# Environment and Natural Resources Trust Fund
# 2019 Request for Proposals (RFP)

**Project Title:**                                                    **ENRTF ID:**  **111-BH**

Warmer Winter Effects on Water Quality and Fish

**Category:**     H. Proposals seeking $200,000 or less in funding

**Sub-Category:**   B. Water Resources

**Total Project Budget: $**   177,911

**Proposed Project Time Period for the Funding Requested:**   June 30, 2022 (3 yrs)

**Summary:**

This project will determine the importance of warm winter and spring conditions in controlling harmful cyanobacteria, phosphorus cycling, oxygen distribution, and suitable coldwater fish habitat in Minnesota lakes.

**Name:**   Lesley          Knoll

**Sponsoring Organization:**  U of MN

**Title:**

**Department:**

**Address:**   28131 University Circle, Itasca Biological Station and Labs

Lake Itasca          MN   56470

**Telephone Number:**   (218) 699-3550

**Email**  lbknoll@umn.edu

**Web Address**

**Location**

**Region:**  Statewide

**County Name:**  Anoka, Chisago, Clearwater, Cook, Douglas, Lake, St. Louis

**City / Township:**

**Alternate Text for Visual:**

The visual highlights our goals: 1) examining how winter/spring conditions influence water quality and fish, 2) creating a website with real-time data, and 3) offering programs at Itasca State Park.

| _____ Funding Priorities | _____ Multiple Benefits | _____ Outcomes | _____ Knowledge Base |
|---|---|---|---|
| _____ Extent of Impact | _____ Innovation | _____ Scientific/Tech Basis | _____ Urgency |
| _____ Capacity Readiness | _____ Leverage | _____ TOTAL | _____% |
| | _____ If under $200,000, waive presentation? | | |

**PROJECT TITLE:** Warmer winter effects on water quality and fish

## I. PROJECT STATEMENT

Cyanobacteria (blue green algal) blooms are noxious and cause unsafe, unsightly and undesirable conditions in our lakes. Two factors that are likely playing roles in their increased abundance are excess nutrient levels, especially phosphorus, and warmer waters. We aim to determine the importance of these factors by examining year-to-year differences in winter/spring air temperatures, water quality and coldwater fish habitat in a diverse set of Minnesota lakes. Records indicate recent years with more extreme meteorological conditions such as warmer winter and spring air temperatures are leading to shorter ice cover on lakes. This trend is expected to continue.

*Our project will use existing MN DNR Sentinel Lakes data and new data to assess how years with extreme vs normal winter/spring air temperature control:*
- the amount of harmful cyanobacteria in the summer (activity 1)
- the amount of contaminants (phosphorus) in bottom-waters in the summer (activity 1)
- the amount and distribution of oxygen in the summer (activities 1 & 2)
- the amount and distribution of suitable coldwater fish habitat in the summer (activity 2)

We currently cannot predict how variable winter/spring conditions influence these key lake variables and which lake types (deep, large, shallow, etc.) may be most vulnerable to extreme conditions. We hypothesize that warmer winters/springs will negatively influence water quality and fish habitat by increasing lake surface temperatures and reducing oxygen in the deep parts of lakes. It was historically difficult to study these seasons because of unsafe ice conditions. We will use new sensor technologies that allows us to collect this information remotely. Our project will leverage: 1) data from six MN DNR Sentinel Lakes and two additional lakes, and 2) recent infrastructure funding to Knoll and Cotner from the National Science Foundation ($391,050).

For our third activity, we will create 1) a website with real-time data that anglers and other public members can use to view lake temperature and other measurements like wind speed, light levels, etc., and 2) educational displays with the website interface for Itasca State Park and Cedar Creek Ecosystem Science Reserve.

Lakes in the first two activities are: (Sentinel Lakes italicized, NSF equipment in underlined lakes) *Bear Head* (St. Louis Co.), Cedar Bog (Anoka Co.), *Carlos* (Douglas Co.), Elk (Clearwater Co.), *Greenwood* (Lake Co.), Itasca (Clearwater Co.), *South Center* (Chisago Co.), *Trout* (Cook Co.). The third activity will use the underlined lakes.

