

M.L. 2019 Projects

[MN Laws 2019, First Special Session, Chapter 4](#), Article 4 Section 2 (beginning July 1, 2015)

Visit [the LCCMR website](#) for the most up-to-date project information and reports

Subd. 03 Foundational Natural Resource Data and Information

Subd. 03b Restoring Native Mussels in Streams and Lakes - \$500,000 TF (FY2020)

Mike Davis

MN DNR

2109 North Lakeshore Drive

Lake City, MN 55041

Phone: (651) 314-6302

Email: mike.davis@state.mn.us

Appropriation Language

\$500,000 the first year is from the trust fund to the commissioner of natural resources to restore native freshwater mussel assemblages, and the ecosystem services they provide, in the Mississippi, Cedar, and Cannon Rivers and to inform the public on mussels and mussel conservation. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Reestablishing historical mussel assemblages through laboratory propagation began in 2016 at the MNDNR Center for Aquatic Mollusk Programs (CAMP). Since then, CAMP has released 9,541 sub-adult mussels from five species in three watersheds; restoring ecosystem services and enhancing Minnesota rivers with each mussel.

OVERALL PROJECT OUTCOME AND RESULTS

Minnesota's native mussels are critically important to aquatic ecosystems but have been lost or diminished in many water bodies. Harvest for pearls and buttons, pollution, dams, and destabilized waterways have caused mussel populations to decline dramatically, 80% of Minnesota's species are affected. Improvements from Clean Water Act implementation, stream restoration work, and protective laws are creating opportunities to reverse this trend. However, dams that limit fish movement are still hindering mussel recolonization, because mussels rely on fish as hosts to complete their life cycle. Thus, conservation methods such as laboratory propagation and reintroduction are needed to help mussel populations recover, and ultimately, restore ecosystem benefits. CAMP has implemented this work for three watersheds in Minnesota, which were chosen based on historical records, habitat, and fish communities. We constructed several propagation systems specifically designed for juvenile recovery and culture over time, improving our success along the way. Since 2016, CAMP has produced more than 1.5 million juvenile mussels. Due to the challenges of culture, survivorship varies between species and years. Juvenile survival after 90-days ranged from 0 – 84%. Newly metamorphosed juveniles were placed into various culture containers including a recirculating system, static system, or a flow-through system. Survival rates vary between systems, and within systems. Factors such as dissolved oxygen, ammonia, pH, and conductivity are monitored throughout growing period. Overall, survival is highest in the flow-through system, however, the system requires the most person-hours per juvenile. From July

2019 until June 2021, CAMP has released 7,038 sub-adult mussels from five species in three watersheds. Since our first ENRTF grant CAMP has released more than 9,500 sub-adult mussels. Mussels will enhance water clarity and improve habitat in the Cannon, Cedar, and Mississippi Rivers for years to come.

PROJECT RESULTS USE AND DISSEMINATION

CAMP's efforts to restore native freshwater mussels were featured in several news articles, including an Episode 1 of Season 3 on [MN DNR Prairie Podcast](#). The [Star Tribune](#) and [Cedar Watershed District](#) discussed our efforts to reclaim stretches of the river with mussel populations. Moreover, CAMPs [newsletters](#) reach more than 5,000 users. Lastly, with the upcoming launch of Clam Counter App for IOS and Android platforms, a digital field guide and general information regarding mussels will be available to all smartphone users.

Project Completed: 6/30/2021

FINAL REPORT

Subd. 03c Quantifying Exposure of Minnesota's Raptors to Mercury and PFAS - Research Project - \$250,000 TF (FY2020)

Matthew Etterson

Hawk Ridge Bird Observatory
6770 Haugen Lane
Duluth, MN 55803

Phone: (218) 590-7029

Email: metterso@d.umn.edu

Web: <https://www.hawkridge.org/>

Appropriation Language

\$250,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the Hawk Ridge Bird Observatory to quantify the exposure and health risk of two environmental neurotoxins to Minnesota raptors.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

These results are a first look at polyfluoroalkyl substances (PFAS) in Minnesota's Birds of Prey. Among vertebrates, birds appear to be most vulnerable to PFAS effects, which can result in reproductive failure. Birds of prey are vulnerable to PFAS because of their position atop both aquatic and terrestrial food webs.

OVERALL PROJECT OUTCOME AND RESULTS

Polyfluoroalkyl substances (PFAS) are a class of chemicals used in industrial processes and fire suppression. Mercury (Hg) enters the environment from point-source releases due to industrial processes and through combustion of coal for power generation. Both Hg and PFAS are present locally at highly contaminated sites and ubiquitously due to atmospheric deposition. Due to their predatory nature, birds of prey are at unique and elevated risk of exposure to both PFAS and Hg that concentrate in animal tissues; with each link in their food chain, predators consume and concentrate these toxicants contained in their prey. We collected blood and feather samples from 355 birds of prey at two

Minnesota locations, Hawk Ridge in Duluth, and The Raptor Center in St. Paul. We analyzed blood plasma for up to 40 PFAS chemicals and feathers for total mercury concentration. Our objectives were to (1) collect baseline data on exposure of MN raptors to Hg and PFAS and (2) to test specific hypotheses about patterns of exposure in relation to ecological variables such as diet, age, sex, and species identity. As expected, perfluorooctane sulfonate (PFOS) was the PFAS of highest concentration across all species and in each individual species, typically at concentrations ten or more times that of other PFAS. Bald Eagle (*Haliaeetus leucocephalus*) had the highest exposure, probably reflecting the greater representation of aquatic prey (fish) in its diet. However, Cooper's Hawks (*Accipiter cooperii*) had comparable exposures and they consume entirely terrestrial prey. Among ecological variables, species identity offered the greatest explanatory power, followed by a measure of species' tolerance of human activity, which may serve as a proxy for likelihood of exposure. These results will prove invaluable for understanding and managing both human and ecological exposures to PFAS and Hg in Minnesota.

PROJECT RESULTS USE AND DISSEMINATION

Dr. Etterson has presented results at internal meetings of the US Environmental Protection Agency's PFAS Working Group at the Great Lakes Toxicology and Ecology Division, Duluth, MN. Final PFAS results were received from the contract laboratory on 29 June 2022, just prior to the close of the project period and we expect dissemination activity to increase considerably over the next year. Dr. Ponder will present some results from this work at the upcoming International Ornithological Congress in Durban, South Africa, August 2022. We expect at least two manuscripts will be submitted to peer-reviewed journals for publication in the coming year.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 03g Mapping Habitat Use and Disease of Urban Carnivores - Research Project - \$500,000 TF (FY2020)

Nicholas McCann

U of MN

B52 Skok Hall, 2003 Upper Buford Circle

St. Paul, MN 55108

Phone: (763) 286-2215

Email: mccan062@umn.edu

Appropriation Language

\$500,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to map habitat use and diseases of urban foxes and coyotes, evaluate risks these animals may pose to people and pets, and generate information needed to reduce human-wildlife conflicts.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

This study provides information to residents and managers about coyotes and foxes. Our results reveal key insights, including about habitat requirements, the expansion of coyotes, and relationships between disease prevalence and free-roaming cats. They suggest outreach efforts to reduce free-roaming pets and management to increase natural vegetation in residential greenspaces.

OVERALL PROJECT OUTCOME AND RESULTS

Coyotes and foxes have not been studied in the Twin Cities Metro Area.

1. We captured, collared, and collected biological samples from 17 coyotes, 16 red foxes, and two gray foxes across the TCMA to assess space-use, survival, diet, and disease.
2. We found that coyote survival was greater than for red foxes, suggesting higher population growth. Canid attacks caused most fox mortalities, likely reflecting coyote population expansion and the presence of free-roaming dogs. Coyote and fox diets consisted of natural foods, with few individuals exhibiting diets associated with people. Toxoplasmosis gondii, a cat feces-transmitted pathogen found in both coyotes and foxes, was especially frequent in red foxes, potentially due to fox selection of residential areas with more free-roaming cats. Higher heavy metal content in the hair of coyotes was likely a result of using industrial areas. Home range sizes suggest coyotes found resources more easily than red foxes. Den sites reflected the more general differences space-use; coyotes denned in non-residential areas while fox dens were in residential. We estimated 0.27 coyotes/km² and 0.21 red foxes/km²; lower than in other cities.
3. Overall, our results suggest coyotes expanded into areas once occupied by red foxes, but both species rarely became nuisances. Outreach promoting leashing pets and keeping cats inside is likely to improve the health of pets, coyotes, and foxes. Communicating the smaller-than-expected weight (males=14.3 kg [31.5 lbs.]; females=11.9 kg [26.2 lbs.]) and low risk of attack should reduce negative perceptions of coyotes. Improving natural habitat in residential greenspaces is likely to benefit red foxes.
4. This study's results provide much-needed information to residents and wildlife managers about two charismatic species that are relatively unstudied in Minnesota.

PROJECT RESULTS USE AND DISSEMINATION

We delivered 17 presentations to colleges (e.g., Anoka Ramsey Community College and Macalester College), grade schools, and municipalities (e.g., Cities of Bloomington). We also provided 12 interviews to news outlets and podcasts (e.g., MPR, BBC, and Three Rivers Park District's "Wandering Naturalist" podcast), content for two Friends of the Mississippi River newsletters, and led over 60 volunteers into the field and coordinated with two UMN courses (60 students total). To further disseminate information, we created a [University website](#), [Facebook page](#), and [iNaturalist page](#) for the project, and we have drafted one scientific manuscript (set to be published this year).

Project Completed: 6/30/2022

FINAL REPORT

Subd. 03i Den Boxes for Fishers and Other Nesting Wildlife - Research Project - \$190,000 TF (FY2020)

Michael Joyce

U of MN - Duluth NRRI
5013 Miller Trunk Hwy
Duluth, MN 55811

Phone: (218) 788-2656

Email: joyc0073@d.umn.edu

Appropriation Language

\$190,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute in Duluth to build, install, and evaluate den boxes as habitat enhancement for fishers and other cavity-nesting wildlife in managed forests where a lack of large trees may be threatening population survival. The final outcome for the project must include guidelines and best practices for use of den boxes for fisher habitat.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Fishers used some den boxes, but it appears fishers find natural cavities to raise young. Den cavity availability alone is likely not causing the fisher population decline. Den boxes were used by many other wildlife species. Installing den boxes could be locally beneficial and increases public involvement with wildlife.

OVERALL PROJECT OUTCOME AND RESULTS

The fisher population in Minnesota declined by 50% from 2000-2015. Large cavity trees are critical habitat resources that female fishers use to raise kits. Previous research on fishers in Minnesota suggested that lack of large cavity trees could be one factor limiting the fisher population. We evaluated whether den boxes could provide critical habitat for fishers where natural cavities are rare. Our objectives were to build, install, and monitor fisher den boxes to describe use of den boxes by fishers and other wildlife, determine what factors influence whether fishers use den boxes, and to develop guidelines and recommendations for using den boxes to improve habitat. We built and installed 99 den boxes during fall and winter 2019-2020 and captured over 3 million images of wildlife visiting and using den boxes. Fishers visited 41% of den boxes and used 11% of den boxes on 43 different occasions. Use by fishers was lower than in other studies. Low use rates by fishers could indicate cavity availability is not limiting fishers, but additional work is needed to more fully understand why fisher use of den boxes was low and to evaluate other potential causes of the fisher population decline. Habitat suitability at den box sites was not associated with use by fishers. Fisher presence at den boxes increased over time, and fishers should continue to find and use den boxes in the future. Martens, red squirrels, gray squirrels, flying squirrels, and weasels also used den boxes to rest, store food, avoid predators, and care for young. Frequent use of den boxes by other wildlife demonstrates the value of den boxes to wildlife despite low use by fishers. Den box plans and guidelines we developed have allowed many members of the public to build and install their own den boxes, increasing public involvement with wildlife.

PROJECT RESULTS USE AND DISSEMINATION

We created den box building instructions and guidelines for den box installation. Throughout the project, we shared these documents directly with 120 members of the public and resource managers who requested information on the project. Project results were disseminated to technical and non-technical audiences through presentations, print and broadcast media, social media posts, and a [Minnesota fisher den box project website](#) we developed. Results are also summarized in a master's thesis. We are currently finalizing a technical report and three manuscripts using data from this project that will be submitted to scientific journals and shared with wildlife managers.

Project Completed: 6/30/2022

FINAL REPORT

[Fisher Den Box Building Plans - 12 pgs](#)

[Fisher Den Box Instructions - 2 pgs](#)

Subd. 03j Red-Headed Woodpeckers as Indicators of Oak Savanna Health - Research Project - \$171,000 TF (FY2020)

David E. Andersen

U of MN

1980 Folwell Avenue, 200 Hodson Hall

St. Paul, MN 55108

Phone: (612) 626-1222

Email: dea@umn.edu

Web: <http://mncoopunit.cfans.umn.edu/>

Appropriation Language

\$171,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to evaluate red-headed woodpecker survival and habitat needs and to use this data to develop and disseminate a long-term oak savanna management plan that supports red-headed woodpeckers and other oak savanna habitat-dependent species.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Our project results provide important information on the factors associated with red-headed woodpecker habitat use, survival, and productivity in savanna ecosystems, which can aid ongoing habitat management and conservation efforts intended to conserve and restore this species in Minnesota.

