Final Abstract

Final Report Approved on January 9, 2026

M.L. 2021 Project Abstract

For the Period Ending June 30, 2025

Project Title: Trout Stream Habitat Restoration Success

Project Manager: Valerie Brady

Affiliation: U of MN - Duluth - NRRI

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Funding Source:

Fiscal Year:

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 04a

Appropriation Amount: $319,000

Amount Spent: $319,000

Amount Remaining: -

Sound bite of Project Outcomes and Results

Of six realigned stream segments, four mostly met restoration objectives. However, all had less stream shading leading to higher water temperatures for most. Two experienced significant flood damage. Excess erosion risk may increase on larger streams. Restored channels improved aquatic habitat and had fish and macroinvertebrates similar to unrestored channels.

Overall Project Outcome and Results

Restoration of trout streams is a high priority to improve fish habitat and fish assemblages. But such restorations can cost hundreds of thousands of dollars for restoration of only a few hundred yards of stream channel. For such a price, these restorations should be carefully evaluated for success, longevity, and resilience to floods.

We selected stream channels that received an intensive restoration called full-channel realignment, in which a new stream channel is created to fix a damaged section of stream. At least one year after restoration was completed, we compared restored stream channels to upstream channel segments that did not need restoration, evaluating fish, fish habitat, and aquatic macroinvertebrates that serve as fish food between the two types of stream channels (6 restored/unrestored pairs).

Four restored stream channels met most of their restoration objectives (stable channels, enhanced floodplain reconnection, and creation of fish habitat). However, all restored channels had less tree canopy cover and most had higher stream temperatures than the unrestored channels, emphasizing the significant time lag to meet objectives of reducing stream temperatures using native vegetation. Two restored channels experienced significant damage due to floods during our project period.

Restored channels had increased pool habitat and depths, more instream wood, and sometimes improved substrate for biota (more rocks with less fine sediments), but they also had more open tree canopies with reduced stream shading leading to higher stream temperatures as compared to unrestored channels. Connectivity with near-surface groundwater was similar in restored and unrestored channel reaches. Fish and aquatic macroinvertebrate assemblages were comparable between restored and unrestored stream segments, and fish communities were comparable to historic data from other Duluth-area streams. Successful restoration projects appear achievable, but the risks for failure may increase on larger streams; appropriate channel design and construction oversight are crucial.

Project Results Use and Dissemination

We have given 11 presentations on our project and results and there have been three masters' student theses resulting from this project. Several of our presentations were given directly to those at state agencies who work on stream restoration. Within a few months we plan to post our data and report to the University of Minnesota Data Repository so that it is accessible to stream restoration practitioners and others.

Environment and Natural Resources Trust Fund

M.L. 2021 Approved Final Report

General Information

Date: February 2, 2026

ID Number: 2021-050

Staff Lead: Mike Campana

Project Title: Trout Stream Habitat Restoration Success

Project Budget: $319,000

Project Manager Information

Name: Valerie Brady

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Project Reporting

Final Report Approved: January 9, 2026

Reporting Status: Project Completed

Date of Last Action: January 9, 2026

Project Completion: June 30, 2025

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 04a

Appropriation Language: $319,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute to evaluate the effectiveness and durability of previous trout stream habitat restoration projects to improve the success and cost effectiveness of future projects. This appropriation is available until June 30, 2025, by which time the project must be completed and final products delivered.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: Minnesota has spent millions on stream habitat improvement and restoration; we will evaluate effectiveness and durability of project designs. Results will inform success of future projects and improve cost effectiveness.

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Are stream habitat improvement projects actually effective for improving the ecology and habitat of Minnesota's streams? Do the current methods used for stream improvements result in permanent solutions that can persist through increasingly challenging weather conditions?

As of December 2018 at least $19 million dollars has been spent by the Lessard-Sams Outdoor Heritage Fund alone to improve trout stream habitat or restore stream reaches in poor condition. These stream habitat projects have been implemented using a variety of engineering methods and designs. However, very few stream restorations or habitat improvements are evaluated rigorously or quantitatively. For example, in addition to achieving design goals (e.g., stop bank erosion), a successful restoration should both improve the physical structure (habitat) and result in healthier biological communities, (i.e., fish and fish food). Anglers, in particular, are not sure if habitat restorations actually provide the right kind and amount of habitat for fish and other aquatic organisms. There is also the continuing concern that some restorations cannot withstand flood events and need repair after just a few years. We will address the questions: How successful are different improvement designs? How well do different improvement projects withstand large storm events?

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

Sufficient numbers of habitat improvements and restorations have now been conducted across Minnesota to assess their long-term status and determine if projects resulted in appropriate and lasting improvements to these streams. We will select 5-7 realigned stream sites in the Arrowhead region of Minnesota (paired with 5-7 control [reference] sites) to assess outcomes and longevity of these projects. Our team has pre-restoration data for some stream reaches where this type of work has been completed. Having quantitative pre-restoration data will allow the “gold standard” assessment to be done: Before-After, Control-Impact (BACI) analysis. This statistical technique uses pre-restoration and post-restoration data at both control (reference) and restoration sites to assess how well restoration projects succeeded in improving fish habitat and restoring stream ecosystem function. Analysis will include how the permitting process influenced the restoration design.

We will leverage this activity with work by Dr. Doug Dieterman (MNDNR) to assess stream restoration projects in southeast Minnesota. We will align our study designs and share data for a broader analysis of which engineering and construction designs work best and how to improve this work in the future.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state’s natural resources?

This project will greatly improve our understanding of the effectiveness and durability of stream realignment project designs; specifically, which hold up better over time, require less repair, result in increased fish habitat and food resources, and better restore stream ecosystem function, including connectivity with shallow groundwater. Fisheries managers, restoration practitioners, and funding and permitting agencies will have more information available to evaluate design success and cost-effectiveness. In the long term, our results will inform the development of better and more reliable stream realignment projects.

Project Location

What is the best scale for describing where your work will take place?

Region(s): NE

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Characterize fish populations, food resources and habitat at realigned and reference sites to quantify results of stream realignment projects

Activity Budget: $136,178

Activity Description:
Five to seven stream channel realignment sites will be selected to represent: 1) different realignment designs, and 2) time since activity was completed. An equivalent number of reference sites will be compared to completed project sites to assess outcomes of restoration activities. Each reach will be characterized with respect to: 1) fish populations, 2) stream macroinvertebrates (fish food), and 3) habitat structure with the goal of assessing the extent of improvement. We will assess fish populations with catch-and-release electrofishing. We will collect macroinvertebrate samples throughout the stream for identification in the laboratory. We will assess stream habitat following protocols and metrics used by MN and WI DNRs.

