Environment and Natural Resources Trust Fund
2014 Request for Proposals (RFP)

DRAFT
N

Project Title:

Shallow Lakes: Assessing Quality and Predicting Future Change

Category: B. Water Resources

Total Project Budget: $ 433,223

Proposed Project Time Period for the Funding Requested: 3 Years, July 2014 - June 2017

Other Non-State Funds: $ 0

Summary:

We propose a 3 part approach to improve management of Minnesota's shallow lakes: data gathering, identification of lake quality drivers, and a comprehensive modeling strategy for predicting future lake conditions.

Name: Mark Hanson

Sponsoring Organization: MN DNR

Address: DNR Wildlife Research, 102 23rd Street NE
Bemidji MN 56601

Telephone Number: (218) 308-2283

Email mark.alan.hanson@state.mn.us

Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

MP: 0613-2-118-proposa
Budget: 0613-2-118-bud
Qual: 0613-2-118-qualifi
Map: 0613-2-118-map-H
Resolution:
List:

_____ Funding Priorities _____ Multiple Benefits _____ Outcomes _____ Knowledge Base

_____ Extent of Impact _____ Innovation _____ Scientific/Tech Basis _____ Urgency

Capacity Readiness Leverage Employment TOTAL

Environment and Natural Resources Trust Fund (ENRTF)
2014 Main Proposal
Project Title: Shallow lakes: assessing quality and predicting future change

I. PROJECT STATEMENT

WHY this project needs to be done: Lake managers face unprecedented challenges to surface and groundwater quality. Minnesota has more than 4000 shallow lakes and these waters are especially vulnerable because they often occur in close proximity to intensive agriculture, they are highly interconnected, and thus are very susceptible to the spread of undesirable, even invasive aquatic species, and because they very quickly transition from clear-water to turbid-water conditions with accompanying poor water quality. Traditionally, shallow lakes were often ignored or viewed as important only to waterfowl and other wildlife. We now know, however, that shallow waters are key elements of Minnesota landscapes, providing a suite of resource benefits, including the potential for higher quality of both surface water and groundwater. Shallow lakes will require special attention as local and state resource managers respond to growing pressures from agriculture, shoreland development, and many other demands on water resources including potential for spread of invasive species, and challenges associated with a changing climate.

This project builds on previous shallow lakes research in Minnesota, extending our current knowledge regarding the causes of lake deterioration. It is also unique, however, in that it will support the development of tools for predicting future lake conditions and evaluating management actions appropriate for mitigating future threats.

Overall GOALS of the project and HOW the project will achieve these goals: We propose a three-step approach to assess current and future threats to water quality and overall health of Minnesota's shallow lakes:

- Conduct an intensive survey of the current status of Minnesota shallow lakes (Fig. 1A). This survey will build on and utilize the MN DNR Shallow Lakes Program, fill in existing geographic data gaps, and provide current information on spatial "hotspots" or areas with clusters of healthy and unhealthy lakes.

- Develop statistical models that identify the factors associated with both healthy and unhealthy lakes (Fig. 1B), and evaluate whether key drivers of lake quality vary across the state.

- Forecast changes in shallow lakes due to future threats in Minnesota (e.g. climate change, increased agriculture in watersheds, more extensive ditching) (Fig. 1C). Models will be developed to help managers identify primary causes of poor water quality and lake health, evaluate future threats to shallow lakes, and determine management actions that can mitigate or minimize impacts.

Efforts described here build on previous LCCMR-funded shallow lake studies by our group during 2010-11, but the current project is unique in several ways.

First, here we focus on a statewide assessment of shallow lake quality. Previous LCCMR research helped to clarify variables indicating lake quality, but also showed a need for a more extensive sampling across the state.

Second, the proposed study connects shallow lake quality to factors responsible for declines at a large geographic (Ecological Section) scale. This will improve our understanding of the factors responsible for lake quality, help project future status and trends in shallow lakes, and aid in conservation planning.

