

43RD ANNUAL MEETING
of The **MIDWEST**
AQUATIC PLANT MANAGEMENT SOCIETY



Equipped

MARCH 13-16

2023

AMWAY GRAND PLAZA

Grand Rapids, Michigan

PROGRAM + ABSTRACTS



THE MIDWEST AQUATIC PLANT MANAGEMENT SOCIETY

OUR VISION

To be the leading regional resource for the sound management of aquatic plants and algae.

OUR MISSION

To promote the exchange of science-based technologies for the management of aquatic resources.

OUR CORE VALUES

Discovery and Innovation
Integrity
Professionalism
Stewardship
Outreach

OUR STRATEGIC GOALS

In five years, MAPMS intends to successfully:

- Expand engagement in MAPMS through improved communication and outreach to key partners.
- Increase member diversity, development, and engagement.
- Broaden the areas of expertise represented in the annual conference and overall society
- Foster relationships with state and regional universities to promote research and student development.

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**AND HELP US WITH OUR OUTREACH EFFORTS BY COMMENTING, LIKING, AND SHARING.
THE MORE INTERACTION WE HAVE THE MORE PEOPLE WE REACH.**

PAST PRESIDENTS + MEETING SITES

2022
MATTHEW JOHNSON
Lake Geneva, Wisconsin

2021
RYAN THUM
Virtual

2020
JAKE BRITTON
Indianapolis, Indiana

2019
NATHAN LONG
Chicago, Illinois

2018
PAUL HAUSLER
Cleveland, Ohio

2017
DICK PINAGEL
Milwaukee, Wisconsin

2016
JACOB MEGANCK
Grand Rapids, Michigan

2015
JOHN GOIDOSIK
Indianapolis, Indiana

2014
TYLER KOSCHNICK
Lombard, Illinois

2013
MATTHEW JOHNSON
Cleveland, Ohio

2012
DICK PINAGEL
Milwaukee, Wisconsin

2011
JIM KANNENBERG
Grand Rapids, Michigan

2010
DAVID ISAACS
Indianapolis, Indiana

2009
JASON BROEKSTRA
Lisle, Illinois

2008
JOE BONDRA
Sandusky, Ohio

2007
KEVIN DAHM
Milwaukee, Wisconsin

2006
ROBERT JOHNSON
Grand Rapids, Michigan

2005
BILL RATAJCZYK
Indianapolis, Indiana

2004
DAVID ISAACS
Lisle, Illinois

2003
BILL KIRKPATRICK, JR.
Columbus, Ohio

2002
RAY VANGOETHEM
Milwaukee, Wisconsin

2001
EDWARD BRAUN
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2000
BILL RATAJCZYK
Indianapolis, Indiana

1999
ROBERT JOHNSON
St. Charles, Illinois

1998
JOE BONDRA
Huron, Ohio

1997
SHANE ORR
Madison, Wisconsin

1996
STEVE METZER
Battle Creek, Michigan

1995
SCOTT JORGENSEN
Indianapolis, Indiana

1994
GREG CHEEK
St. Charles, Illinois

1993
EVERETT LIENHART
Huron, Ohio

1992
GARY JOHNSON
Milwaukee, Wisconsin

1991
G. DOUGLAS PULLMAN
East Lansing, Michigan

1990
HOWARD KROSCH
Indianapolis, Indiana

1989
RICHARD HINTERMAN
South Bend, Indiana

1988
JAMES SCHMIDT
Columbus, Ohio

1987
CAROLE LEMBI
Grand Rapids, Michigan

1986
DAVID EISENTROUT
Fontana, Wisconsin

1985
NICK GOWE
Ft. Wayne, Indiana

1984
RICHARD HINTERMAN
Indianapolis, Indiana

1983
ROBERT JOHNSON
Ft. Wayne, Indiana

1982
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1981
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West Lafayette, Indiana

1980
ROBERT JOHNSON
West Lafayette, Indiana



HONORARY MEMBERS

An honorary member is someone who has contributed significantly to the field of aquatic vegetation management. They must be a voting member of MAPMS for no less than five years. An honorary member has actively promoted the Society and its affairs during their membership and have been elected by unanimous vote of the Board of Directors. Honorary Members shall hold all rights of Active Members in perpetuity.