We will analyze data using the rigorous Before-After, Control-Impact (BACI) method in reaches where pre-restoration data exists for a realigned site and its paired reference site. We will compare other realigned sites to their matched reference sites for post-restoration data only and assess statistically.

Outcome 1: Paired data from each realigned site and its reference site for fish, fish food and habitat.
Outcome 2: Determination of effectiveness and durability of stream realignment designs for fish, fish food and habitat.

Activity Milestones:

Description	Approximate Completion Date
1. Five to seven stream realignment projects selected for study, paired with reference sites.	August 31, 2021
2. Fish, macroinvertebrate, and habitat data collected for 5-7 paired realigned and reference sites (10-14)	September 30, 2024
4. Data from #1 compared between realigned and reference sites without pre-restoration data using ordinations	April 30, 2025
3. Data from #1 compared between realigned and reference sites with pre-restoration data using BACI.	April 30, 2025

Activity 2: Assess stream realignment project status and longevity; assess stream ecosystem function relative to reference reaches

Activity Budget: $160,154

Activity Description:
Task 1. At 5-7 stream habitat improvement or restoration sites, assess each project's effectiveness at meeting its objectives and assess its longevity.
Methods: At each site we will assess whether the project's objectives were well-defined and quantifiable. We will compare current stream conditions with surveys done at each project's completion to determine how much change (erosion, deposition, or lateral migration) has occurred. We will also assess vegetation growth and bank stability.
Outcome: Assessment of how well each project met its own objectives, survived, and the characteristics that caused projects to fare better or worse.

Task 2. At four realigned sites, assess stream ecosystem function compared to matched reference (control) sites.
Methods: We will quantify ecosystem function by measuring 1) the connectivity between stream surface water and groundwater using a unique water tracer test; and 2) nutrient uptake by in-stream biota.

Outcome 1: Comparison between realigned and control stream reaches to assess if there are significant differences in ecosystem health.
Outcome 2: Determination of which types of work alter any of these three major components of stream ecosystem function.

Activity Milestones:

Description	Approximate Completion Date
1. Stream ecosystem measurements made in 5-7 paired restoration and reference sites (10-14 sites total).	September 30, 2024
2. Water quality and nutrient cycling analyses completed at 6 sites, including 2 before-after..	February 28, 2025
3. Data compared between realigned and reference sites.	April 30, 2025

Activity 3: Outreach and knowledge/technology transfer

Activity Budget: $22,668

Activity Description:
Task 1. Derive summary of efficiency and longevity by realignment design.
Task 2. Provide results of stream realignment assessments to those involved in stream restoration work or permitting.

Methods: We will provide project results to MNDNR fisheries managers, stream managers, MPCA staff, soil and water conservation district staff, Board of Water and Soil Resources staff, and non-profit staff using webinars, outreach at state meetings (e.g., the Water Resources Conference), reports and other venues or media.We know that much of this stream work is being done by soil and water conservation districts and angler enthusiast groups, with oversight and permitting through MNDNR and MPCA. Thus, we believe it is important to target these groups with our findings to ensure that the lessons learned about previous stream work are used to improve future activities.

Outcome 1. Ensure entities engaged in stream realignment, or in the permitting of those activities, are engaged in a discussion about the results of our assessment and their implications.
Outcome 2. Our results can be used to improve future stream realignment projects.

Activity Milestones:

Description	Approximate Completion Date
Results presented at a state conference, such as the Water Resources Conference.	November 30, 2024
Results presented to staff of entities engaged in stream realignment or restoration.	June 30, 2025
Discussions with entities engaged in stream work to improve future restoration or realignment designs	June 30, 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Doug Dieterman	Minnesota Department of Natural Resources	Dr. Dieterman has proposed a companion project in southeastern MN. He will train our project team to collect stream data comparable to his team's data.	No
Dr. Karl Koller	Minnesota Department of Natural Resources	Dr. Karl Koller will assist with site selection and consult with the team on stream hydrologic and hydrogeomorphic assessment methods.	No
Dr. Ricardo Gonzalez-Pinzon	University of New Mexico	Dr. Gonzalez-Pinzon developed a tracer test that measures surface water-groundwater exchange within a stream bed. He will travel to Minnesota to teach our team his technique and assist with data analysis and report writing.	Yes
Ann Thompson	South St. Louis Soil and Water Conservation District	Ann Thompson will provide geomorphic surveys of reference reaches that are paired to realigned reaches that SSL SWCD is re-surveying in 2020 to assess how well they have survived. Surveys include Rosgen Level II including longitudinal profile, cross section, and substrate data.	Yes
Dr. Jeff Tillma	Minnesota Department of Natural Resources	Dr. Tillma will assist with selection of realigned sites to be assessed and consult on field methods.	No

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
Data will be shared with the MNDNR Fisheries Research Division through Dr. Doug Dieterman, a collaborator on this project who does similar work in southeastern Minnesota. Data will also be provided to MPCA and SWCD's upon request or if we become aware of agency personnel interested in our dataset. The South St. Louis SWCD is a collaborator on this project.
We will provide project results to MNDNR fisheries managers, stream managers, MPCA staff, soil and water conservation district staff, Board of Water and Soil Resources staff, and non-profit staff using webinars, outreach at state conferences (e.g., the Water Resources Conference), reports and other venues or media. We know that much of the stream realignment work is being done by soil and water conservation districts with oversight and permitting through MNDNR and MPCA. Thus, we believe it is important to target these groups with our findings to ensure that the lessons learned about previous stream work are used to improve future activities. Because this outreach is so important, we have made it one of our activities, Activity 3, with formal outcomes and milestones.

All presentations, seminars, outreach meetings, etc., will acknowledge ENTRF funding using the logos and wording provided by LCCMR staff.
Data will be preserved through the University of Minnesota's Data Repository system (DRUM), a library system designed to archive data from UM researchers and projects.

