



# Environment and Natural Resources Trust Fund

2022 Request for Proposal

## General Information

**Proposal ID:** 2022-136

**Proposal Title:** Photosynthetic Temperature Response of Parrot Feather (*Myriophyllum aquaticum*)

## Project Manager Information

**Name:** Christopher Ruhland

**Organization:** Minnesota State Colleges and Universities - Minnesota State University Mankato

**Office Telephone:** (507) 389-1323

**Email:** christopher.ruhland@mnsu.edu

## Project Basic Information

**Project Summary:** Parrot feather is potentially invasive to Minnesota waters. Little is known about its ability to photosynthesize and survive under ice, and as such its ability to expand its invasive range.

**Funds Requested:** \$151,000

**Proposed Project Completion:** July 31 2024

**LCCMR Funding Category:** Small Projects (H)

**Secondary Category:** Aquatic and Terrestrial Invasive Species (D)

## 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.**

Parrot feather is an emergent aquatic milfoil species native to South America but has become invasive in the United States. It is found from New Jersey to California but has not yet invaded Minnesota waters. However, isolated populations have been found in Wisconsin, Iowa and Ontario. It is highly adaptive and the EPA predicts parrot feather will have a high environmental impact if introduced into the Great Lakes. Parrot feather stems reach 2 meters in length and can quickly shade and outcompete native aquatic plant species by forming dense mats. In addition, it could clog waterways, alter water chemistry, reduce oxygen concentrations and impact recreational activities. In Europe, parrot feather overwinters either as submerged plants or as rhizomes, and unpublished reports suggest it can survive for 6 weeks under ice cover. It appears that parrot feather can grow slowly under ice, but almost nothing is known about carbon acquisition during these periods. Investigations measuring photosynthesis have only been conducted over narrow temperature ranges (22-40 degrees Celsius) and on emergent (rather than submerged) plants. Interestingly there is almost no information on the ability of submerged parrot feather to photosynthesize at near-freezing temperatures under ice.

### **What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.**

The proposed research will measure leaf-level photosynthetic rates of parrot feather using ecophysiological techniques such as infrared gas analysis (IRGA) and chlorophyll fluorescence. Recently, Li-Cor (Lincoln, Nebraska) has introduced a new instrument to measure gas exchange of aquatic plants. This instrument measures the uptake of dissolved carbon dioxide in water using an open system, which is much more ecologically relevant than traditional measures of photosynthesis in aquatic plants. This instrument allows rapid measurements of photosynthesis and physiological parameters can be measured with relative ease. Chlorophyll fluorescence will be used in conjunction with gas-exchange measurements to elucidate underlying mechanisms that may explain limitations on photosynthesis. These approaches have been used by the principal investigator on species of plants in locations such as Antarctica and Minnesota. Plants will be grown in aquatic chambers under strict temperature regimes in the laboratory of Dr. Ryan Wersal who is a collaborator on this project. The proposed research is expected to take two years to complete. Funding is sought to purchase the LiCor IRGA which will also be utilized in the new Agronomy program at MNSU. In addition, funding is sought for both graduate and undergraduate students and the principal investigator to oversee and mentor students.

### **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?**

Minnesota is home to 13.1-million acres of surface water and with this comes the heritage that citizens hold dear. Parrot feather has emergent and submergent growth, potentially giving it an advantage to invade a variety of habitats. However, little is known about physiological adaptations of this species. Knowledge of temperature ranges that parrot feather could photosynthesize and grow at will provide information on its ability to invade and spread in Minnesota waters. Targeting parrot feather when photosynthetic activity is low may improve management strategies. This would help protect native aquatic vegetation, improve lakes, recreational activities and assist conservation efforts.

## Activities and Milestones

### Activity 1: Photosynthetic Temperature Response

**Activity Budget:** \$151,000

**Activity Description:**

We propose to examine how photosynthesis in parrot feather responds to a wide variety of temperatures similar to those found in Minnesota lakes. We will construct temperature-response curves using a new and novel technique utilizing infrared gas analysis (Li-Cor Biosciences). This technique has recently been utilized in algae and we propose to do similar experimentation on aquatic plants using a customized chamber. We will grow parrot feather in a variety of temperatures under controlled laboratory conditions in the Aquatic Weed Science laboratory with assistance from Dr. Wersal (see attachment). After plants have matured and acclimated, response curves will be constructed using circulating water baths to control temperatures in the chamber. Measurements will be made at 5-degree Celsius increments from freezing to 40 degrees Celsius. Simultaneous measurements of chlorophyll fluorescence will be conducted during gas-exchange measurements to explain underlying mechanisms for temperature-induced limitations on photosynthesis. Understanding how photosynthesis is limited by temperature in parrot feather will elucidate what waterbodies this species can invade and potentially make managing this species easier and more cost effective. Results from this study will be presented at local/regional and national conferences, peer-reviewed journal articles and contribute to thesis research by a graduate student.