OVERALL PROJECT OUTCOME AND RESULTS

Red-headed Woodpeckers (*Melanerpes erythrocephalus*) are charismatic cavity-nesters that breed in savannas and open forest systems across the eastern and Midwestern United States and south central and eastern Canada. Historically, they were common across the Midwest, but populations have experienced dramatic regional declines. Habitat restoration initiatives have been challenged by a general lack of information on the factors that make savannas desirable for this species. With collaborators from the University of Toledo in Ohio, we studied red-headed woodpecker demography, habitat associations, and migration ecology from 2017 – 2020 in Ohio and Minnesota to elucidate critical periods, locations, life stages, and habitat characteristics associated with population growth rates and to provide habitat restoration and management recommendations for land managers and the public (separate funding sources for research in Ohio). Our results indicate that red-headed woodpecker productivity is higher in landscapes with both open and closed-canopy forest and that even in large stands of oak savanna, productivity near the center of those stands is predicted to be lower than in savanna closer to other forest types. GPS tracking data show detailed information on the migratory and overwintering locations and behaviors of adult red-headed woodpeckers, which, to our knowledge is the first reported data of its kind for this species in Minnesota. Our results provide information on snag density around nest trees, the importance of nest tree wood hardness, and habitat use by adult and fledgling woodpeckers. We have also gained considerable information on the community of predators that may impact red-headed woodpecker nest survival through our trail camera project, now hosted on Zooniverse. We have engaged with thousands of volunteers from around the world to share more about our research through our cavity camera project. Our best management practices are based on current results and we intend to update our recommendations in consultation with collaborators and other experts.

PROJECT RESULTS USE AND DISSEMINATION

We presented our research at professional conferences (the Annual meeting of the Minnesota Ornithologist's Union, the American Ornithological Society Annual Conference, and at the Toledo Museum of Natural History Forum on Local Natural History and Research). We also presented eight invited talks to public audiences through the University of Minnesota, Cedar Creek Ecosystem Science Reserve, multiple local Audubon Chapter organizations, and a Naturalist club in Brandon Manitoba in Canada. Our research project was featured in articles in the following newspapers and magazines: Terrain.org, University of Minnesota College of Biological Sciences, and the Minneapolis Star and Tribune.

We are also currently in the process of preparing three manuscripts for publication in the peer-reviewed, scientific literature focused on red-headed woodpecker nest survival and nest site selection, landscape productivity, and mating system:

Project Completed: 6/30/2022

FINAL REPORT

Subd. 03n County Geologic Atlases - Part A, Mapping - \$2,000,000 TF (FY2020)

Barbara Lusardi

U of MN - MN Geological Survey
2609 Territorial Road
St. Paul, MN 55114

Phone: (612) 626-5119

Email: lusar001@umn.edu

Web: <https://www.mngs.umn.edu/>

Appropriation Language

\$2,000,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota, Minnesota Geological Survey, to continue producing county geologic atlases to inform management of surface water and groundwater resources. This appropriation is to complete Part A, which focuses on the properties and distribution of earth materials to define aquifer boundaries and the connection of aquifers to the land surface and surface water resources.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

County Geologic Atlases were completed in two counties and work continued in 17 counties. Based on the time spent, this is equivalent to "completing" about five atlases. Atlas maps and data provide foundational information that supports water management activities to the benefit of drinking water and aquatic habitat.

OVERALL PROJECT OUTCOME AND RESULTS

A Geologic Atlas provides the geologic framework of our state. It describes the materials and features at the land surface and extends all the way down to the bedrock surface. An atlas provides information useful for resource management and land-use planning. Each Atlas typically requires more than 7,000 person-hours of work. Some of that work is in the field: drilling test borings, examining, sampling, and

describing outcrops. Much of the work follows afterward: interpreting field measurements, recognizing and formally naming geologic units described in well records, and making maps. The result is a detailed account of the distribution and properties of the rock and sediment that lie below the land surface. These materials, and their ability to store or transmit water, determine where we can find water, and how we can protect and make wise use of that water. This includes our lakes and rivers as well as groundwater.

As part of this 2019 award, Rock and Nobles counties were completed. Over 8,000 well construction records, primarily located by County staff, were compiled into the database to support mapping, document water use in specific aquifers, and to help resolve well problems. Progress continued on mapping the bedrock and surficial geology, subsurface Quaternary stratigraphy, bedrock topography and glacial sediment thickness in 17 other counties. We've described hundreds of outcrops, taken thousands of hand samples, and drilled 13 continuous cores allowing us to sample rocks and sediment up to 300 feet deep.

Continuing under the M.L 2020 award, atlases for St. Louis, Aitkin, and Steele counties should be complete within the next three months. Lake, Ottertail and Lac Qui Parle counties should be finished within the next 12-18 months. Work on the remaining counties, Lincoln, Pipestone, Pennington, Cook, Yellow Medicine, Polk and Chippewa, will continue. The County Geologic Atlas program began in 1981 and continues with support of the Environment and Natural Resources Trust Fund as well as the Clean Water Fund, the Department of Natural Resources, and the U.S. Geological Survey. To date we have completed atlases for 46 counties, 29 are underway; and 16 have yet to be started. All of our mapping products and data are available in print or digital formats.

PROJECT RESULTS USE AND DISSEMINATION

Completed atlas products have been posted to the MGS website and linked to the University's Digital Conservancy as noted above. PDF products as well as all of the related GIS data are available on these pages. In addition, the MGS hosts an [Open Data Portal](#) on which many of our county geologic atlases are presented as "Story Maps" that allow for direct access of the data without any special software or interface.

Project Completed: 6/30/2022

[FINAL REPORT](#)

Subd. 03o County Geologic Atlases - Part B, Mapping Aquifer Hydrology - \$2,400,000 TF (FY2020)

Paul Putzier
MN DNR
Box 25, 500 Lafayette Rd N.
St. Paul, MN 55155

Phone: (651) 259-5692

Email: paul.putzier@state.mn.us

Web: http://www.dnr.state.mn.us/waters/groundwater_section/mapping

Appropriation Language

\$2,400,000 the first year is from the trust fund to the commissioner of natural resources to continue producing county geologic atlases to inform management of surface water and groundwater resources for drinking water and other purposes. This appropriation is for Part B, which uses the geologic formations mapped in Part A of the county geologic atlases to characterize the potential water yields of aquifers and the aquifers' sensitivity to contamination.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

The Groundwater Atlas provides foundational, science-based, information for use and management of Minnesota groundwaters. The atlas is valuable to government, industry, and for research. The grant supported work on nineteen atlases and publication of county groundwater atlases (County Atlas Part B) for Brown, Hennepin, Kanabec, Meeker, Morrison, Redwood, and Winona counties.

OVERALL PROJECT OUTCOME AND RESULTS

The Groundwater Atlas provides foundational, science-based, information for use and management of Minnesota groundwaters. The atlas is valuable to government, industry, and research. During the period of the grant, county groundwater atlases (County Atlas Part B) were published for Brown, Hennepin, Kanabec, Meeker, Morrison, Redwood, and Winona counties. Mapping activities also continued through the end of the grant in Aitkin, Becker, Cass, Dodge, Houston, Hubbard, Isanti, Kandiyohi, Nobles, Olmsted, Rock, and Wadena, with publication of completed groundwater atlases for Becker, Cass, Dodge, Houston, Hubbard, Isanti, and Wadena expected in 2023.

The following related reports were also published:

- The Karst Landscape Unit Map for Winona and Houston counties.
- Minnesota Groundwater Provinces 2021. This document is one of the most widely used reference documents from the Atlas Program.
- Groundwater Atlas Users Guide.

Groundwater sampling is a key element in the completion of an atlas. Sampling efforts necessarily slowed during the pandemic. However, groundwater sampling was completed in Dodge, Kandiyohi, Nobles, Olmstead, Rock, and Steele counties. Letter reports with all sampling results were provided to well owners for all wells sampled as part of this grant.

DNR Groundwater Atlas staff completed field work for the geophysical investigation of Pennington County as part of the atlas process. DNR Groundwater Atlas staff also completed planning for the geophysical investigations in fall 2022 of Douglas, Grant, Polk, and Red Lake counties.

As part of the atlas development process, DNR staff conduct reviews of draft County Geologic Atlases (Part A) prepared by the MGS. During the grant this included DNR reviews for Aitkin, Becker, Cass, Dakota, Lac qui Parle, Lake, Otter Tail, Steele and St. Louis.

Dissemination and outreach activities continued throughout the grant period including presentations, news releases, GovDelivery list serve (6,000 recipients) notifications, and virtual meetings with county staff and county boards, seminars, and presentations.

PROJECT RESULTS USE AND DISSEMINATION

Dissemination activities focused on notification of sampling activities and publication of atlases through

news releases and GovDelivery (6,000 recipient list serve), participation in seminars, presentations, and educational/technical field trips to a diverse set of stakeholders and resources managers including county SWCDs, county boards, the Clean Water Council, BWRS, MPCA, the Legislative Conference of Minnesota Counties, LCCMR events, and others. Dissemination also included workshops with counties, publication of summary articles, updated website and many personal contacts with users of the atlas. Atlas staff also worked closely with university staff to incorporate atlas materials in the classroom and to collaborate on projects.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 03p Unlocking Science of Minnesota's Moose Decline - \$199,000 TF (FY2020)

Nicole Mattson

Minnesota Zoological Garden
13000 Zoo Blvd.
Apple Valley, MN 55124

Phone: (952) 431-9540

Email: nicole.mattson@state.mn.us

Web: <http://mnzoo.org/>

Appropriation Language

\$199,000 the first year is from the trust fund to the Minnesota Zoological Garden to develop educational displays, interactive exhibits, and engaging online programs that summarize and share scientific findings about moose decline in Minnesota. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

The Minnesota Zoo gathered moose researchers to share their key scientific research findings about Minnesota's moose decline. The research findings were used to develop interactive interpretive features for the Zoo's moose habitat, an educational website, and an engaging online game that highlights the survival challenges influencing Minnesota's moose population.

OVERALL PROJECT OUTCOME AND RESULTS

The moose is an iconic Northwoods animal that has had an important presence in Minnesota and at the Minnesota Zoo. However, moose in Minnesota have experienced periods of dramatic population decline over the last 30 years. They have nearly disappeared from northwestern Minnesota. Since 2004, moose numbers have decreased by roughly 50% in the northeastern part of our state. Significant public resources have been invested in scientific research to understand Minnesota's moose decline. Many Minnesotans are keenly aware of the moose decline and want to know more about its causes and what can be done to help.

With ENRTF support, the Minnesota Zoo collaborated with researchers from across the state to identify key scientific research findings about Minnesota's moose decline and population dynamics. This project used those key research findings to develop interactive interpretive displays at the Minnesota Zoo's

moose habitat. A new, accessible, educational website was created to make the research findings available for broad virtual access. The website features basic moose natural history, information about moose research in Minnesota, and a custom, interactive game. The game encourages a user to experiment with habitat features to create a simulated environment where moose thrive. While the player attempts to manage for a healthy moose population over the course of a year, random, unexpected events occur. Players learn about some of the challenges wildlife managers (and moose) face in Minnesota.

The physical interpretive elements and online resources created from this project focus on complicated research findings in an engaging, accessible, and easily understandable fashion. These deliverables will be maintained by the Minnesota Zoo and will benefit learners of all ages for years to come.

PROJECT RESULTS USE AND DISSEMINATION

Through meetings, presentations and seminars, hundreds of Minnesota Zoo staff and volunteers have learned about Minnesota's moose decline and this ENRTF project. Thousands of guests have interacted with the interpretive elements created for the Zoo's moose exhibit. Thousands of people have also engaged with the virtual components resulting from this project.

Virtual components of this project include:

- [Mission Moose website](#)
- [Aerial Moose Survey video](#)
- [Moose Research video](#)

These online resources have been featured in professional newsletters, publications, listservs, websites and on social media platforms. The Dakota County Tribune also wrote an article about the Mission Moose website and game.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 03q Forest and Bioeconomy Research - \$2,200,000 TF (FY2020)

Rolf Weberg

U of MN - Duluth NRRRI
1049 University Dr.
Duluth, MN 55812

Phone: (218) 788-2697

Email: rtweberg@d.umn.edu

Web: <https://www.d.umn.edu/>

Appropriation Language

\$2,200,000 the first year is to the Board of Regents of the University of Minnesota for academic and applied research through MnDRIVE at the Natural Resources Research Institute to develop and demonstrate technologies that enhance the long-term health of Minnesota's forests, extend the viability

of current forest-based industries, and accelerate emerging industry opportunities. Of this amount, \$500,000 is to support development of a forest optimization tool for Minnesota forest resources, \$800,000 is for maintenance and expansion of the Natural Resource Atlas to statewide coverage, \$400,000 is to the Minnesota Forest Resource Council for continued advancement of biochar development and application to forest health, and \$500,000 is to advance emerging Minnesota technologies to produce clean syngas to drive high-value markets for forest biomass feedstocks.

