Project Title:

Quantifying effectiveness of BMPs in reducing field erosion

Category: 2. Research that contributes to increasing the effectiveness of protecting the states environment and natural resources.

Total Project Budget: $ 256,462

Proposed Project Time Period for the Funding Requested: 3, July 2013 to June 2016

Other Non-State Funds: $

Summary:

Sediment concentrations in our rivers remain high, despite widespread adoption of BMPs to reduce field erosion. Changing sources and loads will be reconstructed from sediment cores to evaluate BMP effectiveness.

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Location

Region: Statewide

County Name: Statewide

City / Township:

Main Proposal: 0412-2-094-proposal-LCCMR SED BMP Main.docx
Project Budget: 0412-2-094-budget-LCCMR Sed Budget final.xls
Qualifications: 0412-2-094-map-Sed BMP graphic.pdf
Map or Graphic:
Letter of Resolution: 0412-2-094-qualifications-SPS Qual.doc
Acquisition List:

PROJECT TITLE: QUANTIFYING EFFECTIVENESS OF BMPs IN REDUCING FIELD EROSION

I. PROJECT STATEMENT

Many rivers and lakes continue to have serious sediment turbidity impairments, despite significant efforts to implement soil conservation practices. This raises the questions: how effective have best management practices (BMPs) been at reducing field erosion and subsequent suspended sediment concentrations in rivers? This question remains largely unanswered at a watershed scale, yet needs to be addressed for future management strategies to be cost effective.

Simply because current monitored suspended sediment concentrations on many agricultural rivers are high, does not necessarily mean that BMPs have been ineffective in reducing field erosion. There are two important and often under appreciated elements complicating the understanding of how BMPs have effected field erosion and suspended sediment concentrations.

1) *Suspended sediment in rivers does not result solely from erosion of agricultural fields*. Erosion of non-field sources such as streambanks and bluffs contribute to the suspended load. Suspended sediment concentrations are a combination of field and non-field sources. To understand the effect of BMPs on reducing suspended sediment, it is necessary to know how much sediment comes from each source.
2) *We don't know how suspended concentrations have changed over time*. While there are many current measurements of suspended sediment and turbidity in rivers and lakes, there are very few measurements prior to the 1980's, and the measurements that exist are at the outlets of large watersheds making specific relationships and lag times hard to infer. This lack of "before and after" monitoring makes it difficult to determine how effective combined BMP and management efforts have been.

Thus, to evaluate the effectiveness of soil conservation practices in reducing turbidity impairments, we need to know how much of the sediment is from field sources, and more importantly we need to know how the field component (load) has changed over time.

This project will use radioisotope tracers (sediment fingerprinting) in combination with dated sediment cores from five riverine lakes in agricultural watersheds to quantify changes in field and non-field sediment loads before and after BMP implementation. Trends of sediment accumulation rates in lake cores provide an excellent, integrated record of the erosion history of a watershed but require a source apportionment method to separate changes in field and non-field contributions. Existing geochemical sediment-fingerprinting methods are well suited to estimating existing source apportionment but are less precise in quantifying how sources have changed over time. This project will develop the use of the long-lived radioisotope Berylium-10 to allow fingerprinting of erosion sources on a decadal scale over the past ~150 years, thereby distinguishing changes in field and non-field loading over long time frames.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Develop method to determine sediment inputs before and after BMP implementation. **Budget:** $ 35,000

Current sediment fingerprinting methods use radioisotope with short half-lives rending them less effective at estimating sources (field or non-field) on older sediments. To evaluate changes in sediment sources over time, and the relationship to land use, we will add the long-lived radioisotope tracer Berylium-10 (^{10}Be) to the fingerprinting method. Detention ponds created by erosion control dams collect sediment

eroded from fields and provide ideal samples for developing the ^{10}Be field reference fingerprint. Surface sediment samples from 10 ponds will be collected and analyzed to create a composite upland fingerprint of ^{10}Be.

