

**Environment and Natural Resources Trust Fund**

# M.L. 2025 Final Work Plan

## **General Information**

**ID Number:** 2025-046

**Staff Lead:** Michael Varien

**Date this document submitted to LCCMR:** June 9, 2025

**Project Title:** Are All Walleye Created Equal? Probably Not.

**Project Budget:** $298,000

## **Project Manager Information**

**Name:** Nicholas Phelps

**Organization:** U of MN - College of Food, Agricultural and Natural Resource Sciences

**Office Telephone:** (612) 624-7450

**Email:** phelp083@umn.edu

**Web Address:** https://cfans.umn.edu/

## **Project Reporting**

**Reporting Schedule:** March 1 / September 1 of each year.

**Project Completion:** June 30, 2028

**Final Report Due Date:** August 14, 2028

## **Legal Information**

**Legal Citation:** M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 03b

**Appropriation Language:** $298,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to investigate Minnesota walleye strain physiology and disease responses to warming water and to build a tool to guide adaptive management of walleye in a warming climate.

**Appropriation End Date:** June 30, 2028

## **Narrative**

**Project Summary:** Given that walleye are vulnerable to climate change, we will investigate Minnesota walleye strain physiology and disease responses to warming water, and build a tool to guide adaptive management strategies.

**Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.**

Warming waters associated with climate change can create stressful conditions for fish, leading to reduced recruitment, physiological changes, and increased susceptibility to infectious diseases. As a cool-water species, walleye are particularly vulnerable to warming temperatures. In Minnesota, genetic strains of walleye are generally associated with major watersheds and are adapted to different thermal regimes. We hypothesize that walleye strains better adapted to higher temperatures may show a greater physiological resilience to warming water and lower susceptibility to opportunistic pathogens. Indeed, recent findings by the Minnesota DNR have shown evidence of adaptations to regional environments, and northern walleye strains stocked in southern lakes and rivers show poor persistence compared to their local counterparts. Differences in thermal tolerances (i.e., adaptations to regional thermal regimes) between strains may be an important contributing factor to variations in strain performance. Recent research linking walleye recruitment failures to short winters and warm summers underscores the urgency of understanding physiological responses and disease susceptibility in relation to temperatures expected in the future. Walleye strains more resilient to warming may play a critical role in climate adaptation of Minnesota walleye populations and inform management trade-offs between conserving local genetic integrity versus assisted migration of resilient populations.

**What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.**

With a collaboration between an interdisciplinary UMN research team and the MN DNR Walleye Tech Team, we aim to investigate the resilience of Minnesota walleye strains to warming waters to inform long-term management of walleye populations across the state. We will assess strain resilience to warming conditions by evaluating the thermal tolerances and temperature-driven disease susceptibility of three strains native to northern and southern regions of Minnesota: Pike River, Pine River, and the Lower Mississippi. We will conduct experimental trials simulating current and future thermal conditions in the laboratory. During the trials, we will collect baseline data of physiological changes and morbidity/mortality rates of strains, as well as expose strains to an opportunistic pathogen that exhibits higher virulence at elevated temperatures. We will also opportunistically collect samples for a complimentary project exploring walleye subpopulation genetics, informing our understanding of allele-specific differences in thermal tolerances. Finally, we will use the results of our investigation to improve the resolution of previous models predicting walleye population changes due to rising Midwest temperatures. The results will be presented in an online interactive tool that forecasts strain-level population changes across Minnesota and allows users to simulate outcomes associated with a range of management scenarios.

**What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state’s natural resources?**

Walleye are vital to ecosystems, hold a special significance to Tribal Nations, are prized by recreational fishers, and the popularity of walleye support fisheries which contribute substantially to local economies. Knowing that walleye are particularly vulnerable to warming water, it is imperative that we explore the consequences and solutions to the future impacts of a changing climate. The resilience of walleye strains to warming waters has direct applications and can inform management strategies aimed at sustaining viable walleye populations. The proposed online tool will make this research accessible for managers, supporting their efforts to maintain walleye in Minnesota waters.