Third, we propose to develop tools useful for forecasting changes in Minnesota lakes in response to anticipated loss of grasslands and riparian areas in lake watersheds, and changes in temperature, precipitation patterns and hydrologic conditions. Such "future lake-condition models" should be extremely useful for lake managers and conservation planners responsible for making informed policy decisions that impact water quality in Minnesota.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: CONDUCT AN INTENSIVE SURVEY OF THE CURRENT HEALTH OF MINNESOTA SHALLOW LAKES; characterize shallow lake conditions by Ecological Sections **Budget: $ 311,904**

Outcome	Completion Date
1. Provide detailed spatial analysis of shallow lake water quality and lake health, determine whether there are clusters of healthy and unhealthy lakes.	*January 2017*
2. Establish measurement criteria useful for ranking shallow lake condition and assessing trends in shallow lake status.	*January 2017*

Activity 2: DEVELOP STATISTICAL MODELS THAT IDENTIFY THE PRIMARY DETERMINANTS OF BOTH HEALTHY AND UNHEALTHY LAKES; connect lake quality to adjacent landscape characteristics **Budget: $ 71,019**

Outcome	Completion Date
1. Identify variables driving water quality and lake health across the state of Minnesota, assess whether key drivers of lake quality vary across the state.	*June 2017*
2. Provide management recommendations to local, county, and state lake managers based on our analysis of what drives health of shallow lakes across the state.	*June 2017*

Activity 3: DEVELOP PREDICTIVE MODELS FOR LAKE MANAGERS: DEVELOP CONCEPTUAL AND QUANTITATIVE MODELS TO FORECAST FUTURE SHALLOW LAKE CONDITIONS in response to changes in watersheds, land-cover and land-use patterns, hydrologic features, temperature and precipitation **Budget: $ 50,300**

Outcome	Completion Date
1. Develop predictive models to assess future threats based on data collected in Activity 1 and the statistical models developed in Activity 2. Some example threats include increased nutrient runoff, climate change, increased connectivity, and increased agricultural areas in watersheds.	*June 2017*
2. Provide guidance to lake managers for acting proactively on future threats for MN shallow lakes.	*June 2017*

III. PROJECT STRATEGY

A. Project Team/Partners - We've assembled a diverse team of shallow lake ecologists and modelers from DNR, UM, University of St. Thomas (St. Paul), and a private consultant with a strong track record of international research (also Emeritus faculty member at UM). Most team members have collaborated previously. Team members include: J. Fieberg (presently DNR; UM beginning fall 2013), N. Hansel-Welch (DNR), M. Hanson (DNR), B. Herwig (DNR), W. Hobbs (Science Museum), A. Starfield (UMN Emeritus), R. Wright (DNR), K. Zimmer (St Thomas), and J. Cotner (UM). All co-investigators will share in performing Activity 1, but only Fieberg, Hobbs, Starfield, and Zimmer will receive salary support. Fieberg and Starfield will jointly conduct modeling of lake characteristics and will supervise a MS student; collectively, they will collaborate closely with lake scientists in development of empirical modeling described in Activity 2. Fieberg, Starfield, and the MS student will also lead efforts to develop frame-based models for predicting future shallow lake conditions as outlined in Activity 3.

B. Timeline Requirements - Data required for assessments of shallow lake water quality and health will be collected during 2014 and 2015 (Activity 1). Data summaries and preliminary model development for assessing current shallow lake conditions will be developed during 2015-16 (Activity 2). Products from site-level lake models will be used to generate ECS Section-specific models during 2015 and 2016 (Activity 3).

C. Long-Term Strategy and Future Funding Needs - We anticipate that funding needs will extend from 1 July 2014 – 30 June 2017. No subsequent needs for this project are anticipated.

