

**Environment and Natural Resources Trust Fund
2010 Request for Proposals (RFP)**

LCCMR ID: 023-A3

Project Title:

Adapting Aquatic Resource Management to a Changing Climate

LCCMR 2010 Funding Priority:

A. Water Resources

Total Project Budget: \$ \$599,345

Proposed Project Time Period for the Funding Requested: 3 years, 2010 - 2013

Other Non-State Funds: \$ \$33,312

Summary:

We will develop tools and recommendations for adapting the management of Minnesota's aquatic ecosystems to changes in climate, with an emphasis on predicting future fish habitat in lakes and streams.

Name: Lucinda Johnson

Sponsoring Organization: UMD, NRRI

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Location:

Region: Statewide

County Name: Statewide

City / Township:

_____ Knowledge Base	_____ Broad App.	_____ Innovation
_____ Leverage	_____ Outcomes	
_____ Partnerships	_____ Urgency	_____ TOTAL

PROJECT TITLE: Adapting Aquatic Resource Management to a Changing Climate

I. PROJECT STATEMENT:

Large changes are upon us or coming - we need to understand them and adapt as quickly as possible. Changing storm intensities, season lengths, river flows and temperatures will impact all of Minnesota's ecosystems and the services they provide. In addition to reducing greenhouse gas emissions, we must address the realities of anticipated ecosystem responses to changing climate. We will develop predictive models to provide information on hydrology and water quality which in turn will project changes of brook-trout habitat in streams and fish habitat in lakes. **The overall aim of this project is to provide tools and recommendations for adapting the management of Minnesota's aquatic ecosystems to changes in Minnesota's climate.**

The Statewide Conservation and Preservation Plan (SCPP) identified vulnerable areas within the state based on human-derived stressors and the relative value of particular aquatic resources, absent climate change. But vulnerability of aquatic ecosystems will be influenced by climate change. Impacts of future climate change will, in general, worsen the impacts of current anthropogenic stressors. Using climate projections calibrated to six regions within Minnesota and vulnerability assessments from the SCPP we will employ a risk assessment framework to: **1) develop and apply mechanistic models to predict characteristics of Minnesota's aquatic resources under future climate scenarios; 2) assess the vulnerability of specific aquatic resources to climate change with respect to specific stressors; 3) develop specific recommendations for adaptation and mitigation; and 4) expand an Internet tool (initiated under current funding from LCCMR) to deliver resulting data and recommendations to managers and stakeholders.** Results from LCCMR-funded projects ("Impacts on aquatic resources from climate change" [2006], and "Minnesota's Water Resources: Impacts of Climate Change - Phase II" [2007]) will contribute to this effort and result in better-informed policy and management options under changing climate regimes.

II. DESCRIPTION OF PROJECT RESULTS

Result 1: Risk assessment for climate change.

Budget: \$ 332,439

We will develop a set of spatially-explicit projections of hydrological and ecological conditions, and identify the primary threats to Minnesota's aquatic resources. Stressors such as temperature, eutrophication, stormwater runoff, drought, susceptibility to invasive species, turbidity, erosion and other impairments will be quantified. Human-induced stressors to aquatic ecosystems are expected to be exacerbated by increased water temperatures and peak flows, as well as changes in precipitation patterns. We will augment results from the 2006 and 2007 LCCMR climate projects by developing and applying causal models that incorporate current and projected climate variables (e.g., air temperature, relative humidity, wind speed, and precipitation). Such models, which couple climate to aquatic systems, have been developed previously, and after adaptation and testing over specific areas and time frames, can serve the purposes of this project. Using case studies conducted along climatic and disturbance gradients, we will model seven endpoints sensitive to climate change: 1) stream temperatures, 2) stream flow, 3) stream nutrient loading, 4) lake levels, and 5) lake water quality, 6) brook trout habitat (streams) and 7) fish habitat (lakes). Model estimates will be made for current and future climate conditions; data recorded under current and past conditions will be used to test the models. The results will provide new information, along with measures of uncertainty, on the response of aquatic ecosystems to predicted climate change for prioritizing mitigation and adaptation strategies.

Deliverables

1. **Compilation of statewide stream and lake data**
2. **Statewide quantification of non-climate stressors**
3. **Quantified responses to current and future climate**

Completion Date

Dec 2011
June 2012
June 2013

Result 2: Vulnerability map for aquatic ecosystems.

