



Environment and Natural Resources Trust Fund

2022 Request for Proposal

General Information

Proposal ID: 2022-132

Proposal Title: Monitoring post-nourishment beach evolution on Minnesota Point

Project Manager Information

Name: John Swenson

Organization: U of MN - Duluth

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Project Basic Information

Project Summary: Following significant storms, we will obtain topographic / bathymetric / grain-size data from recently nourished beach areas on Minnesota Point. These data will document post-nourishment beach evolution and inform sediment-transport models.

Funds Requested: \$99,000

Proposed Project Completion: June 30 2024

LCCMR Funding Category: Small Projects (H)

Secondary Category: Methods to Protect, Restore, and Enhance Land, Water, and Habitat (F)

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?

Region(s): NE

When will the work impact occur?

During the Project and In the Future

Narrative

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

Can sand nourishment on Minnesota Point mitigate long-term beach erosion and, if so, what strategies maximize its benefits? Answers to these questions are grounded in careful observation and data acquisition in the months and years following nourishment events.

Recent, near-record-high levels on Lake Superior fueled intense wave erosion on Minnesota Point, damaging infrastructure and critical habitat. Erosion was focused ‘down-drift’ of the Duluth and Superior ship canals, where piers and breakwaters disrupt the natural sediment pathways that historically fed and maintained Minnesota Point. In 2019 and 2020, the US Army Corp of Engineers (USACE) deposited dredge spoils in the affected areas, thereby ‘nourishing’ the beach to offset erosional losses; these nourishments are the latest in a half century of such projects. Subject to availability of suitable dredge spoils, the City of Duluth is considering additional beach nourishment events in 2021 and beyond. Dredge spoils from the adjacent harbor generally are finer-grained (silt rich) than the ambient beach material they are supplementing. Finer-grained sediments likely are more mobile, thus reducing the effectiveness and lifespan of nourishment and potentially increasing nearshore turbidity.

By collecting frequent, high-resolution observations of post-nourishment beach evolution, our work can inform predictive sediment-transport models and future decision making.

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.

Each beach nourishment is a large, semi-controlled experiment, in which a known volume of sediment is ‘instantaneously’ added to an existing beach. The alongshore migration and dispersion of that sediment volume over the ensuing months and years provides invaluable, site-specific knowledge of how sediment transport depends on observed storm intensity and lake level.

We will leverage recent technological advances to gather high-resolution topographic and bathymetric data from the beach and adjacent lake floor. Following the September-2020 USACE nourishment near the Duluth ship canal, our team has been collecting repeat, high-quality topographic data after each significant storm event. Expanding our beach surveys to include the nearshore, we will collect repeat echosounder and sidescan sonar surveys of the lake floor within and down-drift of nourishment sites. In addition, we will repeatedly collect sediment samples from the beach and lake floor along static transects; the evolution in grain-size and elemental ‘fingerprint’ of these samples will provide additional metrics of post-nourishment sediment migration and dispersal.

Proximity to Minnesota Point allows us to respond rapidly and collect data immediately after each significant wave event (storm), thus isolating the topographic / bathymetric / grain-size changes from individual storms with observed characteristics, e.g. wave height, duration, etc.

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?

The deliverables of this project will be time series data of 1) high-resolution digital-elevation models (DEMs) of the beach and nearshore environment, 2) maps of lake-floor texture (grain size) from side-scan sonar, and 3) surface grain size and bulk elemental composition (chemical fingerprint). These data will quantify changes over time in beach volume, shape, and sediment composition following nourishment. Stakeholders can use these data to make informed decisions about future beach nourishment projects. In particular, these data will allow the development and calibration of high-resolution sediment transport models that can be used on the sub-decadal timescales required in this system.

Activities and Milestones

Activity 1: Collect and analyze high-resolution topographic, bathymetric, and sidescan sonar data following significant storm events

Activity Budget: \$49,714

Activity Description:

Task: Develop post-nourishment time series of beach topography and lake-floor bathymetry and texture (from sidescan sonar) within and down-drift of nourished sites.

Methods: Following significant storm events, we will 1) utilize drones to obtain high-resolution, georeferenced beach topography and 2) obtain high-resolution, georeferenced nearshore bathymetry using a manned, shallow-water vessel (LLO's R/V Kingfisher) and an unmanned, autonomous vessel (UAV). Combining beach and lake-floor data will yield a single, high-resolution digital-elevation model (DEM) for each storm event. Differencing of DEMs provides maps of erosion/deposition. We will utilize a two-pronged approach to our data collection: We will collect drone imagery georeferenced with a high-resolution differential GPS/GNSS receiver following all major storm events (target is 12-15 events over the course of the study). The bathymetry and sidescan-sonar data will be collected approximately every other event, with a goal of capturing the full component of off-shore data after the largest storm events.

