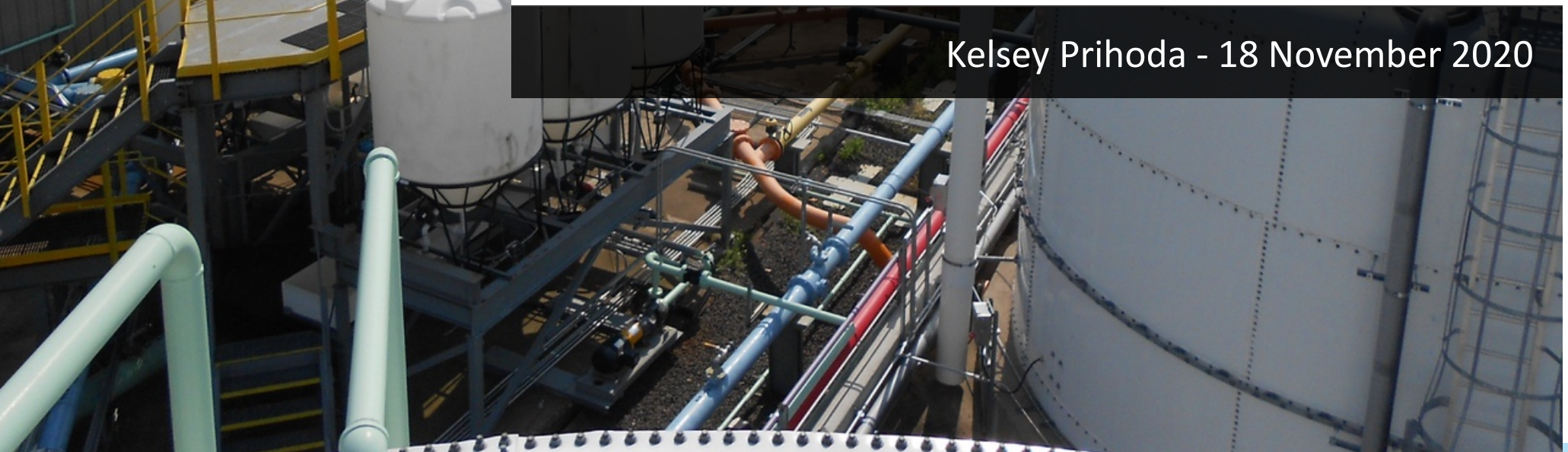
Great Waters Research Collaborative

Great Lakes Panel on Aquatic Nuisance Species – Fall 2020 Meeting



Kelsey Prihoda - 18 November 2020

Great Waters Research Collaborative

Acknowledgements

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FUNDING AGENCIES

Great Lakes RESTORATION

U.S. Department of Transportation

Maritime Administration

AMI

Consulting Engineers P.A.

