



# Environment and Natural Resources Trust Fund

M.L. 2023 Approved Work Plan

## General Information

**ID Number:** 2023-120

**Staff Lead:** Corrie Layfield

**Date this document submitted to LCCMR:** June 2, 2023

**Project Title:** Predicting the Future by Understanding the Past

**Project Budget:** \$170,000

## Project Manager Information

**Name:** Lynn Waterhouse

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

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## Project Reporting

**Date Work Plan Approved by LCCMR:** June 22, 2023

**Reporting Schedule:** April 1 / October 1 of each year.

**Project Completion:** June 30, 2026

**Final Report Due Date:** August 14, 2026

## Legal Information

**Legal Citation:** M.L. 2023, Chp. 60, Art. 2, Sec. 2, Subd. 03g

**Appropriation Language:** \$170,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to use past and present information to model future ranges of native aquatic species in Minnesota to generate publicly available tools for species and habitat management.

**Appropriation End Date:** June 30, 2026

## Narrative

**Project Summary:** We will predict the ranges of native aquatic species in Minnesota using recently available high quality datasets and information on past and present ranges coupled with powerful statistical techniques.

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

Native aquatic species have had their ranges impacted by habitat degradation, climate change, invasive species, harvest, and other anthropogenic impacts. Each year the state of Minnesota spends millions of dollars on the conservation of aquatic native species. A booming economy relies on the state's natural resources, with the outdoor recreation economy alone valued at \$16.7 billion in 2022. The climate in Minnesota is predicted to continue changing substantially throughout this century, average annual temperature across the state has already increased nearly 3°F since the late 1800s. Climate models predict temperature increases, changed winter freeze-thaw cycles, and increasing precipitation. The new climate regime will result in species altering their ranges in order to persist. To support the goal of Minnesota's Department of Natural Resources, that 'the benefits of all Minnesota's natural resources are enjoyed by all Minnesotans', it is important to anticipate and plan for likely future scenarios. By identifying native aquatic species most likely to be impacted by future climate change, and geographic areas with high levels of species change, management agencies can better focus their resources to protect and conserve these aquatic species in areas that will be most suited to them, for the benefit of Minnesota's future.

**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.**

We will take advantage of the many high quality and high resolution climate and habitat data sources available for Minnesota, along with current and historical native aquatic species occurrence information (for the entire native range), to build a model that accurately predicts species' ranges under current and future conditions. We will include data that cover chemical, physical, geographic, and anthropogenic factors so that the model can select which factors are most important in modeling the current species range. To the extent that we are able to include biological data (e.g., plant cover or zooplankton abundance) we will, assuming data for future projections are available in order to complete the prediction step. The project will take advantage of modern statistical methods for predicting species distributions (boosted regression trees), made possible by the combination of powerful computing resources and high quality climate and habitat data that are now available. The model will then be coupled with future climate projections to predict range shifts of the native species. We will convene and advisory panel that we will meet with throughout the project consisting of species experts, natural resource managers, and policy makers from government, tribal organizations, universities, and non-governmental organizations.

**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?**

This project would result in two useful tools for managers focusing on aquatic resources and species management. The first would be a map of water bodies in Minnesota that are ranked (low, medium, high) in terms of their risk of changes to native species populations from future climate scenarios. The second tool would be a list of the native aquatic species selected by the advisory panel that are at high risk of change and a list of the resilient species. This information will help with planning for the future protection, conservation, preservation, and enhancement of the state's natural resources.

## 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: Modeling the past and present locations of native aquatic species in Minnesota: deciding species, collecting data, building model

**Activity Budget:** \$89,854

**Activity Description:**

We will convene an advisory panel (with representatives from Minnesota Department of Natural Resources and Minnesota Tribal Environmental Committee) to select the Minnesota native aquatic species and discuss the project. We will continue to convene with and update the advisory panel throughout the project duration. We plan to include native aquatic species from one or more of these categories: environmentally important, economically important, culturally important, and special status (i.e., endangered, threatened). For each native aquatic species of interest, we will extract all records from the Global Biodiversity Information Facility. We will need to meet with owners of the data to ensure its proper use. Model predictor variables will include a host of physical, biological, chemical, anthropogenic, and geographic covariates. We will restrict our focus to datasets that also have complementary future predicted values available (in order to complete Activity 2). By using only publicly available datasets the project will be reproducible and more accessible for future projects. All analyses will be done using the free software R. We will use a powerful statistical model which has been shown to perform very well for predicting occurrence data, boosted regression trees, to model the past and current ranges of native aquatic