Subproject 1 - SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Projections of Minnesota forest composition and associated ecosystem services were developed under different climate and management scenarios from 2020 to 2100. This information was made freely available through a custom website and interactive mapping tool, providing resource managers with critical information for planning.

Subproject 1 - OVERALL PROJECT OUTCOME AND RESULTS

Forest management is an increasingly complex discipline that requires the balancing of economics and ecology in the face of changing markets and climate. Beyond providing lumber, pulp, and other forest products, forests provide many additional goods and services that benefit society. Known as “ecosystem goods and services,” these include sequestering carbon, providing habitat for wildlife, maintaining water quality and quantity, and others. Understanding both how forests will change over time and how society values the goods and services they provide is critical to the successful management of Minnesota's forests.

This project was designed to provide projections of how forest composition and the goods and services that forests provide will change from 2020 to 2100 under different management and climate scenarios on 3,800,000 acres in northern Minnesota. It also helps users understand how Minnesotans value those forest goods and services. Foundational landscape change modeling was done using the LANDIS-II model, allowing for a better understanding of forest composition and carbon. Subsequent wildlife habitat and water quality and quantity modeling were done using the WHINGS and HSPF models, respectively. All models were run for each of the 12 unique combinations of our management and climate scenarios. Focus groups and surveys were used to quantify value.

Minnesota's forest managers indicated that they would like to consider ecosystem services when making harvest and management decisions but lack the information to do so. The primary deliverable of this project is the Forest Change Assessment Simulation Tool, or ForCAST. This interactive mapping and decision support tool contains all of our projections of forest composition and associated ecosystem services and estimates of value, allowing for the development of informed, long-term management strategies that aren't exclusively driven by the economics of timber markets.

Subproject 1 - PROJECT RESULTS USE AND DISSEMINATION

ForCAST, an interactive mapping and decision support tool developed as the main deliverable of this project, is freely and publicly available through the project website. The website also provides access to comprehensive project and methodology documentation. During development, awareness was raised about the project through presentations at the Minnesota GIS/LIS conference and a combined meeting of the Minnesota Society of American Foresters and the Sustainable Forests Education Cooperative's (SFEC) Forestry and Wildlife Research Review. ForCAST was launched through a SFEC webinar in July 2022 with a subsequent training event scheduled through SFEC in September.

Subproject 2 - SOUND BITE OF PROJECT OUTCOMES AND RESULTS

The Minnesota Natural Resource Atlas is an easy to use interactive mapping tool and spatial database that is freely available to all Minnesotans. It lowers or removes the barriers that prevent spatial data from informing the decisions that impact our state's natural resources.

Subproject 2 - OVERALL PROJECT OUTCOME AND RESULTS

Organizations and natural resources managers in Minnesota are often required to make decisions that impact our natural resources while using incomplete information. Spatial data contains valuable information that can improve decision making and outcomes. However, accessing it typically requires specialized software and advanced technical skills. The Minnesota Natural Resource Atlas was designed to be a statewide resource that improves access to spatial data and the information and insights that it contains.

The Atlas project was a statewide expansion and enhancement of an earlier version that served 27 counties in northeast and north central Minnesota. We worked closely with our original Atlas users, target users in the expanded geographic area, and our advisory committee to identify data and functionality needs. More than 500 additional data sets, with an emphasis on agriculture, forestry, and water resources, were developed or acquired. Functionality that allowed users to more easily visualize, analyze, and share data was developed, tested, and deployed. Improvements were also made to make the Atlas more robust, responsive, and reliable.

Training, outreach, and education were used to raise awareness of the project and expand Atlas users. Google analytics on the site indicate a growing user base with typical daily weekday unique visitors ranging from 60 to 100 and their locations distributed throughout the state, with the highest concentration in the Twin Cities metro area and Duluth. Internal software was developed that allows us to monitor which data is being requested and for which geographical area. This software indicates that water, natural and administrative boundaries, and biological data are the most frequently accessed and that users are viewing data for locations throughout the state.

The Minnesota Natural Resource Atlas is a valuable resource for the state. Ultimately, it is making spatial data more accessible for all Minnesotans.

Subproject 2 - PROJECT RESULTS USE AND DISSEMINATION

The [Minnesota Natural Resource Atlas](#) is freely and publicly available online. Dissemination through training, outreach, and education were key components of the project. Articles were contributed to relevant newsletters and publications to raise awareness, and free training sessions were offered to organizations throughout the state. Eight 15 to 30 minute project overview presentations that included Atlas demonstrations were also conducted. In total, 38 training or demonstration events were conducted with over 1000 individuals participating from conservation organizations, K-12 or post-secondary education, academia, and tribal, local, state, and federal governments.

Subproject 3 - SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Biochar is a material that can be produced from residual biomass that can improve soil health and reforestation while storing carbon for the long term in soils. This project demonstrated production and deployment of insect-damaged balsam fir and black ash as biochar to improve seedling regrowth and retain nutrients in sandy forest soils.

Subproject 3 - OVERALL PROJECT OUTCOME AND RESULTS

We demonstrated the concept of using Minnesota black ash and balsam fir as feedstocks for the generation of biochar for forest soil amendments to improve reforestation efforts. We produced biochars from both black ash and balsam fir wood chips at a variety of temperatures and characterized these by measuring different physical and chemical properties.

The fully-characterized biochar samples were evaluated in greenhouse plant growth studies. Biochars from black ash and balsam fir processed at 550°C were the most promising candidates for positive soil health improvements, as these products revealed a) the highest water holding capacities, b) minimization of potentially harmful mobile organics (extractives content), and c) greatest nitrogen and dissolved organic carbon retention. Field trials were then performed at the Cloquet Forestry Center to evaluate biochar impact on red pine and red oak seedling survival. Biochars were added to the soil surrounding newly-planted red pine and red oak seedlings using a randomized nested design with appropriate controls. Early results on photosynthesis and respiration rates from the field study are positive but conclusions on biochar's role on improving seedling survival will require long-term monitoring at the field site, extending beyond the end of this project.

We also produced two literature reviews. The first study examined net carbon sequestration potential of using biochar in forest regeneration projects and concluded that there is ample supply of black ash in Minnesota to support industrial-scale biochar production and that 20 years of biochar production in Minnesota, just from black ash, would sequester approximately 6.7 million tons of CO₂. The second study was a techno-economic analysis performed by Dovetail Partners. This report concluded that the ecological and economical benefits of biochar implementation are best suited for revegetation efforts for jack and red pine in areas with sandy soils. This report can be found online: Dovetail Partners report.

Subproject 3 - PROJECT RESULTS USE AND DISSEMINATION

Toczydlowski, Alan JZ; Robert A Slesak; Rodney T Venterea; Kurt A Spokas. Effect of Biochar Feedstock and Pyrolysis Temperature on Nutrient Cycling in Forest Soil. 2021 ASA, CSSA and SSSA International Annual Meetings, Salt Lake City, Utah. Oral presentation November 7-10, 2021.

1. Reuling, Laura F; Alan JZ Toczydlowski; Robert A Slesak; Marcella A Windmuller-Campione. Effects of biochar on drought tolerance of *Pinus banksiana* seedlings. USFS National Silviculture Workshop, Kellogg, ID. Oral presentation July 12-14, 2022.
2. McFarland, Ashley; Fernholz, Kathryn; Groot, Harry. Biochar Potential in Minnesota's Forests. [Commissioned Report 2021](#).
3. Singaas, Eric. Engineering functional biochar for specific applications. North American Biochar & Bioenergy Conference, Morgantown, West Virginia. Oral Presentation August 8-11, 2022.
4. Barry, Brian. A new approach for complete pore size distributions and regime-specific total pore volume determinations of biochars. North American Biochar & Bioenergy Conference, Morgantown, West Virginia. Oral Presentation August 8-11, 2022.
5. Singaas E, Barry B, Kolomitsyna O, Kacharov O, Yemets S, Young M, Toczydlowski A, and Slezak R. 2022. Biochar from insect-damaged trees used as a forest soil amendment: production, characterization, and application. Natural Resources Research Institute, University of Minnesota Duluth, [Technical Report](#) NRRI/TR-2022/16.
6. Singaas, E., Kolomitsyna, O., Kacharov, O., Young, M., and Barry, B. 2022. Biomass pretreatment to make clean syngas from Minnesota wood residuals. Natural Resources Research Institute, University of Minnesota Duluth, [Technical Report](#) NRRI/TR-2022/17

7. Wright, C. 2022. Biochar Production Scenarios in Minnesota Utilizing Ash (*Fraxinus* spp.) as a Feedstock. Natural Resources Research Institute, University of Minnesota Duluth, [Technical Report](#) NRRI/TR-2022/15
-

Subproject 4 - SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Synthesis gas (syngas) is a mixture of combustible chemicals that can be used to replace fossil fuels for industrial processes, hydrogen, and fuel production. This project demonstrated that forest residuals from insect-damaged trees can be pretreated to improve their conversion efficiency to make cleaner syngas.

Subproject 4 - OVERALL PROJECT OUTCOME AND RESULTS

Achievement of Minnesota's renewable energy transition and associated greenhouse gas (GHG) reduction goals requires development of non-fossil fuel alternatives for fuels and processes that are impractical to convert to electrical power. Key syngas applications include production of renewable diesel, jet fuel, and hydrogen, as well as direct use of syngas for production of iron and steel products. Our objective was to demonstrate that low-value forest biomass could be used to generate clean syngas for these markets in Minnesota by pretreating the biomass to improve its physical and chemical properties.

Our objective was to determine the best pretreatment conditions for one Minnesota biomass that would improve the yield of syngas components (H₂, CO, CH₄) relative to contaminants (tars) with the minimal processing temperature, time, and handling. Our results showed that addition of temperature and steam during pretreatment significantly reduced the tars produced during gasification, but with some loss in syngas yield. Therefore, we concluded that a mild steam treatment between 240-260°C with low residence time was optimal for pretreating black ash to make syngas.

Pilot-scale gasification trials on pretreated biomass was performed at the University of North Dakota Energy & Environmental Research Center, which ran pilot tests in their fluidized bed gasifier on eight different samples of black ash pretreated between 180 and 300°C and untreated biomass controls. The pilot results confirmed that pretreatment reduced tar production at the expense of reduced syngas yield. More importantly, however, the pilot tests showed that pretreatment improves the grindability of the biomass, making it easier to handle and feed to a gasifier.

These results demonstrate that renewable hydrogen, methane, or fuels can be made from Minnesota's biomass residuals by gasification, and low-temperature pretreatment will help.

Subproject 4 - PROJECT RESULTS USE AND DISSEMINATION

Singsaas E, Kolomitsyna O, Kacharov O, Yemets S, Young M, Barry B. 2022. Biomass pretreatment to make clean syngas from Minnesota wood residuals. Natural Resources Research Institute, University of Minnesota Duluth, Technical Report NRRI/TR-2022/17.

Project Completed: 6/30/2022

[FINAL REPORT](#)

[Subproject 1 Abstract](#)

[Subproject 2 Abstract](#)

Subd. 03r Minerals and Water Research - \$883,000 TF (FY2020)

Rolf Weberg

U of MN - Duluth NRRI
1049 University Dr.
Duluth, MN 55812

Phone: (218) 788-2697

Email: rtweberg@d.umn.edu

Web: <https://www.d.umn.edu/>

Appropriation Language

\$883,000 the first year is to the Board of Regents of the University of Minnesota for academic and applied research through MnDRIVE at the Natural Resources Research Institute to develop and demonstrate technologies that enhance long-term Minnesota mineral opportunities. Of this amount:

- (1) \$300,000 is to support continued applied research to advance new technologies to improve water quality;
- (2) \$275,000 is to initiate the characterization of western Mesabi iron resources and development of next-generation Minnesota iron products;
- (3) \$158,000 is to develop emerging hydrometallurgy technology to support high-value mineral product development in Minnesota; and
- (4) \$150,000 is to support efforts of the Natural Resources Research Institute to accelerate demonstration of high-capacity, cost-effective energy storage using Minnesota's historical auxiliary mine lands.

This research must be conducted in consultation with the Minerals Coordinating Committee established under Minnesota Statutes, section 93.0015.

Subproject 1 - SOUND BITE OF PROJECT OUTCOMES AND RESULTS

The project provides a cost-effective process for treating wastewater to meet the wild rice sulfate standard of 10 mg/L. The data gathered from the field pilot trial at two wastewater treatment plants will help in implementing a full-scale treatment system to reduce sulfate level for protecting water resources in Minnesota.

