Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)

Project Title: **ENRTF ID: 183-F**

Sediment Hazards to Trout in Southeast Minnesota Streams

Category: F. Methods to Protect or Restore Land, Water, and Habitat

Total Project Budget: $ 337,000

Proposed Project Time Period for the Funding Requested: 3 years, July 2018 to June 2021

Summary:

Excess sediment in southeast Minnesota streams can smother trout eggs. Large floods can crush them with gravel. We build knowledge to restore and improve trout populations, fishing, and habitat.

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Sponsoring Organization: U of MN

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Location

Region: Southeast

County Name: Dakota, Goodhue, Wabasha, Winona

City / Township:

Alternate Text for Visual:

Protecting trout habitat as streamflows and sediment inputs change: fine sediment deposition can smother trout embryos, while bed sediment scour can crush them.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%

Project Title: Sediment Hazards to Trout in Southeast Minnesota Streams

I. PROJECT STATEMENT

The **spring-fed rivers** of southeastern Minnesota weave through iconic blufflands and host **world-class trout fishing**. However, **excess sediment** in these rivers can **kill trout embryos** in eggs that trout lay among river bed gravels:

- **Fine sediments** smother the river bed, choking and killing the trout embryos
- **Coarse sediments**, if mobilized, will crush the eggs and kill the embryos

We will devise and deliver a plan to manage these sediments and the flows that move them. This will improve the productivity of the trout fishery and the tourism economy of southeastern Minnesota.

"Goldilocks" problem

- **Flows that are too low** cause fine sediments to deposit, killing the trout embryos
- **Flows that are too large** produce floods that mobilize the river bed gravels, crushing trout eggs

How do we ensure that these heavily-managed agricultural catchments remain **"just right" for trout**, in the face of **increasing large floods and legacy agricultural fine-sediment loads**?

Field sites

Our project will focus on the **Cannon River** and **Whitewater River**. The former is a popular destination close to the Twin Cities. The latter lies in the heart of Minnesota's trout fishery. In each catchment, we will sample and instrument the full scale of small to large streams to obtain the **broadest possible picture of sediment mobility** in southeastern Minnesota's waters.

Fine Sediment management

Fine sediments are largely the legacy of Euro-American settlement and poor agricultural practices in the Upper Mississippi valley that led to multiple feet of soil erosion and sediment pollution. Modern sediment loads are sourced from these legacy deposits and from modern agriculture. We will:

- **Fingerprint sources of fine sediment** that arrive in waters throughout the catchment, elucidating sediments coming from recent landscape erosion, channel banks and bluffs, and legacy in-stream sources
- **Calculate the flows and sediment inputs required** to prevent fine sediments from depositing on the bed
- **Develop management strategies** to reduce the fine sediment load, based on results of our fingerprinting analysis. Examples include adding vegetation for streambank stability, building in-river retention structures, and direct fine sediment removal.

Coarse Sediment management

Increasingly-frequent "mega-floods" in southeastern Minnesota rivers can scour streambed gravels. If these floods occur during late spring and early summer (spawning season), the gravels may crush trout eggs.

- **Find the magnitude and frequency of floods that move coarse sediments**, especially considering the increase in large floods across Minnesota – including the large Whitewater River flood in 2007 that fortunately missed the trout spawning season
- **Build plans for water storage on fields and hillslopes** (for example, through vegetation and landscape alterations) to reduce flood peaks (that can mobilize streambed gravels). This incidentally will maintain longer-term flow to rivers and streams after storms, aiding fine-sediment transport and removal.
- **Recommend trout refugia locations**, spaced along streams to sustain spawning populations. Designs can protect trout eggs with coarse sediments and have been successfully built by Trout Unlimited volunteers.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: ***Assess sediment sources and their potential impact on trout habitat*** **Budget: $144,000**

- Identify significant sources of fine sediment pollution that can suffocate trout eggs using a sediment fingerprinting approach
- Map grain size and scour hazard of fine sediment; this can crush trout eggs

Outcome	Completion Date
1. Fingerprint fine sediments to source areas; identify problematic "hot spots"	04/01/2020
2. Map grain size of riverbed gravels and its susceptibility to scour	11/01/2019
3. Data digitization and curation for distribution to the general public	06/01/2020

Activity 2: ***Establish a detailed history of flows and their impact on trout; make future projections that include streambed scour monitoring*** **Budget: $141,000**