Lake Superior Research Institute

LSRI

Est. 1967

Natural Resources Research Institute

University of Minnesota Duluth

Driven to Discover℠

Great Waters Research Collaborative

QUALITY DATA WITH A FRESHWATER PERSPECTIVE

LAKE SUPERIOR RESEARCH INSTITUTE PROGRAM, EST. 2017

MARITIME-RELATED ENVIRONMENTAL RESEARCH SERVICES

MANY YEARS OF EXPERIENCE WORKING TOGETHER IN SUPPORT OF GREAT SHIPS INITIATIVE

BALLAST WATER TREATMENT AND COMPLIANCE MONITORING TECHNOLOGY TESTING

GREAT LAKES COMMERCIAL PORT MONITORING

BALLAST WATER SAMPLING AND ANALYSIS METHOD DEVELOPMENT

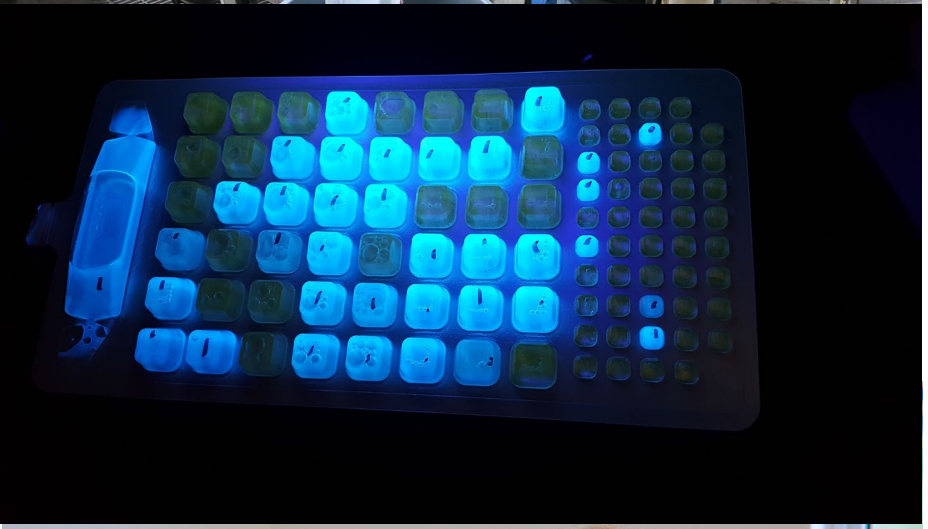
EDUCATION AND OUTREACH

GWRC Project Updates

2019 - 2020

Technology Testing

Great Lakes-Specific Ballast Water Treatment Research and Development



Technology Testing

LABORATORY SCALE

TREATMENT TECHNOLOGY PROTOTYPES

RESEARCH AND DEVELOPMENT QUESTIONS

LAND-BASED SCALE

LARGE-SCALE, CONTROLLED TREATMENT TECHNOLOGY TESTING

FRESHWATER VALIDATION OF TREATMENT PROCESSES

FRESHWATER TYPE APPROVAL TESTING

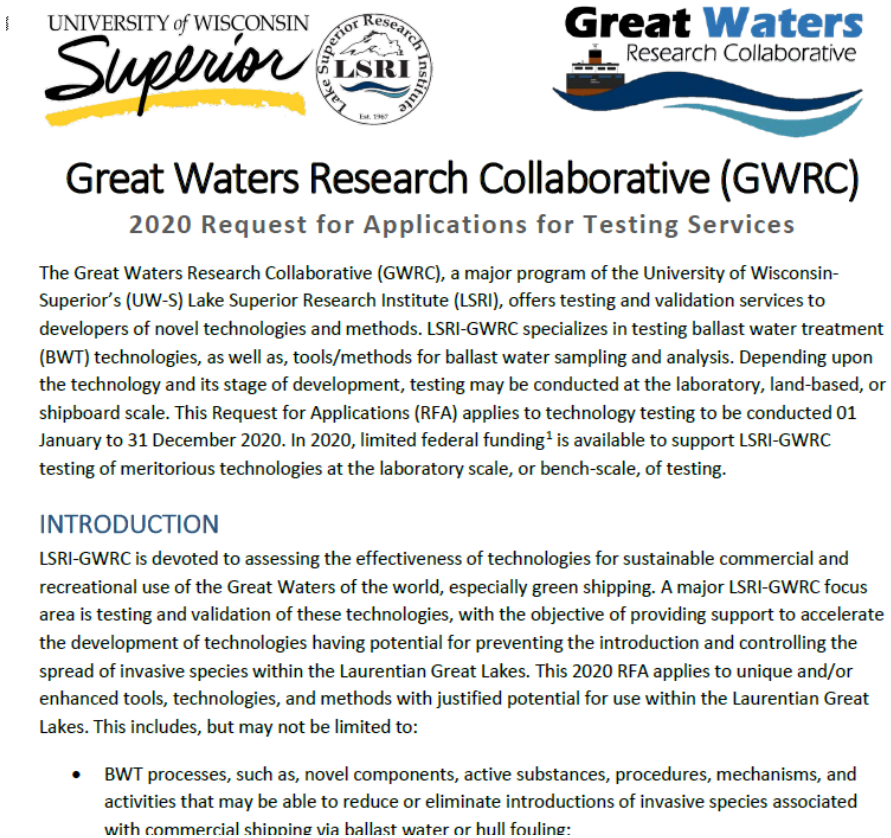
SHIPBOARD SCALE

TREATMENT TECHNOLOGY TESTING UNDER NORMAL VESSEL OPERATING CONDITIONS

REAL-WORLD, FRESHWATER VALIDATION OF TREATMENT PROCESSES

TYPE APPROVAL TESTING

GWRC Technology Testing Program



Great Waters Research Collaborative (GWRC)

2020 Request for Applications for Testing Services

The Great Waters Research Collaborative (GWRC), a major program of the University of Wisconsin-Superior's (UW-S) Lake Superior Research Institute (LSRI), offers testing and validation services to developers of novel technologies and methods. LSRI-GWRC specializes in testing ballast water treatment (BWT) technologies, as well as, tools/methods for ballast water sampling and analysis. Depending upon the technology and its stage of development, testing may be conducted at the laboratory, land-based, or shipboard scale. This Request for Applications (RFA) applies to technology testing to be conducted 01 January to 31 December 2020. In 2020, limited federal funding[1] is available to support LSRI-GWRC testing of meritorious technologies at the laboratory scale, or bench-scale, of testing.