Subproject 1 - OVERALL PROJECT OUTCOME AND RESULTS

The State of Minnesota adopted a sulfate standard of 10 milligrams per liter (mg/L) for wild rice waters in 1973. Compliance with this standard is a challenge for small industries and municipalities as membrane-based technologies typically require high capital and operation costs. The Natural Resources Research Institute (NRRI) has developed a mobile treatment system based on barite precipitation reactions to reduce sulfate levels. In this project, NRRI deployed the trailer-based modular

demonstration treatment system at two municipal wastewater treatment plants (WWTPs) in northeastern Minnesota to perform field pilot trials. The objectives of the field pilot trials were to:

1. Evaluate the efficacy of the chemical precipitation process at a flow rate of 1-2 gallons per minute with different wastewater sources (domestic and industrial wastewater);
2. Optimize the chemical reagent dosage levels; and
3. Estimate the chemical reagent costs.

The pilot tests were conducted using effluent from the Virginia WWTP and the Grand Rapids WWTP from June 2021 until October 2021. The Virginia WWTP treats domestic wastewater exclusively, and the resulting effluent has relatively steady sulfate concentrations of 60 mg/L. The Grand Rapids WWTP treats a mixture of domestic wastewater and industrial wastewater supplied from a regional paper mill with a sulfate level ranging from 85 to 115 mg/L. The pilot test results indicated that the chemical precipitation system consistently reduced the sulfate levels of both wastewaters to below 10 mg/L with optimal chemical dosage rates. The chemical costs were estimated to be \$2.27 and \$5.50 per thousand gallons of effluent from Virginia and Grand Rapids wastewater treatment plants, respectively. Information gained from the field trials was used to develop guidelines for the future design and operation of a plant-scale system.

Subproject 1 - PROJECT RESULTS USE AND DISSEMINATION

This project has produced materials of interest to a wide variety of stakeholders, including the researchers, city councils, wastewater treatment plant operators, and the community. Among these products are presentations, posters, and videos. Sulfate treatment research results were presented in three conferences (Minnesota Water Resources conference, The Society for Mining, Metallurgy & Exploration Inc. conference, and the International Mine Water Association conference), the Virginia City Council, and the University of Minnesota Duluth University for Seniors class. A YouTube video was created to describe the sulfate problem in Minnesota and our solution.

The full report is publicly available on the University of Minnesota Duluth Natural Resources Research Institute (NRRI) [Website](#).

Subproject 2 - SOUND BITE OF PROJECT OUTCOMES AND RESULTS

This study initiated a long-term characterization program of the iron resources in Minnesota. Analysis of two sections of the iron formation produced a better understanding of the variability and potential for developing new iron-based products. With continued support, this program will provide a foundation for the future iron industry in Minnesota.

Subproject 2 - OVERALL PROJECT OUTCOME AND RESULTS

Iron mining has been an important part of the economy of northern Minnesota for over a century. Today, mining companies process magnetite-rich taconite ore. Magnetite is important due to its chemical, magnetic, and thermal properties. All iron mining companies encounter magnetite that has been oxidized to various degrees. Minor amounts of oxidation can negatively impact the economic processing of iron ore, so oxidized material is either not mined or mined and stockpiled. Significant unoxidized parts of the iron formation are also stockpiled because they cannot be economically processed with current technology.

The purpose of this study was to initiate a long-term comprehensive characterization program of the

remaining iron resources of the Mesabi Iron Range to provide a foundation for future iron industry in Minnesota. This data is being used to direct research in the areas of reducing reliance on fossil fuels, reducing emissions, and to identify and develop value-added iron products that could be produced from under-utilized portions of Minnesota iron resources. This approach can also be applied to understanding and processing waste iron stockpiles. This study has been leveraged to obtain additional State and Federal support for other mineral related studies in Minnesota.

Two complete sections of the iron formation were analyzed in this study. The results have contributed to a better understanding of the mineralogical variability within the iron formation; the impacts of oxidation on iron product quality; the potential for new iron-based products; and the presence of trace elements. Furthermore, this study also indicated that there may be a significant resource of siderite, an iron carbonate mineral, on the Mesabi Range. While siderite is unlikely to be a primary source of metallic iron, there may be other applications for siderite. Future research will focus on opportunities to reduce environmental impact while creating value-added iron products in Minnesota.

Subproject 2 - PROJECT RESULTS USE AND DISSEMINATION

Presentations

- Minnesota Minerals Coordinating Committee 2021 Virtual Cloquet Workshop Agenda Lightning Talks (4/23/2021)
- SME Minnesota Conference 2022 Presentations (4/13/2022)
- Minnesota Iron Ore and the Green Economy webinar (3/16/2022)
- Articles
 - Business North: 'Iron of the Future' program looks to new iron making technologies, Lee Bloomquist Sep 16, 2021 [Article](#).
 - Business North: A bright future for mining, Lee Bloomquist Dec 27, 2021 [Article](#).
- [Technical Report](#)
 - Johnson, R.C., Mlinar, M.A., Spigarelli, B.P., Post, S. Western Mesabi Iron Resource of the Future. Natural Resources Research Institute. September, 2022. Report NRRI/TR-2022/11.

Subproject 3 - SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Based on outcomes of “voice of customer survey” and funding opportunities available through federal agencies, the project has identified emerging hydrometallurgical innovations with potential for processing Minnesota’s in-situ and waste mineral resources with a reduced water, energy, and environmental footprint. The project has also identified bench-top hydrometallurgical research equipment required to initiate development of next generation value-added products from under-utilized and under-valued in-situ mineral and waste resources in Minnesota, specifically low-grade ores, waste tailings, metallurgical residues, incinerator ash, power plant combustion residues, and waste electrical and electronic equipment.

Subproject 3 - OVERALL PROJECT OUTCOME AND RESULTS

Minnesota has abundant in-situ mineral resources, including deposits of iron, iron manganese, copper-nickel-cobalt-platinum group elements, titanium-vanadium, copper-zinc, gold with and without silver, sand, and aggregate. Commercial and industrial byproducts such as mine tailings, industrial residues, and waste electrical and electronic equipment also contain valuable mineral resources. To address significant environmental impact concerns associated with mining, collection, and processing of these

materials, new processing technology approaches with reduced water and energy consumption and minimal environmental footprints are needed to support production of value-added products. Emerging hydrometallurgical processing technologies offer promising opportunities. To evaluate the technical, economic, and environmental benefits of emerging hydrometallurgical innovations, the Minnesota Legislative-Citizen's Commission on Minnesota Resources provided funding to the Natural Resources Research Institute (NRRI) to evaluate how to best support the development of emerging hydrometallurgical technologies in the state. The study highlights Minnesota's mineral and waste resources that have the highest potential for hydrometallurgical processing. The report also highlights key challenges anticipated by stakeholders during the commercial development of mineral and waste resources using hydrometallurgical technologies. The emerging hydrometallurgical innovations that may resolve various challenges are also identified by means of the stakeholder engagement survey and funding opportunities available through the federal agencies. The report summarizes research priorities that support development of emerging hydrometallurgical technologies in applications ranging from high-value materials to water remediation to carbon sequestration. The report shortlists key bench-scale and semi-pilot laboratory tools that will help NRRI to advance the readiness level of emerging hydrometallurgical technologies in Minnesota. The capital estimates for bench-top and semi-pilot laboratory prototypes range from \$600,000 to \$1.2 million. The personnel, installation, and collaboration costs range from \$300,000 to \$400,000.

Subproject 3 - PROJECT RESULTS USE AND DISSEMINATION

NRRI conducted a "Voice of Customer" survey through interviews with a broad range of stakeholders around the country. These included current or prospective mineral/metal producers, metal recyclers, hydrometallurgical R&D labs, engineering and technology providers, consultants, academia and educators, regulators, and federal agencies. The study produced a report of investigations of interest to wide variety of stakeholders, including regulators, mineral rights holder, federal agencies, prospective manufacturing and resource extraction companies, and the community.

[Technical Report](#): Rao, S., Mlinar, M., Hudak, G., Kangas, K., and Peterson, D., 2022. Developing Emerging Hydrometallurgical Technologies: Report to the Legislative-Citizen Commission on Minnesota Resources. Natural Resources Research Institute, University of Minnesota Duluth, Report of Investigations NRRI/RI-2022/10. 179 p.

Subproject 4 - SOUND BITE OF PROJECT OUTCOMES AND RESULTS

The purpose of this project was to provide a technology survey and a geographical recommendation of potentially feasible, non-battery, long-duration energy storage technology concepts that can utilize Minnesota's various topographies, geologies, and infrastructure to facilitate the state's renewable energy and greenhouse gas reduction goals. Numerous technology concepts with related siting recommendations are reported for consideration by state leaders.

Subproject 4 - OVERALL PROJECT OUTCOME AND RESULTS

Achievement of Minnesota's renewable energy transition and associated greenhouse gas reduction goals requires development and installation of both short- and long-term energy storage capability. Battery storage options (lithium batteries) readily provide 2-4 hour duration storage. Longer-term (>8hr), high-capacity (35-200 milliwatt) storage can better facilitate capture of available renewable energy and potentially eliminate the need for natural gas-based peaking plants to provide a more stable electrical supply when intermittent resources (e.g., solar or wind) cannot supply the necessary electricity. Non-battery options harnessing physical principles involving gravity, compressed gas, waste

heat and chemical processes can offer storage options with long lifetimes that do not require access to critical minerals and may offer safety improvements. Many of these options are in the development or demonstration phase and can take advantage of Minnesota's natural and man-made (former mine workings) topographical and geological features.

The project consisted of two parts. The first was a thorough survey of existing and emerging long-term, high-capacity, non-battery storage technologies with potential for applications in Minnesota. This entailed engagement with technology leaders, onsite concept evaluations and discussions with energy industry collaborators to characterize each technology. Identified technologies ranged from concepts that take advantage of mineland topographic features in northern Minnesota to others that could be deployed in municipalities or metropolitan areas. This information was collated into a summary format including industry contacts for each concept to facilitate follow-up by the state and/or industry.

The second part of the project entailed development of an interactive mapping tool to identify areas in the state where each identified technology might best be suited, considering the local topography, geology, and proximity to distribution infrastructure, industry, and applicable brownfield areas. This tool shows that there are multiple non-battery storage options in regions across Minnesota, primarily located in the vicinity of distribution infrastructure.

Subproject 4 - PROJECT RESULTS USE AND DISSEMINATION

The full report and three appendices are publicly available on the University of Minnesota Duluth Natural Resources Research Institute (NRRI) [Website](#). NRRI:

- collaborated with Clean Energy Resource Teams (CERTs) personnel to organize two presentations to state stakeholders (agency, industry, academia, government) to communicate report findings and solicit feedback;
- presented to DER Energy Storage Workgroup meeting with Great River Energy and support from CERTs;
- was presented at a Minnesota House Climate and Energy Finance and Policy Committee hearing on renewable energy generation and storage; and
- Continues conversations with Minnesota Department of Commerce in conjunction with CERTs and University of Minnesota colleagues to model energy storage opportunities.

Project Completed: 6/30/2022

FINAL REPORT

[Subproject 1 Abstract](#)

[Subproject 2 Abstract](#)

[Subproject 3 Abstract](#)

[Subproject 4 Abstract](#)

Subd. 04 Water Resources

Subd. 04c Wastewater Nutrient Reduction through Industrial Source Reduction Assistance - \$200,000 TF (FY2018)

Laura Babcock
U of MN

200 Oak St. SE, Suite 350-1
Minneapolis, MN 55455

Phone: (612) 624-4678

Email: lbabcock@umn.edu

Web: <http://www.mntap.umn.edu/>

Appropriation Language

\$200,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to provide technical assistance for industrial facilities to optimize their processes, reduce nutrient loads to wastewater treatment facilities, and improve water quality. The economic savings and water quality improvements achieved through this work must be documented.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

This project explored ways to keep Minnesota surface waters at high quality and make municipal wastewater treatment easier by reducing nutrient load sent to wastewater facilities by applying source reduction technical assistance at upstream industrial sites.

OVERALL PROJECT OUTCOME AND RESULTS

Nutrient pollution refers to the presence of excess nitrogen and phosphorus in water and is a major environmental concern. High nutrient levels promote plant growth that can result in eutrophication, algal blooms, or the creation of 'dead zones' in bodies of water where beneficial aquatic life cannot thrive. Wastewater treatment facilities are critical infrastructure sites purposed with reducing nutrient levels in wastewater to levels safe for the environment.

Wastewater treatment operations work hard to discharge high quality treated water. In areas of increasing community growth and industrial expansion, the wastewater infrastructure may not be able to keep up with treatment needs. When discharge exceeds the treatment capacity, communities have few choices: they can regulate load sent to the treatment plant limiting community growth or invest in costly new infrastructure.

The purpose of this project was to explore a third option to improve water quality by reducing nutrient pollution discharged by industrial facilities to municipal wastewater treatment facilities. This reduction is supported by source reduction technical assistance at the industrial site. The primary activities of this project included:

- Engaging industrial facilities in communities with high nutrient discharge;
- Providing technical assistance to identify and implement nutrient reduction; and
- Sharing strategies for industrial nutrient reduction with additional facilities.

