Environment and Natural Resources Trust Fund
2011-2012 Request for Proposals (RFP)

LCCMR ID: 028-B

Project Title: Mississippi Water Quality – Deeper Look, Broader Impacts

Category: B. Water Resources

Total Project Budget: $ $623,445

Proposed Project Time Period for the Funding Requested: 2.5 yrs, July 2011 - Dec 2014

Other Non-State Funds: $ 16,670

Summary:

New DNA sequencing approaches and chemical analyses will be used to assess water quality in the Mississippi River, producing searchable databases that will be incorporated into classrooms and public exhibits.

Name: Michael Sadowsky

Sponsoring Organization: U of MN

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Saint Paul MN 55108

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Web Address http://www.cbs.umn.edu/main/news/inthefield/m3p.shtml

Location

Region: Statewide

Ecological Section: Western Superior Uplands (212K), No. Minnesota Drift and Lake Plains (212N), Paleozoic Plateau (222L), Minnesota and NE Iowa Morainal (222M)

County Name: Statewide

City / Township:

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

PROJECT TITLE: Mississippi Water Quality – Deeper Look, Broader Impact

I. PROJECT STATEMENT

This project provides a more complete understanding of the impact of human activity on the upper Mississippi River, with the goal of improving water quality. We will produce an extensive database cataloging the biodiversity and functions of microbial life in the Mississippi River using a new tool of metagenomic analyses. Metagenomics provides us a way to understand, for the first time, more about the microbiology of the River than we currently know through traditional analyses. The Mississippi River metagenome represents all the DNA in a water sample, regardless of its origin. Information about the diversity and function of microorganisms in the Mississippi, and the types of pathogens present, can be rapidly and directly obtained through the analysis of the DNA sequences in each sample. We will also determine how this data relates to other indicators of water quality, including the input of chemical pollutants, pharmaceuticals, and nutrient run-off.

Some of the greatest causes of pollution in the environment are due to the release of sewage, sewage-derived bacteria, and chemicals into waterways. The major human-generated inputs into the Mississippi River Watershed includes nutrients from runoff and sewage treatment facilities, antibiotics and pharmaceuticals, and industrial and agricultural chemicals. These materials not only affect the diversity and functioning of microorganisms in the waterway, but also lead to accelerated aging (eutrophication) of the watershed and pollution with pathogenic microorganisms.

Despite our State's rather intimate relationship with the Mississippi River, including its headwaters and the first navigable locks, we really know little about the impacts of pollution on the functioning of this River watershed and its microorganisms. Microorganisms are the driving force, the engine, that runs the watershed. They are critical to the biological and chemical cycling of elements and materials that keep the planets ecosystems in balance, and to the health and wellbeing of all plants and animals on earth. However, due to major technical limitations, it is estimated that less than 1% of all microorganisms in any environmental sample can be grown in the laboratory and the majority are currently unknown to us. Consequently, current efforts to monitor water quality in the Mississippi using "indicator" bacteria to measure fecal contamination are overshadowed by our lack of knowledge about 99% of the microorganisms in the water, including pathogens. This research project fills this knowledge gap concerning the Mississippi within Minnesota. The cataloging and analysis of the majority of microbes in the water will eventually lead to more confidence in the validity of our regulations and policies, and lead to more targeted remediation efforts by State and Local Agencies.

To obtain research data, we plan to engage students at the 7-12, undergraduate, and graduate levels in metagenome data analysis. This data will be available for use in large scale (e.g., Minnesota or national) studies to address human impacts on the River –that is more than a transportation corridor. It is also a watershed and drinking water source for over 50 cities and 18 million people and a habitat providing for fish and wildlife and recreation for millions of people over 31 states.

These studies will put Minnesota at the forefront of this important area of environmental research. Project outcomes will provide more insight into selection of proper remediation efforts and the future environmental needs of the watershed to improve water quality. We also believe that one of the best approaches to remediate the Mississippi is to engage the public through education programs; including exhibits at the Science Museum of Minnesota, the Bell Museum, and the Itasca State Park Nature Center. Formal and informal education efforts will engage the state's citizens in this novel exploration of the Mississippi.

II. DESCRIPTION OF PROJECT RESULTS

ACTIVITY 1: Analysis of Microorganisms — Budget: $416,984

This proposal will fund two and a half years of sampling and metagenome analysis of water samples from the Mississippi River at 10 critical junctures in Minnesota, from Lake Itasca to La Crescent (see attached map), focusing on the headwaters and confluences with other major Rivers. We are currently planning to obtain preliminary data from these 10 sites this summer, and are proposing here to request funding for in depth studies of these sites for two additional years. At each sampling location and time point we will also obtain information on other indicators of water quality, including industrial and agricultural chemicals and pharmaceuticals, inputs that impact microbial diversity and functioning.