Outcome	**Completion Date**
1. Determination of field fingerprint of ^{10}Be.	January 2014
2. Develop method to separate field from non-field inputs over past century.	February 2015

Activity 2: Quantify long-term trends of field erosion contributions to suspended sediment.

Budget: $ 150,000

Lake sediment records provide an archive of how field erosion rates have changed over time. Five lakes with field and non-field inputs will be cored and dated. Radioisotopes tracers will be analyzed on 20 intervals from each core to determine decadal loading rates of field and non-field inputs over the past ~150 years. Loading rates will be normalized to available flow values of tributaries entering the lakes to estimate changes in turbidity over time, and help correct for climatic variability.

Outcome	**Completion Date**
1. Collection of sediment cores and chemical analysis.	November 2013
2. Quantify reduction or changes in field and non-field loading.	May 2015

Activity 3: Assess effectiveness of BMP's on improving water quality.

Budget: $ 71,462

County and State records documenting the implementation history of soil conservation practices such as no-till planting, residue management, buffer strips, grassed waterways and wetland restoration will be assembled and correlated to the trends in sediment loading. The relationship between BMPs and field contributions to suspended sediment will be compared in each of the watersheds. Extent of BMPs and implementation trends will be correlated to changes in sediment loading. The measured relationship of BMPs to field sediment reductions will be used to predict future turbidity trends under different implementation strategies.

Outcome	**Completion Date**
1. Correlation between BMP implementation and sediment loads.	May 2015
2. Quantify effectiveness of BMPs in reducing field erosion.	May 2016
3. Prediction of future sediment reduction based on BMP installation	June 2016

III. PROJECT STRATEGY

A. Project Team/Partners (St. Croix Watershed Research Station)

Dr. Shawn Schottler will be responsible for coordinating the overall project. Dr. Jim Almendinger will assist with sampling and be responsible for assembling GIS data of BMPs.

B. Timeline Requirements

The project will require three years to complete. Sediment sampling will occur over the first year of the project. Geochemical analyses will take at least 18 months, and commence mid-way through the project. Six months is allotted for synthesis and final reporting.

C. Long-Term Strategy and Future Funding Needs

Results of this project will be used to predict the effectiveness of future BMP implementation strategies on reducing field contributions to sediment turbidity impairments.

2012-2013 Detailed Project Budget

IV. TOTAL TRUST FUND REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT
Personnel: **SCWRS Staff:** Amounts are Salary + Benefits. Benefits are 28% of Salary. Shawn Schottler Salary + Benefits 35% /yr 3 yrs 89,862 Jim Almendinger Salary + Benefits 20% /yr 3 yrs 52,600	$142,462
Contracts: Analytical Services: Be-10 analysis and organic size fractionation 90 samples @ $450/sample	$ 40,500
Equipment/Tools/Supplies: Lab supplies and liquid nitrogen	$ 4,500
Travel: Collect sediment cores from lakes. At least four coring trips. Mileage, food and lodging from Meto area to lakes in agricultural regions of western, southern an central MN.	$ 3,000
Additional Budget Items: **Analytical Services** at St. Croix Watershed Research Station: Includes Lead-210 dating, gamma spectrometry, sample preparation, particle size and sediment composition. 165 samples at $400/sample for all combine analysis	$ 66,000
TOTAL ENVIRONMENT & NATURAL RESOURCES TRUST FUND $ REQUEST	$ 256,462