JOE BONDRA

DAVID ISAACS

JIM SCHMIDT

DR. GREG CHEEK

DR. CAROLE LEMBI

RICHARD HINTERMAN

ROBERT JOHNSON

GARY JOHNSON

BILLIE WILSON

EVERETT LIENHART

ED BRAUN

HOWAR KROSCH

CHARLES GILBERT

ROBERT HILTIBRAN

DISTINGUISHED SERVICE AWARD

Awarded at the President's discretion. Successful completion of a project taking considerable effort and time resulting in advancement of plant management science, educational outreach and performance above and beyond the call of duty as an officer, chair or special representative of MAPMS; or member or non-member achievement in the science of aquatic plant management and/or participation in MAPMS leading to the advancement of its members, goals, and objectives. Award may be used for an individual, agency, corporation, institution, or other organization in recognition of service.

**2022
CARLTON LAYNE**

**2019
DR. MICHAEL D. NETHERLAND**

**2017
LEAH RUST-ESSEX**

**2014
DAVID ISAACS**

**2012
JOE BONDRA**



ROBERT L. JOHNSON MEMORIAL RESEARCH GRANT RECIPIENTS

Grants are competitively awarded to qualified graduate students pursuing a degree in aquatic plant management or related field at any accredited university or college, or independent research which contributes to the mission of the Society. MAPMS considers all applications pertaining to research on aquatic plant and algae management, including ecology or biology, and chemical, mechanical, or biological control of aquatic vegetation. Winners are announced at the awards banquet each year. Recipients are required to present their research findings at the annual conference the following year.

**2022
SYDNEY VANFROST
University of Wisconsin**

**2020
HANNAH HOFF
Montana State University**

**2020
NATALIE MOSES
Minnesota State University-Mankato**

**2019
JEFF PASHNICK
Montana State University**

**2019
JENS BEETS
North Carolina State University**

**2018
GREGORY CHORAK
Montana State University**

**2018
DALTON SINK
University of Michigan**

**2017
RYAN VAN GOETHEM
Michigan Technological University**

**2016
JEFF PASHNICK
Montana State University**

**2016
CIERA KINLEY
Clemson University**

**2015
KYLA IWINSKI
Clemson University**

**2015
ALYSSA CALOMENI
Clemson University**

**2014
BRADLEY SARTAIN
Mississippi State University**

**2013
JUSTIN NAWROCKI
North Carolina State University**

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THIRD OF THREE YEAR TERM

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Thank you!

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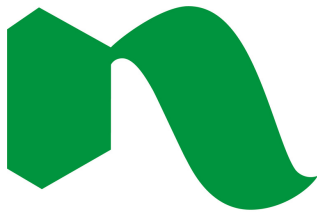


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2023 CONFERENCE EXHIBITORS



2023 CONFERENCE AGENDA AT-A-GLANCE

MONDAY, MARCH 13, 2023

1:00 PM - 5:00 PM	MAPMS PRE-CONFERENCE BOARD MEETING (VANDENBERG A)
1:00 PM - 5:00 PM	EXHIBITOR SETUP (AMBASSADOR EAST)
3:00 PM - 5:30 PM	CONFERENCE REGISTRATION (WEST CONCOURSE)
5:30 PM - 6:30 PM	STUDENT + NEW MEMBER MIXER WITH EXHIBITORS (AMBASSADOR EAST)
6:30 PM - 10:00 PM	PRESIDENT'S RECEPTION (PANTLIND BALLROOM) <i>President McClain invites you to a catered reception with a cash bar and games.</i>