Outcome 1: Time series of DEMs that document qualitatively (graphically) and quantitatively the post-nourishment evolution of dredge spoils.

Outcome 2: Time series of changes in dredge-spoil volume in the beach and nearshore. Changes in this volume provide a measure of offshore transport (loss) of the fine-grained (silt) fraction

Activity Milestones:

Description	Completion Date
Collection and analysis of topographic / bathymetric / sidescan data from first 'storm' season.	May 31 2023
Compilation of first-season storm-specific meteorological and oceanographic data.	July 31 2023
Collection and analysis of topographic / bathymetric / sidescan data from second 'storm' season.	May 31 2024
Compilation of second-season storm-specific meteorological and oceanographic data.	June 30 2024
Sensitivity analysis of all sediment-surface changes to all storm-specific meteorological / oceanographic data.	June 30 2024

Activity 2: Collect and analyze beach and lake-floor sediment samples following significant storm events

Activity Budget: \$24,468

Activity Description:

Following nourishment, we expect grain size at locations down-drift of emplaced sediment to become finer with time, reflecting migration of dredge spoils and their mixing with coarser-grained beach sand. Given the provenance of sediments beneath the harbor floor, dredge spoils may carry a distinctive elemental 'fingerprint,' which we will measure with a portable x-ray fluorescence (pXRF) device, relative to beach sands. We will use both grain size and bulk elemental composition to quantify mixing of dredge spoils with ambient beach sand.

Task: At ten geo-located, shoreline-perpendicular transects distributed within and down-drift of the nourished site, collect and analyze an onshore-to-offshore series of sediment grab samples after each significant storm.

Methods: At each transect, we will collect a series of grab samples from the beach and—when using R/V Kingfisher—the adjacent lake floor. At each (repeat) sample location, we will 1) produce grain-size distributions and 2) use the pXRF to analyze the bulk elemental composition of each grain-size class.

Outcome: Time series of grain-size distributions and bulk-elemental compositions at each sample site will provide quantitative measures of migration and dispersal of dredge spoils. These time series of sediment properties will complement the topographic/bathymetric time series from Activity 1.

Activity Milestones:

Description	Completion Date
Collection, processing, and analysis of sediment samples from first ‘storm’ season.	May 31 2023
Collection, processing, and analysis of sediment samples from second ‘storm’ season.	May 31 2024
Sensitivity analysis of all grain-size changes to all storm-specific meteorological / oceanographic data.	June 30 2024

Activity 3: Outreach and knowledge transfer

Activity Budget: \$24,818

Activity Description:

Task 1: Make available to the public 1) all data from our study and 2) effective summaries of our findings in written and graphical format.

Task 2: Communicate effectively our findings to stakeholders.

Methods: Beach nourishment on Minnesota Point is a contentious topic. The raw data we collect will undergo rigorous QA/QC procedures to ensure their suitability in decision-making and/or litigation. We will coordinate with data-transfer experts to ensure wide dissemination of our data and associated interpretations / summaries. Similarly, we will consult visualization experts to produce user-friendly graphical representations of our findings, e.g. animations of beach / lake-floor DEMs. Our team has excellent working relationships with many stakeholder groups, e.g. City of Duluth, USACE, MNDNR, South St. Louis SWCD, and Park Point Community Club. We will transfer knowledge to these groups and the general public via presentations (informal, public, regional conference), webinars, social media, written reports, and other vehicles.

Outcome 1: Facilitate knowledge transfer to all interested parties by providing multiple, transparent pathways to access raw data from the study and our interpretations of these data.

Outcome 2: Ensure stakeholders are aware of our findings so that this information is incorporated into decision-making processes for future beach

Activity Milestones:

Description	Completion Date
QA/QC and web-publish raw topographic / bathymetric / grain-size data from first storm season.	September 30 2023
Present observations and preliminary interpretations to various stakeholders.	December 31 2023
QA/QC and web-publish raw data and visualizations from second storm season.	May 31 2024
Present findings at state research conference; present results to stakeholders.	June 30 2024
Prepare and web-publish report of project results; present final results to City of Duluth.	June 30 2024

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?