Outcome	Completion Date
1. Sampling of the Mississippi River and analysis of samples for microbial species diversity and functionality at each sampling location	December 31, 2013
2. Correlations of data to physical, chemical and land use data at each location	December 31, 2013

ACTIVITY 2: Professional Development of 7-12 teachers. **Budget:** $136,661

In this result we will develop hands-on professional development program for 7-12 teachers, offered both in the Twin Cities and in Northwest Minnesota (Itasca) to provide greater access to this opportunity statewide. This professional development will focus on preparing teachers to include Mississippi metagenomics studies in their science curriculum in a way that meets state standards for science inquiry.

Outcome	Completion Date
1. Provision of professional development workshops, Summer 2011 and 2012	August 30, 2012
2. Production of curriculum packets, webinars, books, materials, presentations	August 30, 2012
3. Incorporating this information and approach into 7-12 classrooms.	December 31, 2013
4. Annotation of gene identity and function in Joint Genome Institute website by 7-12 students.	December 31, 2013

ACTIVITY 3: Project data dissemination. **Budget:** 69,800

In this result we will develop a dedicated website making the metagenome diversity and functional and chemical data accessible to middle and high school students, undergraduate and graduate students, researchers, and the public. We will utilize existing national web resources, such as Dolan DNA Learning Center, the Joint Genome Institute, and Mothur databases to facilitate archiving, retrieval, and analysis of metagenome data. The website will also host all correlative data concerning "River health" obtained from chemical and physical analyses.

Outcome	Completion Date
1. Production of a web accessible, searchable database with downloadable datasets for use in the 7-12 and undergraduate classrooms, as well as by researchers in Minnesota and elsewhere	June 30, 2012
2. Production of public exhibits	August 31, 2012
3. Dissemination of project data and results via webinars, seminars and workshops.	August 31, 2013
4. Incorporation of project results into grades 7-16 curricula.	December 31, 2013

III. PROJECT STRATEGY

A. Project Team/Partners. The project will be carried out under the direction of Drs. Michael Sadowsky (PI) and co-PIs James Cotner, and William Koskinen. Funded project partners will include Pat Hamilton of the Science Museum of Minnesota, Itasca State Park, and the Bell Museum. We will also collaborate with the National Park Service at the SMM, Adam Birr at the Minnesota Department of Agriculture, and Barb Peichel at MPCA for dissemination activities.

B. Timeline Requirements. The project will be completed in 2.5 years, but the impact will last for many more. Multiple years of sampling and analysis are required for adequate, reliable data and multiple years are required for effective incorporation into 7-16 curricula and public education venues.

C. Long-term Strategy and Future Finding Needs. This request seeks funding for the first 2.5 years of this program. This will provide the basis for a long-term, continuing study of the health of the River that will include all the states bordering the Mississippi and eventually all the states in the Mississippi watershed. Since the River starts in Minnesota at Itasca, this new in depth study and broad impact program begins in Minnesota. Additional funding for more long term and more extensive analyses (of the upper and lower Mississippi River) will be obtained from the National Science Foundation., other states, and other foundations. This National project will be organized similar to the MN project, but involve researchers, students, and the public all the way to New Orleans.