## **Project Location**

**What is the best scale for describing where your work will take place?** Statewide

**What is the best scale to describe the area impacted by your work?** Statewide

**When will the work impact occur?** During the Project and In the Future

## **Activities and Milestones**

### **Activity 1: Evaluate the thermal tolerances of three Minnesota walleye strains under current and future climate scenarios**

**Activity Budget:** $102,450

**Activity Description:**We will obtain and acclimate walleye fry from selected strains (provided by DNR) to laboratory conditions prior to the start of trials. To assess strain resilience to future warming, we will replicate a 4-month season (May-August) in the laboratory, slowly increasing temperatures under the current normal (~6-22ºC) and potential future conditions (~6-32ºC). During the trial, we will record morbidity/mortality and collect baseline data of key physiological changes that are important indicators of thermal tolerance: growth, stress responses, and immune function. By collecting multiple measures of each physiological indicator, our investigation will capture a range of mechanisms that allow fish to cope with rising temperatures. We will monitor growth patterns by recording the weight and length of individual fish. Measures of stress responses will include cortisol levels, the expression of heat shock proteins, and signs of oxidative stress. We will assess the maintenance of adequate immune defenses under various temperatures with measures of both innate and adaptive immune function (e.g., respiratory burst activity and immunoglobulin expression). Sample collection at regular intervals throughout the 4-month trial will enable us to closely monitor these physiological changes. Tissue collection for the genetics project will occur concurrently with other sampling.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Approximate Completion Date** |
| Coordinate with the Minnesota DNR to obtain fry of each selected walleye strain | April 30, 2026 |
| Acclimate walleye fry to laboratory conditions | May 31, 2026 |
| Expose walleye strains to current and future conditions | August 31, 2026 |
| Evaluate differences in physiological responses of walleye strains to current and future conditions | December 31, 2026 |

### **Activity 2: Evaluate disease susceptibility of three Minnesota walleye strains under current and future climate scenarios**

**Activity Budget:** $102,450

**Activity Description:**We will run a simultaneous trial with an identical experimental design as Activity 1, except here we will introduce the fish to a virulent strain of the bacterium, Flavobacterium columnare. This opportunistic pathogen is known to exhibit higher virulence at elevated temperatures and cause columnaris disease – an important disease increasingly implicated in summer fish kills, including walleye. We will expose a subset of fry from each strain to the pathogen under both current and future conditions, planning the exposure during optimal growth of the bacteria (20-27ºC; disease outbreaks often occur at or above this threshold). Due to more rapid warming, fish experiencing future temperatures will be exposed to the pathogen earlier in the trial compared to those under current conditions. This mirrors the more prolonged period of vulnerability to warmwater pathogens that walleyes are expected to experience with more rapid and extreme spring/summer warming. Following pathogen exposure, sampling will continue to occur at regular intervals to monitor the physiological changes and mortality/morbidity of walleye strains as described in Activity 1. We will also include measures of pathogen shedding rates from infected fry as an additional assessment of disease susceptibility and population-level risk.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Approximate Completion Date** |
| Identify and culture a virulent strain of an opportunistic bacteria | March 31, 2026 |
| Expose walleye strains to an opportunistic pathogen under current and future conditions | July 31, 2026 |
| Evaluate differences in disease susceptibility of walleye strains under current and future conditions | December 31, 2026 |

### **Activity 3: Develop an online tool to inform long-term walleye management under current and future climate scenarios**

**Activity Budget:** $93,100

**Activity Description:**We will incorporate our data, which will describe strain-specific changes in physiology and disease susceptibility associated with temperature, into existing models predicting temperature-driven changes in walleye abundance. Using tools generated to inform the long-term management of Wisconsin walleye populations as a guide, we will present the product of this activity as an online interactive R-Shiny tool that forecasts strain-level population potential across Minnesota lakes. Our tool will integrate the existing data of walleye population dynamics and lake thermal regimes and include features allowing users to visualize predicted changes in walleye populations and simulate a variety of status quo or new management scenarios (e.g., trade-offs between conserving local genetic integrity versus assisted migration of southern-strain walleye to northern Minnesota) to better understand potential outcomes. Simulated management practices and descriptions of outcomes will be guided by “resist, accept, direct” conservation planning. This will present essential information in a familiar decision framework to direct the selection of management priorities and conservation strategies. The co-development of our tool will be a highly collaborative process involving a close partnership with the MN DNR Walleye Tech Team, composed of fisheries researchers and managers statewide who will provide feedback to improve the tool’s effectiveness and user-friendliness.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Approximate Completion Date** |
| Incorporate data describing the physiological changes and disease susceptibility of strains in relation to temperature | January 31, 2027 |
| Integrate existing data of walleye population dynamics and lake thermal regimes into the management tool | February 28, 2027 |
| Evaluate and update tool functionality for fisheries managers and other end users | May 31, 2027 |
| Collaborate with the Minnesota DNR Walleye Tech Team to plan management tool development | June 30, 2027 |