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?
We will provide our data, analyses, and reports to Dr. Doug Dieterman (MNDNR) to be combined with the results from

his partner project in southeastern MN. He will continue working with DNR fisheries researchers and managers to implement these results in stream project selection and permitting so that future designs selected for stream habitat improvement and restoration projects are those that are most likely to provide the best outcomes for stream fish and ecosystems. It is our hope that these results will also inform future Lessard-Sams Outdoor Heritage project funding.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
MAISRC Subproject 15: Determining Highest Risk Vectors of Spiny WaterFlea Spread	M.L. 2017, Chp. 96, Sec. 2, Subd. 06a	$0

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
Crew chief Josh Dumke		Leads fish, invertebrate and habitat sampling; assist with reporting and data analysis. NRRI research staff (not teaching faculty) receive minimal salary support from UMD; they are largely paid on grant monies and their effort on this project will be paid from ENTRF.			26.7%	0.39		$32,138	-	-
Principle Investigator Valerie Brady		Overall project management and coordination; invertebrate data analysis; lead reporting and outreach. NRRI research staff (not teaching faculty) receive minimal salary support from UMD; they are largely paid on grant monies and their effort on this project will be paid from ENTRF.			26.7%	0.15		$19,400	-	-
Undergraduate student technician		The undergraduate summer technician will assist with all field sampling, particularly assisting the graduate student.			0%	0.7		$21,309	-	-
Co-investigators (Lucinda Johnson & Karen Gran)		Lead nutrient cycling and hydrology/geology aspects of project; co-advise graduate student			26.7%	0.12		$23,311	-	-
Graduate student		Conduct nutrient cycling and surface water- groundwater connectivity studies			43.7%	1		$63,028	-	-
Summer technician		Summer technician will assist with all field sampling, especially assisting the graduate student			7.3%	0.7		$24,657	-	-
Taxonomists (2) and technician (1)		Fish and invertebrate identification and sampling; data entry and checking. NRRI research staff (not teaching faculty) receive minimal salary support from UMD; they are largely paid on			24.1%	1.23		$75,974	-	-

		grant monies and their effort on this project will be paid from ENTRF.								
							Sub Total	**$259,817**	**$259,817**	**-**
Contracts and Services										
UMD NRRI Analytical Lab	Internal services or fees (uncommon)	Water quality analyses for multiple (basic) water chemistry parameters for up to 16 sites, and in-depth nutrient analyses for up to 16 sites (4 streams, 2 reaches each plus 2 streams, 2 reaches each before and after restoration).				0.16		$16,708	$16,708	-
South St. Louis Soil and Water Conservation District	Subaward	Team will provide geomorphic surveys of reference reaches that are paired to realigned reaches that SSL SWCD is re-surveying in 2020 to assess how well they have survived. Surveys include Rosgen Level II including longitudinal profile, cross section, and substrate data.				0.12		$14,080	$14,080	-
University of New Mexico	Subaward	This collaborator developed a tracer test that can be used to measure surface water-groundwater exchange within a stream bed. He will travel to Minnesota to teach our team his technique and assist with data analysis and report writing.		X		0.05		$9,275	$9,275	-
							Sub Total	**$40,063**	**$40,063**	**-**
Equipment, Tools, and Supplies										
	Tools and Supplies	Fish and invertebrate sampling and lab supplies	Batteries for electrofishing equipment; preservative, vials, and labels for 200 stream invertebrate samples. Survey equipment (meter sticks, flagging, survey tape).					$1,840	$1,840	-
	Tools and Supplies	Stream nutrient and hydrology sampling meters and field and lab supplies	Eight temperature loggers ($160). Test chemicals,					$7,426	$7,426	-

			filters and sample bottles ($6146).							
	Tools and Supplies	General field supplies	Waders and nonskid boot studs for 3 people, waterproof paper & labels, gloves, batteries for GPS units and cameras					$805	$805	-
							Sub Total	**$10,071**	**$10,071**	**-**
Capital Expenditures										
							Sub Total	**-**	**-**	**-**
Acquisitions and Stewardship										
							Sub Total	**-**	**-**	**-**
Travel In Minnesota										
	Miles/ Meals/ Lodging	Mileage to travel to 14 sites over three years with each site requiring several days for two field crews to sample it completely.	Travel to stream sites 123 miles/site x 0.67/mile x 14 sites x 8 visits/site					$7,970	$7,970	-
							Sub Total	**$7,970**	**$7,970**	**-**
Travel Outside Minnesota										
	Conference Registration Miles/ Meals/ Lodging	One person present results at stream restoration conference in Iowa. Registration $400, lodging $110x 4 d = $440, per diem $68 * 5 d = $340, mileage 700 miles @ $0.67 = $469	Attend stream restoration conference to present results to restoration practitioners and agency personnel.	X				$1,079	$1,079	-
							Sub Total	**$1,079**	**$1,079**	**-**
Printing and Publication										
							Sub Total	**-**	**-**	**-**
Other Expenses										

							Sub Total	**-**	**-**	**-**
							Grand Total	**$319,000**	**$319,000**	**-**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Contracts and Services - University of New Mexico	Subaward	This collaborator developed a tracer test that can be used to measure surface water-groundwater exchange within a stream bed. He will travel to Minnesota to teach our team his technique and assist with data analysis and report writing.	This researcher developed this relatively new technique that we plan to use for our project. His expertise is not available in MN. He will travel to MN and train us so we can become the regional experts in this technique in MN and the Midwest/Great Lakes.
Travel Outside Minnesota	Conference Registration Miles/Meals/Lodging	One person present results at stream restoration conference in Iowa. Registration $400, lodging $110x 4 d = $440, per diem $68 * 5 d = $340, mileage 700 miles @ $0.67 = $469	Target conference moved from MN to Iowa for 2025 unexpectedly. This is conference most attended by stream restoration practitioners. Due to proximity to MN, MN agency folks expected to attend.

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount	$ Amount Spent	$ Amount Remaining
State						
In-Kind	MNDNR staff contributed effort.	MNDNR staff will work with us to select appropriate sites for assessment, provide in-field cross-training on sampling methods to ensure comparability of data collection between this project and the companion Dieterman MNDNR proposal, and integrate our data into their data for additional analysis. D. Dieterman ($9000) and J. Tillma ($6000) in effort match.	Potential	$15,000	-	$15,000
			State Sub Total	**$15,000**	**-**	**$15,000**
Non-State						
In-Kind	UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% modified total direct costs.	Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs)	Secured	$166,415	$166,415	-
			Non State Sub Total	**$166,415**	**$166,415**	**-**
			Funds Total	**$181,415**	**$166,415**	**$15,000**

Attachments

Required Attachments

Visual Component

File: 6ab439d3-30f.pdf

Alternate Text for Visual Component

Our graphic shows a time series of photos of a trout stream bank restoration, from pre-restoration to post-restoration with two outcomes: damage after flooding and successfully stabilized banks. We observed both in our study. The line drawing depicts our observations of control vs. restored reaches in the best case....

