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

Project Title: **ENRTF ID: 076-B**

Impacts of Water Quality on Yearling Walleye Survival

Category: B. Water Resources

Total Project Budget: $ 178,000

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

Summary:

Minnesota's walleye fishery is dependent on the survival of juvenile fish. Our study determines the impacts of contaminants on juvenile walleyes, and establishes landscape-based tools for predicting population vulnerability.

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Relationship between run-off, juvenile survival and adult walleye availability; statements of goals, outcomes and benefits

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

PROJECT TITLE: Impact of water quality on yearling walleye survival

I. PROJECT STATEMENT

Our goal is to develop a landscape-based tool for identifying walleye fisheries and regions that are vulnerable to overharvesting due to the impacts of contaminants. Rural and urban run-off can contain contaminants that are known to limit the ability of young fish to catch prey and escape predators. Because yearling walleye survival determines the amount of adult walleye biomass that we can sustainably harvest, walleye in contaminated systems can be overharvested if the impacts of contaminants on juveniles are ignored. Minnesota's billion-dollar-a-year walleye fishery is supported by lakes and rivers that are subject to varying degrees of run-off, but the impact of contaminants on sustainable harvest rates is not widely accounted for (i.e., only in large lakes). In this study, we will use a combination of lab, field and modeling approaches to:

- **Determine behavioral changes and mortality of yearling walleye in simulated rural and urban environments under varying contaminant loads,**
- **Incorporate these data into an existing model to adjust estimates of walleye yield based on statewide walleye regulations and thresholds of population collapse, and**
- **Develop a tool for identifying vulnerable walleye fisheries based on contaminant load**.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Directly measure predation mortality of juvenile walleye in simulated rural and urban lakes using lab experiments and field validation.* **Budget: $160,430**

We will use a combination of lab and field experiments to determine how predation risk and foraging efficiency of juvenile walleye vary with the type of contaminant (i.e., urban or rural run-off) and contaminant load (e.g., low, medium or high). We will expose a total of 1300 fingerlings to synthetic wastewater and rural run-off at three concentrations (low, medium, and high). The chemical classes and concentrations in these two mixtures will be based on environmental data collected by the USGS and FWS. Data from both the field and laboratory experiments allow us to quantify survival effects and their cause. Results will be used to inform the model in Activity 2.

- **Laboratory experiments** will determine how the ability of walleye fingerlings to catch prey and avoid predators varies with contaminant type and load. Results will be based on biomechanical assays, muscular histopathology and genetic techniques (40 fish per treatment plus 40 control fish for both urban and rural contaminant profiles).
- **Field validation** of laboratory results will be via mark-recapture experiments. We will mark and stock control, low, medium and high treatment fingerlings (10 per treatment x 12 replicates) as well as a predator fish (northern pike) at realistic densities in experimental pools located at the Sherco plant biological station. Juveniles will be recaptured every two days for eight days, and the proportions of surviving individuals from each treatment quantified.

Outcome	Completion Date
*1.Determine and compare contaminant-induced **changes in the predator evasion behavior and foraging efficiency of yearling walleye** exposed to synthetic urban wastewater*	*07/31/2018*
*2. Determine and compare contaminant-induced **changes in the predator evasion behavior and foraging efficiency of yearling walleye** exposed to synthetic rural run-off*	*03/31/2019*
*3. Determine the **mortality of yearling walleye** exposed to synthetic urban wastewater under field conditions.*	*12/31/2019*
*4. Determine the **mortality of yearling walleye** exposed to synthetic rural run-off under field conditions.*	*05/01/2020*

Activity 2: *Develop a tool for identifying vulnerable walleye fisheries based on existing harvest regulations and contaminant-adjusted thresholds of population collapse.* **Budget: $ 18,370**