TUESDAY, MARCH 14, 2023

6:00 AM - 7:00 AM	EXHIBITOR SETUP (AMBASSADOR EAST)
7:00 AM - 8:00 AM	CONTINENTAL BREAKFAST (AMBASSADOR EAST)
7:00 AM - 5:00 PM	EXHIBITS OPEN (AMBASSADOR EAST)
7:30 AM - 4:00 PM	CONFERENCE REGISTRATION (WEST CONCOURSE)
8:30 AM - 9:40 AM	OPENING SESSION + KEYNOTE SPEAKER MARK OSTACH (AMBASSADOR WEST)
9:40 AM - 10:00 AM	REFRESHMENT BREAK + EXHIBITS (AMBASSADOR EAST)
10:00 AM - 11:40 AM	SESSION A: EURASIAN WATERMILFOIL RESEARCH AND MANAGEMENT (AMBASSADOR WEST)
11:40 AM - 1:40 PM	LUNCH ON YOUR OWN
11:40 AM - 1:00 PM	PAST PRESIDENTS' LUNCHEON (VANDENBERG B)
1:40 PM - 3:00 PM	SESSION B: AQUATIC VEGETATION RESEARCH, MANAGEMENT, AND OUTCOMES I (AMBASSADOR WEST)
3:00 PM - 3:20 PM	REFRESHMENT BREAK + EXHIBITS (AMBASSADOR EAST)
3:20 PM - 4:20 PM	SESSION C: SURVEYS, MONITORING, AND ENGAGING THE PUBLIC (AMBASSADOR WEST)
4:20 PM	ADJOURN

WEDNESDAY, MARCH 15, 2023

7:00 AM - 8:00 AM	CONTINENTAL BREAKFAST (AMBASSADOR EAST)
7:00 AM - 5:00 PM	EXHIBITS OPEN (AMBASSADOR EAST)
7:30 AM - 12:00 PM	CONFERENCE REGISTRATION (WEST CONCOURSE)
8:30 AM - 10:00 AM	SESSION D: WATER QUALITY AND RESTORATION (AMBASSADOR WEST)
10:00 AM - 10:20 AM	REFRESHMENT BREAK + EXHIBITS (AMBASSADOR EAST)
10:20 AM - 11:40 AM	SESSION E: USING TECHNOLOGY TO SUPPORT MANAGEMENT (AMBASSADOR WEST)
11:40 AM - 1:20 PM	LUNCH ON YOUR OWN
11:40 AM - 1:00 PM	STUDENT + GOVERNMENT AFFAIRS LUNCHEON (VANDENBERG B)
1:20 PM - 2:00 PM	SESSION F: INDUSTRY UPDATES (AMBASSADOR WEST)
2:00 PM - 2:20 PM	REFRESHMENT BREAK + EXHIBITS (AMBASSADOR EAST)
2:20 PM - 3:20 PM	SESSION G: AQUATIC VEGETATION RESEARCH, MANAGEMENT, AND OUTCOMES II (AMBASSADOR WEST)
3:20 PM - 4:20 PM	MAPMS MEMBERSHIP MEETING - ALL MEMBERS REQUESTED TO ATTEND (AMBASSADOR WEST)
6:30 PM - 10:00 PM	RECEPTION + 43RD ANNUAL MAPMS AWARDS BANQUET (CROWN FOYER + AMBASSADOR WEST)

THURSDAY, MARCH 16, 2023

9:00 AM - 11:30 AM	RISE SPECIAL SESSION (PANTLIND BALLROOM)
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The opinions expressed by presenters, speakers, discussion panelists, committee members, and exhibitors are those of said individuals and are not necessarily those of The Midwest Aquatic Plant Management Society, its Board of Directors, or sponsors.



MIDWEST AQUATIC PLANT MANAGEMENT SOCIETY 2023 TECHNICAL PROGRAM + ABSTRACTS



TUESDAY MARCH 14, 2023

OPENING SESSION

LOCATION: Ambassador West
TIME: 8:30 AM – 9:40 AM Eastern Time
MODERATOR: Garrett McClain, President MAPMS

8:30 AM Welcome and Opening Announcements. Garrett McClain, President MAPMS

8:40 AM KEYNOTE ADDRESS: Fostering Connection and Wellness in 2023 *Developing the Courage to Connect*. Mark Ostach; Detroit, MI