**Activity Milestones:**

Description	Approximate Completion Date
Convene advisory panel to select Minnesota native aquatic species to focus on	August 31, 2023
Identify and collect data on chemical, physical, biological, geographic, and anthropogenic covariates for native range	January 31, 2024
Work with MN experts to collect and understand data on native aquatic species ranges/occurrences	January 31, 2024
Build, test, train model for predicting current and past ranges/occurrence of native aquatic species	August 31, 2024
Meet with advisory panel to continue discussion of data, species selected, and project progress	August 31, 2024

### Activity 2: Predicting future ranges for native aquatic species in Minnesota and development of management tools

**Activity Budget:** \$72,419

**Activity Description:**

We will take the model constructed in activity 1 and use predicted future values for Minnesota (the same subset of physical, biological, chemical, anthropogenic, and geographic covariates used to build the model) to predict the future occurrences of native aquatic species in Minnesota. We will use these predictions to construct two tools for managers and policymakers. The first will be a ranking of all of the native aquatic species based on the amount of predicted range shifts (being high, medium, or low). The second tool will be a ranking of water bodies in Minnesota based on the amount of predicted change in species (being high, medium, or low). These two tools should help inform management strategies and budget decisions in the future. The project results will be shared with the scientific community via peer-reviewed publications and presentations at scientific conferences (both while the model is being developed and once we have results). Sharing the results at conferences will provide a unique opportunity to receive feedback from other scientists working on similar problems or with similar models. The peer-reviewed publications will share the final project results with the scientific community via open access publications making the work accessible and repeatable.

**Activity Milestones:**

Description	Approximate Completion Date
Identify and collect projected data (future predicted values) on covariates for water bodies in Minnesota	October 31, 2024
Use model to predict future ranges/occurrence of native aquatic species in MN	March 31, 2025
Use predicted future ranges/occurrences results to build management tools	April 30, 2025
Submit final papers for publication	June 30, 2025
Present preliminary project findings and final project findings at scientific conferences	June 30, 2025

### Activity 3: Outreach activities and dissemination of management tools

**Activity Budget:** \$7,727

**Activity Description:**

We will host a variety of workshops to share these results with interested parties (one focusing on scientists interested in the quantitative tool and others for managers and policymakers). The postdoctoral fellow involved in the project will share final results through an outreach activity with the Bell Museum of natural history at UMN. The outreach event at the Bell Museum will be at the Spotlight Science event. Spotlight Science are regular programs hosted at the Bell Museum that connect their visitors with current science, conducted at the University of Minnesota and beyond. Our Spotlight science event will feature conversations and unique interactive experiences. To make the interactive experience we will use printed materials, plush native aquatic species, laminated cards, maps, and game materials. The interactive experience will be developed working with experts from Bell Museum (Holly Menninger).

**Activity Milestones:**

Description	Approximate Completion Date
Build and present outreach activity with Bell Museum based on results and submit other outreach	June 30, 2025
Share management tools with managers and policy makers at targeted meetings/workshops	June 30, 2025
Share quantitative tools and methods with scientists at targeted meetings/workshops.	June 30, 2025

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Nick Phelps	UMN - College of Food Agriculture and Natural Resource Sciences	co-PI. Helping with species specific data, outreach, collaboration within MN.	No
Richard Erickson	USGS Upper Midwest Environmental Sciences Center	Co-PI. Helping with horizon scanning, coding, and data wrangling.	No
Ryan C. Burner	USGS Upper Midwest Environmental Sciences Center	Co-PI. Helping with horizon scanning, coding, and data wrangling.	No
Wesley M. Daniels	USGS Wetland and Aquatic Research Center	Co-PI. Helping with horizon scanning, coding, and data wrangling.	No
Holly Menninger	Bell Museum	Will help with outreach activity at Bell Museum.	Yes
future postdoctoral fellow (to be named)	University of Minnesota	Collecting data, building model, predicting future ranges. Will be the person conducting model of the data analysis with guidance from the other scientists (L. Waterhouse, R. Erickson, R. Burner, and W. Daniels). Will also participate in outreach activities (with L. Waterhouse and H. Menninger).	Yes

## 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.**

Before we begin the project, we will convene an advisory panel. The advisory panel will work collaboratively with the principal investigators throughout the duration of this project. The main goals of this collaboration will be to ensure that (1) species are selected that are culturally, economically, and ecologically important to Minnesota and the people of Minnesota; (2) all relevant datasets are discovered and utilized in the modeling work; (3) discussions, when appropriate, occur about additional data needs for future collection to support ongoing modeling efforts; and (4) interpretation and use the results of the model in planning for species and habitat management. The advisory panel will consist of members from tribes, local, state, and federal agencies.

As part of the outreach plan we will offer online and in-person workshops targeting two distinct groups of people. One will target people interested in the quantitative methods used in the project. The other workshop will target managers and policymakers who wish to understand the management tools developed by the project. The workshops will most likely take place at UMN St. Paul campus and will be open to anyone interested. If necessary we can also offer remote access to the workshops to increase accessibility.