Budget: \$ 104,028

Adapting Aquatic Resource Management to a Changing Climate

In the SCPP, aquatic resource value was mapped and stress levels were overlain on an aquatic resource value map to identify vulnerable areas (See Map). We will improve the utility of the SCPP vulnerability index by incorporating stressors related to climate change. Data reflecting the combined impacts of climate change, non-climate stressors, and resource value (system rarity, biodiversity, economic use, cultural use, water quality and quantity) will be evaluated for inclusion in this index. A risk assessment protocol will be used to develop refined vulnerability predictions.

Deliverable

Enhanced SCPP vulnerability data and maps

Completion Date

June 2013

Result 3: *Recommend appropriate conservation and management practices.*

Budget: \$ 54,682

We will identify the most appropriate conservation practices or programs (e.g., land purchase, CRP, RIM, BMP) for a given resource based on human stresses and climate change using the enhanced vulnerability data (Result 2) and MN-specific climate projections (2007 project). The SCPP identified tiers of practices for resources with varying levels of vulnerability. The updated vulnerability data will be used to recommend climate-sensitive protection and conservation strategies across Minnesota. These recommendations may be helpful in identifying and prioritizing restoration and conservation projects for distribution of habitat and clean water project funds.

Deliverable

Recommended practices based on spatially explicit vulnerability data

Completion Date

June 2013

Result 4: *Develop a searchable map-based tool for disseminating results.*

Budget: \$ 108,196

This on-line tool will allow users to: 1) select specific streams, lakes or groups of lakes to retrieve trends and relationships between stream/lake condition, stressors, and climate; 2) retrieve historic and current data in an easily downloadable format, and 3) graphically display trends through time for an individual stream/ lake with statistical information. Prototype data retrieval, display and visualization tools developed for the climate change projects and the SCPP will be enhanced to allow managers to query climate, water quality, and vulnerability data and easily generate trends and forecasts to complement official agency databases. This tool will provide public access to monitoring data in a timely manner to improve environmental decision making, and reduce the need for highly sophisticated GIS and programming expertise.

Deliverable

User-friendly data and forecasting tools for managers

Completion Date

December 2012

III. PROJECT STRATEGY AND TIMELINE

A. Project Partners: Dr. H. Stefan, Dr. W. Herb- Univ. Minnesota, Dept. Civil Engineering, St. Anthony Falls Laboratory; Drs. R. Axler, T. Brown and G. Host - Univ. Minnesota Duluth, Natural Resources Research Institute. Dr. K. Blumenfeld, Dept. Geography, Univ. Minnesota. Partners include staff at the MN DNR (D. Pereira, K. Rusterholz; D. Wright, J. Zandlo); MPCA (B. Wilson, P. Ciborowski, E. Swain). *See letters of support for details about agency commitments.*

B. Timeline Requirements: July 2010 – June 2013

C. Long-Term Strategy. In the 2006 project, we document trends in lake water quality, lake levels, evaporation and fish communities due to past climate conditions. The 2007 project develops empirical (statistical) models to predict future conditions based on past and projected climate. We have identified several ecosystem changes consistent with changing climate in our current project. Causal- mechanistic models will allow us to develop specific projections of the behavior of both lakes and streams based on the fundamental processes that control the system. These predictions will provide more robust predictions that can be used to design monitoring and assessment tools and practices under future climatic conditions. Our proposal addresses only aquatic resources, but similar approaches could be implemented to assess impacts and vulnerability in terrestrial systems as well. A formal vulnerability assessment, including socio-economic factors would be a logical extension of this project.

Project Budget

IV. TOTAL PROJECT REQUEST BUDGET (3 years)

BUDGET ITEM	AMOUNT
Personnel:	
Dr. Lucinda Johnson- Project Leader (Salary: \$25,180; FB \$8,132) 8%, 8%, 8%	\$ 33,312
Dr. Richard P. Axler - Result 4 Lead (\$17,059; \$5,509) 5%, 5%, 5%	\$22,568
Dr. Heinz Stefan - Result 1 Lead (\$0; \$0)	\$0
Dr. George Host - Result 2 (\$5,276; \$1,704) 0%, 0%, 5%	\$6,980
Dr. Terry Brown - GIS Programmer: Results 1,2,3,4 (\$69,894; \$22,574) 30%, 30%, 50%	\$92,468
Dr. Wm. Herb - Hydrologist Result 1 (\$81,812; \$26,424) 50%, 50%, 25%	\$108,236
Mr. Norm Will - Programmer Result 4 (\$43,155; \$15,967) 0%, 25%, 50%	\$59,122
Dr. Kenneth Blumenfeld - climatologist: Result 1 (\$31,827; \$10,280) 50%, 0%, 0%	\$42,107
Connie Host - GIS Results 1,2,3,4 (\$21,114; \$7,831) 20%, 20%, 20%	\$26,443
Graduate Research Assist. #1- Result 1 (\$58,954; \$39,053) 50%, 50%, 25%	\$98,007
Graduate Research Assist. #2 - Result 1 , 3 (\$54,324; \$38,178) 50%, 50%, 25%	\$92,502
	\$ -
Equipment/Tools/Supplies:	
	\$ -
Computer & GIS supplies	\$ 3,000
GIS access fees	\$ 5,000
Travel:	
	\$ -
Project meetings (Duluth-TC travel- 6 per year)	\$ 3,600
In-state conferences (Year 2 & 3)	\$ 6,000
Additional Budget Items:	
	\$ -
TOTAL PROJECT BUDGET REQUEST TO LCCMR	\$ 599,345