9:40 AM – 10:00 AM REFRESHMENT BREAK + EXHIBITS: AMBASSADOR EAST

SESSION A: EURASIAN WATERMILFOIL RESEARCH AND MANAGEMENT

LOCATION: Ambassador West
TIME: 10:00 AM - 11:40 AM Eastern Time
MODERATOR: John Goidosik, Director MAPMS

10:00 AM Designing and Monitoring Florpyrauxifen-benzyl (ProcellaCOR™) Treatment Strategies in Wisconsin Lakes. Todd W. Hanke, Eddie J. Heath, Tim Hoyman; Onterra, LLC, De Pere, WI

10:20 AM Investigating Quantitative Aquatic Plant Response to ProcellaCOR™ Treatments Targeting Invasive Watermilfoil Across Multiple Wisconsin Lakes. Eddie J. Heath, Todd W. Hanke, Tim Hoyman; Onterra, LLC, De Pere, WI

10:40 AM STUDENT PRESENTATION: Quantifying the Contribution of Several Transformation Pathways to the Fate of Florpyrauxifen-benzyl, an Emerging Aquatic Herbicide, in Freshwater Environments. Sydney R. Van Frost¹, Amber M. White², Christy Remucal³, Katherine McMahon⁴; ¹University of Wisconsin-Madison Civil and Environmental Engineering Department, Madison, WI, ²University of Wisconsin-Madison Environmental Chemistry & Technology Department, Madison, WI, ³University of Wisconsin-Madison, Madison, WI, ⁴University of Wisconsin-Madison, Madison, WI

11:00 AM Mesocosm Evaluation of Diquat and Florpyrauxifen-Benzyl Alone and in Combination to Improve Control of a Unique Hybrid Watermilfoil Genotype in an Indiana Lake. Leif N. Willey; Aquatic Control, Inc., Seymour, IN

11:20 AM Low-dose Fluridone as a Management Tool Produces 7 Years of Control in a Metro Minnesota Lake. April R. Londo, Keegan Lund, Wendy Crowell; Minnesota Department of Natural Resources, Saint Paul, MN

11:40 AM – 1:40 LUNCH BREAK

SESSION B: AQUATIC VEGETATION RESEARCH, MANAGEMENT, AND OUTCOMES I

LOCATION: Ambassador West
TIME: 1:40 PM - 3:00 PM Eastern Time
MODERATOR: Ed Spanopoulos, Director MAPMS

- 1:40 PM Progress Toward Eradication of Parrot Feather and Yellow Floating Heart in Michigan. William Keiper;** MI Dept. of Environment, Great Lakes, and Energy, Lansing, MI
- 2:00 PM Selective Control of Curly-leaf Pondweed in Central Minnesota with Galleon SC. Michael Hiatt;** SePRO Corporation, Noblesville, IN
- 2:20 PM Controlling Nuisance Woody Growth in Exposed Lake Bottomlands Following a Catastrophic Dam Failure. Paul J. Hausler;** Progressive AE, Grand Rapids, MI
- 2:40 PM Invasive European Frog-bit Monitoring and Control: Progress by the EFB Collaborative and Early Detection and Response Initiative. Tom G. Alwin, Billy Keiper, Sarah LeSage;** EGLE, Lansing, MI

3:00 PM – 3:20 PM REFRESHMENT BREAK + EXHIBITS: AMBASSADOR EAST

SESSION C: SURVEYS, MONITORING, AND ENGAGING THE PUBLIC

LOCATION: Ambassador West
TIME: 3:20 PM - 4:20 PM Eastern Time
MODERATOR: Emily Henrigillis, Director MAPMS

- 3:20 PM STUDENT PRESENTATION: Developing an Aquatic Macrophyte Survey Protocol for Michigan Inland Lakes: Findings from Summer 2022. Molly C. Engelman¹, Jeremy A. Harsock¹, Jo A. Latimore², Erick L. Elgin³;** ¹Michigan State University Department of Fisheries and Wildlife, East Lansing, MI, ²Michigan State University, East Lansing, MI, ³Michigan State University Extension, East Lansing, MI
- 3:40 PM Hydroacoustic Technology for Lake Management: Techniques for Bathymetry, Plant Management, and Substrate Monitoring. Ashlee Haviland;** Solitude Lake Management, Goshen, IN
- 4:00 PM Keeping the "I" in Aquatic Plant Management: Legislation and Regulation Impacting the Industry. Megan Striegel;** RISE (Responsible Industry for a Sound Environment), Arlington, VA
- 4:20 PM Adjourn**