Our data and interpretations will provide a transparent reservoir of information for agencies and the public to ascertain the effectiveness of beach nourishment and the implications for the fate of Minnesota Point. We will 1) provide detailed observational data to the USACE for use in future efforts to construct high-fidelity models of sediment transport on Minnesota Point, 2) communicate our findings to the City of Duluth for use in decision-making procedures regarding future beach nourishment, and 3) post all data for public access. If stakeholders request additional post-nourishment monitoring, we will seek federal funding (USACE, USGS) or more LCCMR funding.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Landslide Susceptibility, Mapping, and Management Tools	M.L. 2017, Chp. 96, Sec. 2, Subd. 03i	\$500,000

Project Manager and Organization Qualifications

Project Manager Name: John Swenson

Job Title: Associate Professor

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

Dr. John B. Swenson is an Associate Professor in the Department of Earth and Environmental Sciences (DEES) at UMD. His research interests include sediment transport and coastal geomorphology. Swenson has studied coastal erosion and sediment pathways in the western arm of Lake Superior—including Minnesota Point—for the last five years. His work has addressed a) the genesis of Minnesota / Wisconsin Point, b) the long-term sediment budget in the Duluth area (bluff erosion feeding barrier-island deposition), c) century-scale perturbations to this sediment budget from installation of Superior and Duluth ship canals, and d) potential ramifications of climate changes on coastal erosion in the Duluth area. He has established working relationships with stakeholders and affected parties, including the City of Duluth, USACE, Arrowhead Regional Development Center's Coastal Erosion Hazards Mapping Group, Minnesota DNR, and the Park Point Community Club. Swenson will provide overall project management, supervise research staff, and lead the assessment of coastal sediment transport.

Dr. Karen Gran is a Professor in DEES, where she is a geomorphologist. Her work focuses on river, hillslope, and deltaic response to changes in land use and climate. Gran has extensive experience managing interdisciplinary federal and state projects with logistically complex field components. She will lead the acquisition and interpretation of topographic data.

Dr. Nigel Wattrus is an Associate Professor in DEES and Large Lakes Observatory (LLO), where he is a geophysicist specializing in acquisition, processing, and interpretation of high-resolution seismic and acoustic data (including echosounder, sidescan and multibeam sonar). Wattrus has over 35 years of experience leading field-based geophysical projects. He has participated in multi-institutional projects in North, Central and South America, East Africa, Iceland and Indonesia. He will lead the acquisition, processing, and interpretation of nearshore bathymetric and lake-floor-textural data from the R/V Kingfisher and the UAV.

Organization: U of MN - Duluth

Organization Description:

The Department of Earth and Environmental Science (DEES) is housed within UMD's Swenson College of Science and Engineering, hosts 13 tenured and tenure-track faculty, and offers undergraduate degrees in Geological Sciences and Environmental Science and the MS degree in Earth Sciences. DEES faculty have extensive experience managing a wide range of interdisciplinary research projects. Relevant to this project, DEES has well-equipped lab facilities for conducting analyses (grain size, mineralogy) of surface sediment samples. In addition, DEES recently acquired a portable x-ray fluorescence (pXRF) device, which allows rapid, low-cost elemental analysis of sediment samples for fingerprinting purposes.

UMD's Large Lakes Observatory (LLO) is a research institute dedicated to the interdisciplinary study of large lakes throughout the world.

LLO's twelve faculty strive to understand the functioning of lakes in the ancient, modern, and future. This project would make use of LLO's 25-foot research vessel, Kingfisher, which can be used to collect lake-floor sediment samples and echosounder and side-scan-sonar imagery in very shallow water. DEES and LLO together possess the necessary computation power and software to process the large volume of topographic, bathymetric, and lake-floor-textural data likely to result from this project.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Principal Investigator John Swenson		Overall project management and coordination; supervise research staff; lead assessment of coastal sediment transport; lead reporting and outreach.			27%	0.08		\$15,068
Co-Investigator Karen Gran		Co-Investigator in charge of spatial data analysis, GPS, and photogrammetry.			27%	0.04		\$7,568
Co-Investigator Nigel Watrus		Co-Investigator in charge of bathymetry surveys, supervision and training of research assistant in bathymetric data processing.			27%	0.08		\$14,234
Graduate Student		Graduate research assistant for one year plus summer. Student will be in charge of drone flights, imagery processing, sediment collection, sediment analyses, bathymetric data collection, and bathymetric data processing.			48%	0.5		\$43,280
Undergraduate Research Assistant		Undergraduate research assistant to help with data collection, sediment processing, and GIS work.			0%	0.12		\$3,044
							Sub Total	\$83,194
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
	Equipment	Sonar software	Process and visualize sidescan sonar data					\$390
	Equipment	Echosounder, cable, batteries, and microcomputer	Acquire bathymetric data.					\$760
	Tools and Supplies	Field supplies (sample bags, field notebooks)	Collection of sediment samples and general field observations					\$50
							Sub Total	\$1,200
Capital Expenditures								