## II. PROJECT ACTIVITIES AND OUTCOMES

**Activity 1:** Investigate how winter/spring air temperature conditions affect summer water quality
**ENRTF BUDGET: $74,277**

Warm lake surface temperatures with underlying cold water provide an ideal environment for cyanobacteria, oxygen depletion, and phosphorus accumulation in bottom-waters. When ice-out occurs early, these stratified conditions should develop earlier and last longer through the summer. We will use existing and new data on 8 lakes (up to 14 years) to assess these patterns by developing predictive models. The models can be used to predict trends across Minnesota and identify lake types for modified management by state agencies.

| Outcome | Completion Date |
|---|---|
| *1. Collect water quality samples and maintain temperature/oxygen sensors (sensors also used in activity 2.). Some sensors/samples are managed by the Sentinel Lakes program and some by Knoll/Cotner.* | *October 2021* |
| *2. Develop predictive models describing how winter/spring conditions control: oxygen depletion, phosphorus in bottom-waters, and cyanobacteria quantity in varying lake types* | *June 2022* |

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**Activity 2:** Investigate how winter/spring air temperature conditions affect summer coldwater fish habitat
**ENRTF BUDGET: $57,176**

Coldwater fish, like walleye, have specific temperature and oxygen requirements that limit their suitable habitat, especially in summer. Warm lake temperatures and low oxygen can stress and, in extreme conditions, result in fish kills. We expect that warm winters/springs may increase summer lake temperatures and decrease oxygen reducing suitable habitat. We hypothesize these effects may vary by lake type. We will calculate two oxygen-temperature metrics to assess these questions in eight Minnesota lakes with up to 14 years of data. Fish habitat models can be used by MN DNR for lake management (fish stocking, etc.)

| Outcome | Completion Date |
|---|---|
| 1. Compile all existing and new oxygen and temperature data to calculate coldwater fish habitat metrics | March 2022 |
| 2. Develop predictive models to assess whether winter/spring conditions control summer coldwater fish habitat and how this varies by lake type | June 2022 |

**Activity 3:** Use real-time, streaming lake data for an informative website and public outreach displays/programs
**ENRTF BUDGET: $46,458**

We will create a website showing real-time data on three lakes. Anglers are often interested in lake temperature and how it changes with depth. Our website will provide this and other water quality materials. We will also create displays showing website data for Itasca State Park (Clearwater Co.) and Cedar Creek Ecosystem Science Reserve (Anoka Co.). These sites reach a large audience of public and K-12 visitors each year (500,000+ to Itasca, ~10,000 to Cedar Creek). Our programs complement established relationships with Itasca State Park.

| Outcome | Completion Date |
|---|---|
| 1. Create website with real-time streaming data | May 2021 |
| 2. Create educational displays with real-time, streaming data from website | May 2021 |
| 3. Offer public programming to the 500,000+ annual visitors of Itasca State Park | June 2022 |

**III. PROJECT PARTNERS:**
**A. Partners receiving ENRTF funding**

| Name | Title | Affiliation | Role |
|---|---|---|---|
| Dr. Lesley Knoll | Station Biologist, Adjunct Assistant Professor | University of Minnesota | PI |
| Dr. Jim Cotner | Professor | University of Minnesota | Co-PI |

**B. Partners NOT receiving ENRTF funding**

| Name | Title | Affiliation | Role |
|---|---|---|---|
| Dr. Casey Schoenebeck | Sentinel Lakes Long-Term Monitoring Coordinator | Minnesota DNR | Collaborator |

**IV. LONG-TERM- IMPLEMENTATION AND FUNDING:**

Our proposed project will provide data and models for water quality (MN PCA) and fish management (MN DNR) in Minnesota. We will leverage existing projects, equipment, and infrastructure that are part of the MN DNR Sentinel Lakes Program and a new NSF award to Knoll and Cotner. Plans are in place to maintain these. The website will need periodic updates in future years and student interns will assist Knoll as needed.

**V. TIME LINE REQUIREMENTS:**
We are planning a 3 year proposal period. The project will start in July 2019 and end in June 2022.

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# 2019 Proposal Budget Spreadsheet