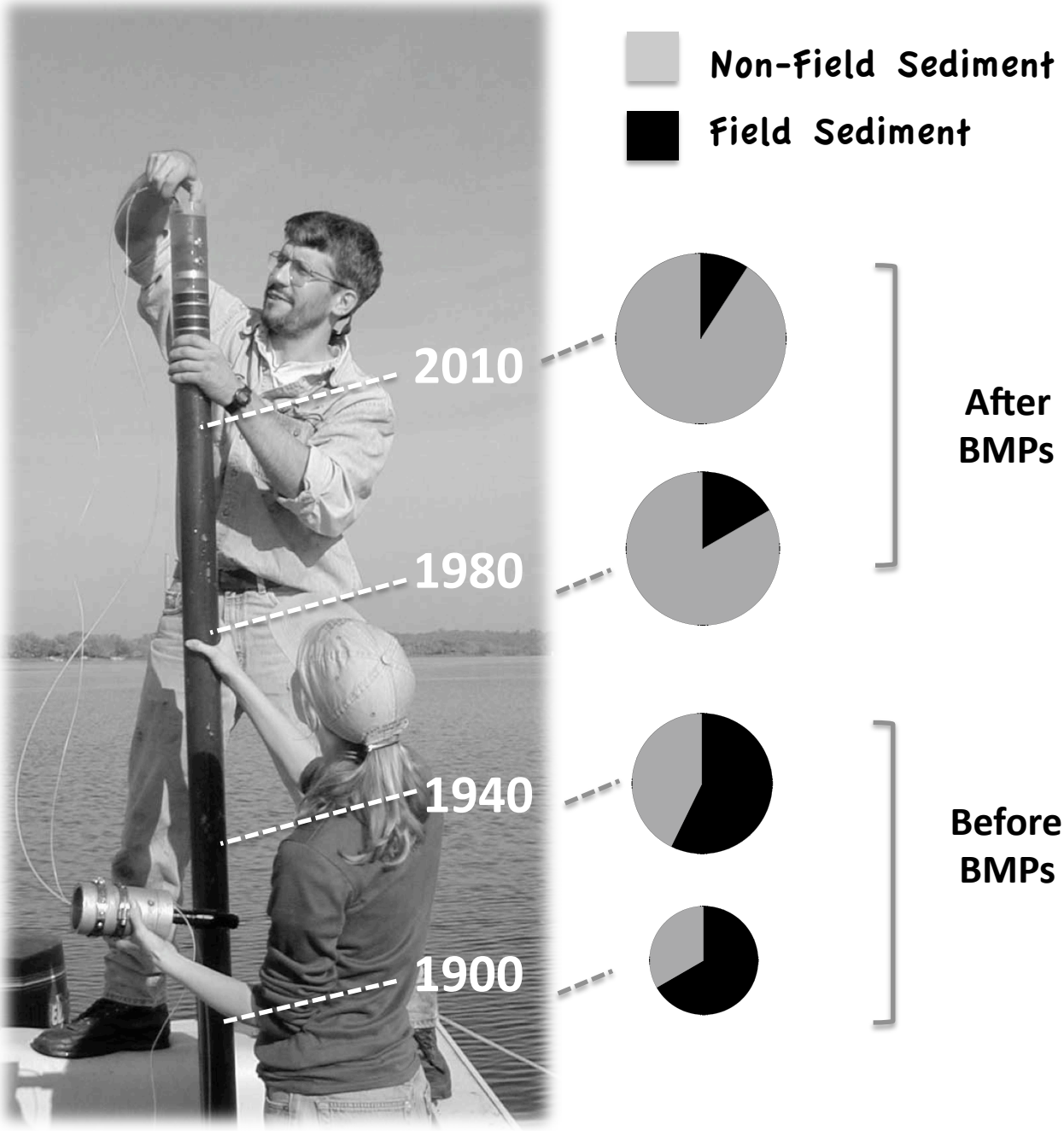
V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period:	NA	
Other State $ Being Applied to Project During Project Period: Funding from MPCA to conduct complimentary work on additional lakes	$ 105,000	*approved, pending workplan*
In-kind Services During Project Period: *Foregone indirect expenses, 25% of project total*	$64,115	
Remaining $ from Current ENRTF Appropriation (if applicable):	NA	
Funding History: LCMR, 1999: Identification of Sediment Sourcs in Agricultural Watersheds.	$350,000	

Have Erosion BMPs Worked?