		Sidescan sonar: The migration and dispersal of nourished sediment by waves and currents will continue after the completion of this project. We will maintain the sidescan sonar device and continue to use it indefinitely for monitoring of sediment dispersal on Minnesota Point.	Device is used to obtain information on the lake-floor texture (grain size), which is a critical measure of dredge-spoil dispersion.					\$6,773
							Sub Total	\$6,773
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Local travel to field site: 15 trips to collect data at 15 miles RT for 2 people: \$121.50	Local travel to field site for data collection.					\$121
	Conference Registration Miles/ Meals/ Lodging	Local stakeholder meetings do not require travel expenses. Expenses included for one trip to local conference, e.g. the Minnesota Water Resources Conference, to present results (2 people) (\$96/night hotel (2 rooms), 200 registration (*2), 320 for mileage (\$172.80), perdiem (55/day*2 days * 2 people)	Travel to present project results to stakeholders.					\$1,014
							Sub Total	\$1,135
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
		Ship time on R/V Kingfisher: 6 days at \$750/day	Collect bathymetric and sidescan-sonar data using a shallow-water research vessel.					\$4,567
		Rental of CHIRP sub-bottom profiler (charge = \$350/day for 6 days)	Collection of subsurface data to aid in identifying changes in sediment grain					\$2,131

			size associated with dredge-spoil dispersal.					
							Sub Total	\$6,698
							Grand Total	\$99,000

Classified Staff or Generally Ineligible Expenses

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

Category	Specific Source	Use	Status	Amount
State				
In-Kind	UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% modified total direct costs.	UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% modified total direct costs.	Secured	\$41,691
			State Sub Total	\$41,691
Non-State				
			Non State Sub Total	-
			Funds Total	\$41,691

Attachments

Required Attachments

Visual Component

File: [987642bf-69c.pdf](#)

Alternate Text for Visual Component

Collage showing 1) erosion of 2019 and 2020 beach nourishments on north and south ends of Minnesota Point, respectively, and 2) long-term (80 year) erosion on the south end of MN Point. Fall 2019 south-end nourishment was severely eroded by winter storms, resulting in large-scale sediment mobilization. Long-term erosion on south end exceeds one meter per year of lateral shoreline retreat. Photos superimposed atop a line drawing of Duluth-Superior Harbor....

Optional Attachments

Support Letter or Other

Title	File
LCCMR Transmittal letter	d3f3f299-07e.pdf
Letter of support from City of Duluth	d0a2fdc5-2d1.pdf
Letter of support from Arrowhead Regional Development Commission	d12a62dc-021.pdf
Letter of support from Park Point Community Club	4bf122a2-e75.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

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

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?

No

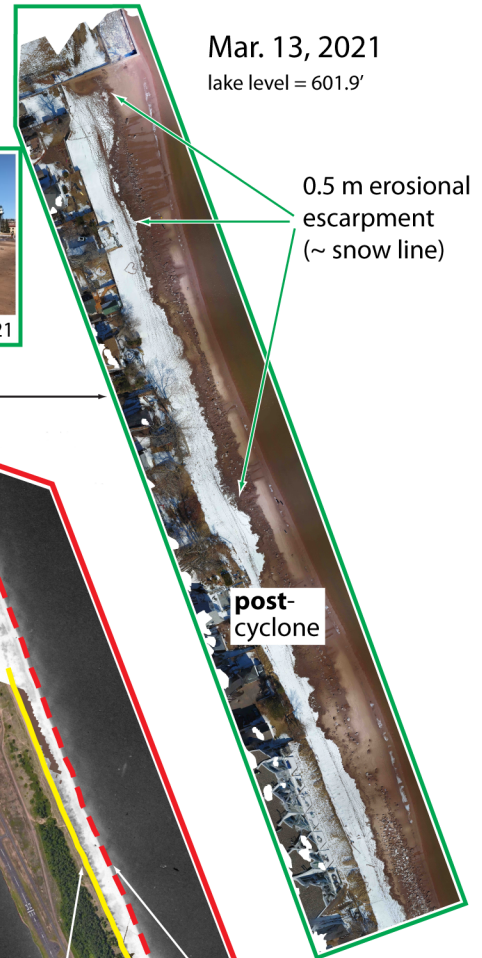
Minnesota Point Erosion: Recent and historical perspectives

2020 North End Nourishment

Note: All over-winter erosion the result of a **single, modest** cyclone on March 10, 2021.



Repeat drone surveys by Pls after Aug. 2020 nourishment



Dec. 10, 2020
lake level = 602.8'

pre-cyclone

Duluth Entry

Duluth Harbor

Historical Perspective

2016 image (color) overlaid on 1938 air photo (gray)

2016 shoreline (yellow, solid)

1938 shoreline (red, long dash)

90 m erosion in 78 yrs (>1 m/yr)

Abrams Aerial Survey Corp. Lansing, Mich.

Superior Entry

Line drawing of Duluth-Superior Harbor from USACE (2001)

October, 2019

Immediately after beach nourishment

March, 2020

Over-winter erosion

1+ meter erosional escarpment

Image: USACE

2019 South End Nourishment