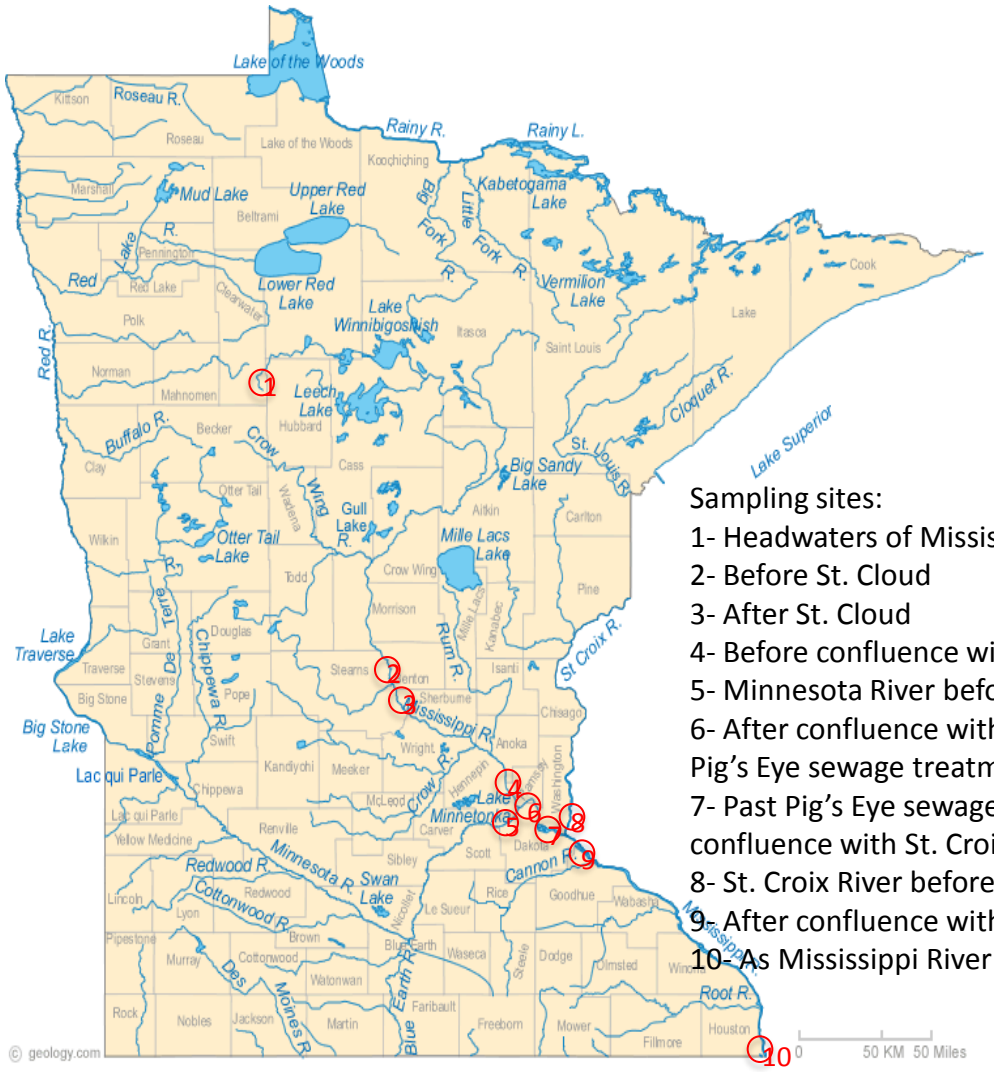
2011-2012 Detailed Project Budget

IV. TOTAL TRUST FUND REQUEST BUDGET 2.5 year project - Links to Activity and Outcomes shown as (Activity-Outcome, e.g., Activity 1-Outcome 1 shown as *1-1*)

BUDGET ITEM	AMOUNT
Personnel:	
Postdoctoral student (100% time, 84% salary, 16%fringe, 2 years, 1 person) *(1-1,1-2*	$95,200
Technician (100%time, 73%salary, 27%fringe, 2 years, 1 person) *(1-1, 1-2)*	$95,900
Website staff (2% time, 73%salary, 27%fringe, 1 year, 1 person) *(3-1, 2-4)*	$1,414
Instructor (5%time, 76%salary, 24%fringe, 2 years, 1 person) *(2-1, 2-2, 2-3)*	$12,000
Advanced graduate student (25%time, 77%salary, 23%fringe, 1 year, 1 person) for assessment of student achievement in 7-12 classrooms in this program. *(2-3)*	$9,167
Contracts: Two teachers (grade 7-12) as co-leaders of professional development workshop/program for teachers ($3000 per teacher X 2 teachers X 2 years) *(2-1, 2-2)*	$12,000
Exhibit staff at Science Museum of Minnesota (30% time, 73%salary, 27%fringe,, 2 years, 1 person) *(3-2)*	$54,800
Equipment/Tools/Supplies:	
Text and reference books, information materials (e.g., posters) for classrooms $190 X 20 teachers X 2 years (*2-3, 3-4)*	$7,600
Laboratory supplies $385 per teacher X 20 teachers X 2 years *(2-3, 3-4)*	$15,400
Exhibit materials: metal and wood stands, glass frames, photographs (3 sites X $5000 per site) *(3-2)*	$15,000
Acquisition (Fee Title or Permanent Easements):	$0
Travel:	
In-State Travel for 10 samplings per year X 2 years @1800 mi *$0.50/mi *(1-1)*	$900
Room & board for 4 people X 3 days/year X 2 years for sampling: $1664 for lodging; $1120 for food *(1-1)*	$2,784
Participant travel (30 mi/dayX 5 day*40 teachers * 0.50/mi) *(2-1)*	$3,000
Housing/food for instructor and co-teachers during teacher professional development program: 1 week/year X 2 years for instructor and co-teachers *(2-1, 2-3)*	$4,800
Additional Budget Items:	
Fees for participants for graduate credit: Tuition is waived for the project, but there will be an administrative fee of $100 per registrant + $157 fees (total $282) X 20 teachers X 2 years *(2-1)*	$11,280
Stipend ($1500 per teacher for 1 week workshop/followup work X 20 teachers X 2 years) *(2-1)*	$60,000
Sample analysis: 20 samples for each analysis: (genome preparation @$5000/sample = $100,000, genome analysis @$6000/sample = $120,000, $300 for robot use to prepare plates , physical analysis @ $20/sample = $400, chemical analysis @$75/sample = $1500). Genome preparation and all genomic, physical, and chemical analyses are done most cost effectively in specialty labs that charge by the sample. *(1-1)*	$222,200
TOTAL ENVIRONMENT & NATURAL RESOURCES TRUST FUND $ REQUEST	$623,445