INTRODUCTION

LSRI-GWRC is devoted to assessing the effectiveness of technologies for sustainable commercial and recreational use of the Great Waters of the world, especially green shipping. A major LSRI-GWRC focus area is testing and validation of these technologies, with the objective of providing support to accelerate the development of technologies having potential for preventing the introduction and controlling the spread of invasive species within the Laurentian Great Lakes. This 2020 RFA applies to unique and/or enhanced tools, technologies, and methods with justified potential for use within the Laurentian Great Lakes. This includes, but may not be limited to:

- BWT processes, such as, novel components, active substances, procedures, mechanisms, and activities that may be able to reduce or eliminate introductions of invasive species associated with commercial shipping via ballast water or hull fouling;

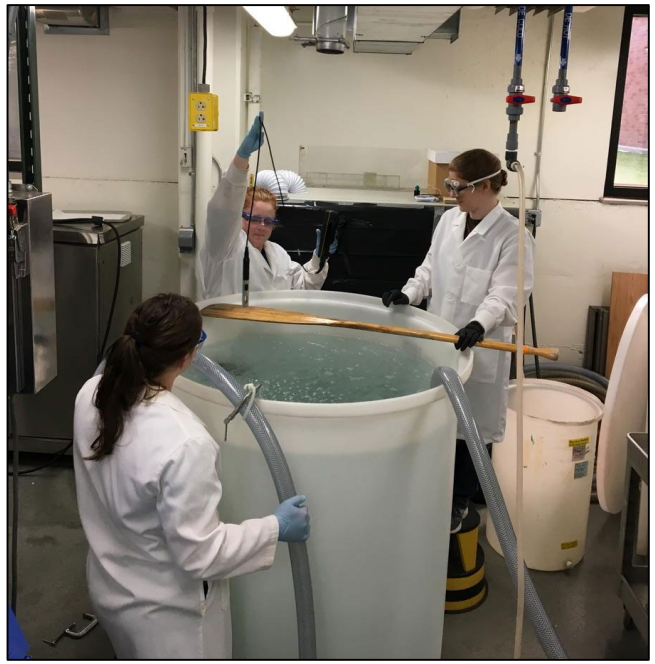
Solicit applications from interested developers of ballast water treatment and analysis technologies

Work with developers to design test plan to answer research and development questions

Funding available for testing technologies with demonstrated applicability to the Great Lakes

- US EPA Great Lakes Restoration Initiative
- US Department of Transportation – Maritime Administration

Goal of program is accelerated technology development



KRIA Ionizer Superoxide Generator

Produces Superoxide (O_2^-) which leads to a supersaturated dissolved oxygen concentration

Water-only tests completed in both lab water and amended lab water at 10°C and 25°C

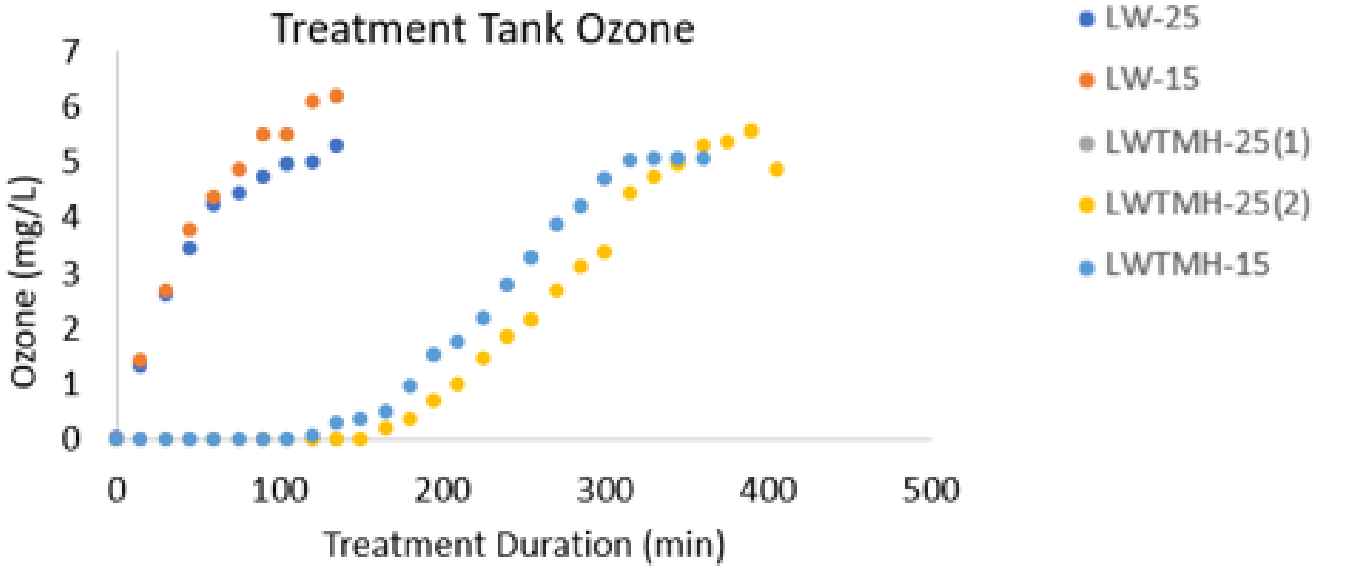
Algae and microbe tests conducted in lab water