Almost no watershed monitoring data exist to answer this question.

Hypothetical Watershed – With Effective BMPs



Sediment cores coupled with isotope fingerprinting provide a record of the effectiveness of BMPs in reducing sediment in our rivers.

Project Manager Qualifications: Shawn P. Schottler

Research Expertise

My research focuses on quantifying the relationship between changing landuse and water quality conditions in agricultural watersheds. My expertise uses lake sediment records and geo-chemical tracers to understand changes in sources and transport of contaminants from large watersheds. Areas of current research include: (1)Radioisotopic fingerprinting of sediment sources; (2) Historic nutrient and contaminant loading to the Minnesota River; (3) Evaluating the role of crop conversion, artificial drainage and climate in in changing river hydrology.

Affiliations

1997-present: Senior Scientist, St. Croix Watershed Research Station, Science Museum of Minnesota

Education

1996. Ph.D., Environmental Engineering. University of Minnesota, Minneapolis, MN
1989. B.S., Geotechnical Engineering, University of Minnesota, Minneapolis, MN

Selected Publications

Schottler S. P., Ulrich J., Belmont, P., Moore, R., Lauer, J.W., Engstrom, D.E., Almendinger, J.E. Twentieth century agricultural drainage creates more erosive rivers. In review

P. Belmont, K. B. Gran, **S. P. Schottler**, P. R. Wilcox, S. S. Day, C. Jennings, J. W. Lauer, E. Viparelli, J. K. 2011. Large shift in source of fine sediment in the upper Mississippi River. *Environ Sci Technol.*, Published on web: http://dx.doi.org/10.1021/es2019109

Schottler S. P. and Engstrom, D. R. 2006. A chronological assessment of Lake Okeechobee (Florida) sediments using multiple dating markers. Journal of Paleolimnology, v. 36, 19-36.

Schottler, S. P., Engstrom, D. R., Blumentritt, D. (2010) Fingerprinting sources of sediment in large agricultural river systems, Final Report to Minnesota Pollutions Control Agency CFMS # A94798. *http://www.smm.org/static/science/pdf/scwrs-2010fingerprinting.pdf .*

Schottler S. P. and Engstrom, D. R. 2006. A chronological assessment of Lake Okeechobee (Florida) sediments using multiple dating markers. Journal of Paleolimnology, v. 36, 19-36.

Schottler S. P. and Engstrom, D. R. 2006. A chronological assessment of Lake Okeechobee (Florida) sediments using multiple dating markers. Journal of Paleolimnology, v. 36, 19-36.

Engstrom, D. R., **Schottler, S. P**., Leavitt, P. R., and Havens K. E. 2006. A Re-evaluation of the cultural eutrophication of Lake Okeechobee using multiproxy sediment records, Ecological Applications, v.16(3), 1194-1206.

Schottler, S.P., Identification of Sediment Sources in an Agricultural Watershed, Final Report to the Legislative Commission on Minnesota's Resources, December 30, 2002

Swackhamer, D.S., **Schottler, S.P**., and Pearson, R.F. Air-Water Exchange and Mass balance of Toxaphene in the Great Lakes, *Environmental Science and Technology*, v.33, pp. 3864-3872, 1999

Schottler S.P. and Eisenreich S.J., A Mass Balance Model for Quantifying Atrazine Sources and Transformation Rates in the Great Lakes, *Environmental Science and Technology*, v. 31, p. 2616-2625, 1997.

Organization Description

The Science Museum of Minnesota (SMM) is a private, non-profit 501(c)3 institution dedicated to encouraging public understanding of science through research and education. Its mission is to invite learners of all ages to experience their changing world through science. The St. Croix Watershed Research Station is a program of the SMM with the mission to foster, through research and outreach, a better understanding of rivers and lakes at the watershed scale and to provide information to help sustain similar ecological systems.