- Analyze historical flooding data and assess the documented increase in "mega-floods" over recent decades
- Build and install stream gauges, bed scour monitoring stations, and turbidity meters to link floods to bed scour and/or fine-sediment deposition and trout egg kills

Outcome	Completion Date
1. Gauge and survey eight cross-sections in the Whitewater and Cannon Rivers for detailed sediment erosion and deposition measurements	11/01/2019
2. Assess the impact of high and low flows on sediment scour or deposition and impacts on trout population health	06/30/2021

Activity 3: Sediment management recommendations for healthy trout populations **Budget: $52,000**

- Trout refugia locations: zones of coarse sediments to promote successful spawning
- Fine and coarse sediment and river flow management strategies (listed above)

Outcome	Completion Date
1. Propose trout habitat improvements	06/30/2021
2. Publish results in open-access scientific journals and online for the general public	06/30/2021

III. PROJECT STRATEGY

A. Project Team/Partners

- **Project Team Manager and PI: Assistant Professor Andrew Wickert, Ph.D., University of Minnesota** (to be funded by the ENRTF; bringing support from funded turbidity sensor development)
  - Fluvial geomorphology, instrumentation development and deployment, coarse sediments
  - Brings instrumentation lab, low-cost field instrumentation design, and survey equipment
  - Will co-advise 1 Ph.D. student and 1 M.S. student with Prof. Karwan (to be funded by the ENRTF)
  - Will supervise Chad Sandell, instrumentation engineer (to be funded by the ENRTF)
- **Project Team co-I: Assistant Professor Diana Karwan, Ph.D., University of Minnesota** (to be funded by the ENRTF; bringing support from funded turbidity sensor development)
  - Fine sediment and sediment fingerprinting; river monitoring expert
  - Will co-advise 1 Ph.D. student and 1 M.S. student with Prof. Wickert (to be funded by the ENRTF)
  - Brings sediment lab and equipment to the project
- **Project Partner: Associate Professor Kyungsoo Yoo, Ph.D., University of Minnesota** (not funded)
  - Sediment fingerprinting to find fine sediment pollution sources
- **Project Partner: Jeff Hastings, Trout Unlimited** (not funded)
  - Advisor for implementation of scientific findings into trout habitat improvement

B. Project Impact and Long-Term Strategy

- Improve southeast Minnesota's trout fishery: **more trout, healthier trout**
- Develop generalizable **trout ecosystem management and improvement plans**
- Build low-cost long-term monitoring capacity on the Cannon and Whitewater Rivers