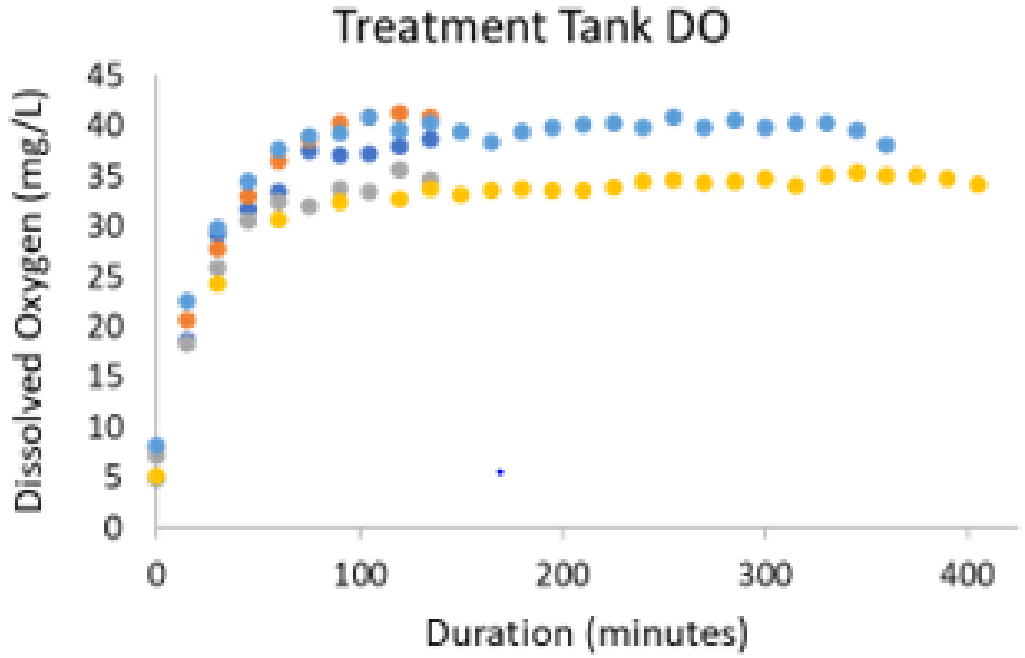
- Algae - no effect at 6 hours treatment
- Microbes - effective at 24 hours treatment
  - Temperature increase may be causing effect

Nanobubble Ozone Technology (NBOT) – 2.5 HP

Produces ozone in nanobubbles

Initially measured ozone and dissolved oxygen concentrations in lab water and amended lab water at 15°C and 25°C





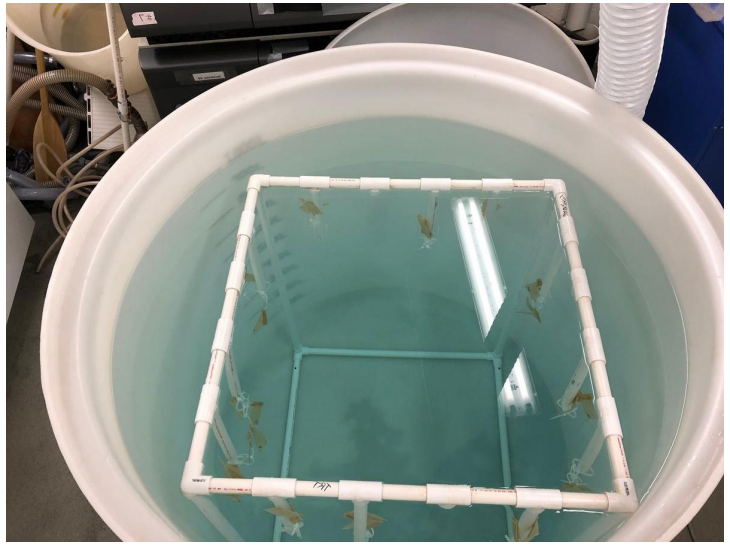
NBOT – 2.5 HP Biological Effectiveness

Laboratory Water

- *S. capricornutum, E. coli, E. faecium* had 100% mortality within 30 minutes
- *Eucyclops* and *D. magna* had 100% mortality within 30-60 minutes

Amended Laboratory Water

- *S. capricornutum* and *E. coli* had 100% mortality within 4 hours
- *E. faecium* had 100% mortality within 390 minutes
- *Eucyclops* and *D. magna* had 100% mortality within 4 – 6.5 hours
- *D. magna* Ephippia – No effect on hatch rate in either water type



NBOT – 2.5 HP Chronic Residual Toxicity

In Laboratory Water following overnight degradation of ozone:

- *C. dubia* – no statistically significant effect on reproduction or survival
- *P. promelas* – no statistically significant effect on growth or survival
- *S. capricornutum* – no statistically significant effect on growth or survival

