Environment and Natural Resources Trust Fund (ENRTF)
2010 Work Program

Date of Report: November 24, 2009 (Revisions December 18, 2009)
Date of Next Progress Report: June 30, 2012
Date of Work Program Approval:
Project Completion Date: June 30, 2012

I. PROJECT TITLE: Assessment of Shallow Lake Management

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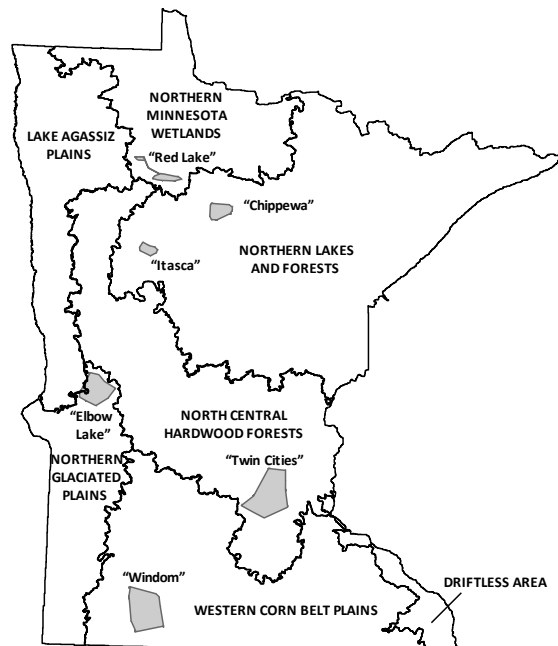
Location: 6 study areas as indicated below

Figure 1.   Map showing locations of proposed study landscapes (shaded gray) in relationship to Minnesota's aquatic ecoregions (thick black lines).

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Total ENRTF Project Budget: ENRTF Appropriation $ 262,000
                                    Minus Amount Spent: $ 0
                                    Equal Balance: $ 262,000

Legal Citation: M.L. 2010, Chap. 362, Sec. 2, Subd. 5g

Appropriation Language:
$262,000 is from the trust fund to the commissioner of natural resources to evaluate the major causes of deterioration of shallow lakes in Minnesota and evaluate results of current management efforts. This appropriation is available until June 30,2013, by which time the project must be completed and final products delivered.

II. PROJECT SUMMARY AND RESULTS:

Minnesota's shallow lakes provide numerous direct human benefits such as clean water, hydrologic storage to limit flooding, recreational opportunities, and access to unique wild areas. They also contribute valuable ecosystem services including carbon sequestration and habitat for native species. Unfortunately, water and habitat quality of Minnesota's shallow lakes have deteriorated dramatically during the past century. Conversion from native upland covers, widespread wetland drainage and surface-water consolidation to facilitate agricultural and urban/residential development have been implicated as major causes for these changes. We propose to study approximately 150 shallow lakes in 5 ecological regions of Minnesota to:
- Identify major factors leading to deterioration
- Evaluate results of specific lake restoration approaches, including cost-effectiveness of various combinations of lake management strategies
- Assess the impacts of increased surface water connectivity on fish invasions and resulting habitat quality

Our efforts will include: comprehensive sampling of shallow lakes to identify direct and indirect causes of deterioration, evaluation of approximately eight lakes currently undergoing rehabilitation, and economic analyses to determine which restoration strategies are likely to produce the greatest improvements in water quality and other lake characteristics per unit cost. Research results will provide to lake managers scientific synthesis and practical guidance for shallow lakes throughout Minnesota and will be made available in the form of scientific publications and a synthesis document especially for lake management. Ultimately, our results will help guide municipalities, state, county, and local governments, and private organizations in identifying cost-effective approaches for maintaining and restoring ecological integrity of shallow lakes throughout Minnesota. Special attention will be directed towards development of regionally-specific recommendations for sustainable lake management.

III. PROGRESS SUMMARY: November 24, 2009

IV. OUTLINE OF PROJECT RESULTS:

RESULT 1: Identify and estimate major factors responsible for deterioration of shallow lakes in 6 areas of Minnesota

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Description: We propose to gather data from, and characterize watershed features of approximately 140 shallow lakes (hereafter Extensive lakes) from 6 regions of Minnesota (Figure 1). Lakes will be sampled once each summer (July) to assess general ecological features and determine whether basins exhibit characteristics of clear- or turbid-water regimes. Lake watershed characteristics associated with each study lake will also be determined by creating and applying numerous lake watershed variables via GIS technology and interpretation of aerial photography. Resulting data will be used to develop models to identify combinations of variables that explain most variability in shallow lake characteristics, especially water quality features and lake regime status (turbid or clear). Special attention will be given to assessing influences of resident fish populations, extent of surface-water connectivity associated with study lakes, and proportion of agriculture in lake watersheds because these are believed to be major determinants of water quality in Minnesota's shallow lakes. Resulting data will help identify and estimate magnitude of major factors responsible for deterioration of water quality and ecological characteristics in our regional subsets of study lakes.

