Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)

Project Title: How Will Changes in Evaporation Impact Our Lakes?

ENRTF ID: 067-B

Category: B. Water Resources

Total Project Budget: $ 1,197,450

Proposed Project Time Period for the Funding Requested: 3 years, July 2017 – June 2020

Summary:

Lake levels in many Northeastern Twin Cities Metropolitan Area Lakes have been at historic low levels. This project examines how evaporation (present/future) impacts lake levels and water resources.

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Location

Region: Metro

County Name: Ramsey

City / Township: White Bear

Alternate Text for Visual:

Direct measurement of evaporation from a lake using a weather station, which helps to improve water budget estimates of lakes. Better water budgets allows better understanding of lake level, water augmentation, and impacts on water quality.

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

PROJECT TITLE: How Will Changes in Evaporation Impact Our Lakes?

I. PROJECT STATEMENT

What is the Problem? Understanding the water budget of lakes is needed to effectively determine the cause of lake-level fluctuations and to assess any proposed solution to low levels. Evaporation is one of the largest components of a lake's water balance, yet it is rarely measured directly. Preliminary data from White Bear Lake (WBL) indicate that about 1.6 billion gallons of water was evaporated from the lake during 2015—the warmest year on record. A warmer climate will increase lake evaporation, but we don't know how much. An urgent need exists to examine other lakes within the same region to evaluate if they are responding similarly to climate.

Why is this project important? Minnesota lakes provide enormous economic and recreational benefits to its citizens. Lake levels in many northeastern - Twin Cities Metropolitan Area lakes, including WBL, have been at historic low levels. Water augmentation (i.e. supplemental water from other sources) strategies are being proposed for several lakes to fix the problem. It is essential to understand how changes in evaporation within the region will impact water quantity, the need for augmentation, and how that will influence water quality.

Project Goals: 1) Make direct measurements of evaporation from lakes to improve our understanding of the region's water balance; 2) Obtain water quality data to better assess how changes in lake water balance, water use, and augmentation influence future water quality; 3) Develop tools to assess how changes in regional evaporation and water use will impact water availability and water quality over the next 30 years.

Outcomes: 1) Evaporation data for two representative lakes within the region; 2) Reduced uncertainty of lake water budgets; 3) Provide tools to state hydrologists that can be used to assess the influence of climate change and water augmentation on regional water supply and lake water quality (i.e. impacts on nutrients, algal blooms, invasive species, etc); 4) The techniques developed and tested within the scope of this project will be available to be used by the MNDNR and by consultants for the evaluation of augmentation projects, and more broadly, sustainable water use within the region.

II. PROJECT ACTIVITIES AND OUTCOMES

The project will be conducted in two lakes where lake-level augmentation is being considered: White Bear and Turtle Lake. These two lakes differ in bathymetry and other physical characteristics.

Activity 1: ***Investigate the Evaporation and Water Quality of Metro Lakes*** **Budget: $785,450**

A. Evaporation and Energy Balance Study of White Bear Lake and Turtle Lake

Four eddy covariance evaporation systems (two systems in each lake) will be installed and maintained to continuously monitor evaporation (water loss) and energy exchange from the lakes over a three-year period.

B. *Water-quality Monitoring in White Bear and Turtle Lake*

Four lake temperature profiling systems (2 in each lake) will be installed to continuously monitor water temperature at various depths and locations. Monthly water-quality depth profiles will be collected near each of the lake temperature profiling systems. Monthly water-quality samples will be collected from the lakes and inflowing groundwater, and analyzed for major ion, nitrogen, phosphorous, and total organic carbon analyses.

Outcome	Completion Date
1. Determine evaporation rates and annual evaporation budgets of Turtle and WBL lakes	*4/2020*
2. Obtain water temps/dissolved oxygen concentrations over depth/time in lakes	*11/2019*
3. Assess water-quality in lake water and groundwater of Turtle and WBL lakes	*4/2020*

Activity 2: ***Investigate Future Evaporation, Lake-Level, and Water Sustainability*** **Budget: $120,000**

National Center for Atmospheric Research (NCAR) Forecasting tools will be used to simulate lake evaporation and to project how changes in climate will impact lake evaporation over the next 30 years. Water balance tools will be used to estimate available water within the region and will examine potential demands and potential impacts of lake augmentation needs within the region for likely future scenarios including changes in climate, changes in population, and changing patterns of water use.

