Environment and Natural Resources Trust Fund
2020 Request for Proposals (RFP)

Project Title: **ENRTF ID: 058-AH**

How to Save the Cisco-Trout Lakes

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

Sub-Category: A. Foundational Natural Resource Data and Information

Total Project Budget: $ 185,438

Proposed Project Time Period for the Funding Requested: June 30, 2022 (2 yrs)

Summary:

We will find the mechanism leading to rapid deoxygenation of deep, cold waters, stressing ciscoes and trout in lakes so that the problem can be fixed. The mechanism is unknown.

Name: John Downing

Sponsoring Organization: U of MN -Minnesota Sea Grant

Job Title: Dr.

Department: Minnesota Sea Grant

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Location:

Region: Central, Northwest, Northeast

County Name: Statewide

City / Township: Duluth, Grand Rapids, Ely, Hibbing, Brainerd, Bemidji, Walker, Park Rapids, International

Alternate Text for Visual:

Upper: how cold water fish are being squeezed out by warm water at the surface and oxygen loss at the bottom. Lower: the location of the cisco-trout lakes in Minnesota.

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

PROJECT TITLE: How to save the cisco-trout lakes

I. PROJECT STATEMENT

The purpose of this project is to find out why important Minnesota lakes are losing their cisco-trout-friendly waters so that remedial measures can sustain cold water fisheries. Our purpose is to elucidate the mechanism of oxygen loss so that we can design cost-effective measures to save this important and disappearing fishery. Remediation could include deep-water reoxygenation, iron oxidation, or other approaches that work only for specific mechanisms of oxygen loss. Downing's parents and grandparents caught lake trout in Itasca County's Wabana Lake since 1908; there are none left there now and only a few ciscos. Adjacent lakes have a few ciscoes and trout but the squeeze between warming surface waters and increasing loss of deep-water oxygen is isolating cold-water fish in a thin layer during crucial times of year. This is an unexpected problem because deep-water oxygen loss is normally only found in lakes with poor water quality – and yet these cisco-trout lakes have clear water and little algae.

We can do little about warming weather but we can manage oxygen if we know why it is disappearing so fast. Current management assumes that we can protect cisco-trout lakes by protecting watersheds from excess development and nutrient loss to lakes. Shoreline development-driven oxygen loss is important but not sufficient to explain rates of deoxygenation observed in pilot studies of these lakes. For example, some cisco-trout lakes have rates of oxygen depletion after ice-out that are 2-5-times faster than expected based on the watershed-driven nutrient supply.

Although oxygen uptake through microbial decomposition of algae and other organic matter is often an important mechanism for oxygen removal from deep waters of lakes, there are several other mechanisms, including chemical oxygen demand and catalytic pathways that can remove infinite amounts of oxygen, especially when deep groundwater supplies iron and organic matter. Each mechanism of oxygen loss implies different remediation. There are 176 cisco lakes in Minnesota, according to Mr. Peter Jacobson of the Minnesota Department of Natural Resources. The purpose of this project is to determine how much oxygen is removed from a subset of Tier 1 cisco-trout lakes by different mechanisms, estimate the joint-effect of temperature and deoxygenation on cisco-trout habitat in these lakes, and thereby determine how this problem can be fixed.

II. PROJECT ACTIVITIES AND OUTCOMES
Activity 1 Title: Field measurements of oxygen demand, temperature, and chemistry in Tier 1 cisco lakes

ENRTF BUDGET: $124,487

Outcome	Completion Date
1. Complete seasonal lake profiles and water chemistry	*December 2021*
2. Measure oxygen demand and partition among mechanisms	*April 2021*

Description: *We will measure oxygen and temperature profiles every second week from ice-out to ice cover in 12 Tier 1 cisco-trout lakes (see map) over one full year. Two under-ice profiles will also be measured in each lake. Chemical measurements of nutrients, chlorophyll, iron, and dissolved organic carbon, as well as titration with acidic potassium permanganate will allow us to distinguish decompositional, catalytic, chemical and biochemical oxygen demand. We feel certain that we can complete this work in a single year (calendar year 2021).*