2014 Detailed Project Budget

Project Title: Shallow lakes: assessing quality and predicting future change

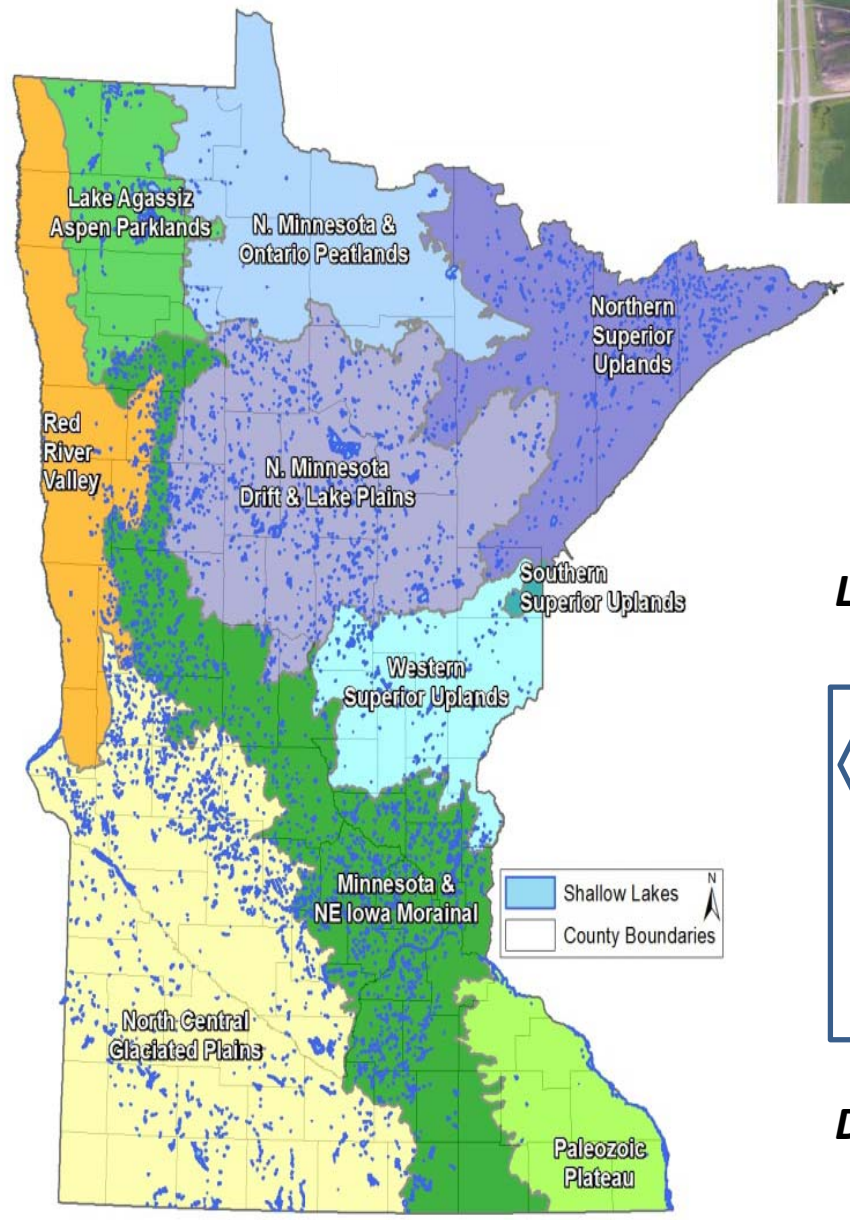
IV. TOTAL ENRTF REQUEST BUDGET: $433,223 years: 3