By promoting strategies for upstream nutrient source reduction, the treatment intensity needed to meet wastewater discharge requirements may be reduced. This could reduce operating costs and possibly postpone or eliminate capital investment needs for treatment expansion projects. Key outcomes of this project include:

- Completed eight facility assessments that investigated nutrient reduction;
- Completed four intern projects with recommendations for nutrient reduction;

- Implemented 14,730 lbs of nutrient reduction or 67% of the identified opportunity;
- Developed a guide for wastewater operators to identify practical nutrient reduction options; and
- Delivered a webinar highlighting successful upstream nutrient reduction practices.

PROJECT RESULTS USE AND DISSEMINATION

Since nutrient pollution in wastewater can be a challenge for many treatment facilities and treatment costs can drain community resources, MnTAP created two resources to share the strategies developed and tested during this project. A [webinar](#) was created featuring wastewater sites and businesses that participated in activities to reduce discharge nutrient. Speakers provided perspectives on nutrient challenges and the value in collaboration. A [guide](#) was created to provide wastewater operators and community leaders with a framework for identifying and addressing opportunities to reduce nutrient pollution at the source and save of treatment costs. Four intern project summaries are posted on the MnTAP website for [Kerry Ingredients](#), [August Schell Brewing](#), [Minnesota Specialty Yeast](#) and [Rochester Meats](#).

Project Completed: 6/30/2022

FINAL REPORT

Subd. 04d Quantifying Microplastics in Minnesota's Inland Lakes - Research Project - \$200,000 TF (FY2018)

Kathryn Schreiner

U of MN - Duluth
2205 E 5th St
Duluth, MN 55812

Phone: (218) 726-8680

Email: kschrein@d.umn.edu

Appropriation Language

\$200,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute in Duluth to quantify the amount, type, and source of microplastics in the water, sediment, and fishes of a range of Minnesota lakes.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

This project has helped to determine the sources and fate of microplastics in inland lakes in Minnesota. This includes differences in loading between different watersheds and ecosystems, and differences in ingestion by different fish species.

OVERALL PROJECT OUTCOME AND RESULTS

When this project was funded, our goal was to determine the amount and fate of microplastics in a set of Minnesota lakes that represent a variety of different types of watersheds, degrees of human influence, and ecosystem characteristics. Our partnership with the MN DNR Sentinel Lakes program allowed us to target lakes that already had long-term study data available, including mapped watersheds, lake temperature and residence time, and known fish populations. This three-year project sampled water column particulates, sediments, and fish (cisco, bluegill, and perch) from four Sentinel lakes in Minnesota (Peltier Lake, White Iron Lake, Ten Mile Lake, and Elk Lake) over the course of two

summer field seasons. All four lakes contained microplastics in the water, sediments, and fish, indicating that like other locations throughout the world, microplastic pollution is widespread in the state. Our findings further indicate that the biggest drivers that increase microplastic loadings into lakes are more human infrastructure and building in the watershed, a longer water retention time, and more shoreline development. There appears to be little connection between concentrations of microplastics in the water column and sediments, though more research will be needed to confirm. Finally, filter feeding fish (like cisco) have increased gut microplastic concentrations with increased water column microplastic concentrations, though visual feeders (like bluegill and perch) do not and appear to be able to distinguish plastics from food in the water column. Taken together, these first results from Minnesota inland lakes provide clear information for scientist and managers and further give Minnesota residents vital information about the health of their inland lakes. All data from this project will be accessible on our [project website](#) once publications have been prepared.

PROJECT RESULTS USE AND DISSEMINATION

Results from this project have been disseminated to the scientific community through meeting presentations and scientific publications currently being prepared. We have maintained a [project website](#) that is available to the public, and which we have advertised in our outreach to the Lake Associations associated with our project lakes. Our website has information about our project, videos from public webinars, and will have data from our scientific publications once those are published. Our collaboration with scientists at the MN DNR has meant that the Sentinel Lakes program has access to our project data along with any interpretations or project publications.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 04i Extracting Deicing Salt from Roadside Soils with Plants - Research Project - \$360,000 TF (FY2018)

Bo Hu

U of MN
1390 Eckles Ave
St. Paul, MN 55108

Phone: (612) 625-4215

Email: bhu@umn.edu

Web: <https://bbe.umn.edu/directory/faculty/bohu>

Appropriation Language

\$360,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to collaborate with the Department of Transportation to evaluate potential native plants that can be grown on roadsides to adsorb and remove toxic salts accumulated from deicing roads and assess uses for the harvested material.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

This project screened and evaluated several halophytic plants that can extract sodium chloride, the deicing salt, from soil, and accumulate it into the leafy biomass. The information can be used to develop

phytoremediation methods to address the environmental pollution caused by the application of roadside deicing agents.

OVERALL PROJECT OUTCOME AND RESULTS

Massive applications of road salts to melt the snow and ice on sidewalks and roads can negatively affect the health of surrounding ecosystem as the salts are leached into lakes, rivers, and groundwater, causing significantly increased salinity and high salt conditions can also negatively affect both plant growth and soil structure. Many agricultural fields have similar concerns over the growing salinity in the soil, especially under the conditions of prolonged drought and improper irrigations. We collaborated with the Minnesota Department of Transportation (MnDOT) to screen and evaluate several halophytic plants that can extract sodium chloride, the deicing salt, from soil, and accumulate it into the leafy biomass. The information can be used to develop phytoremediation methods to address the environmental pollution caused by the application of roadside deicing agents. The research detailed in this project showed that common sunflower and pitseed goosefoot so far are the most promising species for phytoremediation of deicing salt. It is recommended they be mixed in with perennials from MnDOT's seed mixes to improve soil structure and help prevent the salt from reaching the soil surface or the groundwater. Another high salt accumulating plant species, sugar beet and beets in the other cultivar groups, are more suited for agricultural and thus could be used to remediate salt from the growing number of salt-impacted agricultural fields. The harvest and utilization of each of these plants can provide additional value such as animal feed, oil, or reuse of salt in ash if burned for energy. This project and the following phytoremediation method developments can provide a long term sustainable solution to the de-icing salt pollution to our Minnesota environment.

PROJECT RESULTS USE AND DISSEMINATION

The detailed research results are in the final report, and we are drafting two manuscripts for possible publications. Leif was accepted for presenting this work at [AIChE Annual Meeting](#) in November 2022 in Phoenix, Arizona and he was invited to give a presentation at the [MECA \(Minnesota Erosion Control Association\) Annual Conference](#) in January 2023. We have been working at MnROAD site with support and help from MnDOT. Cindy Dorn, writer/producer with Prairie Sportsman, an outdoor show produced by Pioneer PBS that airs on all Minnesota PBS stations is drafting a story on absorbing deicing salts with plants.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 04k Accelerating Perennial Crop Production to Prevent Nitrate Leaching - \$440,000 TF (FY2018)

Dennis Fuchs

Stearns County Soil and Water Conservation District
110 Second Street S. Suite 128
Waite Park, MN 56387

Phone: (320) 345-6477

Email: dennis.fuchs@mn.nacdnet.net

Appropriation Language

\$440,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the Stearns County Soil and Water Conservation District to reduce nitrate leaching on sandy soils of central Minnesota by developing water-efficient production methods, supply chains, and end-use markets for three perennial crops: Kernza, prairie species, and alfalfa. Net income from the sale of products or assets developed or acquired through this project may be reinvested as described in the work plan approved by the Legislative-Citizen Commission on Minnesota Resources according to Minnesota Statutes, section 116P.10.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Perennial cropping systems that include Kernza and alfalfa are effective in reducing nitrate leaching in sandy soils of Central Minnesota. Improved Kernza value chains for food, beverage and non-food have increased interest from farmers, food processors and consumers. The potential for Kernza production to provide future ecosystems services is great.

OVERALL PROJECT OUTCOME AND RESULTS

The City of Cold Spring in Central Minnesota has long struggled with increasing nitrate concentrations in its public water supply. Perennial cropping systems may reduce the amount of nitrate leached into groundwater. In partnership with the University of Minnesota Forever Green the project measured nitrate leaching under three perennial plant systems: 1) native prairie, 2) intermediate wheatgrass (Kernza), and alfalfa under irrigation and dryland plots. This research was conducted at the Rosholt Research Farm in Pope County (managed by the Pope Soil and Water Conservation District). The site has similar sandy soils as in the Cold Spring area. The native prairie planting had limited growth during study because of its slow growth and weed pressure. The perennial cropping systems that included Kernza and alfalfa were effective in reducing the nitrate concentrations in groundwater. Kernza was slightly more effective than alfalfa. Averaged across the growing season, the concentration of nitrate in the soil water measured by lysimeters was 0.64 mg/L, which is consider very low and like other reports below Kernza. It was also discovered that Kernza grain yields were highly affected by drought conditions in 2021, even under irrigation, significantly reducing yields. In partnership with the Agricultural Utilization Research Institute (AURI) value chains for Kernza were explored which will ultimately increase demand for production by farmers. Local breweries and bakeries developed products that provided valuable feedback for new product development. Field day attendance indicated that farmers were interested in growing more Kernza if a market exists. Also, consumers in attendance were interested in Kernza food and beverage products. In addition, both food and non-food value chains will need additional investment to fully develop the market. Kernza production in drinking water supply management areas could reduce nitrate leaching. This could save cities millions of dollars in water treatment costs.

PROJECT RESULTS USE AND DISSEMINATION

The SWCD's [final grant report](#) is posted online. The [full AURI report](#) is also available online. University of Minnesota will be preparing a peer-reviewed report to be submitted as a future addendum to this report. Several field days and outreach events were completed during the project period, information about which are included in the SWCD final report.

Project Completed: 6/30/2022

[FINAL REPORT](#)

Subd. 04m Setting Realistic Nitrate Reduction Goals in Southeast Minnesota - Research Project - \$350,000 TF (FY2018)

John Nieber

U of MN
1390 Eckles Ave.
St. Paul, MN 55108

Phone: (612) 625-6724

Email: nieber@umn.edu

Web: <https://bbe.umn.edu/directory/faculty/johnnieber>

Appropriation Language

\$350,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to develop advanced water-flow and age-dating tools to improve the ability of state agencies to assess how well nitrate reduction best management practices are working in southeastern Minnesota.

Sound bite of Project Outcomes and Results

The long travel time of nitrate in groundwater negatively impacts our ability to assess the effectiveness of best management practices to reduce the nitrate contamination of groundwater resources. This project developed field monitoring and modeling tools to quantify nitrate travel time and enhance the ability to assess BMP effectiveness.

Overall Project Outcome and Results

Nitrate contamination of groundwater resources results from land management practices that ineffectively control the balance of nitrogen in the soil. This inadequate control leads to excessive leaching of nitrate from the soil, eventually loading the groundwater aquifers underlying the managed area. Best Management Practices (BMPs) have been developed to reduce the leaching of nitrate from the soil profile, and this should then have a positive impact on the quality of water in the groundwater aquifers located in the area of BMP presence. The response of the nitrate concentration at a given location in an aquifer, say for instance at a private or municipal well, will be affected by the history of landuse activity in the landscape upgradient (upstream) of the location of concern. The history is important because of the lag time, that is, the travel time (on the order of years to centuries) required for contaminated water to flow in the groundwater from the point of contamination to the well. This lagging of the response of the nitrate concentration at the well confounds the interpretation of the causes for the nitrate found in the well, thereby making it difficult to determine whether BMPs implemented in upgradient fields are actually working effectively. This project involved the development of methodologies to quantify the lag time for groundwater to flow from a landscape point to a well. The methods developed involved using chemical tracers to quantify the age of groundwater collected at wells, and development of models that can be utilized to calculate lag times. With this information, and a history of landuse practices on the landscape it is then possible to evaluate the effectiveness of BMPs in the landscape. It is also possible to identify, with some degree of certainty, the source of nitrate that is contaminating a given well.

Project Results Use and Dissemination

The project involved an ongoing collaboration with Mr. Kevin Kuehner, director of the Field-to-Streams Partnership in Preston. A complex groundwater model we developed for Trout Brook is being shared with the Dakota County SWCD to assist with the assessment of BMPs for reducing nitrate concentrations in Trout Brook. A simplified model of groundwater flow and chemical transport was developed to facilitate relatively easy assessment of the effect of landuse practices, and will be available to consultants, agency personnel, and academic institutions. The project has resulted in the submission of follow-up research proposals to one federal agency and one non-profit institution.

Project Completed: 6/30/2022

[Work Plan](#)

Subd. 04n Mapping Unprofitable Cropland for Water and Wildlife - Research Project - \$100,000 TF (FY2018)

Jason Ulrich

Science Museum of Minnesota - St. Croix Research Station
16910 152nd St N
Marine on St Croix, MN 55047

Phone: (651) 433-5953

Email: julrich@smm.org

Web: <https://www.smm.org/scwrs>

Appropriation Language

\$100,000 the first year is from the trust fund to the Science Museum of Minnesota for the St. Croix Watershed Research Station to conduct the first statewide analysis that maps the extent of Minnesota's unprofitable cropland and estimates both the water-quality and habitat benefits of converting these lands to perennial crops and vegetation. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

This project mapped an estimated 550,000 acres of unprofitable cropland in southern Minnesota. It was then estimated that converting 20% of these acres could significantly improve stream health and wildlife habitat.