Summary Budget Information for Result 1:	**ENRTF Budget:**	**$ 124,000**
	Amount Spent:	**$ 0**
	Balance:	**$ 124,000**

Deliverables	**Completion Date**	**Budget**
A. Provide a clear understanding of specific roles of fish as determinants of shallow lake water quality and habitat features along regional gradients. This will require us to:		
1. Identify and select approximately 140 shallow lakes for use as study sites (Winter 2009-2010)		Non-LCCMR
3. Purchase field work supplies	Aug 30, 2011	$ 6,000
4. Travel/lodging to research sites in Minnesota	Aug 30, 2011	$ 25,000
2. Gather biological, chemical, and physical data samples from approximately 140 lakes (support for 4 field interns during July 2010- August 2011; methods described in Research Addendum)	Aug 30, 2011	$ 36,000
5. Processing samples in lab; catalog resulting data (Sept 2010-March 2011); construct models relating shallow lake characteristics to features of lake watersheds and physical properties of basins (support for 4 lab interns during Sept 2011-March 2011; methods described in Research Addendum)	Mar 30, 2012	$ 18,000
6. Investigator summer salary (Kyle Zimmer, Univ St. Thomas-1.5 mo.)	Aug 30, 2011	$ 10,000
7. Technician salary (Univ MN; 50% - 1 yr)	Aug 30, 2011	$ 29,000
B. Develop and distribute recommendations for management to improve habitat conditions in shallow lakes. To accomplish this, we will:		
1. Integrate results to form a project synthesis document to convey research results directly to shallow lake managers in Minnesota		Non-LCCMR

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2. Convene a regional workshop for communication and information exchange with technical experts and lake managers		Non-LCCMR
2. Develop manuscripts for publication in scientific literature		Non-LCCMR

Result Completion Date: June 30, 2012

Result Status as of December 31, 2010

Result Status as of June 30, 2011

Result Status as of December 31, 2011

Result Status as of March 31, 2012

Final Report Summary: June 30, 2012

RESULT 2: Evaluate and refine specific strategies for improving water quality and ecological characteristics of shallow lakes across Minnesota

Description: We propose to evaluate responses of 8 shallow lakes (hereafter Intensive lakes) currently undergoing lake restoration treatments such as draw downs or fish community manipulation. Ecological characteristics of Intensive lakes will be sampled monthly from May-August during 2 summers, including all components measured in the 140 Extensive sites. Identical landscape-level analyses will be conducted on these areas to determine upland cover and surface-water connectivity in lake watersheds using GIS analysis and aerial photography interpretation. Combining results and data from Intensive and Extensive lakes (Result 1), we will estimate water quality improvements in response to various combinations of treatments including upland restoration and within-lake-basin measures such as fish community manipulation. Specific efforts will be directed to evaluating responses of the Intensive lakes to management applied on each lake. Resulting empirical data from Extensive (140) and Intensive (8) lakes will be integrated and used in an economic analysis comparing various combinations of management costs and lake water quality outcomes. Empirical and economic analyses will provide guidance useful for refining and maximizing efficacy of future lake management efforts with specific attention to variability in lake responses and costs of rehabilitation techniques across different ecological regions of the state.

Summary Budget Information for Result 2: ENRTF Budget: $ 123,000
Amount Spent: $ 0
Balance: $ 123,000

Deliverables	Completion Date	Budget
A. Evaluate current shallow lake restoration strategies using a case study approach to document responses of selected reclamation lakes		

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1. Select approximately 8 lakes presently undergoing rehabilitation for use as case-study sites (Winter 2009-2010) in association with efforts of Ducks Unlimited, the Minnesota DNR Shallow Lakes Program, and perhaps other groups		Non-LCCMR
2. Purchase field work supplies	Aug 30, 2011	$6,000
3. Purchase 2 14-ft aluminum boats with small outboard motors-for use sampling 8 intensive lakes	July 10, 2010	$ 8,000
4. Travel/lodging to research sites in Minnesota	June 30, 2011	$ 25,000
5. Intensively sample biological, chemical, and physical data samples from 8 case-study lakes (support for 4 field interns during July 2010- August 2011; methods described in Research Addendum)	Aug 30, 2011	$ 36,000
6. Processing samples in lab; catalog resulting data (support for 4 lab interns during Sept 2010-March 2012); construct models relating shallow lake characteristics to features of lake watersheds and physical properties of basins (Sept 2011-March 2012)	June 30, 2012	$ 18,000
B. Develop region-specific guidelines useful for identifying cost effective reclamation approaches enabling optimization strategies		
1. Review 8 case-study responses; combine with data from previous lake rehabilitation efforts in Minnesota to develop summary of generalized responses of shallow lakes to various management approaches		Non-LCCMR
2. Conduct cost-benefit analyses comparing water-quality improvements to be expected from various combinations of lake rehabilitation practices (Contract with P. Welle, Bemidji State University)	June 30, 2012	$ 30,000
3. Convene a regional workshop for communication and information exchange with technical experts and lake managers		Non-LCCMR
4. Incorporate results a project synthesis document (identified for Result #1 above) to convey research results directly to shallow lake managers in Minnesota		Non-LCCMR