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
Minnesota DNR Letter of Support	c84bbe77-03a.pdf
Sponsored Projects Transmittal Letter	3516524d-d03.pdf
BradyResearchAddendum2021-050_revised	838506cc-519.docx
Background check form	081a8ea5-377.pdf
Snorkeling stream control reach for trout	347bf89b-224.jpe
Snorkeling stream treatment reach for trout	bb66df0d-653.jpe
Measuring bank slope in stream reach	c88498a6-9c0.jpe
Keene Creek Realigned Channel	1d147a69-b28.jpe
David Baldus M.S. Thesis	c25a1704-eb9.pdf
Bradly Evraets MS Thesis	99fb7587-418.docx
Final report	41a65d3f-cbd.pdf
Presentation on physical stream reach changes	341c9ee6-160.pdf
Presentation on biotic changes with stream restoration	e0af839b-688.pdf

Media Links

Title	Link
MPR Stream Restoration Effectiveness story	https://www.mprnews.org/story/2023/07/14/researchers-turn-streams-purple-to-help-measure-effectiveness-of-restoration
Resazurin, resorufin, and chloride concentrations for input in resazurin processing rate calculations.	https://hdl.handle.net/11299/269039
Ion chromatograph bromide concentration data from Mission Creek 2023	https://hdl.handle.net/11299/269040

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

We achieved our required 15% budget reduction ($56,000) and response to reviewer comments for statistical rigor by reducing the number of stream reach (site) pairs that we will sample from 10 to 5-7, including dropping one intensive-sampling reach pair (from 5 to 4 reaches).

This reduction in sampling effort allowed us to decrease our fieldwork travel, supplies, and water chemistry analyses. We reduced personnel costs by a small amount for most people, but achieved the largest part of the budget reduction by dropping 9 months of the graduate student salary from the budget. We will instead seek a teaching assistantship for the graduate student for two semesters instead of the student being paid for the whole two years on this project. Finally, Dr. Dieterman has offered to travel to Duluth to collaborate with our crew instead of us traveling to

southeastern Minnesota to his location. He will pay for this travel as part of his collaboration with this project.
We added to the narrative the clarification that we will assess how the permitting process may have influenced the type or way that studied restorations were done.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the UMN Policy on travel applies.

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Work Plan Amendments

Amendment ID	Request Type	Changes made on the following pages	Explanation & justification for Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Amendment Request	• Activities and Milestones • Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences • Budget - Non-ENRTF Funds Contributed	We planned to run nutrient uptake, metabolism, hyporheic exchange experiments on four streams (2 reaches each). We will still do hyporheic exchange on four streams (2 reaches each), and will add two additional streams (2 reaches each) for nutrient uptake and survey both before and after restoration. That doubles the nutrient uptake scope, which we can accommodate by dropping the stream metabolism measurements, which provide less information on recovery than do the nutrient uptake experiments.	June 23, 2022	Yes	June 24, 2022
2	Amendment Request	• Budget - Personnel • Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences	We underestimated how much it would cost to send multiple teams to all stream sites multiple times for all the sampling, and we overestimated the cost to process nutrient samples, so we moved money from NRRI services to fieldwork travel. We also did not anticipate the issues we are having with high chloride in streams interferring with these nutrient uptake analyses, and so are moving money from personnel into supplies to re-do 4 sites.	July 9, 2024	Yes	July 15, 2024
3	Amendment Request	• Budget - Travel and Conferences • Budget - Non-ENRTF Funds Contributed	We request permission to present our results at the Upper Midwest Stream Restoration Symposium, Feb. 2025, Dubuque, Iowa. This is the best one for our results because so many stream restoration practitioners attend. We expect many MN agency folks attending because it is reasonable driving distance. We will also present at the Water Resources Conference, fall 2025, but this is	December 2, 2024	Yes	December 3, 2024

			outside the project timeframe and fewer restoration practitioners attend. HIgher cost, so moving travel money.			
4	Amendment Request	• Budget • Other • Budget - Personnel • Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences • Budget - Non-ENRTF Funds Contributed	We request permission to move unspent funds from travel ($1,982 = $1,411 MN travel and $571 conference travel) and lab services ($483) to personnel (effort) who are working to complete aquatic invertebrate data entry and analysis and who will work on writing the final report. We are also correcting a $5 overspend in lab supplies.	May 19, 2025	Yes	May 23, 2025
5	Completion Date	Previous Completion Date: 06/30/2025 New Completion Date: 12/31/2025	LCCMR administrative workaround for final update.	May 23, 2025	Yes	May 23, 2025
6	Completion Date	Previous Completion Date: 12/31/2025 New Completion Date: 06/30/2025	LCCMR administrative workaround for final update.	May 23, 2025	Yes	May 23, 2025
7	Amendment Request	• Budget • Attachments • Budget - Personnel • Budget - Travel and Conferences • Budget - Non-ENRTF Funds Contributed	To match final spending we are requesting to move $153 from personnel effort to travel. This will cover a slight overage in fieldwork and site visit travel incurred this spring.	December 10, 2025	Yes	December 19, 2025

Status Update Reporting

Final Status Update August 14, 2025

Date Submitted: December 10, 2025

Date Approved: December 19, 2025

Overall Update

Treatment and control reaches (6 streams) were surveyed for fish, aquatic macroinvertebrates and habitat to compare treatment reaches with their paired control reach and against example geomorphic reference reaches. Four treatment reaches met most of their restoration objectives (stable channels, enhanced floodplain reconnection, and creation of fish habitat). However, all treatment reaches had less canopy cover and most had higher stream temperatures than control reaches, emphasizing the significant time lag to meet the objective of reducing stream temperatures using native vegetation. One reach did not meet its goals because most of the reach eroded in a flood. A second reach had significant erosion although most of the project remained intact.

