Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-369

Proposal Title: Determining How Altered Streamflows Impair Fish and Macroinvertebrates

Project Manager Information

Name: Jeffrey Ziegeweid

Organization: US Geological Survey - Upper Midwest Water Science Center

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Project Basic Information

Project Summary: The project will expand existing flow-biology relations and use streamflow data and modeling to understand how streamflow alteration negatively impacts fish and macroinvertebrates in streams of varying size and class.

Funds Requested: $600,000

Proposed Project Completion: 2024-12-31

LCCMR Funding Category: Water Resources (B)

Project Location

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

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

When will the work impact occur?
   In the Future

Narrative

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

Altered hydrology is a primary stressor on aquatic life for more than 50 percent of the 1,500 biological impairments in Minnesota, but state agencies lack the tools needed to understand and quantify specifically how altered streamflows affect aquatic life. Development of these tools will guide the implementation of strategies to reduce streamflow-related impairments of fish and macroinvertebrates. Although a recent USGS/MPCA study developed streamflow-biology relations, streamflow data was limited to larger rivers, representing only three of the nine MPCA stream classes used to categorize biological communities. However, the problem is that most biological impairments occur in smaller watersheds and stream classes that were not represented by this data set. Additional investment in the DNR-PCA Cooperative Stream Gaging Network over the last 10 years provides an opportunity to develop flow-biology relations for many additional smaller rivers and streams with more than ten years of data now available. Furthermore, MPCA has developed major watershed models statewide, and these models can be used to generate estimated streamflow records for smaller streams lacking measured streamflow data. Additional streamgages and modeled streamflows present opportunities to expand previous research and develop flow-biology relations representing the range of watershed sizes and stream classes in Minnesota.

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

The proposed project will leverage recently completed collaborative research projects to relate streamflow alterations to changes in fish and macroinvertebrate biotic integrity in a way that (1) quantifies the impacts of altered hydrology on aquatic life, and (2) targets restoration activities that lessen streamflow alteration characteristics that negatively impact the health of aquatic life for nearly 1,500 biologically-impaired streams in Minnesota. This project will enhance current environmental flows science and help State agencies develop long-term, statewide strategies to manage water resources, stream fish communities, and stream macroinvertebrate communities. The accuracy of streamflows estimated using statewide MPCA large watershed models will be evaluated against measured streamflow data. Hydrologic alteration metrics will be computed from streamflow records for previously used USGS streamgages, the DNR-PCA Cooperative Stream Gaging Network, and MPCA model outputs. Innovative machine learning techniques based on current science will be used to develop new relations that describe how altered hydrology affects aquatic life. New relations will encompass all MPCA fish and macroinvertebrate stream classes and be integrated to address aquatic life impairment thresholds established by MPCA. Project results will benefit the MPCA, local government units, and other agencies responsible for protecting and restoring land, water, and habitat throughout Minnesota.

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?

Relations between altered hydrology, fish, and macroinvertebrates will help resource managers quantify the effects of hydrologic changes on aquatic life and develop implementation strategies to best manage critical streamflow components. Relations will help mitigate impacts of hydrologic modifications in urban and agricultural areas and better understand the effects of climate change on streams in Minnesota. Project results will help identify specific hydrologic causes of impairments and hydrologic characteristics that are important for sustaining high-quality and high-value ecological resources in Minnesota. Finally, results will help develop targeted management actions that increase the likelihood that restoration activities are successful for impaired streams.

Activities and Milestones

Activity 1: Evaluate accuracies of model-estimated streamflows against measured streamflows from USGS streamgages and the DNR-PCA Cooperative Stream Gaging Network.

Activity Budget: $250,000

Activity Description:

Stream fish and macroinvertebrate data collected during Index of Biotic Integrity surveys (> 300 sites) will be retrieved from the MPCA database, and then we will compile a list of biological sites that match up to one of the following: (1) a long-term USGS streamgage used in previous research, (2) a short-term or intermittent USGS streamgage, or (3) a short-term or intermittent MNDNR/MPCA streamgage. MPCA staff will generate modeled daily mean flows at the streamgage locations from existing HSPF models. USGS staff will evaluate the accuracy of modeled flows using available measured flow data and Nash-Sutcliffe Efficiency statistical analyses. In addition, modeled and measured hydrographs will be compared visually to look for large deviations during specific events. If modeled flows do not accurately represent measured flows at several sites, we will explore ways to recalibrate and optimize models for a subset of the sites to better match measured flows for computation of accurate hydrologic alteration metrics. The USGS will publish a ScienceBase Data Release of final streamflow records from 1996 through 2019 for use in Activity 2 and present a summary of provisional statistical comparisons of measured and modeled flow data at the Minnesota Water Resources Conference.