**Project Title:**

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

| BUDGET ITEM (See "Guidance on Allowable Expenses") | | AMOUNT |
|---|---|---|
| **Personnel:** | $ | 105,828 |
| Graduate student assistant: $58,370 (52% salary, 48% benefits during the academic year - includes tuition) (87% salary, 13% benefits during the summer); One semester plus the summer at 50% FTE for years 1 and 2. Will assist with sampling, data analysis, and lead lab analysis efforts. | | |
| Undergraduate student: $21,000 (100% salary, 0% benefits); One student at 100% FTE for 14 weeks during the summer for 3 years. Will assist with sampling and outreach efforts while gaining in-depth training in both areas. | | |
| Support staff: $26,458 (72.8% salary, 27.2% benefits); 100% FTE for 6 months. Will develop website and educational display information. | | |
| **Professional/Technical/Service Contracts:** | $ | 8,340 |
| Phytoplankton identification and analyses for 5 lakes (6 times per year) - Phycotech, Inc. 30 samples per year @ $139 for 2 years = $8,340 | | |
| **Equipment/Tools/Supplies:** | $ | 28,760 |
| Sample bottles: 150 per year @ $1 for 2 years = $300 | | |
| Glass fiber filters: 150 per year @ $1 for 2 years = $300 | | |
| Surface water sample analyses: Dissolved Phosphorus: 60 per year @ $12 for 2 years = $1,440 Particulate Phosphorus: 60 per year @ $12 for 2 years = $1,440 Inorganic Nitrogen: 60 per year @ $14 for 2 years = $1,680 Total Dissolved Nitrogen: 60 per year @ $3 for 2 years = $360 Dissolved Organic Carbon: 60 per year @ $12 for 2 years = $1,440 Particulate Nitrogen and Carbon: 60 per year @ $12 for 2 years = $1,440 Algal biomass: 60 per year @ $3 for 2 years = $360 | | |
| Materials and software licenses for educational displays and website (display monitors and mounting hardware, signage, etc) = $20,000 | | |
| **Acquisition (Fee Title or Permanent Easements):** | N/A | |
| **Travel:** | $ | 34,983 |
| Travel for field work to Itasca Field Station (from Twin Cities) and lodging at the station: Undergraduate travel: 1 round trip per year - 440 miles @ 0.545 for 3 years = $719 Graduate student/PI travel: 6 round trips per year - 440 miles @ 0.545 for 2 years = $2,878 Lodging for undergraduate: 14 weeks @ $350 per week for 3 years = $14,700 Lodging for graduate student/PI: 10 weeks @ 525 per week for 2 years = $10,500 | | |
| Lab bench fees at Itasca: 14 weeks per year @ $182 per week for 2 years = $5,096 | | |
| Travel to field sites from Itasca: 1,000 miles per year @ 0.545 for two years = $1,090 | | |
| **Additional Budget Items:** | N/A | |
| **TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =** | $ | 177,911 |

**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:** | N/A | |
| **Other State $ To Be Applied To Project During Project Period:** | N/A | |
| **In-kind Services To Be Applied To Project During Project Period:** Indirect Costs (54% MTDC) associated with this proposal | $ 96,072 | *Secured* |
| **Past and Current ENRTF Appropriation:** | N/A | |
| **Other Funding History:** | N/A | |

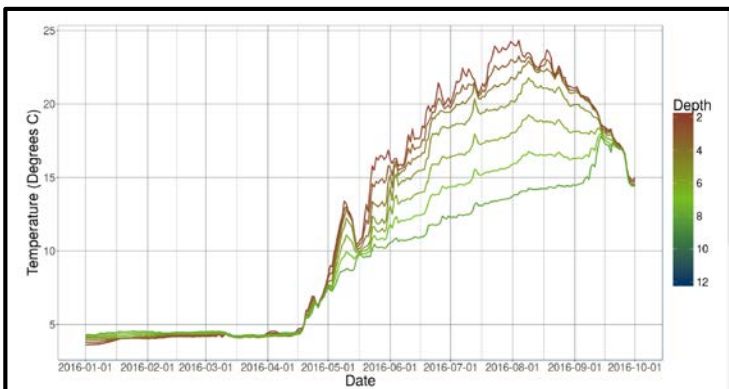Do warmer winter / spring air temperatures lead to lakes with:

**Activity 1**

More toxic algae?
Less oxygen?
More phosphorus?

**Activity 2**

Warmer lake temperatures?
Less oxygen?
Less coldwater fish habitat?

**Activity 3**



Figure shows an example of plotting temperature at multiple depths in a lake for potential use in planned public website. (Courtesy of MN DNR Sentinel Lakes Program)



Public programs by University of Minnesota Itasca Biological Station at Itasca State Park

# Why this matters to Minnesotans

LOCAL

The good old Minnesota winter is losing its bite

By Mary Lynn Smith Star Tribune | DECEMBER 1, 2017 — 9:14PM

AP / November 16, 2017, 4:41 PM

**Toxic algae becoming severe threat nationwide**

Home / News / Your Local News

**Water Worries: Investigating Toxic Water On Minnesota Lakes**

**Blue-Green Algal Blooms Cause Dog Deaths, Sickness In Kids**

*Nikki Davidson, Anchor/Reporter, ndavidson@kqdsfox21.tv*
*Adam Jagunich, Photojournalist, ajagunich@kqdsfox21.tv*

POSTED: 11:19 PM CDT Jul 06, 2016

Climate change is a culprit in decline of Minnesota walleye

As state's lakes warm, walleye's cold water prey fish lose ground, and resort owners pay price.

