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

Project Title: **ENRTF ID: 042-B**

Restoring Agricultural Lakes and Watersheds by Managing Carp

Category: B. Water Resources

Total Project Budget: $ 967,100

Proposed Project Time Period for the Funding Requested: 4 Years, July 2017 - June 2021

Summary:

Whole-lake experiments, surveys, and modeling to show when and where carp management is the most effective and economical approach for improving water quality in lakes and streams across south-central Minnesota.

Name: Przemyslaw Bajer

Sponsoring Organization: U of MN

Address: 2003 Upper Buford Cir, 135 Skok Hall

St. Paul MN 55108

Telephone Number: (651) 335-6261

Email bajer003@umn.edu

Web Address

Location

Region: Central, Metro, Southwest, Southeast

County Name: Anoka, Big Stone, Blue Earth, Brown, Carver, Chippewa, Clay, Cottonwood, Dakota, Dodge, Douglas, Faribault, Freeborn, Grant, Hennepin, Jackson, Kandiyohi, Lac qui Parle, Le Sueur, Lincoln, Lyon, Martin, McLeod, Meeker, Mower, Murray, Nicollet, Nobles, Pip

City / Township:

Alternate Text for Visual:

Map of carp impacts across Minnesota and an example of agricultural lake restoration by carp removal

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

PROJECT TITLE: Restoring agricultural lakes and watersheds by managing carp

I. PROJECT STATEMENT

Our overarching goal is to demonstrate that restoration of lakes across southern Minnesota might be best achieved by managing carp populations that currently overwhelm those systems. Carp management is now possible in many lakes using approaches recently developed at U of M.

Lakes in south-central Minnesota are characterized by high nutrient levels and blooms of harmful cyanobacteria. While excess nutrients are often attributed to agriculture and other human activities, our data indicate that the invasive common carp is a major, underappreciated driver of this problem. Over 70% of lakes in southern Minnesota appear to harbor highly abundant carp (>190 kg/ha). At such densities, carp eliminate aquatic vegetation and release nutrients from lake sediments. As plant cover declines, the capacity of lakes to improve water quality by trapping and transforming nutrients is diminished. Carp management is needed to restore degraded lakes and trap nutrients that flow into those systems from agricultural watersheds. Management of carp can have immediate benefits. For example, carp removal from Pickerel Lake (Albert Lea) resulted in a rapid increase in water clarity and a three-fold decline in phosphorus. Such improvements also reduce phosphorus loads into downstream lakes and rivers by 20-60%.

While carp management could greatly improve water quality, the magnitude of these benefits likely also depends on lake characteristics (e.g., depth, thermal stratification) and external nutrient loads. To guide conservation efforts, it is critical to identify lake and watershed types in which carp management is likely to generate the greatest water quality benefits. **The direct goal** of this project is to quantify water quality benefits from carp management across representative lake and watershed types in south-central Minnesota. We will: 1) perform whole-lake manipulations to generate nutrient budgets and water quality responses before and after carp removal in different types of lakes, 2) assess carp biomass and water quality in 200 lakes across south-central Minnesota to untangle the effects of carp relative to lake characteristics and nutrient loads from watersheds, and 3) develop watershed-scale hydrologic and nutrient models to quantify water quality improvements from carp vs watershed management and provide management tools for watershed restoration.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Whole-lake manipulations **Budget: $447,000**

We will select eight lakes to perform large-scale experiments using a before/after-control/impact design. We will collect detailed data on carp biomass, nutrients, water quality, vegetation, and native fish. We will then reduce carp biomass in four lakes below 100 kg/ha while maintaining four lakes as controls, and document changes in nutrient dynamics, water quality, vegetation, and native fish. This effort is designed to determine the causality and range of carp's effects on water quality in representative lake types across south-central Minnesota and provide key parameters for watershed models (Activity 3).