BUDGET ITEM	AMOUNT	
Personnel:	$	-
DNR interns - approximately 6 - ea. at approximately 3-4 mos. summer salary during each of 2 yr (approximately $12 per hr)	$ 87,360	
DNR GIS technician - 50% - time for approximately 1 yr (approximately $14 per hr)	$ 15,000	
Contracts:	$	-
UM/Fieberg - CoPI - 1 mo. salary - Supervise analytical aspects of project;	$ 10,718	
UM/1 MS student - supervised by Fieberg - conduct logistical aspects of model development - 12 mo. salary, tuition - 2 yrs, graduate student support	$ 80,601	
Ecological modeler/Starfield - consulting role oversee development of predictive modeling tools	$ 30,000	
SCWRS/Hobbs - CoPI - conduct paleolimnological aspects - 1 mo. salary - 3 yrs; lab costs for analyses of lake sediments supporting Activity 1	$ 54,980	
UST/Zimmer - CoPI on overall project - 1 mo. salary - 3 yrs; lab costs for analyses of lake waters supporting Activity 1	$ 37,278	
UST/Undergraduate interns - 2 students - supervised by Zimmer - approximately 6 mos. each yr	$ 27,768	
Direct and Necessary Services required to support this appropriation	$	17,438
Equipment/Tools/Supplies:	$	-
Field sampling gear-fish nets	$ 15,000	
Light meters to measure lake water transparency	$ 3,500	
Lab chemicals and supplies	$ 1,500	
Acquisition (Fee Title or Permanent Easements): *NA*	$	-
Travel, Lodging, Per diem expenses:	$	-
Mileage for traveling to collect data from 250 lakes	18840	
Lodging for approximately 10 student interns during 2014 and 2015	8600	
Per diem and field expenses for approximately 10 student interns during 2014 and 2015	24640	
Additional Budget Items:		
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$	433,223

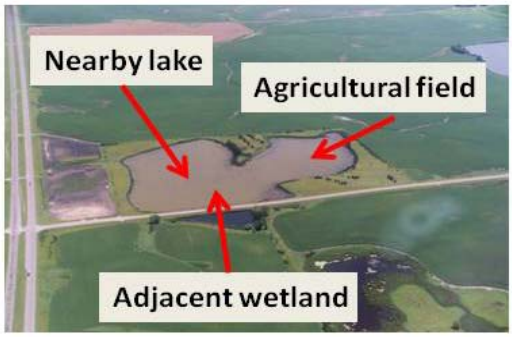
V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period:	$ -	
Other State $ Being Applied to Project During Project Period:	$ -	
In-kind Services During Project Period:		
Hanson salary (DNR source) - approximately 680 hrs per yr; 3 yr	$ 68,340	Secured
Herwig salary (DNR source) - approximately 460 hrs per yr; 3 yr	$ 37,100	Secured
Hansel-Welch salary (DNR source) - approximately 80 per yr; 3 yr	$ 8,000	Secured
Wright salary (DNR source) - approximately 320 hrs; GIS data development and project support	$ 11,200	Secured
Project start-up costs-preliminary field activities, lake site selection, 2014	$ 37,000	Secured
Fleet costs supported by DNR	$ 3,000	Secured
Funding History: Support from LCCMR ENRTF - M.L. 2010, Chap. 362, Sec. 2, Subd. 5g	$ 262,000	past ENRTF-2010/11

Panel A. Extensive sampling of lakes



Panel B. Connect Inputs from adjacent landscape habits



Panel C. Predict future lake condition

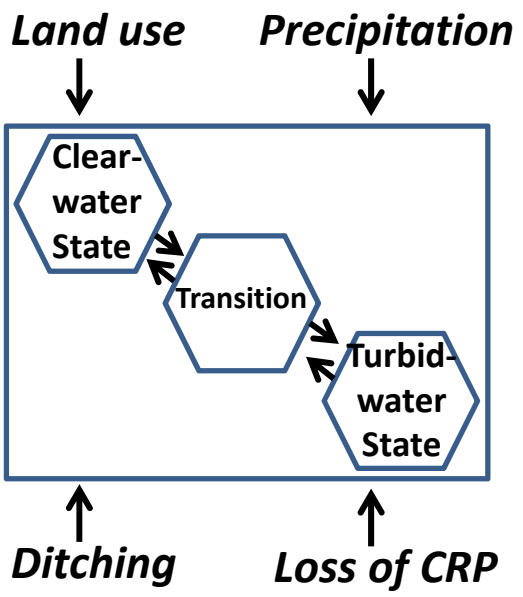


Figure 1. Overall study strategy. **Panel A** shows extent of Ecological Sections where shallow lake sampling is proposed **(Activity 1)**. **Panel B** indicates connections between landscapes inputs and imbedded lakes; these connections (arrows) will be modeled in **Activity 2**. **Panel C** illustrates frame-based modeling approach (**Activity 3**) we plan to use to predict predominant future lake conditions. Predictions will be based on lake responses to potential landscape modifications and other changes within the Ecological Sections.