Activity 2 Title: Determine difference between lakes that have lost ciscoes and trout and those where they still are found

Description: *We will search Minnesota DNR fisheries files to find moderate-large lakes where ciscoes or trout have disappeared over recorded time. Also, we will search MN Lake Finder for data on characteristics of these lakes and use Geographical Information Systems to characterize current landscape and land use information. We will then perform a multi-dimensional analysis to find how lakes retaining ciscoes and trout differ from those from which they have been lost. This will tell us how many there once were and where and why they have been lost.*

ENRTF BUDGET: $51,171

Outcome	Completion Date
1. Student builds database of lakes where ciscoes or trout have disappeared historically.	*June 2021*
2. Augment lake data with chemical, physical, and GIS data on lakes with and without ciscoes or trout	*June 2021*
3. Analyze characteristics of lakes that distinguish cisco-trout lakes that have lost vs retained populations	*June 2021*

Activity 3 Title: Report on remedial measures to fix the problem and bring back ciscoes-trout in other lakes

Description: *Based on the partitioning of oxygen demand among mechanisms of oxygen uptake, we will compile the best and most cost-effective approaches to remediation to use in these valuable lakes. These recommendations will be supplied for each of the study lakes.*

ENRTF BUDGET: $9,780

Outcome	Completion Date
1. Compile a compendium of approaches to re-oxygenation that have been well tested and work specifically to reverse oxygen loss due to diverse mechanisms.	*June 2022*
2. Determine costs of diverse approaches of re-oxygenation that will not alter stratification while sustaining cold water habitat	*June 2022*
3. Make recommendations of lake-specific approaches to enhancing cisco-trout habitat and reproductive success.	*June 2022*

III. PROJECT PARTNERS AND COLLABORATORS:

John A. Downing, Sea Grant College Program, Large Lakes Observatory, and Department of Biology, University of Minnesota (Duluth); **Christopher T. Filstrup,** Natural Resources Research Institute, University of Minnesota (Duluth); **John R. Jones,** School of Natural Resources, University of Missouri, Columbia, MO. Dr. Jones summers in Deer River, MN and will provide his expertise in limnology and biogeochemistry at no cost to the project.

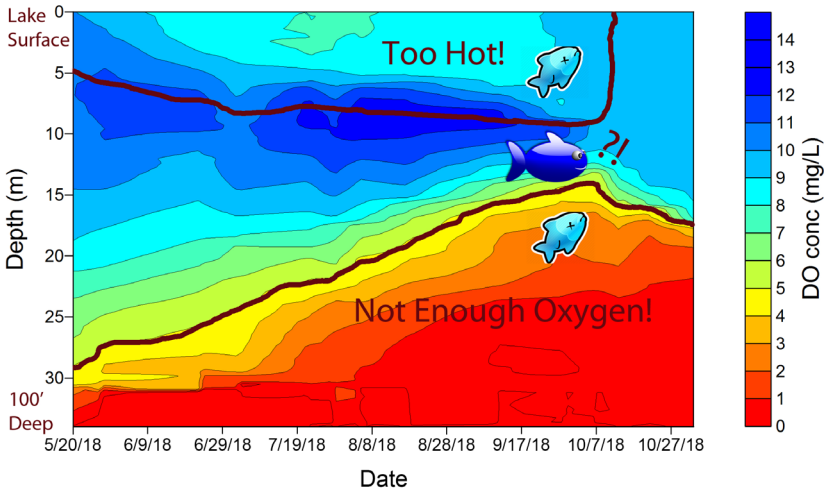
IV. LONG-TERM IMPLEMENTATION AND FUNDING:

The results of this study will inform future management of the cisco-trout lakes of Minnesota. One of the principal outcomes will be to define management strategies for retaining cold water fisheries in Minnesota. Execution of management actions, in some cases, will require funding to treat low oxygen conditions as well as operation of this infrastructure. If innovative methods to inactivate specific processes are needed, funding proposals to USGS, the National Science Foundation, and NOAA will be submitted.