By Josephine Marcotty Star Tribune

**Project Manager Qualifications and Organization Description**

**Project Manager Responsibilities:** Dr. Lesley Knoll will oversee the entire project and coordinate all the activities. She will work closely with the project team on sample collection, data analyses, and modeling efforts.

*Education*
Ph.D.   2011   Miami University, Oxford, OH (Ecology, Evolution, and Environmental Biology)
M.S.   2004   Michigan State University, East Lansing, MI (Fisheries and Wildlife)
B.S.   2001   Miami University, Oxford, OH (Botany, magna cum laude)

*Professional Experience*
2018-present   *Adjunct Assistant Professor*, Dept. of Plant and Microbial Biology, University of Minnesota
2016-present   *Station Biologist*, University of Minnesota Itasca Biological Station and Labs (Lake Itasca, MN)
2012-2015   *Director of Research and Education*, Lacawac Sanctuary Field Station (Lake Ariel, PA)

*Relevant Publications to Proposal*
**Knoll, L.B**., C.E. Williamson, R.M. Pilla, T.H. Leach, J.A. Brentrup, and T.J. Fisher. Browning-related oxygen depletion in an oligotrophic lake. *In press Inland Waters*.

Richardson, D.C., S.J. Melles, R.M. Pilla, A.L. Hetherington, **L.B. Knoll**, C.E. Williamson, and others. 2017. Transparency, geomorphology, and mixing regime explain variability in trends in lake temperature and stratification across northeastern North America (1975 – 2014). Water 9: 442. doi:10.3390/w9060442

**Knoll, L.B.**, A. Morgan, M.J. Vanni, T.H. Leach, T.J. Williamson, and J.A. Brentrup. 2016. Quantifying pelagic phosphorus regeneration using three methods in lakes of varying productivity. *Inland Waters* 6: 509-522.

Brentrup, J.A., C.E. Williamson, W. Colom-Montero, W. Eckert, E. de Eyto, H.P. Grossart, Y. Huot, P. Isles, **L.B. Knoll**, T.H. Leach, C.G. McBride, D. Pierson, F. Pomati, J.S. Read, K.C. Rose, N.R. Simal, P.A. Staehr, and L.A. Winslow. 2016. The potential of high-frequency profiling to assess vertical and seasonal patterns of phytoplankton dynamics: An extension of the Plankton Ecology Group (PEG) model. *Inland Waters* 6: 565-580.

**Knoll, L.B.**, E.J. Hagenbuch, M.H. Stevens, M.J. Vanni, W.H. Renwick, J.C. Denlinger, R.S. Hale, and M.J. González. 2015. Predicting eutrophication status in reservoirs at large spatial scales using landscape and morphometric variables. *Inland Waters* 5: 203-214.

Williamson, C.E., J.A. Brentrup, J. Zhang, W.H. Renwick, B.R. Hargreaves, **L.B. Knoll**, E.P. Overholt, and K.C. Rose. 2014. Lakes as sensors in the landscape: Optical metrics as scalable sentinel responses to climate change. *Limnology and Oceanography* 59: 840-850.

**Knoll, L.B**., O. Sarnelle, S.K. Hamilton, C.E.H. Kissman, A.E. Wilson, J.B. Rose, and M.R. Morgan. 2008. Invasive zebra mussels (Dreissena polymorpha) increase cyanobacterial toxin concentrations in low-nutrient lakes. Canadian Journal of Fisheries and Aquatic Sciences 65: 448-455.

**Knoll, L.B**., M.J. Vanni, and W.H. Renwick. 2003. Phytoplankton primary productivity and photosynthetic parameters in reservoirs along a gradient of watershed land use. Limnology and Oceanography 48: 608-617.

**Organization Description**
The proposed research will be performed at both the UMN Itasca Field Station and the University of Minnesota Twin Cities campus. The field station was established in 1909 and has a long and successful history of supporting field-based biological research. The University of Minnesota is a large and renowned public institution producing cutting-edge research products.