Outcome	Completion Date
1. Obtain lake and regional evaporation rates and budgets from present-time to 2050	*11/2019*
2. Assess future augmentation needs and changes in water use and water availability	*4/2020*

Activity 3: ***Investigate the Links Between Water-Quality and Future Lake Evaporation*** **Budget: $292,000**

The hydrologic software CE-QUAL-W2 will be used with results from NCAR (above) to assess the effects of future evaporation and lake-level augmentation scenarios on the water-quality of the two lakes. These simulations will be done at the USGS, Minnesota Water Science Center.

Outcome	Completion Date
1. Simulate water temperature throughout two lakes – 2018 and 2019	*2/2020*
2. Assess effects of evaporation and lake-level augmentation on water quality – two lakes	*4/2020*

III. PROJECT STRATEGY

A. Project Team/Partners

University of Minnesota: **John Baker** is a micrometeorologist, assisting with the lake evaporation measurements; **Paul Bolstad** is a geographical information system specialist, assisting with the spatial analyses and extrapolation of evaporation to other lakes; **Tim Griffis** is a micrometeorologist, overseeing the lake evaporation measurements and evaporation modeling; **John Nieber** is a hydrologist, assisting with all aspects of the hydrologic modeling and interpretation of lake evaporation; **Shane Missaghi** is a hydraulic engineering researcher, working on the lake hydrodynamics and water quality.

U.S. Geological Survey: **Perry M. Jones**, USGS Hydrologist, managing/assisting water-quality data collection and simulations; **Erik Smith**, USGS Hydrologist, will lead water-quality assessment; **Richard Kiesling**, USGS Limnologist/Water-Quality Specialist, providing expertise in water-quality and lake hydrology.

B. Project Impact and Long-Term Strategy

Project results can be used by state agencies to improve our understanding of how climate change and human activities impact the health of Minnesota lakes. Funding through LCCMR can further help us acquire key data for understanding the long-term implications of water augmentation on the region's water supply, water-quality, and any unintended environmental consequences, such as the introduction of invasive species and adverse impacts on local species. Our study will be useful for evaluating the conditions for any lake/wetland within the northeast Twin Cities Metropolitan Area. Data-collection approach used in this project could be used as a template for assessing the effects of changing evaporation rates on lake water budgets and levels across Minnesota. The techniques developed and tested within the scope of this project will be available to be used by the MNDNR and by consultants for the evaluation of augmentation projects, and more broadly, sustainable water use within the region.

C. Timeline Requirements

A three year project (July 2017 – Sept 2020) duration is estimated based on the extensive data analyses and modeling activities outlined above.

IV. TOTAL ENRTF REQUEST BUDGET *[3]* **years**

BUDGET ITEM *(See "Guidance on Allowable Expenses", p. 13)*	**AMOUNT**
Personnel: Tim Griffis holds a 9-month appointment at the University of Minnesota. He is requesting 0.5 month of summer salary per year. Griffis will oversee the lake evaporation measurements and NCAR modeling. Griffis is requesting a total of $26,926 salary plus $9074 fringe (33.7%). Neiber and Baker hold 12-month appointments and are not requesting funds. Bolstad holds a 9-month appointment but is not requesting funds.	$ 36,000
Personnel PhD student (to be named) will analyze the data and assist Griffis with the NCAR modeling component of this project. The student salary will be $65,934 plus $54,066 fringe total for the three year study period. They will join the Graduate program in Land and Atmospheric Science.	$ 120,000
Personnel A research scientist/technician (to be named) will maintain four lake micrometeorological flux monitoring stations. The salary will be $134,576 plus $36,874 fringe (27.4%) total for the three year study period. They will work in the Dept. of Soil, Water, and Climate with Tim Griffis	$ 171,450
Professional/Technical/Service Contracts U. S. Geological Survey - will conduct Activity One, Part 2 - Water-quality Monitoring in White Bear and Turtle Lake and Activity 3 - Water-Quality Assessment of Future Lake Water Budgets	$ 746,000
Equipment/Tools/Supplies: *Two eddy covariance systems consisting of sonic anemometers and infrared gas analyzers and radiation equipment are requested for*	$ 115,000
Acquisition (Fee Title or Permanent Easements): *In this column, indicate proposed number of acres and and name of organization or entity who will hold title.*	$ -
Travel: *In-state travel to the field sites for installation and maintenance of eddy covariance and meteorological equipment. Travel will include site visits to multiple*	$ 9,000
Additional Budget Items: *In this column, list any additional budget items that do not fit above categories. List by item(s) or item type(s) and explain how number was determined One row per type/category.*	$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 1,197,450