We will combine an existing walleye population model with results from Activity 1 and state-wide contaminant and walleye harvest data to develop a tool for identifying walleye fisheries that are at risk to overharvesting. The walleye model was developed at the University of Minnesota to estimate sustainable walleye harvest for any lake or river based on temperature and fishing regulations. We will incorporate the results from Activity 1 into this model by allowing first-year survival to scale with contaminant load. Using state-wide water contaminant data collected by the USGS, FWS and MPCA we will then use our model to estimate sustainable harvest rates given existing regulations and realistic concentrations of urban and rural contaminants. Finally, we will compare our sustainable harvest estimates to state-wide walleye harvests to identify fisheries and regions where overharvesting is likely. We will publish our tool in the literature and online so that estimates can be updated if conditions change, and so that stakeholders can evaluate alternative scenarios or future projections.

Outcome	Completion Date
1. State-wide maps of walleye harvest and urban and rural contaminant loads	*07/15/2019*
2. A tool for predicting sustainable walleye harvest rates given temperature, walleye regulations, and a range of urban and rural contaminant loads	*11/15/2019*
3. A map showing walleye fisheries or regions that are at risk of overharvesting	*03/15/2020*
4. An online tool for evaluating overharvesting risk due to updated, potential, or future contaminant loads.	*07/01/2020*

III. PROJECT STRATEGY

A. Project Team/Partners

The project team consists of the Principal Investigator (PI) Dr. Jessica Ward (Assistant Professor at St. Cloud State University) and co-PI Dr. Paul Venturelli (Assistant Professor at the University of Minnesota). Dr. Ward will direct the project and partake in the research in Activity 1. Dr. Venturelli will contribute to Activity 1 and build the model for Activity 2. Both investigators propose to receive money from this Environment and Natural Resources Trust Fund request

B. Project Impact and Long-Term Strategy

Managing fish across the Land of 10,000 Lakes is a major challenge because it is only feasible to directly estimate sustainable harvests in a few systems (e.g., large lakes, sentinel lakes). In Minnesota and elsewhere, the trend is to manage widely distributed fisheries via a landscape approach. Doing so requires a landscape-based tool for estimating sustainable walleye harvest rates. However, existing tools generally assume a pristine environment and therefore do not adequately represent many systems. **Our study will result in a state-wide tool that**

- **Accounts for contaminants when estimating sustainable harvest rates; and**
- **Is updatable and can be used by stakeholders to evaluate alternative scenarios.**

This tool can be modified for other game fish (e.g., bass, pike, perch) and fits into a larger research program to understand how to best manage and protect populations in their existing environments. If contaminants are present, then we should account for their tendency to limit juvenile survival and therefore the amount of harvest that a population can sustain. We will disseminate the findings by presenting at state conferences and meetings, and by publishing our analyses in scientific journals and lay publications.

C. Timeline Requirements: We anticipate that it will take three years to conduct the lab exposures and field validations, develop the model, identify vulnerable fisheries and regions in Minnesota, and develop and launch an online population-evaluation tool for general future use.

