset that could be used to join the datasets. In the end, Quade was able to concatenate (link together in a chain or series) township, range, quarter section, and quarter-quarter sections.

Luckily, the GIS software does this. Quade estimates the entire project took her less than 20 hours to complete.

Now, color-coded tiny, mapped squares in the Cloquet Valley State Forest boundaries show which companies harvested, total estimated board feet cut from different sections, tree species cut – white and red pine– and the “last cut” date. The state forest was established in 1931. Quade also acquired historic logging railroad data from a UMD adjunct professor and added that layer to the static maps which clearly shows how important access to rail was to logging.

Jongewaard donated all of his data to the [Minnesota Natural Resource Atlas](#), a free, online tool developed at NRRI that makes GIS data easily accessible to all. The maps might inform forestry professionals who want to study the evolution of the forest after original harvest, to inform future harvests or replantings.

Or, provide interesting trivia to a ride through the forest.

“Now when I’m ATVing with my friends, I can tell them how many board feet were cut from an area in 1921, and we can put an actual date to the big pine stumps we find,” Jongewaard laughed.

Quade also gave Jongewaard a tutorial on how to use the Atlas so he can use it to analyze and share his data. MNAAtlas.org allows him to access the GIS data without needing special software or having prior GIS experience.

“Megan did a fantastic job of making these data visible to the public in the Atlas,” said Jongewaard.

And as an intern, the project gave Quade experience in working with a client’s data, not her own. She will graduate from UMD in December with dual majors, one in Environment, Sustainability and Geography and a second in Geographical Information Systems.

“I had to keep the communications open, emails back and forth and compromise on format,” she said. “Peter did an amazing amount of work pulling this all together and now it’s easy to see and use it.”

MagIron moves forward to make DR grade iron ore products from waste tailings



MagIron LLC Plant 4, in Bovey, Minn., near NRRI's Coleraine facility.

June Breneman
Nov 18, 2022

NRRI research to identify and confirm major ore recovery improvements from waste taconite moves industry forward

Research to help Minnesota's Iron Range remain relevant through economic change has long been an important focus for NRRI. And that research focus is paying off as MagIron, LLC moves ahead with processing iron-bearing stockpiles into direct-reduced grade iron ore concentrates for steelmaking.

MagIron CEO Larry Lehtinen announced that the company has been awarded a mineral lease to process state-owned taconite pellet tailings within the Canisteo area in Itasca County near MagIron's Plant 4 iron ore concentrator. These stockpiles, once considered waste materials from decades of historical mining operations, will produce high quality iron units.

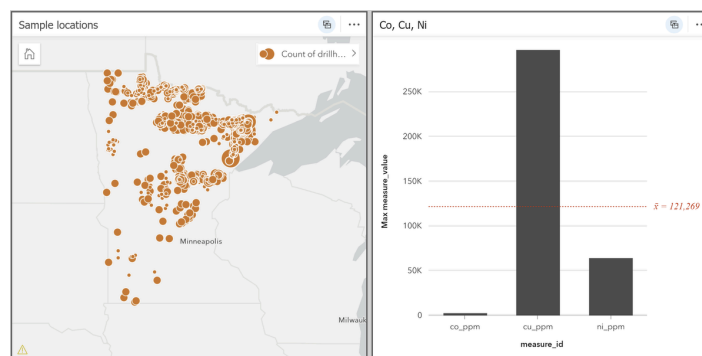
"Our ongoing work with the Natural Resources Research Institute in Coleraine is particularly promising as we are identifying and confirming major recovery improvements that will be part of the new and improved Plant 4 operations," said Lehtinen. "Our goal is to produce DR grade iron ore concentrates to feed the burgeoning electric arc furnace market while striving to decarbonize the global steel industry."

The mineral lease covers 286 acres with a term of 20 years. MagIron plans to reprocess millions of tonnes of the into high quality, low carbon iron units. Plant 4 has previously operated at an annualized run-rate of approximately 2 million tons per year, with the capacity to expand to 3 million tonnes.

"Supporting economic development and sustainable use of Minnesota's natural resources is at the core of our mission," said Kevin Kangas, director of NRRI's Coleraine Labs. "NRRI's research team values its role in delivering sound science that supports industrial growth and improved environmental outcomes."

NRRI's mission is to deliver integrated research solutions that value our resources, environment and economy for a sustainable and resilient future.

AssemblingMN Minerals



June Breneman
Nov 14, 2022

Database pulls it all together for online minerals exploration and discovery

The good news: Reams of data on Minnesota’s geology have been collected and compiled over the decades. The bad news: Much of it was filed away – old school – limiting its usefulness in our digital world.

Geological data – drill core logs, mineral composition and structure, geophysics, sample locations – are important for minerals-related research. And the more data the better. But when that information is stored in multiple formats by multiple organizations, putting that data to work is overwhelming and cumbersome.

The Natural Resources Research Institute at the University of Minnesota Duluth has assembled much of this disparate data in one place to drive better, faster research.

Over the past 30 years, former NRRI Geologist Dean Peterson has methodically digitized and compiled the data into a single database called AssemblingMN. When he left in 2021, the project was taken up by Geographic Information System expert, Will Bartsch, who worked with a team spanning NRRI and U-Spatial, the University’s research hub for GIS expertise, to improve the structure and content of the database and build a corresponding data exploration tool.

“This gives us access to, literally, the data behind the data, and that’s important,” said NRRI Economic Geologist George Hudak. “Better decisions are made when you have more complete information.”

Photo right: George Hudak

All of the information in AssemblingMN was compiled from public sources, like the Department of Natural Resources, U.S. Geological Survey, the Minnesota Geological Survey, and NRRI. A particular strength of AssemblingMN is the extent of drill core data and associated physical and geochemical information.

The tool is designed to facilitate conversation, exploration and ultimately, collaboration with external partners (industry and government) that want to work with NRRI to take advantage of this compilation of data for a wide variety of projects.

“This is something we can bring to the table – a unique contribution – to research partnerships,” said Bartsch. “It’s something that can make NRRI a more valuable partner.”



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](#)