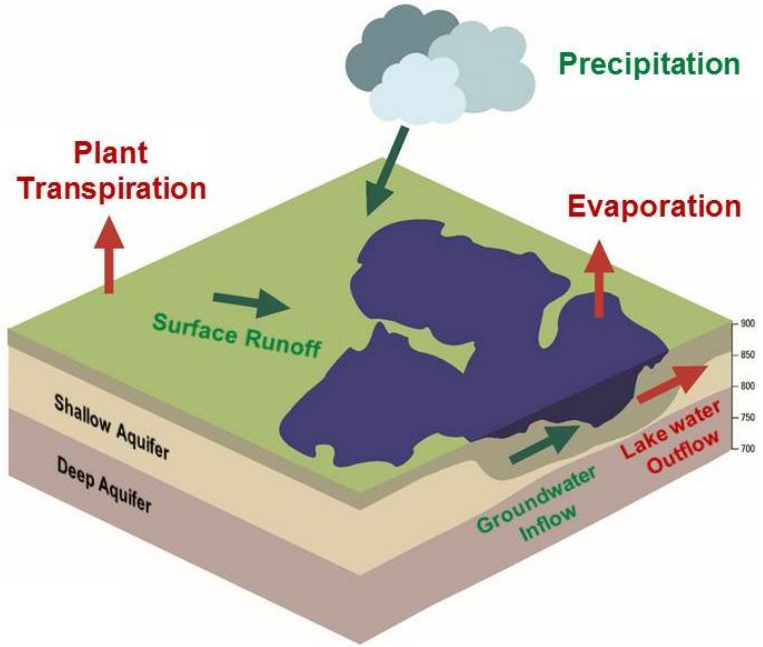
V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ To Be Applied To Project During Project Period: *USGS Cooperative funds*	$ 78,000	*Pending*
Other State $ To Be Applied To Project During Project Period: *Indicate any additional state cash dollars (e.g., bonding, other grants) secured or applied for to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.*	NA	*Indicate: Secured or Pending*
In-kind Services During Project Period: *The University of Minnesota Supercomputing Institute will provide inkind support in the form of Supercomputing units*	$ 36,000	*Secured*
Funding History: A large fraction of the *research infrastructure to be used in this research project was funded by NSF, DOE, and USDA. Proposals are pending to continue the support.*	$ 2,500,000	
Remaining $ From Current ENRTF Appropriation: *Specify dollar amount and year of appropriation from any current ENRTF appropriation for any directly related project of the project manager or organization that remains unspent or not yet legally obligated at the time of proposal submission. Be as specific as possible. Indicate the status of the funds.*	NA	*Indicate: Unspent? Legally Obligated? Other?*