Nano Bubble Ozone/Oxygen Water Cleaning System – 7.5 HP – 60

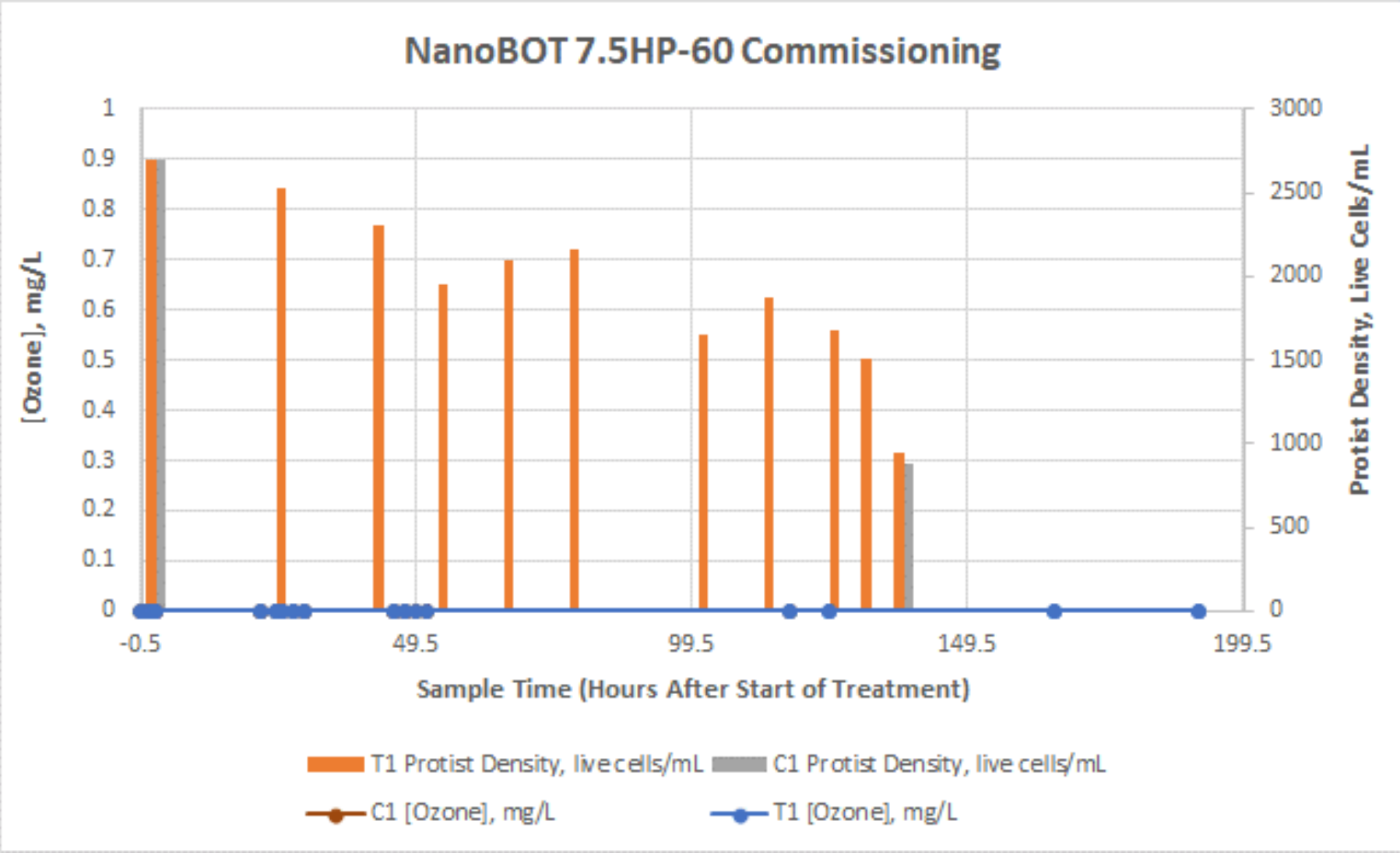
In-tank treatment

Preliminary experiments to determine ozone generation rate, time to saturation, and ozone degradation rate