Treatment reaches had more open canopy with reduced stream shading leading to higher stream temperatures, increased pool habitat and depths, more instream wood, and sometimes improved substrate for biota (more rocks with less fine sediments) compared to control reaches. Connectivity with near-surface groundwater was not decreased by restoration work. Fish and aquatic macroinvertebrate assemblages were comparable, and fish communities were comparable to historic date from other Duluth-area streams. Successful restoration projects appear achievable, but the risks for failure increase on larger streams; appropriate channel design and construction oversight are crucial.

Activity 1

We sampled paired treatment (restoration by channel realignment) and control stream reaches in 6 stream systems for fish, aquatic macroinvertebrates and their habitat. We could not acquire enough pre-restoration data to compare pre- and post-restoration fish or invertebrate assemblages. We were able to compare fish, aquatic invertebrates and their habitat between control and treatment (restored) reaches on each stream as intended and we were able to compare fish communities in these study reaches with historical fish data collected in similar streams around Duluth and the Lake Superior north shore. Overall, we found some habitat improvements in treatment reaches for aquatic biota. Treatment reaches had more pools and instream wood to serve as fish refuges and cover. Some treatment reaches had more rock, especially boulders, for fish cover and reduced fine sediments, which fill in rocky substrate used as invertebrate living space. Because of the construction activities, all treatment reaches had more open canopies, leading to higher stream temperatures in some treatment reaches. The higher stream temperatures were concerning for trout, but overall we found that fish and aquatic macroinvertebrate assemblages were comparable between treatment and control reaches in each stream. Fish communities were also comparable to historic data from Duluth streams.

(This activity marked as complete as of this status update)

Activity 2

In-stream habitat was compared between control and treatment reaches (4 streams) and against geomorphic reference reaches (6 streams). Erosion was measured via drone surveys and compared with lidar data. Most treatment reaches met most of their goals except reducing stream temperatures. When all reaches restored pre-2021 were compared (n=4), rates of channel geometry change were greater in treatment than control reaches and both were higher than reference reaches. Two streams in larger watersheds were damaged by flooding/erosion during the study. When the most heavily eroded site was removed, treatment reaches (n=3) were more stable than control reaches. Treatment reaches had reduced stream shading and warmer water than controls. Hyporheic exchange rates (connectivity to shallow subsurface water; 4 streams) were non-significantly greater in treatment than control reaches, indicating that construction activities did not adversely affect connectivity with groundwater. Due to interference from high chloride levels and beaver activity, only one stream was successfully sampled for nutrient processing rates. The tested treatment

reach responded rapidly to experimental nutrient additions, indicating a rapid biological response to the nutrients, slightly greater than that of the control reach. The ability to process nutrients efficiently is considered a key ecosystem function of streams.
(This activity marked as complete as of this status update)

Activity 3
We have given 11 presentations on our project and results thus far and there have been two masters' theses resulting from this work. Several of our presentations have been directly to those at state agencies who work on stream restoration. Within a few months we plan to post our data and report to the University of Minnesota Data Repository so that it is accessible to stream restoration practitioners and others.
(This activity marked as complete as of this status update)

Dissemination
Brady, V., R. Hell, H. Wellard Kelly, K. Pierce, P. Jeffry, J. Dumke, A. Ulselth. 2025. Comparing fish communities and stream habitat between full-channel realigned and less-disturbed stream reaches. Platform presentation at the Upper Midwest Stream Restoration Symposium, Dubuque, IA.

Brady, V., R. Hell, H. Wellard Kelly, K. Pierce, P. Jeffry, J. Dumke, A. Ulselth. 2025. Comparing fish communities, aquatic macroinvertebrate assemblages and stream habitat between full-channel realigned and less-disturbed stream reaches. Webinar presentation to Minnesota Department of Natural Resources stream restoration staff, June 2025.

Lange, D., Prindle, E., Gran, K.B., 2025. Evaluating post-restoration erosion and streambank stability under various vegetation and flow conditions. Poster presented at the Upper Midwest Stream Restoration Symposium, Dubuque, IA.

Brady, V., R. Hell, H. Wellard Kelly, K. Pierce, P. Jeffry, J. Dumke, A. Ulselth. 2025. Comparing fish, invertebrates and stream habitat between full-channel realigned and less-disturbed stream reaches. Platform presentation for the Minnesota Water Resources Conference, St. Paul, Minnesota, Oct. 2025.

Gran, K. D. Baldus, B. Evraets, D. Lange. 2025. Stream Restoration Assessment: Part 2. Invited presentation for the Minnesota Water Resources Conference, St. Paul, Minnesota, Oct. 2025.

Additional Status Update Reporting

Additional Status Update August 14, 2025

Date Submitted: May 19, 2025

Date Approved: May 23, 2025

Overall Update
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Activity 1
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Activity 2
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Activity 3
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Dissemination
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Status Update Reporting

Status Update June 1, 2025

Date Submitted: May 19, 2025

Date Approved: May 23, 2025

Overall Update
This status update is waived per guidance from LCCMR staff provided on May 16, 2025

Activity 1
This status update is waived per guidance from LCCMR staff provided on May 16, 2025

Activity 2
This status update is waived per guidance from LCCMR staff provided on May 16, 2025

Activity 3
This status update is waived per guidance from LCCMR staff provided on May 16, 2025

Dissemination
This status update is waived per guidance from LCCMR staff provided on May 16, 2025

Status Update Reporting

Status Update December 1, 2024

Date Submitted: November 27, 2024

Date Approved: December 3, 2024

Overall Update
We have sampled fish, aquatic macroinvertebrates (aka “fish food”), habitat, and geomorphology surveys for all stream sites. We also have high-resolution topographic data for 4 streams. One realignment reach that received significant damage this summer was reassessed to get a better estimate of the erosion. Finally, we reran nutrient uptake experiments at 2 streams due to salt interference with the previous runs. Data entry and QC are complete for most data. However, we are still processing and identifying the aquatic macroinvertebrates. Data analysis for all QC’d data will also commence this winter. For 2 streams we have both pre- and post-restoration data at both control and realigned reaches. However, we have had repeated interferences by beaver at one of the control reaches, complicating comparisons. We moved the control reach after the beavers built their first dam, only to this fall find that beavers had now built a dam in our alternate control reach (the original control reach was also still dammed). For the realigned reaches with only post-restoration data, we will be comparing these reaches to their control reaches sampled at the same time.