Mark A. Hanson
Wildlife Research, Wetland Wildlife Populations & Research Group,
Division of Fish & Wildlife, Minnesota Department of Natural Resources
102 23rd NE, Bemidji, MN 56601
ph. (218)308-2283; fax (218)755-2604; mark.hanson@dnr.state.mn.us

Current Position: Research Scientist and Project Leader, Wetland Wildlife Populations & Research Group

Education:

B.A. in Biology, Cedarville College (OH), 1979
M.A. in Biology, Bemidji State University (MN), 1982
Ph.D. in Zoology, North Dakota State University, 1990

Research Experience and perspective:

My research has long been directed toward development of ecologically-based management strategies for wetlands and shallow lakes. I have focused broadly on wetland ecology, relationships among wetland-dependent wildlife species, and interactions between wetland and shallow lake communities and landscape features. Long-term research themes have centered on food web interactions and effects of fish as structuring influences on native communities of invertebrates and water quality features of prairie wetlands and shallow lakes. Most recently, with collaborators and students, I have sought to identify and measure influences of upland vegetation features on communities and hydrological processes in small wetlands, and to use scale- and watershed-dependent landscape characteristics to model fish and invertebrate communities, and regime dynamics (shallow- v. clear-water states) in shallow lakes.

Other Recent Projects:

2010-2011	Sustainable, Cost-Effective Approaches to Management of Shallow Lakes (LCCMR-funded; with B. Herwig, K. Zimmer co PIs)
2004-2007	Functional linkages among landscapes and shallow lakes: evaluating roles of land use and fish on shallow lake characteristics. (with B. Herwig and K. Zimmer co PIs)
2000-2004	Efficacy of forested buffers for conservation of small wetlands (with B. Palik and others)
2000-2003	Evaluating use of walleye fry to suppress fathead minnow populations in shallow lakes (with B. Herwig and others).
1999-2005	Measuring responses of seasonal wetland communities to age structure and removal of adjacent forest (with students and others)

Publications Related to This Proposal:

Herwig, B.R., L.W. Schroeder, K.D. Zimmer, **M.A. Hanson**, D.F. Staples, R.G. Wright, and J.A. Younk. Fish influences on amphibian presence and abundance in prairie and parkland landscapes of Minnesota, U.S.A. Journal of Herpetology 37: In Press.

Kissoon, L.T., D.L. Jacob, **M.A. Hanson**, B.R. Herwig, S. Bowe, and M.L. Otte. 2013. Macrophyte distribution in Minnesota shallow lakes: relationships with water, sediment, and watershed characteristics. Aquatic Botany 109: 39-48.

Hanson, M.A., B.R. Herwig, K.D. Zimmer, J. Fieberg, S.R. Vaughn, R.G. Wright, and J.A. Younk. 2012. Comparing effects of lake-and watershed-scale influences on communities of aquatic invertebrates in shallow lakes. PLoS ONE: 7(9): e44644. Doi:10.1371/journal.pone.0044644.

Friederichs, S.J., K.D. Zimmer, B.R. Herwig, **M.A. Hanson**, and J.R. Fieberg. 2011. Total phosphorus and piscivore mass as drivers of food web characteristics in shallow lakes. Oikos 120: 756-765.

Zimmer, K.D., **M.A. Hanson**, B.R. Herwig, and M.L. Konsti. 2009. Thresholds and stability of alternative regimes in shallow prairie-parkland lakes of central North America. Ecosystems 12:843-852.