The project will also result in at least one manuscript that will be submitted to a peer-reviewed publication. In order to publicize this work, the postdoctoral fellow will start to present the work midway through the project at state and regional meetings in Minnesota and continue until the final results are obtained. Once published, the peer-reviewed publication will be open-access so anyone can access it. Additionally the data analysis code, with appropriate

annotations, will be publicly archived online in the USGS repository. Providing the code (with annotations) and all publications as open-access allows for reproducible science and makes results easy to replicate, or to update as other data sources become available in the future.

Lastly, we will disseminate the project to a broader audience through collaborations and outreach activities with the Bell Museum of Science through their Science Spotlight events. We also plan to publish articles related to this work in newsletters and magazines (ex. Minnesota Conservation Volunteer from Minnesota Department of Natural Resources).

In all of these activities we will be sure to appropriately acknowledge the Environment and Natural Resources Trust Fund for funding.

## 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?**

Results from the project would be shared through a variety of outreach activities. The model, data and results will be archived online through the USGS data portal along with being published in peer-reviewed open-access (free) journals. The model and results will be shared through workshops archived online. The general results will be shared with a broader audience through short articles in regional newsletters, presentations, and outreach activities with the Bell Museum at University of Minnesota. A complementary project focusing on aquatic invasive species in the Upper Mississippi River Basin (including Minnesota) was successfully funded from a USGS funding call.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
Holly Menninger		Leads Public Engagement & Science Learning at Bell Museum. Will help with outreach event at Bell Museum.			33.5%	0.01		\$1,235
Postdoctoral Fellow (to be named)		Will lead data collection, analysis, and outreach efforts.			20.9%	2		\$134,985
							<b>Sub Total</b>	<b>\$136,220</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	-
<b>Equipment, Tools, and Supplies</b>								
	Tools and Supplies	Plush native aquatic species, laminated cards, maps, game materials	Materials for outreach activity (Spotlight Science event) with Bell Museum (plush native aquatic species, laminated cards, maps, game materials)					\$4,292
	Tools and Supplies	(coffee, tea, light snacks) (\$200 x3)	Refreshments for meetings at UMN with managers and policymakers to share final management tools	X				\$600
	Tools and Supplies	(coffee, tea, light snacks) (\$200 x1)	Refreshments for meeting on quantitative methods at UMN to share final model	X				\$200
	Tools and Supplies	computer	Computer for postdoctoral fellow (collecting data, data quality control and transformations, model tuning and testing, model validation, future projections, and creation of management tools). Need to purchase computer with large memory, fast processor, and lots of RAM (32GB+) in order to do quantitative methods in proposal.	X				\$3,500



	Tools and Supplies	Computer accessories (keyboard, mouse, dual monitors).	Dual monitors, mouse, keyboard for postdoctoral fellow (data heavy projects with coding are completed more efficiently with dual monitors)	X				\$1,500
	Tools and Supplies	thumbdrives (35)	digital copies (thumbdrives) for final management tools for meetings (x3) with managers and policymakers also for meeting with scientists on quantitative methods (x1)					\$400
							<b>Sub Total</b>	<b>\$10,492</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	-
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
	Conference Registration Miles/ Meals/ Lodging	2 people, conference registration, miles (320 round trip - using Duluth as best guess of location), lodging (4 nights x 2 rooms), meals (2 days travel, 3 full days)	Minnesota (MN) American Fisheries Society (AFS) registration, meals, lodging, and miles (February 2024) for postdoc and project PI who will both present at the conference.	X				\$1,975
	Conference Registration Miles/ Meals/ Lodging	2 people, registration, mileage (320 miles rounds trip - using Duluth as best guess of location), lodging (4 nights x 2 rooms), meals (2 days travel, 3 full days)	travel to 2025 Minnesota American Fisheries Society (AFS) meeting (location TBD) to present final results of project.	X				\$1,975
	Miles/ Meals/ Lodging	8 total trips. 2 person per trip. 3 days (2 nights lodging - \$165/night), meals (2 days travel, 1 full day @\$79 for full day), mileage (using 320 miles Duluth as proxy for calculating each trip)	Trips for postdoctoral fellow and project PI to visit advisory panel members and data keepers throughout project to work on data collection, analysis, and results interpretation as well as sharing final results.					\$9,938
							<b>Sub Total</b>	<b>\$13,888</b>
<b>Travel Outside Minnesota</b>								