## **Project Partners and Collaborators**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Organization** | **Role** | **Receiving Funds** |
| Laurel Sacco | UMN | Graduate Student, PhD, Conservation Sciences | Yes |
| Walleye Tech Team | MN DNR | Advise project development, study design, and tool development to ensure the project meets management needs and the findings are transferable to the real-world. DNR will provide fry from a variety of walleye strains at no cost to the project. | No |

## **Dissemination**

**Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.**We will pursue multiple avenues to disseminate important information/resources from the project work to diverse audiences including agency, research, industry, and educational entities and individuals who may benefit from or use the work.
- We provide scientific presentations to share the results of this work. Possible platforms for these presentations include conferences, webinars, and the MN DNR’s Fisheries Research Seminar.
- The results of the project work will also be shared with the scientific community via at least one publication in a peer-reviewed journal.
- A primary component of this project work is the development of an online tool to share the results with potential end-users of this research such as resource managers and other decision-makers. This online tool will be publicly available, allowing for the broader Minnesota community to access this work as well.
- We will directly engage with those who may have interest in the results and/or application of this project work, including the Minnesota DNR, Minnesota Tribal Environment Committee, and MN-FISH Sportfishing Foundation & Coalition. We will also make efforts to engage other groups who may benefit from or use this research throughout the project work.
- We plan to share walleye tissue samples and thermal tolerance results with a complementary project investigating the local population genetics of walleye led by MN DNR and NDSU. This mutually beneficial arrangement may provide important insights into the fine-scale genetic patterns underlying possible differences in the thermal tolerances of walleye strains.
- To ensure that the results of this work are widely accessible to Minnesotans we will pursue various avenues of public outreach including social media posts, interviews with news outlets, and public presentations.
- The Environment and Natural Resources Trust Fund will be acknowledged through the use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENTRF Acknowledgment Guidelines.

## **Long-Term Implementation and Funding**

**Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?**This project was co-developed by UMN researchers and members of the MN DNR Walleye Tech Team to address immediate management questions. This partnership will help ensure outcomes are transferable, informing adaptive management strategies that sustain Minnesota's walleye populations in a changing climate. We may identify a need to investigate additional variables and/or add complexity to the management tool, requiring additional research. Funding to support future research needs will be prioritized and pursued by the project team to build on the expected results of this proposed project.

## **Budget Summary**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Category / Name** | **Subcategory or Type** | **Description** | **Purpose** | **Gen. Ineli gible** | **% Bene fits** | **# FTE** | **Class ified Staff?** | **$ Amount** |
| **Personnel** |  |  |  |  |  |  |  |  |
| Nick Phelps, Professor |  | Overall supervision and leadership of all activities |  |  | 37.1% | 0.16 |  | $38,000 |
| Laurel Sacco, Graduate Student |  | Project management and implementation of all activities |  |  | 25.1% | 1.5 |  | $166,344 |
| Gretchen Hansen, Associate Professor |  | Direct involvement with all activities. |  |  | 37.1% | 0.16 |  | $33,900 |
| Undergraduate student support |  | Fish husbandry, sample processing, and system maintenance. |  |  | 0% | 0.6 |  | $10,000 |
| Denver Link, Research Associate |  | Provide support for experimental trials, data collection, and analysis. |  |  | 33.5% | 0.16 |  | $12,915 |
|  |  |  |  |  |  |  | **Sub Total** | **$261,159** |
| **Contracts and Services** |  |  |  |  |  |  |  |  |
| University of Minnesota | Internal services or fees (uncommon) | Access to two fish bays in the MAISRC Containment Laboratory. Charged daily rate ($22.20/day) for 270 days. |  |  |  | 0 |  | $11,988 |
|  |  |  |  |  |  |  | **Sub Total** | **$11,988** |
| **Equipment, Tools, and Supplies** |  |  |  |  |  |  |  |  |
|  | Tools and Supplies | Laboratory supplies | Laboratory supplies and reagents for testing cortisol level and immune function genes, and culturing bacteria. |  |  |  |  | $12,500 |
|  | Tools and Supplies | Laboratory supplies | Supplies for fish husbandry (i.e., food, disinfectants, etc) and sample collection (i.e., rulers, gloves, etc.) |  |  |  |  | $3,553 |
|  | Equipment | 24 aquaria and shelving | Necessary aquaria and shelving for experimental trials. Additional aquaria systems will be used from previous research. |  |  |  |  | $3,600 |
|  |  |  |  |  |  |  | **Sub Total** | **$19,653** |
| **Capital Expenditures** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Acquisitions and Stewardship** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Travel In Minnesota** |  |  |  |  |  |  |  |  |
|  | Miles/ Meals/ Lodging | 4 trips, at approx 250 miles each, 1-2 people per trip | Travel to DNR hatcheries to collect walleye fry |  |  |  |  | $700 |
|  |  |  |  |  |  |  | **Sub Total** | **$700** |
| **Travel Outside Minnesota** |  |  |  |  |  |  |  |  |
|  | Conference Registration Miles/ Meals/ Lodging | 1 conference, 3 days per diem (location TBD), 1 person | Travel to present research results at a nationally relevant conference | X |  |  |  | $2,500 |
|  |  |  |  |  |  |  | **Sub Total** | **$2,500** |
| **Printing and Publication** |  |  |  |  |  |  |  |  |
|  | Publication | peer-reviewed manuscript | Publication of 1 peer-reviewed manuscript to ensure research results are peer-reviewed and widely accessible. |  |  |  |  | $2,000 |
|  |  |  |  |  |  |  | **Sub Total** | **$2,000** |
| **Other Expenses** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
|  |  |  |  |  |  |  | **Grand Total** | **$298,000** |