OVERALL PROJECT OUTCOME AND RESULTS

Despite investing millions of dollars on agricultural conservation, the health of southern Minnesota's streams and rivers has not improved demonstrably. At the same time, increases in agricultural cropland have resulted in dramatic declines in grassland habitat critical for migratory birds, butterflies, and pollinators. An approach for improving both stream health and wildlife habitat lies in replacing portions of southern Minnesota's agricultural land with prairie and wetlands. However, most cropland is profitable and thus too costly for a farmer to take out of production. But what about parts of crop fields that often too wet or too dry to turn a profit - could these be replaced with prairie or wetlands more economically? This project set out to answer the following questions: 1) How much corn and soybean cropland in southern Minnesota is unprofitable? 2) What are the environmental benefits of converting portions of this unprofitable cropland to prairie or wetlands? Our project used county agricultural

financial data and detailed soil maps to pinpoint an estimated 550,000 acres of unprofitable cropland in a 40-county region of southern Minnesota. Next, the project estimated the improvement to streams and wildlife habitat if the most unprofitable of these acres located next to streams (114,000 acres) were converted to prairie or wetlands. The results suggest that targeting unprofitable croplands in this way would significantly improve stream health and wildlife habitat in southern Minnesota and provide a good bang for the buck. The project outcomes are intended to be useful for the public and policymakers to understand the amount and distribution of unprofitable cropland in southern Minnesota and its great potential for improving environmental health in an economical way.

PROJECT RESULTS USE AND DISSEMINATION

The project content was presented at several Science Museum member events over Zoom. And in October 2022, the work will be presented at the MN Water Resources Conference, a premier venue for this type of research.

The results of this project including the GIS files and attached fact sheet will be linked from this Science Museum website when our new web portal is up and running fall of 2022. Interested visitors will be able to download the GIS files and conduct their own analyses based upon those in the study. Announcements about these deliverables and about the key points and highlights of the project will be shared on the Science Museum's social media accounts in fall 2022.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 04o Evaluating Locally Sourced Materials for Road Salt Reduction - Research Project - \$162,000 TF (FY2018)

Chanlan Chun

U of MN - Duluth NRRI
5013 Miller Trunk Hwy
Duluth, MN 55811

Phone: (218) 788-2613

Email: chun0157@d.umn.edu

Web: <https://scse.d.umn.edu/about/departments-and-programs/civil-engineering-department>

Appropriation Language

\$162,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute in Duluth to evaluate the effectiveness and benefits of using locally sourced wood chips, corncobs, and iron-bearing minerals as alternative abrasive materials to lower salt use for protecting Minnesota's water resources. This appropriation is subject to Minnesota Statutes, section 116P.10. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

This project evaluated local ecological abrasive materials for use as alternative materials to lower road

salt use in winter maintenance and consequent environmental impacts. The findings are useful for the development of the formulation and application practice for both water resource protection and safe winter roadway.

OVERALL PROJECT OUTCOME AND RESULTS

The use of chloride-based salt as a deicer for winter road maintenance has been a longstanding practice throughout the state of Minnesota and the country. However, once chloride enters the water, it is not naturally broken down, transformed, or removed from the environment, resulting in accumulation in the watershed and detrimental ecological and water quality impacts in freshwater systems. To protect freshwater resources and to prevent this issue from worsening with time, an alternative method for providing sustainable and effective winter road maintenance is needed. In some cold regions of Minnesota, sand is mixed with salt as an abrasive to provide additional traction to the roads; however, its effectiveness is not well established. This project investigated the potential of regionally available organic and inorganic industrial byproducts as alternatives to conventional sand and salts. Candidate materials include corn grit, timber waste, and taconite waste rocks local to Minnesota. Chemical and physical properties of the materials were characterized, including material elemental composition, morphology, particle size distribution, and specific gravity to establish a foundational understanding of the material. Skid resistance and deicing tests with environmental impact assessment were performed to evaluate traction effectiveness and material safety. The results showed potential for bio-based materials such as corn grit and bark mulch as a sorbent for salt brine deicer with less salt impact and for the waste iron-bearing minerals to be used as effective abrasives in the realm of winter road maintenance. The use of alternative materials for winter road maintenance show promise for lower environmental impact, lower/controlled chloride pollution, increased friction enhancement, and beneficial reuse of industry waste material. In addition, this work provided a streamlined method for evaluating potential abrasives/deicers which will be valuable for expediting future studies of alternative materials.

PROJECT RESULTS USE AND DISSEMINATION

The project findings have been disseminated via reports to LCCMR, master student's thesis, and presentations at regional conferences (Minnesota Water Resources Conference and UMD seminar series). The project findings were shared with the public through public outreach activities for 6th-12th graders and general audience: engineering discussion with middle school students of Arcadia Charter School, Northfield, MN and a video clip, [Safe Roads and Healthy Water](#) to present and discuss our project for achieving safe roads and healthy water using local materials for the [UMD's STEM Discovery Day](#).

Project Completed: 6/30/2022

FINAL REPORT

Subd. 04p Minnesota Spring Inventory Final Phase - \$71,000 TF (FY2018)

Paul Putzier

MN DNR

Box 25, 500 Lafayette Rd N.

St. Paul, MN 55155

Phone: (651) 259-5692

Email: paul.putzier@state.mn.us

Web: https://www.dnr.state.mn.us/waters/groundwater_section/mapping/springs.html

Appropriation Language

\$71,000 the first year is from the trust fund to the commissioner of natural resources to complete the Minnesota Spring Inventory that identifies, catalogs, and assists resource managers in monitoring, assessing, and protecting important and threatened statewide water springs. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Springs are natural points of groundwater discharge that provide flow for trout streams and cool water fisheries, base flow during to streams, and unique ecological habitats. Management of this resource is only possible when we know their location. The MSI project located and makes available information on over 7,200 springs.

OVERALL PROJECT OUTCOME AND RESULTS

Springs are natural points of groundwater discharge that provide flow for trout streams and cool water fisheries, base flow during to streams, and unique ecological habitats. Management of this resource is only possible when we know their locations and characteristics. The primary objective of this project was to find unmapped springs, add the location of those new springs to the existing Minnesota Spring Inventory (MSI) and field verify and characterize as many currently mapped but unverified springs as possible.

For the project, DNR conducted field investigations of targeted parts of the state to find, characterize and map new springs locations. The existing MSI database also held ‘non-verified’ spring locations added to the database from old maps and studies and from the MSI Citizens App. DNR conducted ‘field verification’ by traveling to many of those features to confirm their existence and update the database. Approximately 350 spring locations were added to the MSI through the Citizen App.

The Covid-19 Pandemic and Minnesota’s Stay Safe at Home order limited MSI fieldwork for over twelve months of the two-year project. When restrictions were relaxed in 2021, fieldwork resumed for the MSI team and many springs and features were added the database.

Because of this project (all phases), Minnesotans benefit by having easy access to approximately 7,200 features in the MSI including a combination of field verified springs, and many likely, but non-verified spring locations. The MSI project resulted in a 76% increase in mapped springs and increased from holding verified springs in 22 counties, primarily in the southeast, to verified springs located in 71 counties.

The DNR established special MSI accounts for MPCA and SWCD field staff from the Duluth/ Northern MN region and provide guidance documents and training, allowing them to add springs directly to the MSI using the Survey 123 application.

PROJECT RESULTS USE AND DISSEMINATION

DNR conducts dissemination through individual contacts, presentations and news releases. One example is online at [St. Croix 360](#). Another example came from an environmental consultant in a June 2021 email:

"Can (you) help assist with information gathering regarding seeps & springs in the St Paul area. I'm working with the Capitol Region Watershed District to identify springs within their boundary, and prioritize the springs in order of level of prevalence/risk to become a public comment or threat to infrastructure."

The spring data is accessible at [Minnesota Spring Inventory](#) and GIS files are at the [Minnesota Geospatial Commons](#), and at [Showcase](#).

Project Completed: 6/30/2021

FINAL REPORT

Subd. 04q Restoring Impaired Lakes through Citizen-Aided Carp Management - \$106,000 TF (FY2018)

Andrew Dickhart

Carver County Water Management Organization
600 E. 4th Street
Chaska, MN, 55318

Phone: (952) 361-1871

Email: adickhart@co.carver.mn.us

Web: <https://www.co.carver.mn.us/departments/public-services/planning-water-management/water-management>

Appropriation Language

\$106,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the Carver County Water Management Organization to quantify water quality improvements and the cost-effectiveness of a new citizen-aided carp management method for restoring impaired lakes in Minnesota.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 05 Technical Assistance, Outreach, and Environmental Education

Subd. 05a Expanding Camp Sunrise Environmental Program - \$237,000 TF (FY2020)

Lori Arnold

YouthCARE MN
2701 University Ave SE, Suite 205
Minneapolis, MN 55414

Phone: (612) 338-1233

Email: larnold@youthcaremn.org

Web: <http://www.youthcaremn.org/>

Appropriation Language

\$237,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with YouthCare Minnesota to expand camp opportunities to more school districts and implement improved hands-on environmental education programs for economically disadvantaged youth.

Note: Dollars returned

Project Completed: 6/30/2022

Subd. 05c Mississippi National River and Recreation Area Forest Restoration - \$199,000 TF (FY2020)

Mary Hammes

Mississippi Park Connection
111 Kellogg Blvd E, Suite 105
St. Paul, MN 55101

Phone: (651) 291-9119

Email: mhammes@parkconnection.org

Web: <https://parkconnection.org/>

Appropriation Language

\$199,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the Mississippi Park Connection to work with Conservation Corps Minnesota, local communities, and volunteers to address the loss of ash trees to emerald ash borer by planting approximately 15,000 native trees and plants in affected areas in the Mississippi National River and Recreation Area.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Mississippi Park Connection and its partners planted 15,069 native trees and shrubs in the Mississippi National River and Recreation Area to address tree canopy loss due to Emerald Ash Borer. The project also established a Mississippi River Crew with the Conservation Corps of Minnesota and Iowa and engaged volunteers.

OVERALL PROJECT OUTCOME AND RESULTS

Emerald ash borer (EAB) is a small insect without natural predators that is killing up to 99% of all native ash trees in the Twin Cities Metropolitan Area. In parklands with large natural areas, dying ash trees are creating hazardous conditions for park visitors and creating a gap in the canopy as they die. These canopy gaps are negatively impacting wildlife habitat along the Mississippi River. This project aimed to identify areas where ash trees were being lost to Emerald Ash Borer and support overall forest ecosystem health by planting a diverse set of native trees and shrubs to support the ash-elm-mixed-hardwood ecotype within the Mississippi National River and Recreation Area. Major outcomes achieved during the project include:

1. 15,069 native trees and shrubs were planted in the ash-elm-mixed-hardwood forests of the Mississippi National River and Recreation Area (MNRRA) in order to address tree canopy loss due to Emerald Ash Borer.
2. Trees were protected from herbivory through the installation of tree tubes. Additional measures to support establishment, like watering and the removal of encroaching understory, were also performed.
3. We conducted 246 plant surveys throughout the grant period and worked in 52 different parks within MNRRA. Working in those parks, we consulted with the land managers to identify where EAB infestations had occurred and, throughout the course of the grant, monitor the progression of the infestations. Dead ash trees in areas of high habitat value were kept when possible for habitat and removed as necessary in order to create gaps in the canopy for future plantings. Hazardous ash trees were also removed at the request of land managers. Protocols for working in forested areas with high levels of canopy loss due to EAB are currently being developed as a direct result of working in these late-phase infested forests.

PROJECT RESULTS USE AND DISSEMINATION

The work received recognition in a [Star Tribune Article](#). We also talked about this work in Mississippi Park Connection's e-newsletters, which has 8,806 subscribers. We also celebrated this work in an Earth Day virtual event with over 70 registrants. Finally, we worked with thousands of volunteers who learned more about Emerald Ash Borer and forests and the support that LCCMR has provided to this project. This work is also highlighted on Mississippi Park Connection's [website](#). We created a [video](#) describing the work of the Mississippi River Crew. A document regarding natural resource professional safety working in EAB-affected forests is forthcoming.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 06 Aquatic and Terrestrial Invasive Species

Subd. 06b Oak Wilt Suppression at its Northern Edge - \$100,000 TF (FY2020)

Shannon Wettstein

Morrison Soil and Water Conservation District
16776 Heron Rd
Little Falls, MN 56345

Phone: (320) 631-3553

Email: shannon.wettstein@morrisonswcd.org

Web: <http://morrisonswcd.org/about-us>

Appropriation Language

\$100,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with Morrison Soil and Water Conservation District to eradicate the northern-most occurrences of oak wilt in the state through mechanical means on select private properties to prevent oak wilt's spread to healthy state forest habitats.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Morrison SWCD partnered with DNR Forest Health Specialists and local DNR Foresters to suppress oak wilt at 18 sites within Morrison County through mechanical means. These sites are the northern-most occurrences of oak wilt in the state through on the edge of healthy state forest habitats.