2017 Detailed Project Budget

Project Title: Impact of water quality on yearling walleye survival

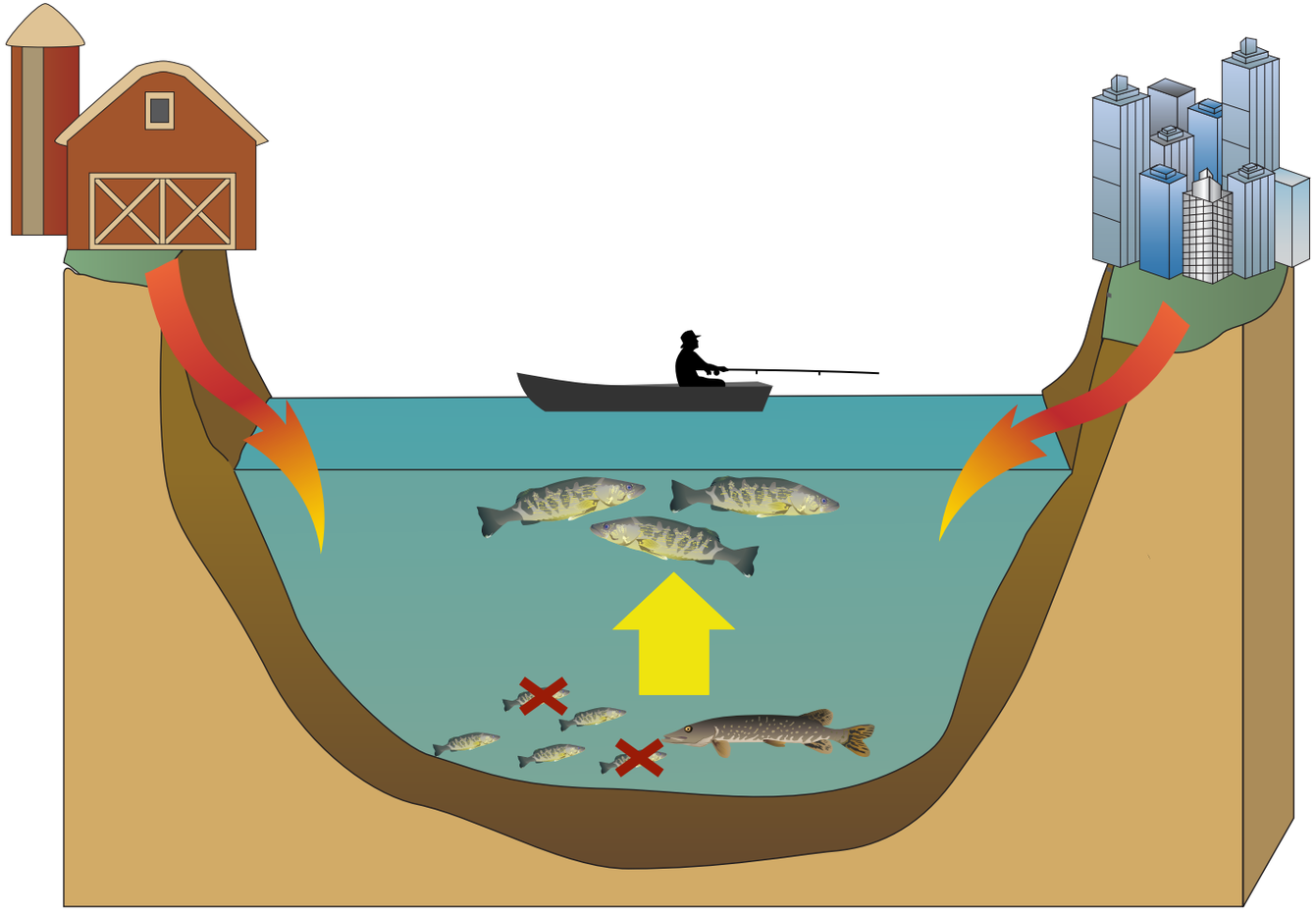
IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT
Jessica Ward, Assistant Professor at St Cloud State University PI ($35000 salary, $12,950 fringe, 37% fringe rate; total for 3 years; 25% effort in Years 1 and 2, 8.3% effort in Year 3). Dr. Ward holds a Fixed Term position that is funded entirely by external grants. She is requesting 3 months of salary in years 1 and 2 and 1 month in year 3.	$ 47,950
One Graduate Research Assistant at SCSU ($28,500 salary, $15,180 fringe (includes healthcare and tuition); total for 2 years; the student will assist Dr. Ward with research on the predator evasion performance of yearling walleyes exposed to contaminants (Activity 1) and the mark-recapture mortality experiments (Activity 2).	$ 43,680
Subcontract to University of Minnesota: Paul Venturelli, Co-PI Assistant Professor ($8,617 salary, $2,903 fringe, 33.7% fringe rate; total for 1 year; 8.3% effort). Dr. Venturelli is requesting 1 month of summer salary in year 3.	$ 11,520
Equipment/Tools/Supplies: Laboratory supplies (fish, fish maintenance in the lab, fish tags for field experiments)	$ 11,100
Exposure chemicals (e.g., herbicides, estrogens, pesticides, plasticizers, pharmaceuticals) blended into complex mixtures representative of either urban wastewater effluent or rural run-off.	$ 30,000
qPCR supplies (includes reagents, plates, tubes, etc.)	$ 3,500
Ethovision software	$ 12,500
Vitellogenin ELISA kits	$ 550
Analytical chemistry analysis of water samples; competitive bid from private lab analysis (20 samples x ~$850/ sample for complex mixtures)	$ 17,000
Travel: Travel between the experimental ponds (yet to be determined; potentially Sherco) and the Twin Cities or St Cloud	$ 1,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 178,800