### **Classified Staff or Generally Ineligible Expenses**

|  |  |  |  |
| --- | --- | --- | --- |
| **Category/Name** | **Subcategory or Type** | **Description** | **Justification Ineligible Expense or Classified Staff Request** |
| **Travel Outside Minnesota** | Conference Registration Miles/Meals/Lodging | 1 conference, 3 days per diem (location TBD), 1 person | Travel to national conference will provide an opportunity for student development, sharing of important findings, and networking with fisheries managers to facilitate adoption of research results. |

### **Non ENRTF Funds**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | **Specific Source** | **Use** | **Status** | **$ Amount** |
| **State** |  |  |  |  |
| In-Kind | University of Minnesota foregone indirect costs | Administrative support of MAISRC activities including payroll and human resources, finance, facilities, and IT. | Secured | $111,564 |
|  |  |  | **State Sub Total** | **$111,564** |
| **Non-State** |  |  |  |  |
|  |  |  | **Non State Sub Total** | **-** |
|  |  |  | **Funds Total** | **$111,564** |

**Total Project Cost: $409,564**

**This amount accurately reflects total project cost?**
 Yes

## **Attachments**

### **Required Attachments**

#### ***Visual Component***

File: [9c798784-c4f.pdf](https://lccmrprojectmgmt.leg.mn/media/map/9c798784-c4f.pdf)

#### ***Alternate Text for Visual Component***

An overview of the project is outlined, including a description of the problem: future climate conditions will likely impact Minnesota walleye strains differently, but we don’t know how or to what degree, resulting in management uncertainty. Three activities are described to fill key knowledge gaps and develop a management tool....

### **Supplemental Attachments**

#### ***Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other***

|  |  |
| --- | --- |
| **Title** | **File** |
| MN DNR Support Letter | [9cd87ca5-858.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/9cd87ca5-858.pdf) |
| UMN Sponsored Projects Office approval | [2f8c0db9-79b.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/2f8c0db9-79b.pdf) |
| 2025-046 Research Addendum revised\_Final | [4c483688-c88.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/4c483688-c88.pdf) |

## **Difference between Proposal and Work Plan**

#### ***Describe changes from Proposal to Work Plan Stage***

No significant changes.

## **Additional Acknowledgements and Conditions:**

The following are acknowledgements and conditions beyond those already included in the above workplan:

**Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?**
 N/A

**Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?**
 Yes, I understand the UMN Policy on travel applies.

**Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?**
 No

**Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?**
 N/A

**Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?**
 N/A

**Does your project include original, hypothesis-driven research?**
 Yes

**Does the organization have a fiscal agent for this project?**
 Yes, Sponsored Projects Administration

**Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing $10,000 or more or large-scale stream or wetland restoration?**
 No

**Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?**
 No

**Provide the name(s) and organization(s) of additional individuals assisting in the completion of this project:**

 Laurel Sacco, UMN; Gretchen Hansen, UMN; Walleye Tech Team representatives, MN DNR

**Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR’s reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements**
 N/A