OVERALL PROJECT OUTCOME AND RESULTS

Morrison SWCD partnered with DNR Forest Health Specialists and local DNR Foresters to suppress oak wilt at 18 sites within Morrison County. Control work was done by an experienced contractor using successful vibratory plow and tree destruction methods. Morrison County is at the leading edge of the known disease range in Minnesota. While the project was focused on private lands, the public good comes from controlling the spread to public forests of the state, and the continued habitat for turkey, grouse, deer and other wildlife.

The DNR Forest Health Specialist made numerous trips to the area to help train local resource professional staff on identification of oak wilt and confirm new spots and local DNR Foresters painted wilting trees throughout the season. At the time of grant execution, the number of known infection sites had jumped from ten to 65 triggering Morrison SWCD and DNR to prioritize work zones based on the proximity of the site to northern public forests. Highest priority sites were largely rural with large intact forests and lower priority sites were found near Little Falls, Minnesota in an actively developing residential area.

Landowners were approached by the SWCD to gain interest in oak wilt suppression activities on their properties. These property owners signed a Landowner Agreement that outlined program requirements, landowner and contractor responsibilities and timelines for treatment. The SWCD received overwhelming support from property owners, with 50 landowners signing on to be part of the program, and because of this, all the known oak wilt pockets in the high and highest priority zones were treated.

The SWCD and DNR continue to educate the public and work with landowners affected by oak wilt in the medium and low priority areas to guide them in properly addressing the disease on their properties until additional funding can be secured.

PROJECT RESULTS USE AND DISSEMINATION

The SWCD received overwhelming support from property owners, with 50 landowners signing on to be part of the program, and because of this, all the know oak wilt pockets in the high and highest priority zones were treated. The SWCD and DNR have both released articles to local newspapers, submitted articles for the Forest Health Unit newsletter and alerted landowners of the presence of Oak Wilt in Morrison County and grant opportunities through talk show programs on the local radio station. Both agencies have updated their websites to reflect current grant opportunities. Website addresses for both of these are located here: https://www.dnr.state.mn.us/treecare/forest_health/oakwilt/index.html ; <https://morrisonswcd.org/gallery/fy2019-projects-events/oak-wilt-main>. Both organizations will include this grant award and outcomes in their 2019 annual reports.

Informational packets were created to easily send in the mail or hand to interested landowners over the counter. These packets include a contractor list of certified arborists and experienced vibratory plow operators, handouts on how to identify oak wilt along with best management practices for suppressing oak wilt and links to additional resources and references. Landowners in the low and medium priority zones where oak wilt was not addressed with these funds were given or sent a packet and told they will be notified in the future if additional funds are secured. Morrison SWCD and DNR will continue to

provide technical support to these landowners so diseased pockets of oak are managed properly. The SWCD is also offering a 10% discount known affected property owners order trees through the office to help offset the cost of reforestation.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 07 Air Quality and Renewable Energy

Subd. 07a Development of Clean Energy Storage Systems for Farms - Research Project - \$650,000 TF (FY2020)

William Northrop

U of MN - WCROC
111 Church Street
Minneapolis, MN 55455

Phone: (612) 625 6854

Email: wnorthro@umn.edu

Appropriation Language

\$650,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the West Central Research and Outreach Center at Morris to develop and test novel clean energy storage systems for farms using wind-generated ammonia to displace fossil fuels and reduce greenhouse gas emissions. This appropriation is subject to Minnesota Statutes, section 116P.10.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 07b White Earth Nation Community Solar for Economic Resilience - \$500,000 TF (FY2020)

Nicole Saccoman

Rural Renewable Energy Alliance
3963 8th Street SW
Backus, MN 56435

Phone: (218) 947-3779

Email: Nicole@rreal.org

Web: <https://www.rreal.org/cs4ca>

Appropriation Language

\$500,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with Rural Renewable Energy Alliance to install a 200-kW White Earth community-owned solar garden to reduce greenhouse gas emissions, increase economic development through environmental education and solar workforce training, and improve energy resilience.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

200 kW of solar community gardens were installed on the White Earth tribal reservation. This project will greatly reduce greenhouse gas emissions for years to come, in addition to providing energy resilience to the White Earth community. Furthermore, this project has increased economic development through environmental education and solar workforce training.

OVERALL PROJECT OUTCOME AND RESULTS

Five 40 kW ground-mounted solar arrays have been completed, were commissioned, and are now operating at 100% at each of the five chosen sites. Those sites are DOVE Shelter, Head Start Daycare Center, Maadaazizi Workforce Center, Naytahwaush Complex, and the Tribal College; all are located within the White Earth reservation tribal community.

Eight interns, in two rounds of four, completed a 45-hour paid internship at a rate of \$15/hour. They each received a Minnesota Installers Certificate and a professional electronic instrument kit. Each student, as part of the 45 hours, spent 15 hours at the solar construction sites during installation. Rural Renewable Energy Alliance (RREAL) and the White Earth Tribal and Community College are expanding this program into a full Associate Degree program in 2022, including work experiences with Minnesota Power and several rural Habitat for Humanity affiliates.

PROJECT RESULTS USE AND DISSEMINATION

This project has directly led to a second year of Solar Tech Customized Education at the White Earth Tribal and Community College. It is also providing the tribal community with sustainable energy to promote energy independence and resiliency. RREAL is continuing to partner with the White Earth tribe to create long-lasting energy sustainability solutions. Please enjoy this video for further information on the collaboration between RREAL and the White Earth nation and how this project will continue to increase economic development and sustainability within the community.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 08 Methods to Protect or Restore Land, Water, and Habitat

Subd. 08c Sauk River Dam Removal and Rock Rapids Replacement - \$2,768,000 TF (FY2020)

Colleen Winter

City of Melrose
225 First St NE
Melrose, MN 56352

Phone: (320) 256-4278

Email: cwinter@cityofmelrose.com

Web: <https://www.cityofmelrose.com/>

Appropriation Language

\$2,768,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the city of Melrose to remove an existing fixed-elevation dam, construct a rock arch rapids, and conduct in-stream and shoreline habitat restoration to improve water quality and native fish passage in the Sauk River. This project requires a match of at least \$1,400,000 that must be secured before trust fund money is spent. At least \$700,000 of this match must come from the city of Melrose.

City of Melrose expenses for the Sauk River dam removal and rock rapids replacement incurred before July 1, 2019, may be counted toward the match.

Note: Dollars returned

Project Completed: 06/30/2022

Subd. 09 Land Acquisition, Habitat, and Recreation

Subd. 09f Accessible Fishing Piers - \$320,000 TF (FY2020)

Nancy Stewart

MN DNR

500 Lafayette Rd

St. Paul, MN 55155

Phone: (651) 259-5616

Email: nancy.stewart@state.mn.us

Web: <https://www.dnr.state.mn.us/>

Appropriation Language

\$320,000 the first year is from the trust fund to the commissioner of natural resources to provide accessible fishing piers in locations that have a high potential to serve new angling communities, underserved populations, and anglers with physical disabilities. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Nine (9) new accessible fishing piers have been installed in various locations around the state to improve fishing opportunities for people of all ages and abilities. The DNR worked with multiple sponsors and donors who brought funding and enthusiasm to the projects.

OVERALL PROJECT OUTCOME AND RESULTS

Accessible fishing piers make fishing safe, easy, and fun for all ages especially children, elderly, disabled, veterans, families, small and large groups, and anyone who doesn't own a boat. Fishing piers provide the "classroom" to teach fishing skills and outdoor education classes. Data shows that 40% of people with fishing licenses do not own a boat (approximately 480,000 anglers). The demand for fishing piers is increasing as more people want to fish close to home and from a safe location. Each fishing pier is expected to last 20 to 25 years with proper maintenance. Below are the nine new fishing pier locations:

- Duck Lake, Blue Earth County (Duck Lake County Park)
- Lake Koronis in Stearns County, City of Paynesville (Veterans Park)
- St. James Lake in Watonwan County, City of St. James (St. James Lake Park)
- Maple Lake, Polk County (Maple Lake East Boat Launch)
- Bingham Lake, Cottonwood County, City of Bingham Lake (Bingham Lake Park)
- Black Oak Lake, Stearns County (Black Oak Lake Public Water Access)
- Hoot Lake, Otter Tail County, City of Fergus Falls (Godel Park)
- Lake Frances (Francis), Le Sueur County, City of Elysian (Lake Frances Public Water Access)

- St. Croix River, Chisago County, City of Taylors Falls (South Lions Park)

PROJECT RESULTS USE AND DISSEMINATION

DNR now has approximately [364 public fishing sites](#); with 282 on partner owned and operated lands, and 82 on state-owned land. Since 1984, the fishing pier program has relied on funds from competitive capital funding sources to grow the program and add new fishing piers (and shore fishing sites) such as Bonding, Legacy and now LCCMR. In a typical year each existing fishing pier is checked and repaired as needed. Summer storms and winter ice are the most common causes for damage. Piers past their useful life are prioritized for rehabilitation or replacement at a rate four to eight each year. The program is hugely successful because of the many partnerships with local units of governments.

Project Completed: 06/30/2021

FINAL REPORT

Subd. 09g Mesabi Trail Extensions - \$3,000,000 TF (FY2020)

Bob Manzoline

St. Louis & Lake Counties Regional Railroad Authority
111 Station 44 Rd
Eveleth, MN 55734

Phone: (218) 744-2653

Email: bmanzoline@rrauth.com

Web: <https://www.mesabitrail.com/>

Appropriation Language

\$3,000,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the St. Louis and Lake Counties Regional Railroad Authority for environmental assessment, permitting, right-of-way easements or other acquisition as needed, and engineering for and construction of four trail segments beginning and ending at the following approximate locations: Darwin Meyers Wildlife Management Area to County Road 21, Embarrass to Kugler, County Road 128 to the Eagles Nest Town Hall, and Wolf Creek to the Highway 169 underpass.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

This project was an important part on nearing the completion of a planned 162 mile long paved bicycle trail stretching from Grand Rapids to Ely, MN. The ENRTF funding along with other funds allowed for the completion of four (4) segments of the Mesabi Trail which are: Darwin Meyers Wildlife Management Area to County Road 21 (approximately 2 miles), Embarrass to Kugler Township (approximately 9 miles), County Road 128 to Eagles Nest Town Hall (approximately 2 miles), and Wolf Creek to the Highway 169 underpass (approximately 3 miles).

OVERALL PROJECT OUTCOME AND RESULTS

For Segment 1: Darwin Meyers WMA to CR 21, we completed about 90% (approximately 1.5 miles) of the trail construction for this segment by June 30th, 2022. We will be using funds from our IRRRB grant to complete the remaining construction management and trail construction for this segment. Segment 2: Embarrass to Kugler, this segment is 100% completed, approximately 9 miles. Our engineering and construction costs were under our original engineering estimates and finished favorable compared to

our budget for this segment. Segment 3: CR 128 to Eagles Nest Townhall, this segment is 100% completed, approximately 2 miles. Our engineering and construction costs were under our original engineering estimates and finished favorable compared to our budget for this segment. Segment 4: Wolf Creek to Highway 169 Underpass, this segment is 100% completed, approximately 3 miles. Typical challenges arose from designing and building these paved bicycle trail segments, such as land formations, wetlands and mitigation, land acquisitions, and rising material costs. To complete these four (4) segments, each required environmental assessments and permitting, engineering plans, services, management, right-of-way acquisition and construction. These key segments allow connections to various communities from the Giants Ridge Golf and Ski Resort in Biwabik through Embarrass and Kugler Township; Eagles Nest Township, Bear Head State Park and the Wolf Creek area towards Ely.

PROJECT RESULTS USE AND DISSEMINATION

The Mesabi Trail news and updates are provided through a variety of media, marketing and publications. Web site is: Mesabitrail.com. The following are some of the groups & organizations that disseminate Mesabi Trail information and typically include updates of newly completed trail segments and activities:

- Club Mesabi (10,000 maps & web site: Mesabitrail.com)
- Iron Range Tourism (30,000 brochures & web site)
- MN Office of Tourism
- amperes radio
- Parks & Trails, Home & Away, other private magazines
- Over 250,000 trail users per year
- Great River Energy/Mesabi Trail annual tour
- Named by the Star Tribune as “Best of Minnesota” in year 2013
- Named by Bicycle Magazine as” top 10 in the country”
- Information distributed at over 70 locations including Chambers of Commerce, visitor centers, businesses
- MN DOT/Pedal MN bikeways map
- “Second best trail in Midwest USA” Dubuque Iowa, 2017

The Environmental and Natural Resources Trust Fund is acknowledged as a funder for the Mesabi Trail with recognition posted in each kiosk along the trail.

The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENRTF Acknowledgement Guidelines.