Activity Milestones:

Description	Completion Date
Compile biological sites sampled since 1996 paired with USGS and MNDNR streamgages throughout Minnesota	2021-03-31
Generate modeled flows using HSPF and statistically compare modeled flows to measured flows at streamgages	2022-10-31
Publish modeled streamflow records from HSPF in a publicly-available U.S. Geological Survey database.	2023-03-31

Activity 2: Use available flow data, biological samples, and machine learning to develop statewide statistical flow-biology relations for all MPCA stream classes.

Activity Budget: $350,000

Activity Description:

A combination of measured and modeled flow records from Activity 1 will be used to calculate hydrologic metrics with the EflowStats package in the R statistical environment. Paired flow-biology locations will be categorized based on MPCA stream class. However, other factors will also be examined, including watershed size, location, and channel condition. Machine learning techniques will be used to develop a set of equations that characterize flow-biology relations for each MPCA stream class across the range of watershed sizes statewide. Staff from USGS and MPCA will work together to ensure that final equations include specific indicators of altered hydrology that directly impact Index of Biotic Integrity scores, the primary indicator for assessing aquatic life impairment status. This will allow development of better tools for identifying cases where altered streamflow is causing impairment. Results will benefit several groups within MPCA, including the Environmental Outcomes and Analysis Division, the Stressor Identification group, and the HSPF modeling group. Stakeholder meetings will be used to engage resource managers from other agencies and expand utility of project results to planning of restoration and management activities. Project results will be published in a journal article or USGS report and presented at the Minnesota Water Resources Conference.

Activity Milestones:

Description	Completion Date
Use machine learning techniques to develop statewide flow-biology relations for all MPCA stream classes	2023-12-31
Present developed flow-biology relations to agency and university stakeholders.	2024-10-31
Submit final project report and a draft of a peer-reviewed publication to LCCMR	2024-12-31

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Pam Anderson	Minnesota Pollution Control Agency	Supervisor of MPCA Research Scientist involved in proposed project.	No
Chuck Regan	Minnesota Pollution Control Agency	Provide HSPF-modeled streamflow data for analyses used to develop project deliverables.	No
John Genet	Minnesota Pollution Control Agency	Serve as the primary MPCA contact to coordinate MPCA support of the work. Help link statistical approaches to MPCA researchers and Stressor Identification staff to ensure that project outcomes directly benefit MPCA monitoring programs.	No

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 be funded?

The tools developed in this project will allow the MPCA to better characterize how streamflow alteration negatively impacts fish and macroinvertebrates in streams. Project results will help local units of government identify and implement management activities that restore and protect the quality of streams in Minnesota. Results will be communicated through stakeholder meetings, conference presentations, and publications. Currently, no additional work is planned beyond the proposed activities, but internal MPCA and USGS funding sources would be examined first. Additional work would improve the tools by incorporating interactions between streamflow, land use change, water chemistry, connectivity, climate, and biology.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Using Hydroacoustics to Monitor Sediment in Minnesota Rivers	M.L. 2015, Chp. 76, Sec. 2, Subd. 04g	$455,000

Project Manager and Organization Qualifications

Project Manager Name: Jeffrey Ziegeweid

Job Title: Supervisory Hydrologist

Provide description of the project manager's qualifications to manage the proposed project.

Jeffrey Ziegeweid is a Supervisory Hydrologist in the Minnesota office of the U.S. Geological Survey Upper Midwest Water Science Center (USGS UMid WSC). He has a M.S. in Forestry and Natural Resources (Fisheries Emphasis) from the University of Georgia. Jeffrey also received his B.S. degree from the University of Wisconsin-La Crosse, with majors in Biology (Aquatic Science Concentration) and Chemistry and a minor in Mathematics. Currently, Jeffrey supervises the River and Coastal Processes Team in the USGS UMid WSC and is also a project chief for several interdisciplinary USGS studies that link physical and hydrologic changes to biological responses in Minnesota streams and rivers. Since 2008, Jeffrey has published 3 journal articles, 11 USGS reports, 2 USGS ScienceBase Data Releases, and 3 cooperator reports. Jeffrey recently completed a research study with MPCA that provided the foundation for the current project proposed

for funding through the LCCMR ENRTF. Study results included statistical flow-biology relations developed using measured streamflow data at paired long-term USGS streamgages and fish community sites sampled by MPCA as part of Index of Biotic Integrity (IBI) surveys. A ScienceBase Data Release has already been published for this work, and an additional Data Release and journal article are currently being prepared for peer review. Jeffrey also has previous experience managing a project funded by the LCCMR ENRTF; in April 2016 he took over a project that was originally awarded to Christopher Ellison of the USGS in 2015. The project was completed on time, within budget, and according to the approved LCCMR ENRTF work plan in December 2018. The project resulted in publication of USGS Scientific Investigations Report 2018-5165 and real-time sediment data on the web (https://nrtwq.usgs.gov/mn/). Results of the previous study were presented at the Minnesota Water Resources Conference.