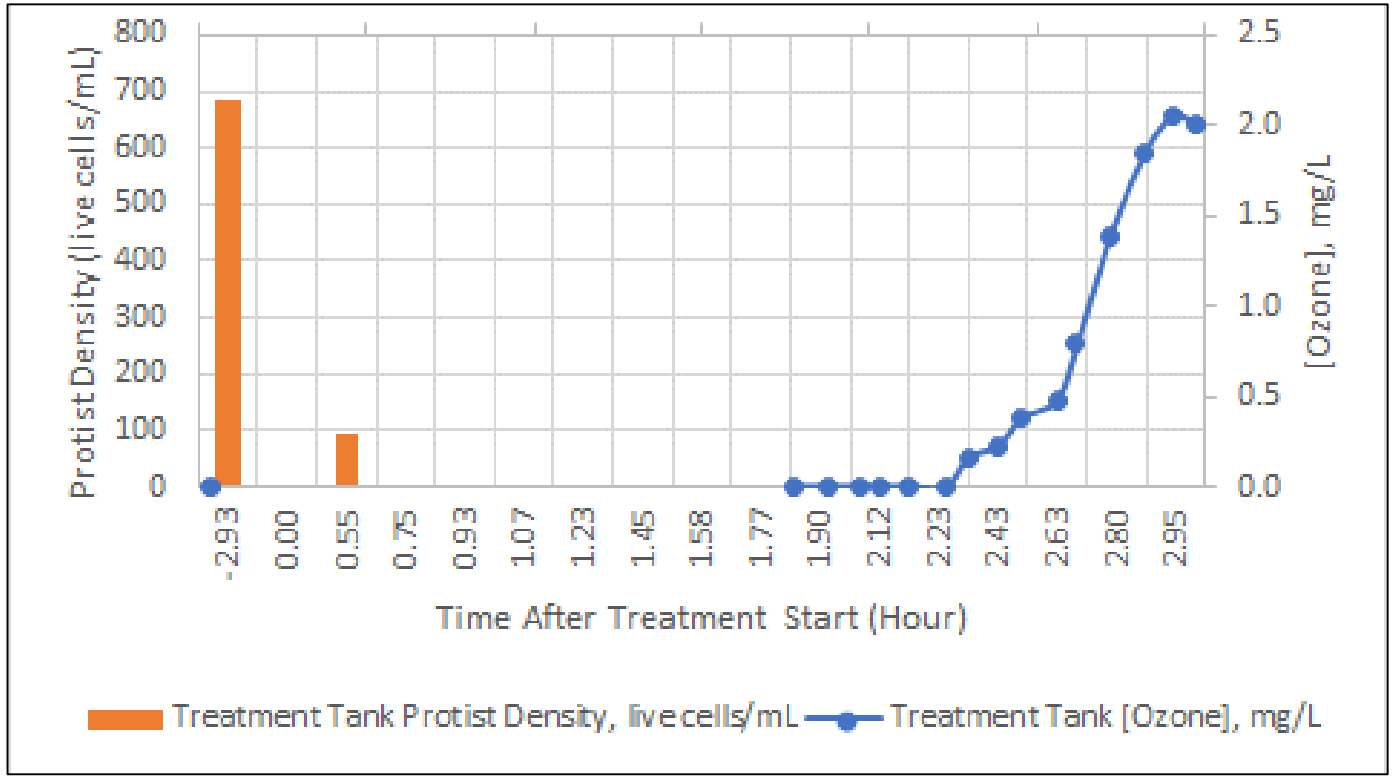
Trials (3) to assess:

- Biological efficacy
- Limited operational efficacy
- Chronic whole effluent toxicity (one of three trials)

Preliminary Experiment
16 – 24 September 2020 (226 m^3)



Small-Scale Experiment
28 September 20 (1.2 m^3)



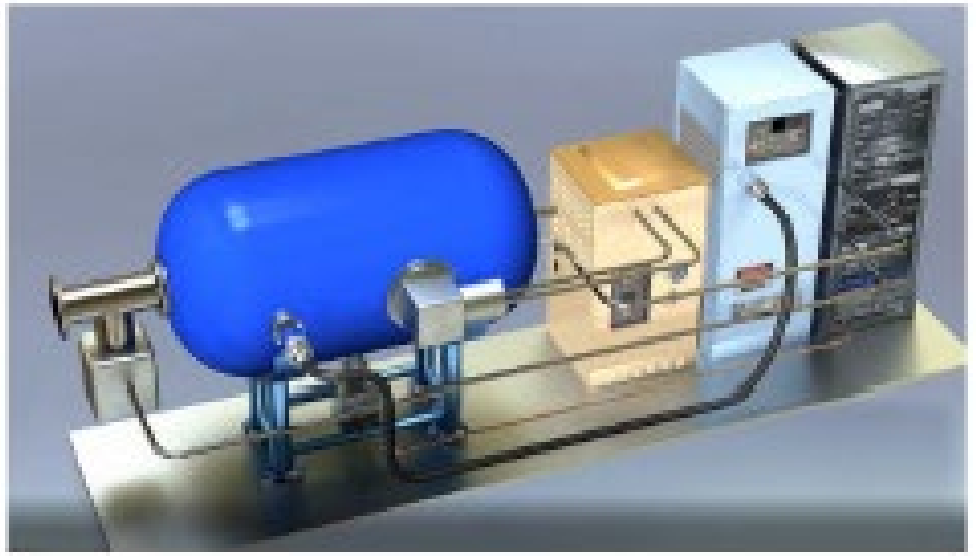
High Average Power Electron Beam Treatment of Water (Fermi Research Alliance)

Application of radiation to ballast water via high-energy, high-power particle accelerator

- Direct damage to exposed organisms via single- or double-strand breaks in DNA
- Indirect damage to organisms via generation of free radicals

Stationary power accelerator

- They can't come to us, so we'll go to them
- Irradiation process conducted by Fermilab staff using Illinois Accelerator Research Center's Accelerator Applications Development and Demonstration Machine