**Activity Milestones:**

Description	Completion Date
Purchase Photosynthetic Instrumentation from Li-Cor and Design Experiment to Measure Photosynthesis in Parrot Feather	September 30 2022
Culture and Grow Parrot Feather and Characterize Photosynthetic Response to Temperature	August 31 2023
Finish Experimentation, Analyze Results and Begin Final Report	June 30 2024
Present Findings at National Meeting (Ecological Society of America or Aquatic Plant Management Society)	July 31 2024
Prepare and Submit Journal Article	July 31 2024

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Ryan Wersal	Minnesota State University	Dr. Wersal's lab is immediately adjacent to Dr. Ruhland's research laboratory. Dr. Wersal will provide plant material and aquatic growth chambers for growing the parrot feather. We will be co-chairs on the graduate student's thesis committee and co-authors on all presentations and publications.	No

## 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 be funded?**

Results from this project will be disseminated in both written and oral forms and will have direct impact on management of parrot feather across the United States. We will publish our findings in appropriate journals, give presentations to scientific societies, state and national resource managers (e.g. Minnesota Department of Natural Resources; MNDNR), community lake associations and the public. Lastly, we will seek funding for future follow-up studies examining the relationship between herbicide efficacy and photosynthetic temperature response from the MNDNR and aquatic species prevention programs.

## Project Manager and Organization Qualifications

**Project Manager Name:** Christopher Ruhland

**Job Title:** Professor of Biological Sciences

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

Dr. Christopher Ruhland has been a plant physiological ecologist at Minnesota State University, Mankato (MNSU) for 20 years. Dr. Ruhland received his PhD at Arizona State University and MS at West Virginia University. His primary focus is studying how plants adapt their physiology to extreme climate conditions. Dr. Ruhland has conducted research primarily in Antarctica, Arizona, Wyoming, West Virginia and Minnesota. He has authored over 30 peer-reviewed research publications on subjects such as polar ecology, biogeochemical cycling and agriculture. This research has been funded by federal agencies such as the National Science Foundation and the US Department of Energy. In the past 20 years he has had over 40 undergraduate and over ten graduate students work in his lab and many have been contributing authors on manuscripts. Dr. Ruhland has been an author on over 40 presentations at national conferences and reviewed scientific manuscripts for over 20 different peer-reviewed journals, grant proposals for NSF, the Chilean government and the University of Maryland. In addition he is an associate editor for the journal *Theoretical and Experimental Plant Physiology*.

**Organization:** Minnesota State Colleges and Universities - Minnesota State University Mankato

**Organization Description:**

The Department of Biological Sciences at MSNU offers programs for students preparing for careers in education, laboratory and field research, agricultural sciences, ecology, biotechnology, environmental sciences, medical laboratory sciences, cytotechnology, food science technology and pre-professional programs. The Plant Ecophysiology Laboratory (Ruhland) offers research opportunities in the physiology of vascular plants and mainly focuses on how plants respond to environmental stress and climate. In collaboration with the Dr. Ryan Wersal (collaborator on this proposal) and the Aquatic Weed Science Laboratory (directly adjacent to the Ruhland lab), we have the ability to culture and grow aquatic vascular plants in flow-through aquaria and mesocosms in both laboratory and greenhouse settings. Research in the Plant Ecophysiology laboratory focuses on plant primary production, photosynthesis, growth and secondary chemistry,

while research in the Aquatic Weed Science laboratory focuses on biomass and carbohydrate (the products of photosynthesis) allocation of invasive aquatic species. Combining the expertise of these two research laboratories will help procure future funding in examining the physiology of aquatic vascular plants for this and future projects.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
Undergraduate Student Personnel		Assistance in sample preparation			7.65%	0.6		\$17,205
Graduate Student Personnel Summer		Performing experimentation			7.65%	0.6		\$19,506
Dr. Christopher Ruhland		Project Coordinator. Oversees experiments, data collection and analysis, and results			19%	0.6		\$40,892
							<b>Sub Total</b>	<b>\$77,603</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	-
<b>Equipment, Tools, and Supplies</b>								
	Tools and Supplies	Consumables for Photosynthesis System	Consumables such as carbon dioxide source, span gasses, desiccants and scrubbers for calibration.					\$4,652
							<b>Sub Total</b>	<b>\$4,652</b>
<b>Capital Expenditures</b>								
		Li-Cor 6800LEEF2 Infrared Gas Analyzer	Instrument for measuring gas exchange and chlorophyll fluorescence of plants.					\$54,945
		Li-Cor LI6800 Aquatic Chamber + accessories for aquatic plants	Accessory for measuring gas exchange of aquatic plants					\$9,700
							<b>Sub Total</b>	<b>\$64,645</b>

<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
							<b>Sub Total</b>	-
<b>Travel Outside Minnesota</b>								
	Conference Registration Miles/ Meals/ Lodging	Professional Society Meeting to Present Findings	Attendance at a professional society meeting (e.g. Ecological Society of America or Aquatic Plant Management Society) to present findings from study. Attendees typically include professional academics, resource managers, watershed district personnel and pesticide applicators. Our findings would be directly relevant to all of these individuals who manage parrot feather in their local waters.					\$3,500
							<b>Sub Total</b>	\$3,500
<b>Printing and Publication</b>								
	Publication	Publication of results in journal article	Publication charges for findings in an appropriate peer-reviewed journal.					\$600
							<b>Sub Total</b>	\$600
<b>Other Expenses</b>								
							<b>Sub Total</b>	-
							<b>Grand Total</b>	\$151,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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## Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
<b>State</b>				
			<b>State Sub Total</b>	-
<b>Non-State</b>				
			<b>Non State Sub Total</b>	-
			<b>Funds Total</b>	-

## Attachments

### Required Attachments

#### *Visual Component*

File: [86f4177c-a19.pdf](#)

#### *Alternate Text for Visual Component*

Image of the flow-through aquaria where we will be growing parrot feather at different temperatures....