Organization: US Geological Survey - Upper Midwest Water Science Center

Organization Description:
The USGS is a non-regulatory science agency that works as a partner with state agencies to collect and analyze a variety of water resource data. The USGS Upper Midwest Water Science Center (UMid WSC) includes offices in the States of Minnesota, Wisconsin, and Michigan. In addition to a robust streamgaging program, the UMid WSC has several Science Teams that focus on different scientific disciplines and include staff across the three States. However, all USGS project team members are based in the Minnesota office. The project team has extensive experience in development of flow-biology relations, has state-of-the-science expertise, and access to the most current science and technology related to environmental flow research from USGS scientists nationwide. The proposed project builds on a previous cooperative study between USGS and MPCA that developed flow-biology relations for large rivers with long-term USGS streamgages. The proposed project would also inform an idea for a larger program being developed by the USGS and the USEPA to work with State partners and develop nationwide ecological flow science programs and standards that meet both State and Federal needs, which makes the USGS uniquely positioned to carry out the work for this project.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineli gible	% Bene fits	# FTE	Class ified Staff?	$ Amount
Personnel								
USGS Supervisory Hydrologist		Project Manager and Lead Scientist			26%	1.54		$361,250
USGS Physical Scientist		Project Support: Developing Code and Conducting Statistical Analysis			19%	1.05		$131,250
USGS Budget Analyst		Project Administrative Support and Billing			18%	0.25		$41,250
USGS IT Specialist		Project IT Support/Maintain secure network, software upgrades, back up data			33%	0.25		$42,500
							Sub Total	**$576,250**
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
							Sub Total	-
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Conference Registration	In-state travel to cooperator meetings, state and local conferences	Discuss study plans and results to ensure direct applicability to resource management goals.					$11,250

	Miles/ Meals/ Lodging							
							Sub Total	$11,250
Travel Outside Minnesota								
-							Sub Total	-
Printing and Publication								
	Publication	USGS Science Base Data Release	Publish project data in a publicly available format					$4,000
	Publication	Journal article or USGS Report summarizing project results	Disseminate results to Minnesota stakeholders and larger scientific community					$6,000
	Publication	USGS Fact Sheet or Online Story Map	Summarize project results in plain language to better inform general public					$2,500
							Sub Total	$12,500
Other Expenses								
-							Sub Total	-
							Grand Total	$600,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	Clean Water Legacy Act (Minn. Stat. 114D.26, subd. 2)	Research Scientist support time to help with study design, describe biological data in study context, interpretation of results, and publication of deliverables. Modeler support time to generate and output streamflow records modeled using statewide MPCA HSPF models.	Secured	$50,000
			State Sub Total	**$50,000**
Non-State				
Cash	U.S. Geological Survey Cooperative Matching Funds	Federal match contributions to cover project indirect costs.	Pending	$200,000
			Non State Sub Total	**$200,000**
			Funds Total	**$250,000**

Attachments

Required Attachments
Visual Component
File: [ce70aa2d-325.pdf](ce70aa2d-325.pdf)

Alternate Text for Visual Component
The file is a map of Minnesota that includes points representing 59 paired streamgages and biological sites used in a previous study to develop streamflow-biology relations that describe the effects of altered hydrology on fish in large rivers of Minnesota. In addition, the map includes points representing hundreds of MPCA stream biological sampling sites throughout Minnesota that are not paired with long-term streamgages. This project will determine the accuracy of modeled flow data and develop streamflow-biology relations using modeled data to better understand the effects of altered hydrology on stream fish and macroinvertebrate communities at these hundreds of biological sites lacking streamgages.

Optional Attachments
Support Letter or Other

Title	File
Ziegeweid_MPCA_SupportLetter_20200429.pdf	[b869bb79-e88.pdf](b869bb79-e88.pdf)
Visual Component in case other upload did not work	[c29dae70-70d.pdf](c29dae70-70d.pdf)

Administrative Use

Does your project include restoration or acquisition of land rights?