Result Completion Date: June 30, 2012

Result Status as of December 31, 2010

Result Status as of June 30, 2011

Result Status as of December 31, 2011

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Result Status as of March 31, 2012

Final Report Summary: June 30, 2012

RESULT 3: Identify surface connectivity elements threatening water quality and biodiversity in shallow lakes

Description: The health of shallow lakes is a reflection of their upstream and downstream watersheds and the hydrologic connectivity within those watersheds. Increased surface water connectivity due to drainage, ditching, road construction, and other anthropogenic activities is known to increase the transfer of organisms, especially undesirable fishes, among shallow lakes in Minnesota. Such connectivity probably also provides major pathways for the spread of invasive species, which threaten native communities.

This effort will identify, delineate and digitize unmapped natural and human created water conveyance features that constitute present-day surface water connectivity. Using data from the Extensive (140) and Intensive-lakes (8), we propose to document water quality, biodiversity, and habitat characteristics and measure their response to various surface water connectivity scenarios. This will allow the development of models useful for assessing probable results from increased surface water connectivity within the watersheds. We believe this will provide useful data and guidance for natural resource managers who frequently must respond to specific requests for landscape modifications that increase surface-water connectivity, runoff and channelized flow contributing to decreased water quality and ecological conditions in shallow lakes throughout Minnesota.

Summary Budget Information for Result 3:   **ENRTF Budget:**   **$ 15,000**
                                                      Amount Spent: **$ 0**
                                                      Balance: **$ 15,000**

Deliverables	Completion Date	Budget
A. Delineations of shallow lake watersheds and surface connectivity networks; determine extent of land cover types within watersheds; summarize resulting data (1 mo. Salary support – hydrologist - Sean Vaughn)	June 30, 2011	$ 15,000
B. Distribute resulting electronic data through DNR (Division of Waters) web links		Non-LCCMR
C. Construct models relating lake watershed characteristics to lake watershed size, surface connectivity, and flow patterns to biological and chemical characteristics of shallow lakes		Non-LCCMR
D. Incorporate recommendations for improved strategies for controlling spread of invasive species by identifying		Non-LCCMR

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key connectivity elements needed to preserve natural biodiversity of shallow lakes into final synthesis document (identified for Result #1 above)		

Result Completion Date: June 30, 2012

Result Status as of December 31, 2010

Result Status as of June 30, 2011

Result Status as of December 31, 2011

Result Status as of March 31, 2012

Final Report Summary: June 30, 2012

V. TOTAL ENRTF PROJECT BUDGET:

Personnel: $ 192,000 Funds requested here will not be used to support classified Minnesota DNR staff positions [costs of classified staff positions are summarized under VI. C below]. Project salary $$ will support 8-10 DNR student interns and 1 technician at University of MN (50%, 1 yr), along with 1.5 month salary support for K. Zimmer. No backfill will be necessary for any of these positions.
Contracts: $ 0
Equipment/Tools/Supplies: $ 18,000
Acquisition (Fee Title or Permanent Easements): $ 0
Travel: $ 52,000
Additional Budget Items: $ 0

TOTAL ENRTF PROJECT BUDGET: $ 262,000

Explanation of Capital Expenditures Greater Than $3,500: Repeated sampling of 8 "Intensive lakes" will require two 14-ft flat bottom boats with small outboard motors.

VI. PROJECT STRATEGY:

A. Project Partners: Our project team has 11 collaborators representing one NGO, state, university, and tribal representatives. Scientific investigations will be lead by S. Bowe (Red Lake DNR), J. Cotner, (UM), N. Hansel-Welch, M. Hanson, B. Herwig (MDNR), P. Welle (Bemidji State University), J. Younk (MDNR), and K. Zimmer (University of St. Thomas). Logistical and financial support also will be provided by Ducks Unlimited (DU, R. Heiniger and J. Schneider) and NSF (through REU to Cotner). Hydrological interpretations, data summaries, and analysis will be conducted and overseen by S. Vaughn (MDNR). Along with an extensive set of 140 shallow lakes, study areas will include approximately 8 lakes currently targeted for restoration by MDNR, USFWS, and MN DU using new LOHC funds.