Activity 1
Data collection for this activity is complete for all sites. We have sampled fish, aquatic macroinvertebrates (aka “fish food”), and habitat and have completed data entry and QC for all but the aquatic macroinvertebrates. Aquatic macroinvertebrate samples are about 20% complete and we will be attempting to complete their processing and identification over the winter. Data analysis for fish populations and habitat will also commence this winter. For 2 streams we have both pre- and post-restoration data at both control and realigned reaches. However, we have had repeated interferences by beaver at one of the control reaches, complicating comparisons. We moved the control reach after the beavers built their first dam, only to this fall find that beavers had now built a dam in our alternate control reach (the original control reach was also still dammed). Having beavers in the Miller Hill area of Duluth is a neat thing, but in this instance is proving problematic. For the realigned reaches with only post-restoration data, we will be comparing these reaches to their control reaches sampled at the same time.

Activity 2
Dec. 2024: This summer we resurveyed all of the sites using NRSA PHAB survey methods to compare with similar surveys conducted in 2020-2022. This will enable us to compare habitat structure between control and treatment reaches while also comparing changes in habitat structure. These can be compared with similar analyses conducted by the SWCD for reference reaches over time. We also completed drone photogrammetry surveys for 4 streams, providing high-resolution topographic data. Because flows were so high in the spring and early summer, these surveys only capture the tops of banks and floodplains, so our erosion analyses will be limited to those areas. We will be comparing drone surveys with as-built or design survey data to track erosion. During summer 2024, the Mission Creek treatment site experienced significant erosion, so we reflew that survey in October to measure more detailed erosion from this event. We will soon complete all of the habitat survey comparisons. The drone change detection analyses will be completed in the spring. In addition, we reran nutrient uptake experiments at 2 streams due to salt interference with the previous runs. However, we again had challenges due to very low flows this fall (drought) and beaver dams in one

Activity 3
No work on this activity during this reporting period.

Dissemination

We have not done any outreach during this reporting period. However, we will be giving a couple of presentations this winter at a major stream restoration conference (please see amendment request).

Note that the presentation to MPCA back in March was a training webinar about how to test hyporheic connectivity (connectivity between stream water and near-surface groundwater beneath the stream bed).

Status Update Reporting

Status Update June 1, 2024

Date Submitted: May 31, 2024

Date Approved: July 15, 2024

Overall Update
We are making good progress twoard completion of this project. Nutrient uptake measurements have been completed at 4 sites, as have assessments of surface water connectivity with the hyporrheic zone. We have completed fish, fish habitat, and aquatic invertebrate sampling at three streams and will complete another three streams this summer (one was done last year but the data are suspect due to the drought followed by a flood). Stream invertebrate sample processing is well underway and will continue into the fall. Geomorphic assessments of stream realignments are currently underway at all 6 stream restoration locations. Comparisons will be made between current stream channel morphology and the design plans as well as as-built surveys for the realigned reaches, and will include comparisons to reference reaches. We gave one presentation in the past 6 months to Minnesota Pollution Control Agency staff.

Activity 1
We have completed data collection at most sites and are this summer finishing data collection for the sites that had most recently undergone restoration and, thus, needed us to wait as long as possible to sample them so that they could have a recovery period. But these two stream restorations are the only ones at which we were able to collect pre-restoration data. We have already deployed temperature loggers at these sites and will be sampling them for fish, fish habitat, and aquatic invertebrates later this summer. We will also re-collect data at one stream that was badly affected by last year's drought and then flood to have data more representative of this stream's true conditions. We are partially through with the invertebrate samples already collected and are training more people to work on these samples to ensure we get them all done in time.

Activity 2
Over the past six months, we developed R code to analyze all of the long profile (stream channel geomorphology) and habitat survey data collected in 2021 and 2022 for comparisons with reference reach data analyzed by the South St. Louis Soil and Water Conservation Distrcit. The SWCD has data collected at two points in time for reference reaches (design reference reaches) and they are analyzing differences in metrics such as pool-riffle spacing and grain size distributions. We will be collecting long profile and cross-section data at all sites again in 2024 to compare with 2021 and 2022 data to assess changes over that time period to compare with changes measured at the SWCD reference reaches. In summer 2024 we will also be collecting detailed topographic data via drone photogrammetry to quantify erosion in treatment reaches between as-built or design surveys and 2024. The drone data will be analyzed using Structure-from-Motion techniques to turn photos into topography. We have already completed stream surface water - stream hyporrheic zone water connectivity tests and nutrient uptake tests at sites.

Activity 3
In the past 6 months we have given one presentation:
Assessing stream realignment success. Given to the Minnesota Pollution Control Agency staff on March 14, 2024 by Valerie Brady, Brad Evraets, and Karen Gran. Several dozen MPCA staffers attended this virtual presentation.

Dissemination
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Assessing stream realignment success. Given to the Minnesota Pollution Control Agency staff on March 14, 2024 by Valerie Brady, Brad Evraets, and Karen Gran. Several dozen MPCA staffers attended this virtual presentation.

Status Update Reporting

Status Update December 1, 2023

Date Submitted: December 1, 2023

Date Approved: January 30, 2024

Overall Update

We sampled paired restored and control reaches in two streams (7 stream reaches total) for fish, aquatic invertebrates and habitat during summer 2023. In addition, temperature loggers were placed in both restored and control reaches for five streams for the entire summer. Challenges this summer included a very late spring record amounts of snow which then transitioned to a drought. When the drought broke, high rainfall events took the streams into flood stage. We completed compilation of habitat data collected thus far. Graduate student David Baldus completed his M.S. thesis combining the nutrient uptake data from one stream's restored and control reaches with their habitat data to better understand stream function. For the tracer work investigating hyporheic connectivity, all data have been analyzed and are being written up by graduate student Bradly Evraets. Our collaborators, South St. Louis Soil and Water Conservation District, re-surveyed four stream sites that were used as references for stream channel realignment designs to better understand natural changes to stream channels. One thesis and thesis defense presentation were given. Team members gave two other public presentations and a number of media outlets ran stories on our stream dye experiments.

Activity 1

We sampled paired restored and control reaches in two streams (7 stream reaches total) for fish, aquatic invertebrates and habitat during summer of 2023. Fish sampling included electrofishing (August – early September) and snorkel surveys (July and October). Macroinvertebrates were quantitatively and qualitatively sampled, and fish/invertebrate habitat data were collected. In addition, temperature loggers were placed in both restored and control reaches for five streams for the entire summer. Challenges this summer included a very late spring with lots of snow which then led straight into a fairly severe drought. Nearly as soon as the drought broke, high rainfall events took the streams into flood stage. We may have to resample one stream for invertebrates next summer because of the combined impact of drought and flooding, which did not allow us to collect invertebrate samples under "average" conditions.