Project Completed: 06/30/2022

FINAL REPORT

Subd. 09I Vergas Long Lake Trail - \$290,000 TF (FY2020)

Julie Lammers
City of Vergas
PO Box 32
Vergas, MN 56587-0032

Phone: (218) 342-2091

Email: cityofvergas@arvig.net

Web: <https://www.cityofvergas.com/>

Appropriation Language

\$290,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the city of Vergas to construct a bicycle and pedestrian bridge, trail, and floating boardwalk along Long Lake including shoreline restoration and stabilization with native plants. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

Project Completed: 6/30/2022

FINAL REPORT

Subd. 09m Glacial Edge Trail and Downtown Pedestrian Bridge - \$600,000 TF (FY2020)

Andrew Bremseth

City of Fergus Falls

112 Washington Avenue W

Fergus Falls, MN 56537

Phone: (218) 332-5403

Email: Andrew.Bremseth@ci.fergus-falls.mn.us

Web: <https://www.ci.fergus-falls.mn.us/>

Appropriation Language

\$600,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the city of Fergus Falls to acquire easements for and construct a trail along the Otter Tail River in downtown Fergus Falls and a bicycle and pedestrian bridge crossing the river. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

On June 30, 2022, the City of Fergus Falls celebrated its 150th anniversary by unveiling a new segment of a shared use path enhancing the riverfront in downtown Fergus Falls.

OVERALL PROJECT OUTCOME AND RESULTS

This project, bolstered by the outcomes of a 2016 Downtown Riverfront Master Plan and colloquially referred to as Downtown Riverfront Improvements, has spanned multiple City Councils, elections, bonding bills, engineers, redesigns, and even a pandemic. Thanks to a shared vision and the strength of public- private partnerships, the City was able to unveil a segment of new shared use path and pedestrian improvements in downtown Fergus Falls at a community celebration on June 30, 2022.

The initial aims of the project included land acquisitions to complete two segments of new trail and a pedestrian bridge over the Otter Tail River. In 2020, land acquisition was removed to reflect an adjusted trail route. Due to impacts from COVID-19 and after additional engineering analysis, the project scope

was further reduced to reflect the community's ability to feasibly finance the intended project, focusing efforts on a first phase section of trail leading up to and crossing a pedestrian bridge. When it came time to finalize design and financing, resistance from the community (specifically and surprisingly to the proposed pedestrian bridge) further impacted project timeline and budget.

Consequently, the work completed by June 30, 2022 was a much reduced scope from the original work plan, but the project unveiled in celebration of the City's 150th anniversary remains impactful. Minnesotans benefit from the completion of a segment of trail that will connect to State and regional trails, the enhancement of a riverfront once flanked by crumbling parking lots and industrial sites, and the recreational and educational opportunities now available to local residents and visitors that increased access to pedestrian infrastructure and the river bring. The successful completion of pedestrian upgrades despite hurdles along the way strongly suggest that Minnesotans see the value in the natural beauty surrounding them and wish to preserve and enjoy that natural beauty.

PROJECT RESULTS USE AND DISSEMINATION

Project updates were shared periodically through a [project website run by Bolton & Menk](#). More consistently, information about this project has been disseminated in in-person updates to City Council and in an unveiling speech given by Mayor Ben Schierer on June 30.

Though not posted before June 30, the kiosk in the project area will include attribution to the ENTRF based on ENTRF acknowledgment requirements.

Project Completed: 06/30/2022

FINAL REPORT

Subd. 09o Restoring Five Sections of the Superior Hiking Trail - \$191,000 TF (FY2020)

Lisa Luukkala

Superior Hiking Trail Association
731 7th Avenue, Suite 2
Two Harbors, MN 55616

Phone: (218) 834-2700

Email: lluukkala@superiorhiking.org

Web: <https://superiorhiking.org/>

Appropriation Language

\$191,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the Superior Hiking Trail Association to restore and repair the most damaged parts of five sections of the Superior Hiking Trail and restore an abandoned route to a natural footpath for hikers.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

The Superior Hiking Trail (SHT), which traverses the ridgeline of Minnesota's North Shore, was repaired in some its most damaged sections. A well maintained SHT keeps people on the trail and water off of it, the adjacent land and water are protected, and a human connection to nature is preserved.

OVERALL PROJECT OUTCOME AND RESULTS

The 310-mile Superior Hiking Trail (SHT), part of the larger North Country National Scenic Trail, is nationally recognized as a premier long trail in the United States. Almost the entire trail was built without application of modern trail-building standards. As a result, and due to the extreme popularity of the Trail, the SHT is in rough shape: decrepit built structures (boardwalks, bridges), severe erosion, and long stretches of muddy trail. With earlier assistance from LCCMR, we were able to complete multiple professional assessments of some of its most damaged sections, which came to known as “the Big Bad Five.”

Using the assessments as a framework to identify distinct projects within those five sections of trail, we worked in partnership with land managers/owners to determine the project scope and type of trail renewal application. We rebuilt, replaced or rerouted trail segments to eliminate around a dozen dangerously built structures (e.g., stairways, small bridges); repaired 1.5 miles of the most eroded or degraded segments.; and replaced or built 1,500 feet of boardwalk.

Ability to maintain the Trail at a level that meets or exceeds industry standards has long-lasting impacts on both the critical role the Trail plays to connecting people to nature and to stewarding the land and water through which the Trail passes. Every year, thousands of Minnesotans utilize the unique access the Superior Hiking Trail affords, allowing people to interact with public lands otherwise not available to them and leaving them with the tenants of land stewardship and conservation that carries on after they return home.

PROJECT RESULTS USE AND DISSEMINATION

The project results (construction) are very tangible and can be seen and experienced. The processes we developed in the implementation, such as the development of design plan sets and identifying alignments through particularly challenging terrain are well documented so they can be used internally and by fellow trail organizations as a resource. [Our Trail Maintenance Manual](#), which highlights many of the sustainable design and maintenance techniques used in our projects is available on our website for the public to access.

Project Completed: 06/30/2022

FINAL REPORT

Subd. 10 Administration and Contract Agreement Reimbursement

Subd. 10a Contract Agreement Reimbursement - \$135,000 TF (FY2020)

Katherine Sherman-Hoehn

MN DNR

500 Lafayette Road

St. Paul, MN 55155-4010

Phone: (651) 259-5533

Email: Katherine.Sherman-Hoehn@state.mn.us

Web: <https://www.dnr.state.mn.us/>

Appropriation Language

\$135,000 the first year is from the trust fund to the commissioner of natural resources, at the direction of the Legislative-Citizen Commission on Minnesota Resources, for expenses incurred for preparing and administering contracts for the agreements specified in this section. The commissioner must provide documentation to the Legislative-Citizen Commission on Minnesota Resources on the expenditure of these funds. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

This appropriation was used to support the ENRTF contract management program, which ensured that ENRTF grantees expended grant funds in compliance with state law, session law, approved work plans, and Office of Grants Management grants policies.

OVERALL PROJECT OUTCOME AND RESULTS

This appropriation was used to support the ENRTF contract management program, which ensured that ENRTF grantees expended grant funds in compliance with state law, session law, approved work plans, and Office of Grants Management grants policies.

The DNR Grants Unit managed 78 grants active in FY 2020. In FY 2021, the Grants Unit managed 72 active grants.

Between 1/1/2020 when billing began and 12/31/2020 when it ended, the DNR Grants Unit:

- Made 136 reimbursements to grantees totaling \$7,395,420
- Finished executing 18 project amendments due to COVID extensions, including implementation of electronic signature process
- Monitored all grants in compliance with Office of Grants Management policies.
- Billed 1,257 hours at the FY 2020 professional services rate of \$66.00/hr and 754 at the FY2021 rate of \$69/hr

PROJECT RESULTS USE AND DISSEMINATION

Project personnel were in frequent contact with appropriation recipients and LCCMR staff. Information was disseminated through manuals, training sessions, orientations, meetings, memos, letters, emails, newsletter, and phone.

Project Completed: 06/30/2021

[FINAL REPORT](#)

Subd. 10c Legislative Coordinating Commission (LCC) Administration - \$3,000 TF (FY2020)**Sally Olson**

Legislative Coordinating Commission
100 Rev. Dr. Martin Luther King Jr. Blvd.
Room 72 State Office Bldg
St. Paul, MN 55155

Phone: (651) 296-9002

Email: Sally.Olson@lcc.mn.gov

Appropriation Language

\$3,000 the first year is from the trust fund to the Legislative Coordinating Commission for the website required in Minnesota Statutes, section 3.303, subdivision 10.

Project Completed: 06/30/2022

Subd. 11 Wastewater Treatment Recommendations

Subd. 11a Water Infrastructure Loans - \$0 TF (FY2020)

Jeff Freeman

Public Facilities Authority
322 Minnesota Street, Suite W820
St. Paul, MN 55101-1378

Phone: (651) 259-7465

Email: jeff.freeman@state.mn.us

Web: <https://mn.gov/deed/pfa/>

Appropriation Language

Up to \$5,000,000 of the money in the trust fund is available to the State Board of Investment to invest in loans through the Public Facilities Authority's clean water revolving fund under Minnesota Statutes, section 446A.07. Notwithstanding Minnesota Statutes, section 446A.07, repayments of principal and interest and any investment income must be credited to the trust fund and are available for reinvestment in the clean water revolving fund.

Project Completed: 06/30/2022

Subd. 11b Optimization Local Mechanical and Pond Wastewater-Treatment Plants - \$500,000 TF (FY2020)

Joel Peck

Minnesota Pollution Control Agency
520 Lafayette Rd. N.
St. Paul, MN, 55110

Phone: (651) 757-2202

Email: joel.peck@state.mn.us

Web: <https://www.pca.state.mn.us/>

Appropriation Language

\$500,000 the first year is from the trust fund to the commissioner of the Pollution Control Agency for the pilot program created under Laws 2018, chapter 214, article 4, section 2, subdivision 4, paragraph (a). This appropriation is available until June 30, 2021, by which time projects must be completed and final products delivered.

SOUND BITE OF PROJECT OUTCOMES AND RESULTS

Wastewater treatment systems are critical infrastructure to manage waste effluent within hundreds of communities throughout Minnesota. Optimization means getting better results through existing infrastructure. This project determined that both mechanical and pond wastewater treatment systems can be optimized, and new effluent limits met, without adding substantial new infrastructure.

OVERALL PROJECT OUTCOME AND RESULTS

Achieving better nutrient treatment in wastewater treatment facilities serves to reduce the likelihood of algal blooms in Minnesota's water bodies resulting in cleaner lakes and rivers.

This project found that Minnesota's mechanical wastewater treatment plants can achieve better biological nutrient removal (BNR) through low-cost operational changes. These improvements were modeled using the Activated Sludge SIMulation Model (ASIM) in order to determine the specific plant operational parameters required to achieve BNR. On average, mechanical plants in this pilot were modeled to have average nitrogen reduction of 14.14 mg/L, average phosphorus reduction of 1.84 mg/L (most sites already treat phosphorus chemically to 1 mg/L) and chemical reductions of 886 lb chemical/Million Gallons (MGal) flow.

Wastewater ponds can achieve much better nutrient treatment by utilizing the 'Steady-State Primary' strategy developed during this project. This strategy involves holding the first pond at six feet, or the maximum depth permitted) with a slide gate. Raw influent continues flowing into pond 1, while treated effluent from pond 1 is used to fill pond 2. Meanwhile, pond 3 is also held full. This strategy maximizes treatment time and drastically improves nutrient treatment quality. The two developed case studies showcase a 69% reduction in phosphorus and 43% reduction in nitrogen when compared to the prior year's effluent. Secondary recommendations to wastewater ponds is to reduce inflow and infiltration, reduce fecal loading from waterfowl, and to encourage the growth of aquatic plants, with a specific emphasis on the growth of coontail.

By quantifying the role that optimization has in effective wastewater treatment, Minnesota's lakes and streams can meet standards in a more cost effective means.

PROJECT RESULTS USE AND DISSEMINATION

The project and its results have been presented in 17 different events and conferences by members of this team, including Minnesota Rural Water Association's annual conference, Minnesota Pollution Control Agency's annual conference, the Conference on the Environment, and many others. However, only one mechanical treatment plant has elected to move ahead with a pilot study, and one additional has expressed interest in doing so in the near future. The team has heard from staff and consultants of participating facilities that without a nitrogen standard as a driver, they feel little urgency to adopt optimization recommendations. Other facilities are meeting phosphorous limits under current flow, but would face difficulty at increased flow. Additionally, BNR design and operation is not a common treatment system in our Minnesota climate, and there may be some trepidation to moving toward that form of treatment until other facilities lead the way.

We have seen eight pond systems adopt the steady-state-primary flow regime in their operations, with more hoping to do so in the near future. Those that have done so already have reported roughly 50 percent reduction in nutrient discharge. The flow regime still needs additional validation. But, more discharge events will add more confidence with additional datasets from daily monitoring reports. Better flow management through infrastructure maintenance – making sure the control structures function as designed – is going to continue to be an area of importance in order to prevent short circuiting of the treatment in isolated pond cells.

The final report, the final work product of operator field guides for mechanical and pond treatment facilities, case studies of participating facilities, and additional findings, can all be found here, at the [Minnesota Technical Assistance Program's wastewater webpages](#).

Project Completed: 06/30/2021

FINAL REPORT