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other State \$ Being Applied to Project During Project Period: 1) L Johnson salary match 8% per year (\$33,312).	\$33,312	<i>Approved</i>
In-kind Services During Project Period: 1) Maintenance of the MPCA's ice-out database- cost is unknown. 2) Data from DNR's SLICE project sentinel lakes will be used to test models - cost of data unknown. See letters of support.	\$ -	See letters of support
Funding History: 1) LCMR 2006 \$250,000. 2) LCCMR 2007: \$300,000.	\$550,000	

Adapting Aquatic Resource Management to a Changing Climate

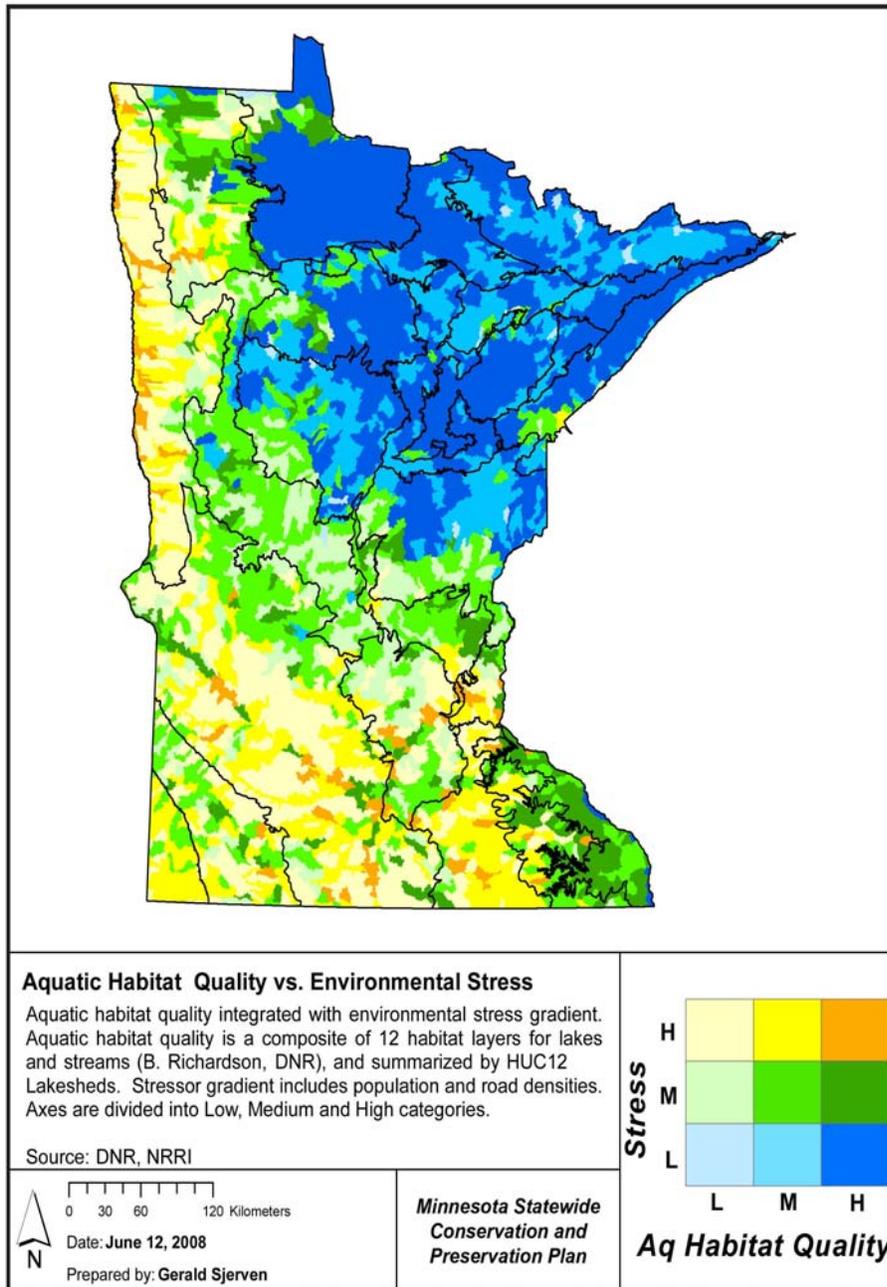


Figure 1. Project will cover and benefit the entire state of Minnesota. Result 2 will enhance this map which depicts the coincidence of habitat quality and environmental stress, by incorporating effects of changing climate.

Adapting Aquatic Resource Management to a Changing Climate

5. Project Manager Qualifications; Lucinda B. Johnson, Natural Resources Research Institute, University of Minnesota Duluth

Key Qualifications

Dr. Johnson is the Interim Center Director and a Sr. Research Associate at the Natural Resources Research Institute. She is an aquatic and landscape ecologist with broad expertise in quantifying interactions between aquatic and terrestrial ecosystems. Her research focuses on indicator development in aquatic ecosystems, and the effects of multiple stressors, including climate change, on rivers and wetlands.

Education

Michigan State University, Zoology, Ph.D. 1999

State Univ. of New York, College of Env. Sci. and Forestry, Entomology, M.S. 1984.

Duke University, Botany. B.A. 1976

Selected Grants (Total > \$14M)

Minnesota's Water Resources: Impacts of Climate Change- Phase II. Legislative and Citizen's Commission on Minnesota's Resources. \$300,000. PI, with R. Axler, R. Newman, H. Stefan, R. Skaggs, V. Card. 2007-2010.

Impacts on Minnesota's aquatic resources from climate change. LCCMR, 2006 – 2009. PI with R. Axler, V. Card, R. Newman, R. Skaggs, H. Stefan. \$250,000. 2006-2009.

Effects of multiple stressors on aquatic communities. Environmental Protection Agency, STAR Program 2003-2006. Co-PI with P Schoff, and G Guntenspergen. \$746,433. .