Outcome	Completion Date
1. Pre-removal assessment of carp, vegetation, nutrients, and water quality	*Dec 31, 2018*
2. Post-removal assessment of carp, vegetation, nutrients, and water quality	*Dec 31, 2020*
3. Laboratory work, data analysis, reports and peer-reviewed manuscripts submitted	*June 30, 2021*

Activity 2: Survey of 200 lakes to untangle the effects of carp vs. land use **Budget: $ 447,300**

Because the effects of carp are likely to be influenced by lake characteristics (depth, size, productivity, thermal stratification, native fish, aquatic vegetation) and land use, it is necessary to examine these relationships across a large number of locations to determine in which types of lakes and watersheds carp management could provide the greatest benefits to water quality. We will achieve this by 1) quantifying carp abundance in 200 lakes by leveraging standardized DNR fish surveys (~70 lakes per summer; 3 summers), 2) using satellite remote

sensing to map water quality and aquatic vegetation in the same set of lakes, and 3) using readily available GIS layers to retrieve lake (e.g. size, depth) and watershed (e.g. land cover, size) data for each lake. We will verify that DNR surveys can accurately portray carp abundance and that remote sensing can accurately measure water quality and vegetation through ground-truthing in a subset of 40 lakes, in which we will conduct detailed assessments of carp biomass, water quality and aquatic vegetation. Using data from all 200 lakes, we will quantify the influence of carp on water quality in different types of lakes (e.g., shallow vs. deep) and watersheds (e.g., agricultural vs. urban). Data from activity 1 & 2 will be used to identify management targets for carp biomass for representative lake types in MN.

Outcome	Completion Date
1. Collection of carp, plants/algae, native fish, nutrient, and land use data for 200 lakes	*Dec 31, 2019*
2. Ground-truthing remote sensing data and DNR fisheries surveys	*Dec 31, 2019*
3. Development of statistical models, reports and peer-reviewed manuscripts submitted	*Dec 31, 2020*

Activity 3: Develop watershed-scale nutrient models to provide management tools for south-central Minnesota. **Budget: $ 72,800**

This serves two key purposes: 1) to quantify the benefits of carp removal vs. land management on water quality in lakes, and 2) to quantify the reduction in nutrient export from agricultural watersheds to the Mississippi resulting from carp removal vs. watershed management. We will develop hydrologic models of selected watersheds to illustrate the relative impacts of carp management and watershed management (nutrient mitigation efforts; e.g., agricultural best management practices and landscape restoration) on water quality and nutrient export. These models will provide decision support tools and enable cost-benefit analyses for future watershed management and water quality improvement efforts.

Outcome	Completion Date
1. Collection of model input data from activities 1-2 and state databases	*Dec 31, 2018*
2. Watershed models, decision-support tools, and associated reports and publications	*Dec 31, 2020*

III. PROJECT STRATEGY

A. Project Team/Partners

Receiving ENRTF money: Bajer – PI, carp, 10% salary YR 1,2, 100% salary YR 3,4; Finlay – water quality, nutrients, 10% salary; Larkin – aquatic vegetation, 4% salary; Olmanson – remote sensing, 25% salary, Dalzell – watershed modeling, 25% salary; 2 graduate students; 1 field technician; 30% lab manager.

Partners and collaborators: Andy Henschel – Shell Rock Watershed District, in-kind support for carp management and infrastructure. Rich Brash – Three Rivers Park District, water quality data, in-kind support.

B. Project Impact and Long-Term Strategy

This project is central to many surface water initiatives within the Minnesota Nutrient Reduction Strategy. Watershed conservation efforts, buffer strips, and land use BMPs may not lead to intended water quality improvements in carp-dominated watersheds. Investing in sustained carp management may be a cost-effective approach for protecting lakes and reducing nutrient pollution and export in southern Minnesota. However, this potential needs to be empirically evaluated using ecosystem-scale experiments, large multivariate datasets, and models linking lake and watershed attributes with water-quality ecosystem services, and these findings need to be translated into decision support tools for watershed management.

C. Timeline Requirements

This is a 4-year project to accommodate two years of water quality data before and after carp removal (Activity 1), and three full field seasons for lake surveys (2018, 2019, 2020) (Activity 2 and 3). Activities and personnel will be staggered to minimize cost without compromising the integrity of study design.