2018 Detailed Project Budget

Project Title: Sediment Hazards to Trout in Southeast Minnesota Streams

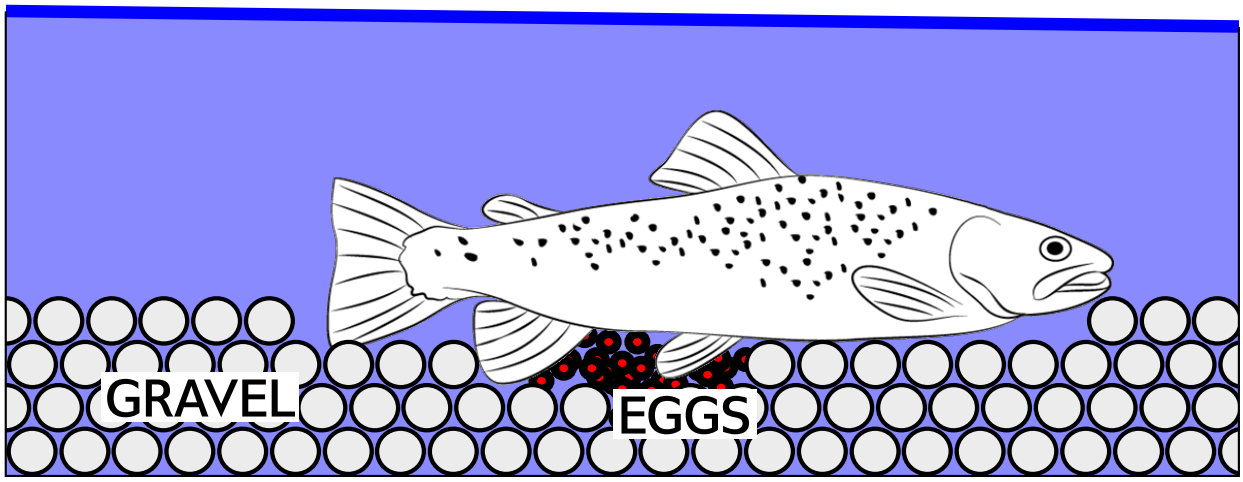
IV. TOTAL ENRTF REQUEST BUDGET: 3 years

BUDGET ITEM	AMOUNT
Personnel:	
Asst. Prof. Andrew Wickert: Team Manager and PI, geomorphology, coarse sediment, and instrumentation (75% salary, 25% fringe); 7.7% FTE for each of 3 years	$ 34,000
Asst. Prof. Diana Karwan: co-I: fine sediment, hydrology (75% salary, 25% fringe); 3.8% FTE for year 1 and 7.7% FTE for years 2 and 3	$ 31,000
Lab Eng. Mr. Chad Sandell, instrumentation development and deployment specialist (79% salary, 21% fringe); 7.8% FTE for year 1, 38% FTE for year 2	$ 38,000
1 PhD student: surveying, hydrology/geomorphology, data analysis (sediments, river flow); 50% FTE for each of 3 years (year 3 is reduced cost at UMN)	$ 122,000
1 MS student: land and sediment surveying, instrumentation; 50% FTE for 2 semesters and 2 summers	$ 52,000
2 Undergraduate research assistants: surveying, sediment grain size analyses, sample preparation, and field logistics at $10/hour	$ 10,000
Equipment/Tools/Supplies:	
Raw materials to build 8 stream gauging stations: 2x pressure transducers (water, atmosphere) @$100/each = $200/gauge, data loggers with telemetry and housings @$300/gauge, stilling well (PVC, screen, anchoring hardware) @$50/gauge, watertight cabling @$50/gauge	$ 4,800
Raw materials to build stream scour stations (measuring pressure under the sediments, which decreases if scour occurs): Anchors, cabling, and conduit @$150/station; 2 puncture-proof water bladders and fittings for pressure measurements @$175/each = $350/station; 2 pressure transducers @$100/each = $200/station; reuses data loggers from stream gauges ($0/station)	$ 5,600
Raw materials to build water turbidity sensors: Custom-machined marine-grade aluminum @$200/sensor; infrared LEDs @$100/sensor; photodetectors @100/sensor; optical-grade glass, fitting hardware, and epoxy @$100/sensor	$ 4,000
Travel:	
Mileage (~6,750 miles): Cannon River (150 miles) and Whitewater River (300 miles); 15 vehicle trips each over 3 years @$0.535/mile (federal rate also adopted by UMN)	$ 3,600
Food and Lodging ($50/person/night, much less than UMN standard per diem): 30 trips x 3 people on average per trip x 2 nights on average per trip x $50/person/night	$ 9,000
Additional Budget Items:	
Analyses of 200 suspended sediment samples @$100/sample in Karwan's lab at UMN so we can fingerprint their source areas and map their motion downstream: cost is for laboratory supplies (consumables)	$ 20,000
Page charges for two open-access scientific publications, proposed for the journals, "Earth Surface Dynamics" and "Hydrology and Earth Systems Science"	$ 3,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 337,000

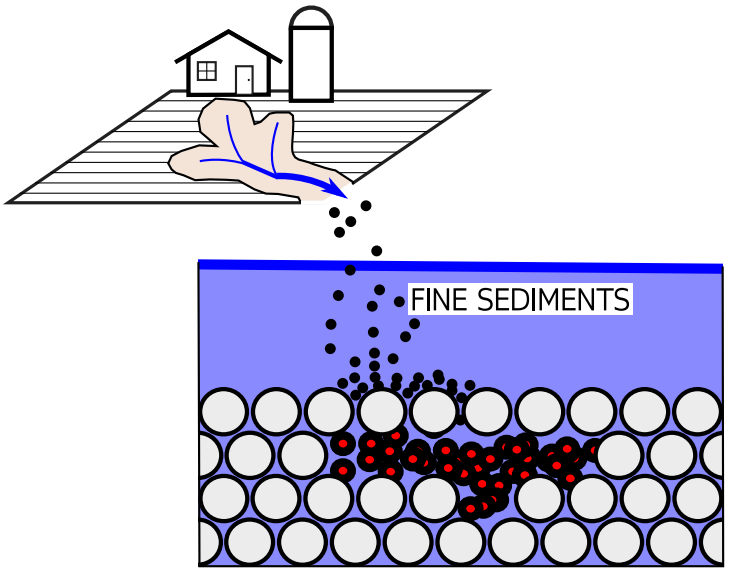
V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period	N/A	*N/A*
Other State $ To Be Applied To Project During Project Period	N/A	*N/A*
In-kind Services To Be Applied To Project During Project Period:		
UMN Indirect cost recovery (54%)	$ 181,440	Secured
Reduced per diem ($50/person/night instead of $140/person/night based on federal rates, times 180 person-nights; reduced costs due to camping and cooking for ourselves)	$ 16,200	Secured
Past and Current ENRTF Appropriation: *2017: Landslide hazards and impacts on*	$ 500,000	Pending
Other Funding History: *USGS WRC grant to develop improved turbidity sensor*	$ 55,889	Secured