Activity 2

We completed compilation of habitat data collected from our study streams and archived this in the University of Minnesota Data Repository (DRUM): Baldus, David, B; Gran, Karen, B. (2023). Northshore Stream Restoration Assessment Physical Habitat Survey Data. Retrieved from the Data Repository for the University of Minnesota, https://doi.org/10.13020/s4db-yk39. Graduate student David Baldus completed his M.S. thesis combining the nutrient uptake data from one stream's restored and control reaches with their habitat data to better understand stream function. For the tracer work investigating hyporheic connectivity, all data have been analyzed and are being written up by graduate student Bradly Evraets. One major challenge was that we experienced interference with our conservative tracer, chloride, in some stream reaches. Using supplemental funding, we tested the conservative tracer bromide as an alternative. This test was successful and showed that bromide makes a better conservative tracer. South St. Louis Soil and Water Conservation District re-surveyed four stream sites that were used as references for stream channel realignment designs to better understand natural changes to stream channels. This will allow us to better assess changes as we compare realignment project completion surveys with our surveys.

Activity 3

Activity 3 has not yet been started.

Dissemination

- Baldus, David, B; Gran, Karen, B. (2023). Northshore Stream Restoration Assessment Physical Habitat Survey

Data. Retrieved from the Data Repository for the University of Minnesota, https://doi.org/10.13020/s4db-yk39.

- Baldus, David B., 2023, Exploring the impact of stream restoration on ecosystem function through changes in nutrient spiraling. M.S. Thesis: University of Minnesota, 59 p.
- Karen Gran gave a presentation to Interfluve in July 2023 that included research on this project. The talk was entitled “Stream management-related research in UMD Earth & Environmental Sciences”. There were approximately 20 people in attendance.
- David Baldus gave a public talk for his M.S. thesis defense in August 2023. The title of the presentation was “Exploring the impact of stream restoration on ecosystem function through changes in nutrient spiraling”. There were approximately 25 people in attendance.
- Valerie Brady and Bradly Evraets gave a presentation at an MPCA water quality volunteer monitoring event Sept. 21, 2023, in Duluth, MN. Talk title was “Assessing Stream Realignment Success”. There were approximately 40 people in attendance.

Status Update Reporting

Status Update June 1, 2023

Date Submitted: May 31, 2023

Date Approved: June 6, 2023

Overall Update
Winter work focused on data entry and cleanup, aquatic invertebrate sample processing, and data analysis of the dye tracer work. Dye tracer analyses investigated transient water storage in the stream bed, exchange of water between the surface stream water and the water in the stream bed (hyporheic zone), and the transit time of the water through the restored and control stream reaches. We had to shift to using an ion chromatograph to analyze concentrations of our conservative tracer (chloride) due to interferences between measuring chloride in water containing a dye. This change in methods led to some inconsistencies with the results at some of the sites. We overcame this issue by developing relationships between conductivity and chloride, and then used the conductivity data to analyze process metrics associated with surface water-groundwater exchange. Two presentations were given about our results to date.

Activity 1
During the winter off-season all fish and habitat data were entered into spreadsheets and stored and backed up in project computer folders, including in the Cloud to ensure that data are not lost. Invertebrate sample sorting commenced and has been completed for several reaches. One of our lab technicians took another job at the end of December, so we were short staffed until hiring a replacement in March. We expect sorting of invertebrate samples will proceed at a faster pace next fall. With the long winter and late spring this year, we do not anticipate starting stream sampling until late July or sometime in August.

Activity 2
Progress in the past six months focused on data analysis of dye tracer experiments. After the first summer, one new site (Chester Creek at Aspenwood) and one new control site (Miller Creek control) were added to the project. Field data collected from those sites in late fall were analyzed. In addition, all of the dye tracer experiments were analyzed to determine data on transient storage, hyporheic exchange, and transit time. We had to shift to using an ion chromatograph to analyze concentrations of our conservative tracer (chloride) and that led to some inconsistencies with the results at some of the sites. We developed relationships between conductivity and chloride and used the conductivity data to analyze process metrics associated with surface water-groundwater exchange. Those analyses are on-going and should be complete by the end of summer 2023.
We began compiling as-built surveys and construction plans that will be used to compare with field surveys to quantify erosion, deposition, and lateral migration. Field surveys will be conducted in summer 2024 and analyzed to measure change.

Activity 3
Two presentations were given at the Upper Midwest Stream Restoration Symposium in La Crosse, WI, in February 2023. This conference draws stream restoration professionals, agency staff, and academic researchers from across the region, including Minnesota. The conference in 2023 was attended by around 150 people.

Evraets, B., Baldus, D., Erickson, A., Gran, K., Swenson, J., Gonzalez-Pinzon, R., and Brady, V., 2023. Channel realignment impacts on flow and aerobic activity in the hyporheic zone. Poster presentation presented at the Upper Midwest Stream Restoration Symposium. Feb. 26-28, 2023, La Crosse, WI.

Baldus, D., Erickson, A., Jicha, T., Gran, K., Brady, V., Johnson, L., 2023. The impact of restoration projects on ecosystem

function through changes in nutrient spiraling dynamics. Poster presentation presented at the Upper Midwest Stream Restoration Symposium. Feb. 26-28, 2023, La Crosse, WI.

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Evraets, B., Baldus, D., Erickson, A., Gran, K., Swenson, J., Gonzalez-Pinzon, R., and Brady, V., 2023. Channel realignment impacts on flow and aerobic activity in the hyporheic zone. Poster presentation presented at the Upper Midwest Stream Restoration Symposium. Feb. 26-28, 2023, La Crosse, WI.

Baldus, D., Erickson, A., Jicha, T., Gran, K., Brady, V., Johnson, L., 2023. The impact of restoration projects on ecosystem function through changes in nutrient spiraling dynamics. Poster presentation presented at the Upper Midwest Stream Restoration Symposium. Feb. 26-28, 2023, La Crosse, WI.