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period: None	$ -	
Other State $ To Be Applied To Project During Project Period: None	$ -	
In-kind Services To Be Applied To Project During Project Period: *Because the project is overhead-free, laboratory space, electricity, and other overhead costs are provided in kind. The St Cloud State University overhead rate is 12%*	$ 21,456	Estimated
Funding History: None	$ -	
Remaining $ From Current ENRTF Appropriation: NA	$ -	

WHAT? Determine the impacts on water quality on juvenile walleye mortality
WHY? Juvenile survival directly determines the number of available adult fish



OUTCOME: An online state-wide tool for identifying current and future over-harvesting risks
BENEFIT: Manage and preserve fish populations in their existing human-impacted environments

Project Manager Qualifications and Organization Description

Jessica L Ward
Assistant Professor, Department of Biological Sciences, St Cloud State University

Hon. B.Sc., Evolutionary Biology, 2002, The University of Toronto, Toronto, CANADA.
Ph.D., Ecology, Evolution and Behavior, 2009, The University of Toronto, Toronto, CANADA

Dr. Jessica Ward is an Assistant Professor at St Cloud State University. She holds a 12-month fixed-term appointment, currently funded to 2020. She will be responsible for overall project coordination and for leading the research in Activity 1. She has been studying fish behavior for 13 years, 5 of which have specifically focused on understanding behavioral effects of contaminants of emerging concern on fish. Recent work has focused on the presence and effects of individual contaminants and contaminant mixtures on species interactions, and the development of new biological endpoints for evaluating exposure. Dr. Ward is currently leading the behavioral toxicology components of LCCMR-funded research on temperature-modulated effects of wastewater estrogens (in collaboration with Paige Novak, Heiko Schoenfuss and Paul Venturelli) and is a Co-PI on FWS-funded research on multi-generational effects of complex contaminant mixtures (in collaboration with Heiko Schoenfuss and Dalma Martinovic).

Dr. Paul Venturelli is an Assistant Professor at the University of Minnesota. He holds a 9-month tenure-track appointment. Dr. Venturelli is an expert on fish population dynamics and modeling. His research examines how temperature, habitat, life history (e.g., growth, maturity, reproduction, longevity) and human activities shape the population dynamics of fish species that are of interest to management and policy. Much of his work involves protecting the sustainability of Minnesota's recreational walleye fishery. In 2015 he served as Chair of the Mille Lacs Lake Blue Ribbon Panel. Dr. Venturelli currently serves as a member of the Mille Lacs Fisheries Advisory Committee.

Organization Description
St Cloud State University is Minnesota's second-largest university. Among its other features, the Department of Biological Sciences is equipped with available temperature-controlled flow-through exposure units, a dedicated well, a complete histology laboratory, and all of the equipment necessary for running qPCR analyses. The Department also has access to large-scale flow-through (Mississippi-fed) pools at the Sherco field station that could serve for field validation experiments. Thus, the facilities and equipment needed to complete the proposed studies are readily available to the PI and Co-PI.