B. Project Impact and Long-term Strategy: Shallow lakes in Minnesota have deteriorated. Numerous factors work together to reduce water quality and ecological characteristics of these areas; some of these influences are well known, others are not. For example, carp and other

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undesireable fishes are known to limit water quality and reduce plant diversity in shallow lakes, yet mechanisms contributing to distribution of carp and other fish species in shallow lakes are poorly known. Also, contributions of other factors such as extent and condition of upland cover types within lake watersheds, influences of ecological regions and regional gradients, and interactions among key drivers are not known. Presently, lake managers are in need of scientific evidence and practical guidelines for future management of shallow lakes throughout Minnesota. More specifically, managers need regionally-specific guidance to identify lake management strategies that are cost-effective and have high probability of success in various ecological regions of the state.

C. Other Funds Proposed to be Spent during the Project Period: $ 433,686 Other state, non-state, University, and NGO support has been committed to the project. Pending support from Minnesota DNR Sections of Fisheries and Wildlife and Division of Ecological Resources will cover permanent staff salaries, research supplies and non-capital equipment, and travel to field research sites ($232,790). Secured support from The Red Lake Reservation Department of Natural Resources includes funds for permanent staff salary, support of a graduate student and student interns, non-capital research equipment and supplies, and travel and lodging expenses ($162,396). Support for non-capital equipment and undergraduate student assistants has been secured from the University of St. Thomas and the University of Minnesota ($28,500). Ducks Unlimited MN has committed funds and in-kind support for data gathering activities ($10,000).

D. Spending HIstory: *None*

VII. DISSEMINATION: We anticipate several peer-reviewed publications from major aspects of this research. In addition, we plan to develop a project summary that will provide regionally-specific guidelines for shallow lake managers in Minnesota. Due to length of time required to process and analyze biological samples, manuscripts for peer-review journals will be developed after June 2012.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than at 6 mo. intervals as described. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS: Research Addendum attached

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Attachment A: Budget Detail for 2010 Projects											
Project Title: Sustainable, Cost-Effective Approaches to Management of Shallow Lakes											
Project Manager Name: Mark A. Hanson											
Trust Fund Appropriation: $ 262,000											

2010 Trust Fund Budget	Result 1 Budget:	Amount Spent *(date)*	Balance *(date)*	Result 2 Budget:	Amount Spent *(date)*	Balance *(date)*	Result 3 Budget:	Amount Spent *(date)*	Balance *(date)*	TOTAL BUDGET	TOTAL BALANCE
	Identify and estimate major factors responsible for deterioration of shallow lakes in 6 areas of Minnesota			Evaluate and refine specific strategies for restoring shallow lakes in Minnesota			Identify surface connectivity elements threatening water quality and biodiversity in shallow lakes				
BUDGET ITEM											
PERSONNEL: wages and benefits											
Student Interns (4) - 140 Extensive lakes (per each approximately 4 mos during each year)	54,000	0	54,000			0			0	54,000	54,000
Student Interns (4) - 8 Intensive lakes (per each approximately 4 mos during each year)			0	54,000	0	54,000			0	54,000	54,000
Sean Vaughn (DNR Hydrologist-25% time - 1			0			0	15,000	0	15,000	15,000	15,000
Kyle Zimmer (Univ St. Thomas- 1.5 mo.summer salary)	10,000	0	10,000			0				10,000	10,000
UM technician (1;supervised by J.Cotner-50% 1	29,000	0	29,000			0		0		29,000	29,000
Contracts			0			0		0		0	0
Bemidji State University - Graduate student support			0	30,000	0	30,000		0		30,000	30,000
Capital equipment over $3,500			0			0		0		0	0
2 14-ft aluminum boats with small outboard motors-for use sampling 8 intensive lakes			0	8,000	0	8,000				8,000	8,000
Supplies			0			0		0		0	0
Field sampling gear, nets, etc.	3,500	0	3,500	3,500	0	3,500		0		7,000	7,000
Lab supplies, storage containers, etc.	2,500	0	2,500	2,500	0	2,500		0		5,000	5,000
Travel expenses in Minnesota			0			0		0		0	0
Travel (fleet/fuel costs) to 140 extensive lakes	18,000	0	18,000			0		0		18,000	18,000
Lodging to sample 140 extensive lakes	5,400	0	5,400			0		0		5,400	5,400
Per diem to sample 140 extensive lakes	1,600	0	1,600			0		0		1,600	1,600
Travel (fleet/fuel costs) to 8 case study lakes			0	18,000	0	18,000		0		18,000	18,000
Lodging to sample 8 case study lakes			0	5,400	0	5,400		0		5,400	5,400
Per diem to sample 8 case study lakes			0	1,600	0	1,600		Per 0		1,600	1,600
Other			0			0		0		0	0
COLUMN TOTAL	$124,000	$0	$124,000	$123,000	$0	$123,000	$15,000	$0	$15,000	$262,000	$262,000
Date: 12-29-09											