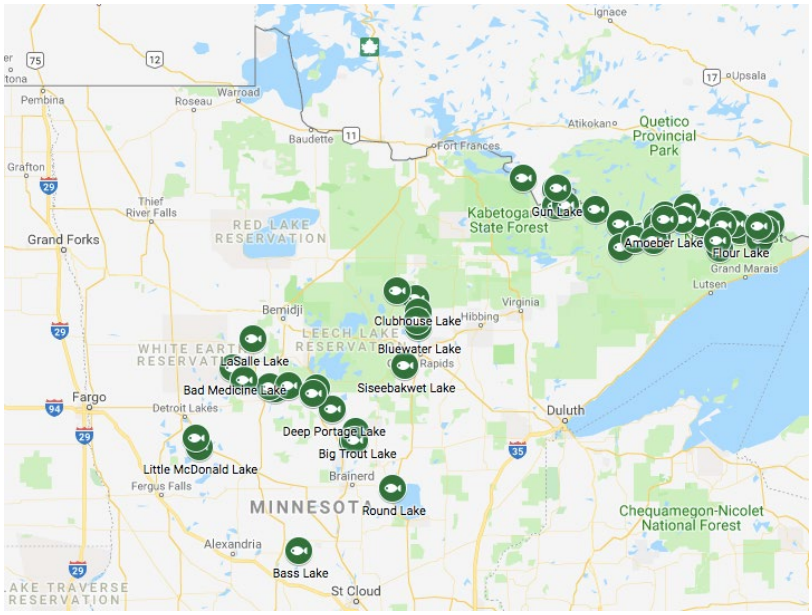
Attachment A: Project Budget Spreadsheet
Environment and Natural Resources Trust Fund
M.L. 2020 Budget Spreadsheet
Legal Citation:
Project Manager: John A. Downing
Project Title: How to save the cisco-trout lakes
Organization: University of Minnesota Duluth (for MN Sea Grant
Project Budget: $185,438
Project Length and Completion Date: June 2022 (2 years)
Today's Date: 4/9/19

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ 125,614	$ -	$ 125,614
John Downing, project manager at 5% time over two years including fringe benefits - $29,339 (74% salary, 26% fringe)			
Chris Filstrup, co-PI, at 5% time, over two years, including fringe benefits. Oversee analysis of samples and manage chemical data - $9,615 (74% salary, 26% fringe)			
MS student 1, 50% FTE graduate research assistant each year - perform analysis of DNR fisheries data in first year, perform field work along with undergrad assistant, Downing, Filstrup, and Jones; $79,940 (52% salary, 48% fringe)			
Undergraduate student assistants - 14 sampling events, $15/h, 8h/day, 4 days/event or 21.5% FTE; $6720 (100% salary)			
Professional/Technical/Service Contracts			
	$ -	$ -	$ -
Equipment/Tools/Supplies			
Chemicals and field collection bottles	$ 775	$ -	$ 775
Capital Expenditures Over $5,000			
YSI multi parameter sonde	$ 14,725	$ -	$ 14,725
Fee Title Acquisition			
	$ -	$ -	$ -
Easement Acquisition			
	$ -	$ -	$ -
Professional Services for Acquisition			
		$ -	$ -
Printing			
	$ -	$ -	$ -
Travel expenses in Minnesota			
14 sampling trips x 600 miles x $0.58 + 1400 miles for data mining	$ 5,684	$ -	$ 5,684
Other			
Chemical analysis: 12 lakes, 2 samples/lake/event, 14 sampling events TN+TP @$28, chlorophyll @$32, DOC@$25 & Fe panel @$30 - at limnology lab at the Natural Resources Research Institute	$ 38,640	$ -	$ 38,640
COLUMN TOTAL	$ 185,438	$ -	$ 185,438

SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
Non-State:		$ -	$ -	$ -
State:		$ -	$ -	$ -
In kind: University of MN unrecovered Indirect Cost @ 54 MTDC	secured	$ 74,916		$ 74,916
Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS	**Amount legally obligated but not yet spent**	**Budget**	**Spent**	**Balance**
		$ -	$ -	$ -