Testing Indicators of Coastal Ecosystem Integrity Using Fish and Macroinvertebrates, EPA-STAR, 2001-2005. PI \$893,628. Subproject of: Development of Environmental Indicators of Condition, Integrity, and Sustainability in the Great Lakes Basin, G. Niemi, and 27 P.I.'s \$6,000,000. 2001-2005.

Selected Publications:

Rohr, J.R., A.M. Schotthoefler, T.R. Raffel, H.J. Carrick, N. Halstead, J.T. Hoverman, C.M. Johnson, **L.B. Johnson**, C. Lieske, M.D. Piwoni, P.K. Schoff, V.R. Beasley. 2008. Agrochemicals increase trematode infections in a declining amphibian species. *Nature*

Hollehorst, T., T. Brown, G. E. Host, **L.B. Johnson** and J.J.H. Ciborowski. 2007. A Multiscale Watershed Approach to Indicator Development for Coastal Ecosystems of the Great Lakes. *J. Great Lakes Res.* 33 (Special Issue 3):13-26.

Kling, G., Hayhoe, K. **L. Johnson**, J. Magnuson, S. Polasky, S. Robinson, B. Shuter, M. Wander D. Wubbles, D. Zak. 2003. *Confronting Climate Change in the Great Lakes Region. Sustaining the Ecology and Well Being of Our North American Heartland.* Union of Concerned Scientists and Ecological Society of America.

Schomberg, J., Host, G.E. **Johnson, L.B.**, and Richards, C. 2005. Evaluating the influence of landform, surficial geology, and land use on streams using hydrologic simulation modeling. *Aquatic Sciences* 67(4):528-540.

Natural Resources Research Institute is a part of the University of Minnesota Duluth. Its mission is to promote private sector employment based on natural resources, in an environmentally sensitive manner. The NRRI scientists have extensive experience in managing large, interdisciplinary projects whose objectives include the development of tools for environmental assessment and resource management. These tools promote citizen education leading to improved understanding of how human activities influence water quality and ecosystem health. Our scientists have been heavily involved in climate change work, in addition to participating as core team members of the MN Statewide Conservation and Protection Plan, where they were instrumental in developing the vulnerability index. Collaborators at the St. Anthony Falls Hydrologic Laboratory have extensive experience developing and implementing mechanistic models, including lake level, stream temperature, and lake water quality.