### Optional Attachments

#### *Support Letter or Other*

Title	File
Quote for Infrared Gas Analysis System	<a href="#">28b5a850-289.pdf</a>

## 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?**

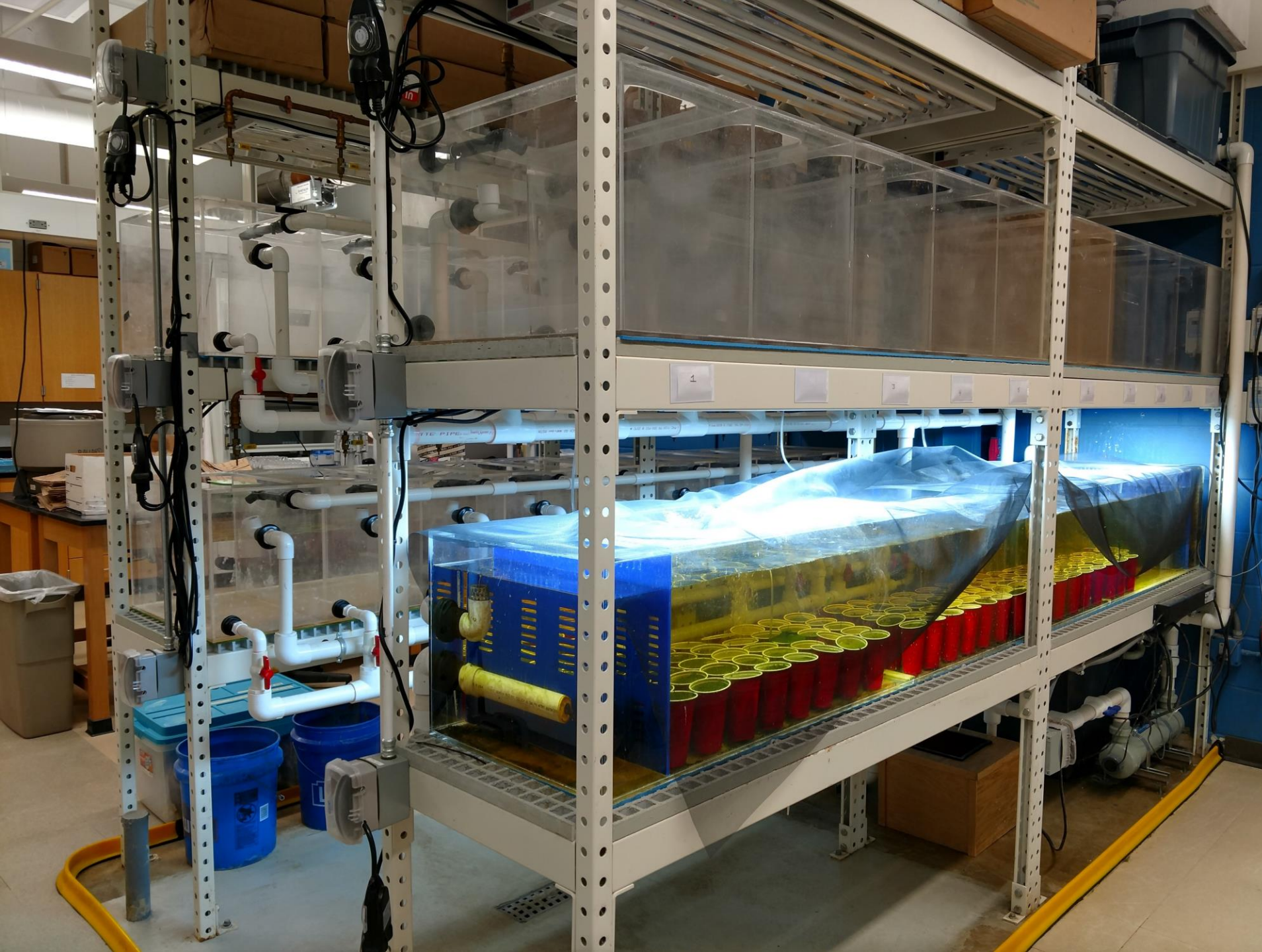
N/A

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

Yes

**Does the organization have a fiscal agent for this project?**

No



Part of the Aquatic Weed Science Laboratory at Minnesota State University, Mankato. The lab is directly adjacent to the Plant Ecophysiology laboratory.

Parrot feather will be incubated and grown at various temperatures in these aquaria using a flow-through system.