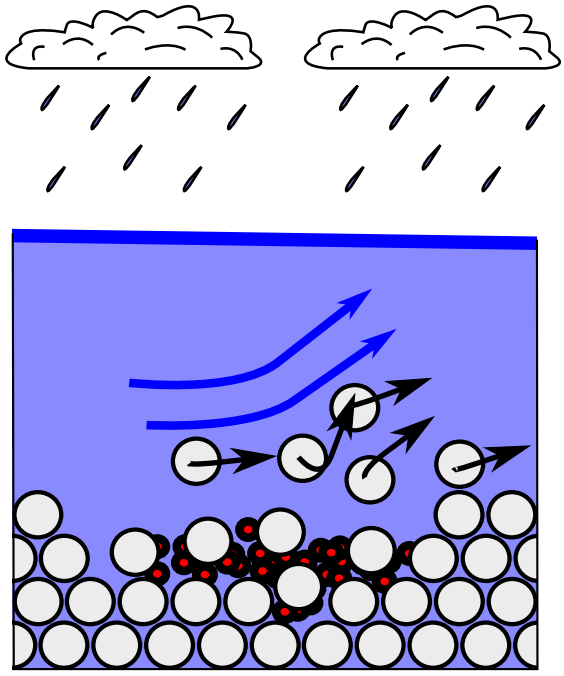
Trout lay eggs in river gravels



But the eggs are not always safe:



Fine sediments can cover trout eggs and suffocate them



Large floods can move river gravels and crush trout eggs

Andrew D. Wickert

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Professor Wickert is a **fluvial geomorphologist**, **glacial geologist**, and **instrumentation developer** who joined the Department of Earth Sciences and the Saint Anthony Falls Laboratory at the University of Minnesota in August 2015, following a postdoctoral research position in the Institute for Earth and Environmental Science at the Universität Potsdam in Germany. He is also a graduate advisor in the Water Resources Sciences program at the University of Minnesota. As a native of Minnesota who cares passionately for its lands, waters, and people, he is committed to understanding and improving the natural environment in his homeland and our interactions with it.

Wickert integrates the **effects of climate and land-use change on the Earth's surface**, and recently co-authored a review of the state of the science at this critical intersection. He has produced scientific articles on the forces driving shifts in river channel position, meltwater discharge from glaciers and their effects on rivers and ocean circulation, how scientists can build their own instrumentation, and the historical discharge of North American rivers. Articles on their way to being published focus on the effects of climate change on river aggradation and incision and the geomorphic history of the Upper Mississippi Valley.

Wickert and his group **develop powerful but inexpensive open-source data loggers and sensors** that have been used to understand denitrification in the Mississippi River delta and the Gulf of Mexico dead zone, measure the effects of frost on hillslope shape and soil development across Colorado, monitor glacier melt in Alaska, and gauge streams in Argentina; these data loggers and sensors are currently being deployed by collaborators to monitor the effectiveness of riparian buffers in improving water quality.

Wickert teaches **geomorphology**, **glacial geology**, and **computational methods in Earth Science.**

Prior to his postdoctoral position in Potsdam, Germany, Wickert received his Ph.D. in geology from the University of Colorado Boulder (2014), his S.B. in Earth, Atmospheric, and Planetary Science from MIT (2008), and graduated from Harding Senior High School on Saint Paul's east side (2004).

Saint Anthony Falls Laboratory, University of Minnesota (Twin Cities)

Research at the historic Saint Anthony Falls Laboratory (SAFL), part of the College of Science and Engineering at the University of Minnesota, is focused at the intersection of fluid dynamics with major societal challenges in energy, environment and health. SAFL scientists and engineers integrate experiments in the laboratory and field with advanced computational tools and theory to obtain innovative, science-based solutions to real-world fluid-flow problems.