2017 Detailed Project Budget

Project Title: *Restoring agricultural lakes and watersheds by managing carp*

IV. TOTAL ENRTF REQUEST BUDGET: *4* **years**

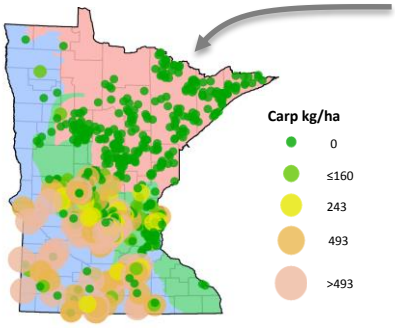
BUDGET ITEM	AMOUNT
Personnel:	
Bajer, Project manager (81% salary, 19% benefits), 10%FTE yrs 1 & 2, 100% FTE yrs 3&4	$ 220,300
Larkin, vegetation surveys (81%salary, 19% benefits), 4% FTE x 4 yrs	$ 21,200
Finlay, nutrient analyses (81%salary, 19% benefits), 4% FTE x 4 yrs	$ 21,200
Dalzell, watershed modeling (66.3% salary, 33.7% benefits), 25% FTE for 4 yrs	$ 72,800
Olmanson, remote sensing (66.3% salary, 33.7% benefits), 25% FTE for 3 yrs	$ 60,000
Field Technician to coord. & conduct field work (66.3% salary, 33.7% benefits) 100% FTE 3 yrs	$ 180,500
Lab tech/manager to analyze water samples (66.3% salary, 33.7% benefits) 33% FTE 3 yrs	$ 54,800
2 Graduate Research Assistants, data analysis (90% salary, 10% fringe), 50% FTE 3 yrs	$ 240,000
Professional/Technical/Service Contracts:	$ -
Commercial fisherman (TBD) to remove carp from 4 lakes	$ 60,000
Equipment/Tools/Supplies:	
Perishable field gear: waders, containers, dip nets, etc.	$ 6,000
Lab supplies for water quality samples	$ 8,300
Travel in MN:	$ -
Mileage (~20,000 miles) to carp management sites and to collect data in 40 lakes x $0.37 mile + truck rental U of M $900/month x 3 months x 3 years (= $15,500)+ occasional overnight stay at romote locations (up to 5 nigts/year x 2 people x 3 years = $1,500)	$ 17,000
Additional Budget Items: costs of publishing in scientific journals	$ 5,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST	$ 967,100

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	NA	
Other State $ To Be Applied To Project During Project Period:	NA	
In-kind Services To Be Applied To Project During Project Period:	NA	
Funding History: $413,300 - ENRTF 2016-2018: Managing carp using biocontrol and toxins	$ 413,000	
Remaining $ From Current ENRTF Appropriation: *Bajer is 100% on LCCMR/MAISRC through 2019; Managing carp using biocontrol and toxins ; salary swap of 10% per year between existing project and this project could be used to save money (~ $20,000)*	$ 20,000	*Other*