Results of a pilot study on Bluewater Lake, Itasca County, showing the top-to-bottom distribution of oxygen across the 2018 ice-free season. Bluewater Lake is a Tier 1 cisco lake that is hoped to be a refuge for cold water fish. The cool colors at the top show depths and dates at which there was sufficient oxygen for cold water fish while the hotter colors at the bottom show where oxygen was insufficient. The top solid line shows the depth/date limit of 10°C water (50°F) above which ciscoes and trout have trouble living. The bottom solid line shows the depth/date limit of water with 5 mg per liter of oxygen, below which ciscoes and trout have trouble living. Depth in the lake is shown in meters (m), approximately equal to yards. We will find out what mechanisms are making low oxygen water rise so far from the bottom so we can find ways of fixing it.



Locations of Minnesota's Tier-1 cisco lakes. These are lakes where ciscoes are present but landscapes are undeveloped enough to potentially provide a refuge for ciscoes – assuming that landscape changes are the principal mechanism leading to loss of oxygen in deep, cold waters. We will select study lakes from Tier-1 lakes. There are 176 cisco-trout lakes in Minnesota and we will choose 12 to study that cover the range of important lake configurations and conditions.

Project Manager Description

Project Manager Qualifications and Responsibilities

John A. Downing will manage this project. He has 40 years of experience in aquatic research and community outreach. He is currently the Director of the Minnesota Sea Grant College Program, a research scientist at the Large Lakes Observatory, and a tenured Professor in the Department of Biology at the University of Minnesota Duluth. Although he has life-long roots in Minnesota, he was formerly a Regent's Excellence Professor of Ecology, Evolution, & Organismal Biology and Agricultural & Biosystems Engineering at Iowa State University and ran one of the best-funded and long-standing research operations at that institution. His 150+ peer-reviewed books and journal articles cover diverse topics in limnology, marine science, environmental economics, and terrestrial ecology. His leadership experience has been as the Director of the Laurentian Biological Station (Montreal, Quebec), the co-founder of the Inter-University Limnological Research Group (Montreal, Quebec), Director of the Iowa State University Limnology Laboratory (Ames, Iowa), Chair of the Environmental Science Interdepartmental Graduate Program (Ames, Iowa), President of the Association for the Sciences of Limnology and Oceanography, and Chair of the Council of Scientific Society Presidents (Washington, DC). Recent outreach programs have assisted citizens in agricultural regions to understand and mitigate nutrient pollution and helped citizens and industries in northern Minnesota combat eutrophication and avoid lake degradation from aquatic invasive species. Christopher Filstrup is an applied limnologist at the Natural Resources Research Institute. John R. (Jack) Jones is a limnologist, Curator's Professor Emeritus, and J. Michael Dunmire Professor in the School of Natural Resources at the University of Missouri Columbia and a resident of St. Paul, Minnesota, and Deer River, Minnesota.

Organization Description

Minnesota Sea Grant, at the University of Minnesota Duluth, is part of the National Oceanic and Atmospheric Administration's (NOAA) Sea Grant Program, which supports 33 similar programs in coastal states throughout the United States and Puerto Rico. Our mission is to facilitate interaction among the public and scientists to enhance communities, the environment and economies along Lake Superior and Minnesota's inland waters by identifying information needs, fostering research and communicating results. Minnesota Sea Grant concentrates on research, outreach, and education in four focus areas: Healthy coastal ecosystems, sustainable fisheries and aquaculture, resilient communities and economies, environmental literacy and workforce development.

This research will be performed using the facilities of the Large Lakes Observatory (LLO) and the Natural Resources Research Institute (NRRI), both in Duluth, Minnesota. LLO has a unique mission: to perform scientific study of the largest lakes of Earth. It is one of the largest water-centered research units at the university and its impact has been felt all over the world. NRRI's mission is to deliver research solutions to balance our economy, resources and environment for resilient communities.