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period: *Federal Stimulus funds paying the undergraduate course instructor and laboratory support personnel, for July and August, 2011.*	$ 16,670	*Secured*
Other State $ Being Applied to Project During Project Period:	$ 4,533	*Secured*
In-kind Services During Project Period: $0	$ -	
Remaining $ from Current ENRTF Appropriation (if applicable): $0	$ -	
Funding History: *Federal Stimulus funding to launch this project at the undergraduate level; $400,000 beginning September, 2009; this is the funding reported in "Other Non-State$" above; $400,000-16,700 = $383,300*	$ 383,300	



Sampling sites:

1- Headwaters of Mississippi River – Lake Itasca
2- Before St. Cloud
3- After St. Cloud
4- Before confluence with Minnesota River
5- Minnesota River before confluence
6- After confluence with Minnesota River, but before Pig's Eye sewage treatment plant
7- Past Pig's Eye sewage treatment plant, before confluence with St. Croix River
8- St. Croix River before confluence with Mississippi
9- After confluence with St. Croix River
10- As Mississippi River leaves Minnesota

Figure 1. Sampling sites and locations used in this study.

Project Manager Qualifications and Organization Description:

Project Manager: Dr. J. Michael Sadowsky

Title: McKnight University Professor and Director BioTechnology Institute

Affiliation: University of Minnesota, Department of Soil, Water and Climate, and BioTechnology Institute

The UMN Biotechnology Institute (BTI) provides advanced research, training, and university-industry interactions in biological process technology, and other areas of biotechnology research. Faculty in the BTI have broad expertise in: Biocatalysis, Metabolic engineering/microbial physiology, Population dynamics, Molecular biology, Proteomics and focused expertise in defined areas such as bioremediation, biomaterials, biosensors, and bioinformatics.

Education:

Ph.D., 1983. University of Hawaii, Honolulu, Hawaii. Major: Microbiology
M.S., 1979. University of Wisconsin-Oshkosh, Wisconsin. Major: Microbiology
B.S, 1977. University of Wisconsin-Madison, Wisconsin. Major: Bacteriology

Professional Experience:

Director BioTechnology Institute, University of Minnesota, St. Paul, Minnesota, 2009 - present.
Co-Director, Microbial and Plant Genomics Institute, University. of Minnesota, 2006-2009.
Distinguished McKnight University Professor: Department of Soil, Water, & Climate, and BioTechnology Institute, University of Minnesota, St. Paul, Minnesota, 04/04 - present.
Professor: Department of Soil, Water, and Climate and Department of Microbiology
University of Minnesota, St. Paul, Minnesota, 07/96 – 04/04.
Associate Professor: Departments of Soil Science and Microbiology
University of Minnesota, St. Paul, Minnesota, 07/93 - 6/96.
Assistant Professor: Departments of Soil Science and Microbiology
University of Minnesota, St. Paul, Minnesota, 06/89 - 6/93.
Microbiologist: U.S. Department of Agriculture-ARS; Beltsville, Maryland, 01/86 - 05/89.

Dr. Sadowsky will have chief management responsibilities for overseeing the proposed project. He will be responsible for working with the co-PIs (Cotner and Koskinen), teaching staff, and project partners and cooperators to ensure that project goals, results and timelines are met. He will also be responsible for working with the undergraduates, teaching staff, and postdoctoral associate at UMN and staff at the SMM and Lake Itasca.

Dr. Sadowsky is an environmental microbiologist with 27 years research experience in the analysis and use of microorganisms in environmental settings. Dr. Sadowsky's laboratory studies the distribution and diversity of microorganisms in aquatic and soil environments and uses genetic, genomic, and biotechnology tools to examine how microorganism become established in new environments. He is currently Director of the BioTechnology Institute, Director of the and is involved in teaching metagenomic courses at the University and Lake Itasca. Dr. Sadowsky is currently involved in three large metagenome projects; the soil metagenome to define novel microbial genes for biofuel and bioenergy; the Mississippi River metagenome that examines the impact of human activity on the diversity and function of microbes in the Mississippi River; and the Human Intestinal metegenome project that defines changes in human intestinal tract microbiota due to *Clostridium difficile* diarrheal disease.