Title: Restoring agricultural lakes and watersheds by managing carp

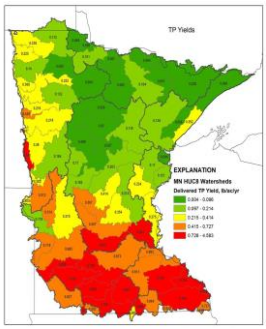
Carp abundance



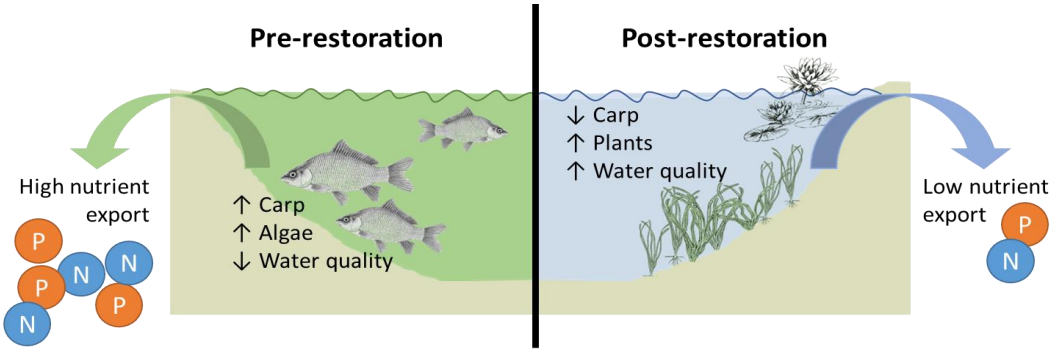
70% of southern Minn. lakes have damaging carp biomass

This correlates w/ harmful levels of phosphorus loading

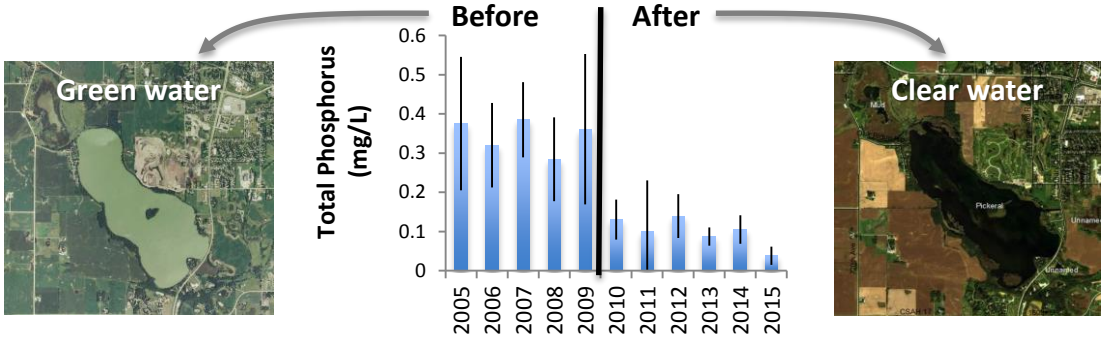
Phosphorus loads



Carp management can restore water quality



Proof of concept: carp removal in Pickerel Lake (Albert Lea)



But lakes are also impacted by other stressors, such as land use.
To guide conservation efforts, it is critical to identify lake and watershed types in which carp management will generate the greatest water quality benefits

We will address this by integrating
(1) Whole-lake experiments
(2) Surveys of 200 lakes to disentangle the effects of carp vs. land use
(3) Watershed-scale models to quantify water quality improvements from carp vs. land management

Carp control is predicted to be a cost-effective strategy for significantly improving surface water quality in southern Minnesota and strengthening ongoing watershed conservation efforts

Proposal title: Restoring agricultural lakes and watersheds by managing carp

Statement of Qualifications

Przemyslaw G. Bajer, Ph.D.,
Research Assistant Professor
University of Minnesota
MAISRC
Department of Fisheries, Wildlife and Conservation Biology
135 Skok Hall, 2003 Upper Buford Circle, St. Paul, MN, 55108, USA
Phone: (612) 625 6277, E-mail: bajer003@umn.edu

Dr. Przemyslaw Bajer is an expert on common carp ecology and management. He has been working at the University of Minnesota since 2006 developing sustainable management schemes for carp populations, several of which are being currently implemented across Minnesota. He has extensive experience with all aspects of this project because he has been conducting whole-lake experiments to determine effects of carp on water quality in lakes and analyzing large data sets to determine processes that regulate carp abundance and invasiveness. He has published 28 peer reviewed publications, including 14 on common carp. He has successfully supervised graduate students and managed LCCMR projects.

Organization Description:

Established in 1851, the University of Minnesota is Minnesota's flagship, land grant university. With over 16,000 graduate and professional students, it's the largest research university in Minnesota. Its broad mission is to change lives through research, education, and outreach.