Status Update Reporting

Status Update December 1, 2022

Date Submitted: November 30, 2022

Date Approved: December 8, 2022

Overall Update

Geophysical habitat and survey data have been collected and tracer studies conducted on paired reaches at six different restoration projects for a total of 13 reaches. Geophysical habitat surveys were conducted using EPA NRSA protocols, and additional BEHI data were collected to enable appraisals with the Minnesota Stream Quantification Tool. Tracer tests included nutrients paired with conservative tracers at all reaches to measure nutrient uptake, and a dye tracer (resazurin) paired with a conservative tracer at all reaches except one. Nutrient uptake experiments were conducted at 11 reaches. Six paired control and restoration reaches (3 streams) were sampled for fish, aquatic macroinvertebrates, and aquatic organisms habitat in summer 2022; counting the reaches sampled in 2021, 10 stream reaches (5 streams) have been sampled for these parameters. Fish sampling included both elctrofishing and snorkel surveys, and habitat surveys looked for fish cover, appropriateness of substrate for fish and aquatic invertebrates, and included temperature and dissolved oxygen measurements. Challenges included beavers taking over a control reach, requiring a new one to be established; a flood destroying an already restored restoration reach; and unexpected interference between our hyporrheic tracer chemicals and our nutrient analyses, requiring a switch in methods and rerunning samples.

Activity 1

Half of the streams with paired restored and control reaches were sampled for fish, aquatic invertebrates (aka "fish food") and aquatic organism habitat during the summer of 2022; this amounted to 6 reaches in 3 streams, one set of restored and control reaches in each stream. Fish sampling included both electrofishing (late August - early Sept) and snorkel surveys (July and October). Macroinvertebrates were sampled quantitatively and qualitatively (all habitats sample). Habitat measures included basic water quality (temperature, dissolved oxygen) and habitat for fish and aquatic invertebrates, including substrate characterization and estimations of how much stream rocks were embedded by fine substrates of sand, silt, or clay. One stream needed both reaches resampled from last summer because the control reach became flooded out by a new beaver dam. A new control reach was selected and both control and treatment reaches were re-sampled for most metrics. Unfortunately, restoration work began on the treatment reach before fish could be re-sampled, but we have the fish sampling data for this reach from late summer 2021. A final challenge is that the snorkeling for trout in the late fall can get quite cold for the crew and care must be taken to prevent hypothermia.

Activity 2

Geophysical habitat and survey data have been collected and tracer studies conducted on paired reaches at six different restoration projects for a total of 13 reaches. Geophysical habitat surveys were conducted using EPA NRSA protocols, and additional BEHI data were collected to enable appraisals with the Minnesota Stream Quantification Tool. Tracer tests included nutrients paired with conservative tracers at all sites to measure nutrient uptake, and a dye tracer (resazurin) paired with a conservative tracer at all reaches except one. Nutrient uptake experiments were conducted at four reaches in 2021 and redone at one reach in 2022 due to problems encountered with the conservative tracer. In 2022, we added 3 streams (7 reaches). In June 2022, Dr. Gonzalez-Pinzon from the University of New Mexico visited to train local researchers on using resazurin as a tracer of hyporheic flow. Challenges encountered: 1) The conservative tracer data from 2021 did not work due to drought conditions. 2) One of the reaches sampled in 2021 experienced a large flood in spring 2022 that destroyed the entire already restored restoration reach. 3) Finally, our methods for nutrient analyses were confounded by the resazurin tracers, necessitating a shift in methods and added expense.

Activity 3

Not yet started.

Dissemination

Students have given two presentations at national or regional meetings about the project:

Baldus, D., Erickson, A., Gran, K., Brady, V. Jicha, T., and Johnson, L., 2022. The impact of stream restoration projects on ecosystem function through changes in nutrient spiraling dynamics. North-Central Section meeting of the Geological Society of America. Cincinnati, OH.

Evraets, B., Baldus, D., Erickson, A., Gran, K., Swenson, J., Gonzalez-Pinzon, R., and Brady, V., 2022. Channel realignment impacts on flow and aerobic activity in the hyporheic zone. Geological Society of America Annual meeting, Denver, CO.

Nutrient uptake data collected for Sargent Creek in 2021 are available from the Data Repository for the University of Minnesota (DRUM):

Baldus, D., Gran, K.B., 2022. Sargent Creek nutrient injection breakthrough curve. Data Repository for the University of Minnesota, https://doi.org/10.13020/q5jh-n325.

Status Update Reporting

Status Update June 1, 2022

Date Submitted: June 23, 2022

Date Approved: June 24, 2022

Overall Update
We have selected 6 streams for study that had full channel realignments completed on them between 2017 and 2022. Control (reference) reaches have been established for 5 of these streams to serve as the comparison. Two streams had "before" restoration sampling completed on both to-be-restored reaches and control reaches in late summer of 2021. Preliminary nutrient cycling measurements were made in two systems in late summer 2021 to capture pre-restoration data, but the drought and very low stream flows made these measurements challenging. We included our agency collaborators in the site selection discussions. We presented our project plan to various MNDNR staff via Zoom meetings.

Activity 1
We have selected 6 streams for study that had full channel realignments completed on them between 2017 and 2022. Site selection was the result of discussion among all collaborators, including MN DNR fisheries and stream ecosystem personnel and South St. Louis SWCD personnel. SSL SWCD was in charge of many of the stream restorations that will be evaluated. A graduate student scouted many of the streams under consideration during summer 2021 to provide pictures and "intel" to assist in the site selection. Control (reference) reaches have been established for 5 of these streams to serve as the comparison. Two streams had "before" restoration sampling completed on both to-be-restored reaches and control reaches in late summer of 2021.

Activity 2
We have decided to concentrate our ecosystem function assessments on nutrient cycling and hyporrheic (shallow groundwater) exchange. Nutrient cycling provides insights into transport and nutrient transformations, and also provides insights into the hydrodynamic properties of a stream. It involves both biotic and abiotic processes including uptake by organisms and mineralization. Nutrient cycling is an ecosystem process measurement that provides insights into both the health of biological processes as well as information about the physical structure of the stream and its hydrology. Preliminary nutrient cycling measurements were made in two systems in late summer 2021 to capture pre-restoration data, but the drought and very low stream flows made these measurements challenging.

Activity 3
Not yet started.

Dissemination
While we have no data to disseminate, we are including our agency collaborators in site selection discussions. We have also presented our project plan to various MNDNR staff via Zoom meetings.