							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
	Publication	Publication fees	Scientific publication fees, open access (2 x \$4000) to share results of project					\$8,000
	Printing	Printed management tools	Printed copies of management tools for meetings (x3) with managers and policymakers					\$300
	Printing	Printed quantitative tool materials	Printed materials (when requested) for workshops on model and quantitative methods (x1)					\$100
	Printing	Printed materials (and lamination) for outreach activity at Bell Museum	Materials for outreach activity at Spotlight Science event at Bell Museum of Science. Materials will be reused for additional future outreach events.					\$1,000
							<b>Sub Total</b>	<b>\$9,400</b>
<b>Other Expenses</b>								
							<b>Sub Total</b>	-
							<b>Grand Total</b>	<b>\$170,000</b>

## Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
<b>Equipment, Tools, and Supplies</b>		(coffee, tea, light snacks) (\$200 x3)	Meeting to share management tools with managers and policymakers will be an important way we share the results of this project. We believe these meetings will be better attended if we are able to offer coffee, tea, and light snacks. Also the caffeine will help everyone with better focus on our exciting and important results.
<b>Equipment, Tools, and Supplies</b>		(coffee, tea, light snacks) (\$200 x1)	Meeting to share quantitative tools with those interested in learning the quantitative methods we employed be an important way we share the results of this project. We believe these meetings will be better attended if we are able to offer coffee, tea, and light snacks. Also the caffeine will help everyone with better focus on our exciting and important results and quantitative methods.
<b>Equipment, Tools, and Supplies</b>		computer	This project is entirely computer based. A computer is necessary in order to complete the data collection and statistical analyses plus prediction step. The computer also needs to have large memory, fast processor, and large RAM (32GB+) to ensure it can handle the data and model. To ensure the postdoctoral fellow has a computer able to complete the project it is best to purchase them a new one. Also, many postdocs may not have their own computer for modeling purposes depending on their prior role.
<b>Equipment, Tools, and Supplies</b>		Computer accessories (keyboard, mouse, dual monitors).	This project is entirely computer based. A computer is necessary in order to complete the data collection and statistical analyses plus prediction step. It will be more efficient to use that computer with a proper keyboard, mouse, and dual monitors given that the project will often involve having multiple datasets open and coding chunks. To ensure the postdoctoral fellow has a computer able to complete the project it is best to purchase them a new one.
<b>Travel In Minnesota</b>	Conference Registration Miles/Meals/Lodging	2 people, conference registration, miles (320 round trip - using Duluth as best guess of location), lodging (4 nights x 2 rooms), meals (2 days travel, 3 full days)	Work (in progress) will be presented at the 2024 Minnesota American Fisheries Society meeting. This is an opportunity to get feedback on the methods and data while the model is still being developed.
<b>Travel In Minnesota</b>	Conference Registration Miles/Meals/Lodging	2 people, registration, mileage (320 miles rounds trip - using Duluth as best guess of location), lodging (4 nights x 2 rooms), meals (2 days travel, 3 full days)	Completed work and management tool will be presented at the 2025 Minnesota American Fisheries Society meeting. This is an opportunity to get feedback on the methods and data while the model is still being developed.

Non ENRTF Funds

Category	Specific Source	Use	Status	\$ Amount
State				
			State Sub Total	-
Non-State				
			Non State Sub Total	-
			Funds Total	-

## Attachments

### Required Attachments

#### *Visual Component*

File: [97c245bf-903.pdf](#)

#### *Alternate Text for Visual Component*

Flow chart of process of research project. Visual depiction of species data for full range of native aquatic species and then using future environmental projections to make predictions of future species range. Visual depiction of management tools created from project. Explanation of problem, approach, and outcomes from the project....

### Optional Attachments

#### *Support Letter, Photos, Media, Other*

Title	File
Letter of approval from UMN Regents / SPA	<a href="#">3c1630d3-4f0.pdf</a>
background check certification form	<a href="#">1b64b157-d74.jpe</a>
Research Addendum	<a href="#">d7bfdea9-e7c.pdf</a>

## Difference between Proposal and Work Plan

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

We removed the matching funds from R. Burner and R. Erickson. The majority of the principal investigators on this project are federal employees (L. Waterhouse, R. Burner, R. Erickson, and W. Daniels). All of them will be working on this project.

We added a dissemination plan.

We uploaded a background form for L. Waterhouse. We will not work directly with children, but children may attend Bell Museum events, so we submitted the form.

We updated the budget to include more details on some of the budget items (no \$ values were changed).

We added a 4th activity so the outreach (Bell Museum and workshops) were no longer part of activity #3.

We updated some of the wording in the narrative.

We added a work phone # for Lynn Waterhouse.

We added the research addendum complete with requested 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 agree travel expenses must 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 agree to the UMN Policy.

**Does your project have potential for royalties, copyrights, patents, or sale of products and assets?**

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