High Average Power Electron Beam Treatment of Water

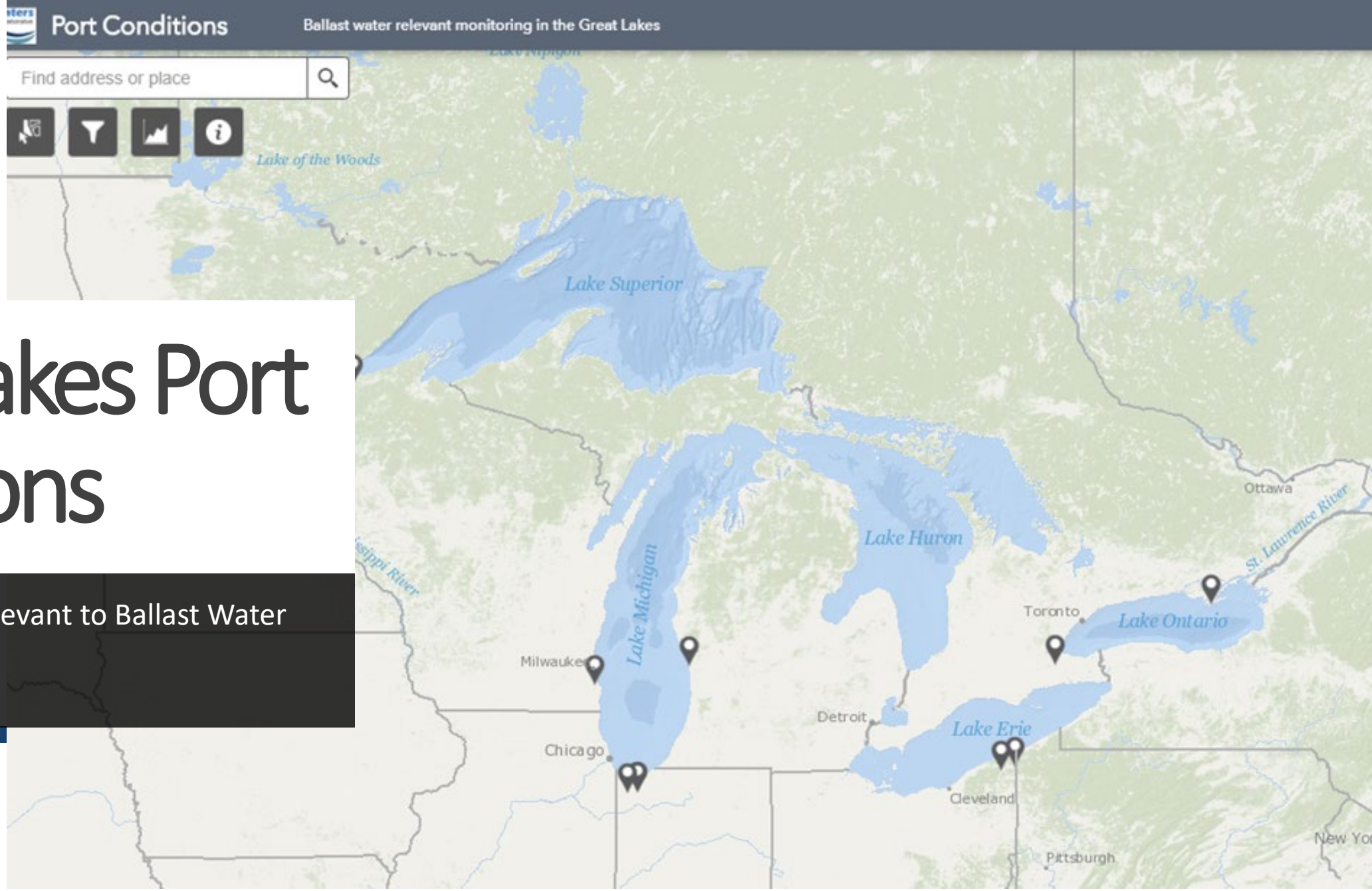
Research questions:

1. What is the relationship between High Average Power Electron Beam Treatment dose and response, in terms of mortality, for a variety of cultured freshwater organisms in low- and high-challenge water?
2. Does High Average Power Electron Beam Treatment have an impact on water quality (e.g., temperature, pH, dissolved oxygen)?
3. Is the dose-response relationship impacted by water quality?

Treatment	Applied Dose (kGy)	Exposure Time (seconds)
Control	0	0
Treatment 1	0.5	0.8
Treatment 2	1	1.7
Treatment 3	2	3.3
Treatment 4	5	8.3
Treatment 5	10	16.7
Treatment 6	20	33.3
Treatment 7	50	83.3

Great Lakes Port Conditions

Water Quality Data Relevant to Ballast Water Treatment



Great Lakes Port Conditions Database: Purpose

Accelerate development of ballast water treatment technologies and compliance monitoring devices

Inform researchers and test facilities conducting shipboard ballast treatment technology testing when adequate testing conditions exist

Inform ship owners/operators of water quality conditions within ports

Guide future improvements/modifications to regulatory testing protocols

Great Lakes Port Conditions Database: Methods

Aggregate data from Great Lakes commercial ports

- May one day expand to global commercial ports in cooperation with Global TestNet

Methods of analysis and quality control data must be available for all data included in database.