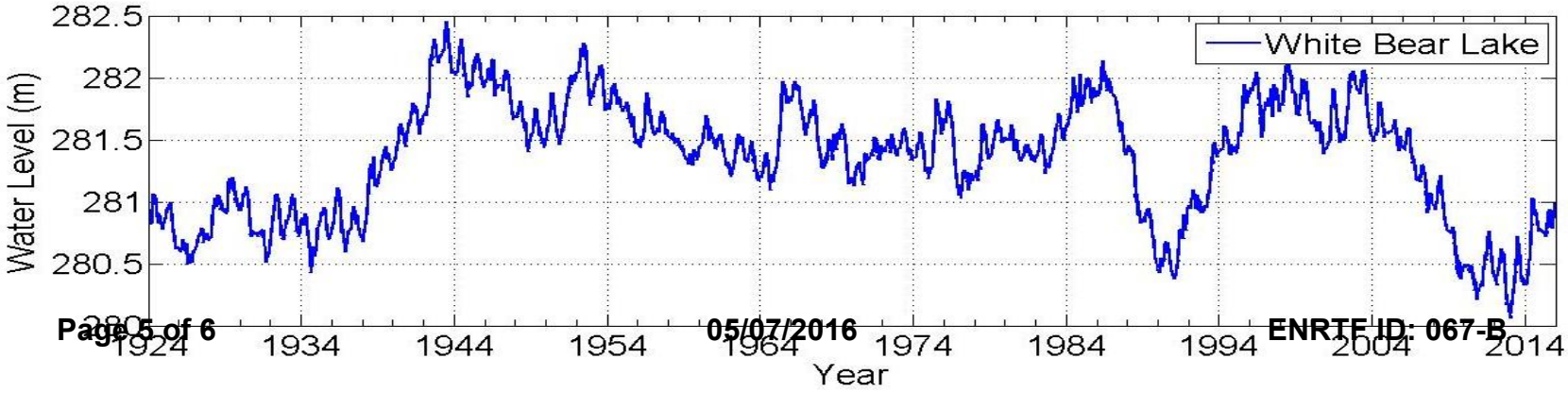
How Will Changes in Evaporation Impact Our Lakes?

1. Measure Lake Evaporation

2. Improve Water Balance Estimates



3. Assess Impacts on Lake Levels, Water Availability, and Water Quality



How Will Changes in Evaporation Impact Our Lakes?

Project Manager Qualifications

Dr. Tim Griffis is a professor in the Department of Soil, Water, and Climate at the University of Minnesota (www.biometeorology.umn.edu). He has been a faculty member at the University of Minnesota since 2002. He teaches courses in micrometeorology and climatology and specializes in boundary-layer meteorology and biometeorology. His research involves the use of boundary layer theory, isotope techniques, and land-atmosphere modeling to study atmospheric transport processes, water budgets, and the greenhouse gas budgets of natural and managed ecosystems at the field to regional scales. He has managed several large scale projects funded by the National Science Foundation, Department of Energy, and United States Department of Agriculture. In the proposed project he will oversee all of the measurement and modeling activities and will ensure that all reporting requirements are met and the project stays on schedule.

Professional Preparation

2002 NSERC Postdoctoral Fellow, Biometeorology, Univ, of British Columbia, BC, Canada
2000 Ph.D., School of Geography and Earth Sciences, McMaster University, ON, Canada
1995 B.Sc., Physical Geography, Brock University, ON, Canada

Appointments

2012-	Professor, Department of Soil, Water, and Climate, University of Minnesota- Twin Cities, USA
2012	Visiting Fellow: School of Forestry and Environmental Studies, Yale University, New Haven, Connecticut, USA
2006-2012	Associate Professor, Department of Soil, Water, and Climate, University of Minnesota-Twin Cities, USA
2002-2006	Assistant Professor, Department of Soil, Water, and Climate, University of Minnesota-Twin Cities, USA
2000-2002	Natural Sciences and Engineering Research Council Postdoctoral Fellow, Biometeorology and Soil Physics Group, University of British Columbia, Canada
1997-2001	Research Assistant, Canadian Land-Atmosphere Surface Scheme Project, Meteorological Service of Canada

Synergistic activities:

- American Meteorological Society – Board Member on Atmospheric Biogeosciences
- Co-Director of Graduate Studies in Land and Atmospheric Science, Dept. of Soil, Water, and Climate, University of Minnesota, 2009-present
- Member of the National Ecological Observatory Network (NEON Inc.)- Fundamental Instrument Unit, Working Group, 2009-present
- Associate Editor, Agricultural and Forest Meteorology, 2008 to present
- Associate Editor, Journal of Geophysical Research-Biogeosciences, 2007 to 2011

Organizational Description

The proposed research will be conducted in the Department of Soil, Water, and Climate at the University of Minnesota. The field research will take place at various lake sites with an emphasis on the northeast metro. All of the proposed data analyses and modeling activities will rely on the University of Minnesota Supercomputing Institute (https://www.msi.umn.edu/). All project personnel are members of the Land and Atmospheric Science program of the University of Minnesota. We will recruit one technician and one PhD student to assist with the data analyses and modeling activities proposed in this study. The student will be mentored by Griffis and colleagues. All of the research will be performed within the guidelines of the University of Minnesota's Responsible Conduct of Research (RCR).