



Environment and Natural Resources Trust Fund

2023 Request for Proposal

General Information

Proposal ID: 2023-120

Proposal Title: Predicting the Future by Understanding the Past

Project Manager Information

Name: Lynn Waterhouse

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

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Project Basic Information

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.

Funds Requested: \$170,000

Proposed Project Completion: June 30, 2025

LCCMR Funding Category: Small Projects (H)

Secondary Category: Foundational Natural Resource Data and Information (A)

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

Narrative

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 an 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 aquatic 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. We would work with managers and policy makers so they understand how to use and interpret the resulting tools.

Activities and Milestones

Activity 1: Modeling the past and present locations of native aquatic species in Minnesota

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. 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 freely available statistical 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 the native aquatic species.

Activity Milestones:

Description	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
Collect 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

Activity 2: Predicting future ranges for native aquatic species in Minnesota and sharing management tools

Activity Budget: \$80,146

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. 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 via peer-reviewed publications, presentations at conferences, and through an outreach activity with the Bell Museum of natural history at UMN.

Activity Milestones:

Description	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 and share results	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

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) has been submitted to a USGS funding call.

Project Manager and Organization Qualifications

Project Manager Name: Lynn Waterhouse

Job Title: Assistant Unit Leader, Fisheries (Minnesota Cooperative Fish and Wildlife Research Unit University of Minnesota Department of Fisheries, Wildlife, and Conservation Biology)

Provide description of the project manager's qualifications to manage the proposed project.

Lynn Waterhouse is the Assistant Unit, Leader in Fisheries at the Minnesota Cooperative Fish and Wildlife Research Unit (MNCFWRU) which is a USGS Cooperative Research Unit at the University of Minnesota UMN). L. Waterhouse is also an Assistant Professor in the Department of Fisheries, Wildlife, and Conservation Biology. L. Waterhouse has a PhD in Biological Oceanography and MS degrees in Fisheries Science and Statistics. L. Waterhouse joined MNCFWRU in June

2021 and is working on growing her lab, and she currently has 2 MS students. L. Waterhouse has experience working with and leading collaborative research projects. L. Waterhouse just concluded working on a large collaborative project assessing the growth of bigeye tuna in the Atlantic ocean with researchers from Europe, Africa, South America, and North America. As part of UMN, funds awarded to L. Waterhouse will go to UMN and have oversight from accounting people there (Kelsey Grachek, grach013@umn.edu). L. Waterhouse is able to bring in additional students and postdoctoral fellows through UMN Department of Fisheries, Wildlife, and Conservation Biology which is a strong program. L. Waterhouse has training in science outreach and will work with the Bell Museum of Natural History at UMN for much of the science outreach. As part of her job with MNCFWRU, L. Waterhouse works closely with other scientists from Minnesota Department of Natural Resources (MN DNR), USGS, and the US Fish and Wildlife Services.

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

Organization Description:

In the College of Food, Agricultural and Natural Resources Sciences (CFANS) we look at the bigger picture. We use science to find answers to the world's grand challenges and solve tomorrow's problems. The goal of CFANS is to advance Minnesota as a global leader in food, agriculture, and natural resources through extraordinary education, science-based solutions, and dynamic public engagement that nourishes people and enhances the environment in which we live. Few other public universities come close to the breadth of our expertise, allowing us to tackle challenges in novel ways. We develop leaders that see more possibilities and produce solutions that work for real people. This creates a powerful force for change. The university also hosts a cutting edge Minnesota Supercomputing Center which researchers use to tackle cutting edge problems. Twelve academic departments and 10 research and outreach centers make up our college, along with the Minnesota Landscape Arboretum, the Bell Museum, and dozens of interdisciplinary centers. The Department of Fisheries, Wildlife, and Conservation Biology has about 20 faculty, 40 staff, 60 graduate students, 200 undergraduates, 1200 alumni, and many friends....all working together to advance our knowledge of fisheries, wildlife, and conservation biology.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
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
							Sub Total	\$136,220
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
	Tools and Supplies	Plush native aquatic species, laminated cards, maps, game materials	Materials for outreach activity 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 tools					\$600
	Tools and Supplies	(coffee, tea, light snacks) (\$200 x1)	Refreshments for meeting on quantitative methods at UMN to share final model					\$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
							Sub Total	\$10,492
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	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	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 share 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.					\$9,938
							Sub Total	\$13,888
Travel Outside Minnesota								
							Sub Total	-

Printing and Publication								
	Publication	Publication fees	Scientific publication fees, open access (2 x \$4000)					\$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
							Sub Total	\$9,400
Other Expenses								
							Sub Total	-
							Grand Total	\$170,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Equipment, Tools, and Supplies		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.
Equipment, Tools, and Supplies		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.
Travel In Minnesota	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.
Travel In Minnesota	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				
In-Kind	USGS	Salary match for Co-PIs Richard Erickson and Ryan Burner (time contribution) to project.	Pending	\$10,000
			Non State Sub Total	\$10,000
			Funds Total	\$10,000

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 or Other

Title	File
Letter of approval from UMN Regents / SPA	3c1630d3-4f0.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

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?

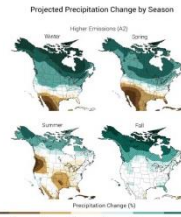
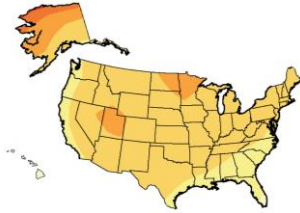
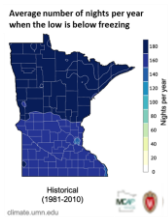
Yes, Sponsored Projects Administration

Predicting the Future by Understanding the Past

THE PROBLEM: Habitat impacts and other changes to the environment can cause aquatic species to shift their ranges. These changes can have large impacts for management depending on the species status. By better understanding future ranges of native aquatic species we can help management make informed decisions.

APPROACH: With guidance from advisory panel of Minnesota stakeholders select native aquatic species. Utilize publicly available data and information on native aquatic species ranges to build robust statistical model for past and present ranges. Using projected future conditions, predict future ranges for native aquatic species.

Covariate Data (chemical, biological, physical, etc.)



Sources: UMN,
National
Climate
Assessment

Species Native Occurrence Information

*Anguilla
rostrata*



*Cycleptus
elongatus*

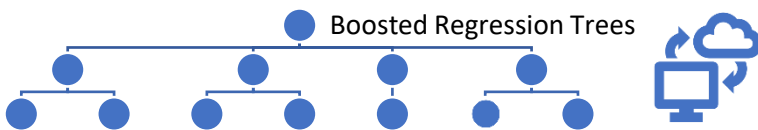


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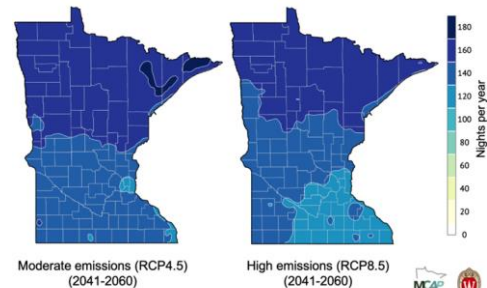
Source: MN DNR

Model Testing, Tuning, and Validation



Future Environmental Conditions

Average number of nights per year when the low is below freezing



Source: UMN

Management Tools

Species	Risk	Locations	Risk
.....	High	High
.....	Medium	Medium
.....	Low	Low

OUTCOME: Model results informed by Minnesota stakeholders that are shared with managers and policymakers via two simple tools with workshops and materials archived online.