The database is hosted in ArcOnline

- Weekly seasonal monitoring at Montreal Pier Facility (Superior, WI)
- GWRC shipboard testing data (ballast uptake only)
- Will accept external data

Great Lakes Verification

Ballast Water Compliance Monitoring Devices

Great Lakes Verification of Ballast Water Compliance Monitoring Devices

Phase I- Laboratory cultured organisms in two water types

- Protists: Colonial Autotroph and *Haematococcus* (0, <10, 10-30 and 75-150 live cells/mL)
- Zooplankton: *D. magna* and *Eucyclops* (0, 5, 10, 15 and 50 live organisms/m^3)

Phase II- Field collected samples comparing traditional microscopic techniques to devices

- Protists: 0, 5-20, 30-50 and 51-150 cells/mL
- Zooplankton: 0, 5-20, 30-50 and 51-150 live organisms/m^3

Phase III- Uptake, Control Discharge and Treatment Discharge water collected during NBOT land-based testing at Montreal Pier Facility

Results of Organism Counts and Device Analysis using *H. pluvialis* in LW.

Sample Description	LW Samples Microscopy Organism Count (cells/mL)	LW Samples Device $C_{calculated}$ (cells/mL)	Mean (CV)
0 cells/mL (Blank)	0	0	0 (0)
		0	
		0	
<10 cells/mL	5.56	0	2.71 (173.2)
		0	
		8.13	
10-30 cells/mL	23.4	24.39	24.39 (8.3)
		26.42	
		22.36	
75-150 cells/mL	103	110.8	119.27 (6.3)
		125	
		122	

Colored highlighting indicates device results for compliance or non-compliancy as decribed in the user manual. Green indicates very low risk, yellow indicates low risk, and red indicates high risk.

Verification Factors

1. **Accuracy**: Measure of device response to a known value (i.e., accepted method of analysis as described in ETV Protocol).
2. **Precision**: Measure of mutual agreement among individual measurements of the same property.
3. **Sensitivity**: Capability of a device to discriminate between device response representing different levels of a variable of interest.
4. **Reliability**: Ability to maintain integrity or stability of the device and data collection over time.

Future Work

Great Lakes Ballast Water Research and Development Plan

R&D Plan Purpose

Identify approaches, methods, and best available technologies that are effective at reducing propagules in Great Lakes ballast water

- Decrease the environmental risk associated with the ballast water vector from vessels operating exclusively within the Great Lakes System
- Projects will also consider the implications of these ballast water management approaches for vessels that operate in the Great Lakes System (but not solely within these waters)

Provide essential scientific and technical information that will support science-based decisions during the VIDA rulemaking and implementation processes

- Data generated will be considered during the five-year review of the ballast water discharge standards established under VIDA

Stakeholder Group Engagement

Help to bring proposed projects outlined in R&D Plan, v.4 from conceptual ideas to fully-formed project plans

Advisory role

Critical to ensuring proposed projects best serve the needs of the Great Lakes region

Formation of Stakeholder Group lead by MARAD and UW-Superior

- Binational

Stakeholder Group Engagement (cont'd)

Kick-off meeting target date: Early January

- Purpose: Introduce stakeholders to plan's objectives and projects and solicit initial feedback
- Focus on Year One

Stakeholder Group will meet twice per federal fiscal year

- First quarter: Project planning and experimental design focus
- Third quarter: Project managers present preliminary results

Public Input

R&D Plan publicly available via UW-Superior's website

Informal public comment via:

- Webpage comment form
- GWRC e-mail address (gwrc@uwsuper.edu)
- Public comments accepted until 31 March 2021 (second announcement in Q1)

Webpage will contain:

- Most current revision of R&D Plan
- Progress updates

Identification of Methods/Alternatives and Cost Assessment	Toward Development of Great Lakes Relevant Testing Protocol	Accelerating Development of Emerging Treatment Technologies	Development of Ballast Water Indicative Monitoring Methods	Assessing the Risk of ANS Transfer from Ballast Water Discharge
1: Determining Operational Characteristics of Great Lakes Vessels	1: Characterize Great Lakes Challenge Conditions	1: Acceleration of Ballast Water Treatment Technology Development	1: Indicative Monitoring Sample Method Development	1: Quantifying ANS Transfer
2: Land-Based BWMS Evaluation	2: Development and Evaluation of Alternative/Emerging Sample Analysis Methods	2: Research and Development Testing for Emerging Technologies	2: Great Lakes Verification of Indicative Analysis Tools	2: Determining Impact of ANS Reduction
3: Shipboard BWMS Evaluation	3: Development of a Great Lakes Adapted Protocol			
4: Ballast Water Filter Performance				
5: Ballast Water BMP Effectiveness				
6: Feasibility Study of Reception Facility Treatment				
7: Management Cost Strategy				

Questions?

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