 No

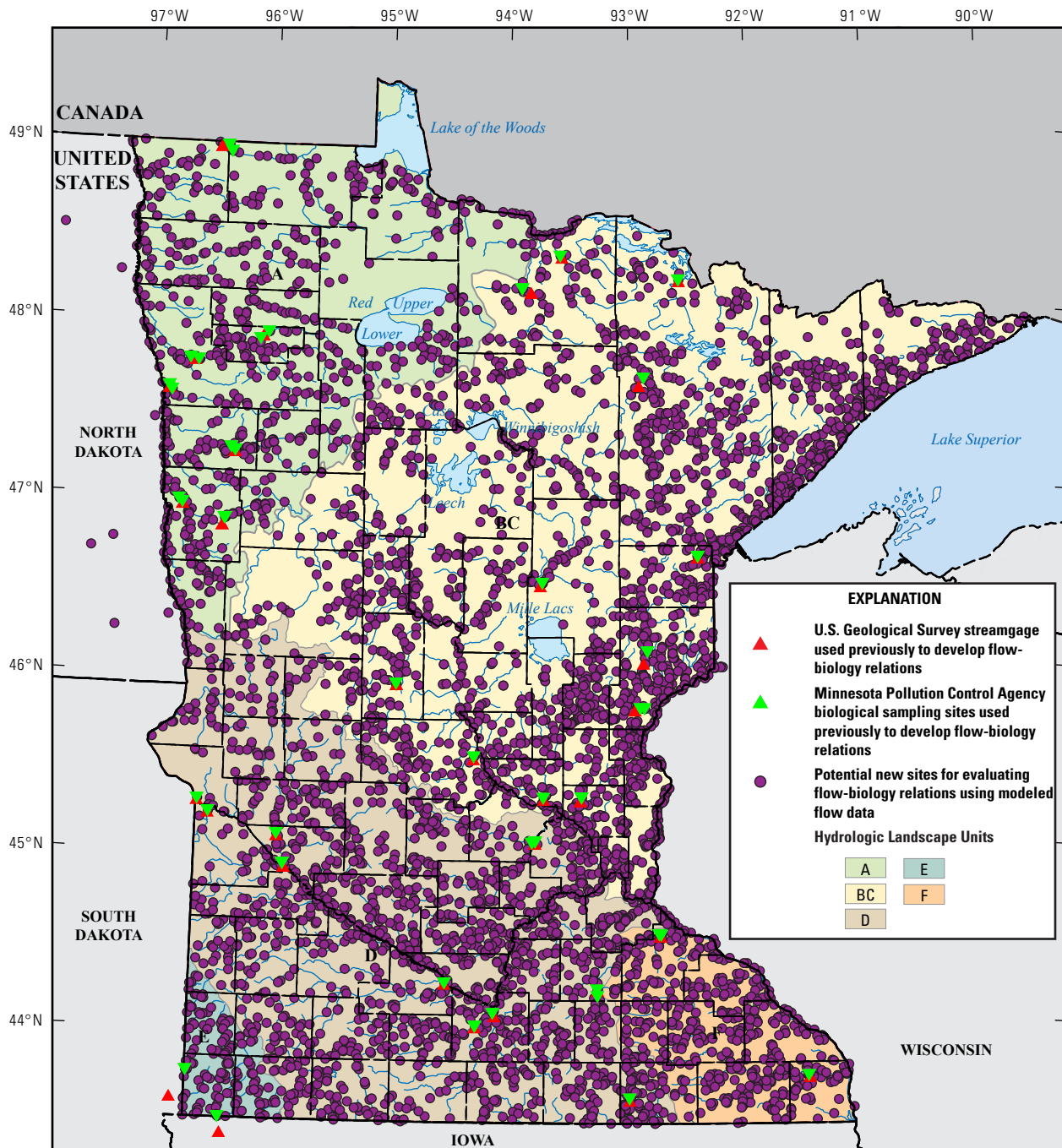**Does your project have patent, royalties, or revenue potential?**

 No

Does your project include research?

 Yes

Does the organization have a fiscal agent for this project?

 Yes

EXPLANATION

▲ U.S. Geological Survey streamgage used previously to develop flow-biology relations

▲ Minnesota Pollution Control Agency biological sampling sites used previously to develop flow-biology relations

● Potential new sites for evaluating flow-biology relations using modeled flow data

Hydrologic Landscape Units

A	E
BC	F
D	

Base map from Minnesota Department of Natiral Resources, 1:100,000, 2012
Universal Transverse Mercator projection, Zone 15
Horizontal coordinate information is referenced to the North American Datum 1983

0 20 40 80 MILES

0 30 60 120 KILOMETERS