WEDNESDAY MARCH 15, 2023

SESSION D: WATER QUALITY AND RESTORATION

LOCATION: Ambassador West
TIME: 8:30 AM - 10:00 AM Eastern Time
MODERATOR: Reid Morehouse, Director MAPMS

- 8:30 AM Announcements**
- 8:40 AM Integrating Selective Herbicides with Phosphorus Mitigation to Enhance Habitat and Water Quality. Bryan Fuhrmann, Ph.D., MBA¹, Mark A. Heilman, Ph.D.¹, Chase Kilgore¹, West Bishop, Ph.D., CLP²;** ¹SePRO Corporation, Carmel, IN, ²SePRO, Whitakers, NC

- 9:00 AM** What is the Desired Oxygen Level in the Water and at the Sediment-water Interface in a Lake? A Literature Review and Possible New Paradigm Shift. Patrick Goodwin; Naturalake Biosciences, Madison, WI
- 9:20 AM** STUDENT PRESENTATION: Biotic Interactions as Drivers of Harmful Algal Bloom Ecology and Evolution. Lacey D. Rzodkiewicz, Martin M. Turcotte; University of Pittsburgh, Pittsburgh, PA
- 9:40 AM** Exploring the Optimal Submersed Aquatic Vegetation Cover for Inland Lakes and its Relationship to Lake Health. Jennifer L. Jermalowicz-Jones; Restorative Lake Sciences, Spring Lake, MI

10:00 AM – 10:20 AM REFRESHMENT BREAK + EXHIBITS: AMBASSADOR EAST

SESSION E: USING TECHNOLOGY TO SUPPORT MANAGEMENT

LOCATION: Ambassador West
TIME: 10:20 AM - 11:40 AM Eastern Time
MODERATOR: Jason Euchner, Director MAPMS

- 10:20 AM** Evaluation of Unoccupied Aerial Systems (UAS) for Aquatic Weed Management. Robert J. Richardson¹, Andrew W. Howell²; ¹North Carolina State University, Raleigh, NC, ²North Carolina State University, Pittsboro, NC
- 10:40 AM** STUDENT PRESENTATION: A Centralized Database of Watermilfoil Strains Across the United States: Initial Insights, and Utility for Stakeholder Communication. Ashley L. Wolfe¹, Ryan Thum¹, Raymond Newman²; ¹Montana State University, Bozeman, MT, ²University of Minnesota, Minneapolis, MN
- 11:00 AM** STUDENT PRESENTATION: Testing the Application of Two Remote Sensing Platforms for Water Quality Monitoring of Residential Stormwater Ponds in South Carolina. Julia L. Chrisco; College of Charleston, Charleston, SC
- 11:20 AM** Bottom Diffused Aeration vs Surface Aeration: What We've Learned and What We Are Still Learning. Cory R. Richmond, Bob Robinson, Chris Cartwright; Kasco, Prescott, WI

11:40 AM – 1:20 LUNCH BREAK

SESSION F: INDUSTRY UPDATES

LOCATION: Ambassador West
TIME: 1:20 PM – 2:00 PM Eastern Time
MODERATOR: Casey Thompson, Director MAPMS

- 1:20 PM** AERF Update. Carlton Layne; Aquatic Ecosystem Restoration Foundation, Marietta, GA
- 1:40 PM** APMS Update. Jeremy Slade; UPL NA Inc., Gainesville, FL

2:00 PM – 2:20 PM REFRESHMENT BREAK + EXHIBITS: AMBASSADOR EAST

SESSION G: AQUATIC VEGETATION RESEARCH, MANAGEMENT, AND OUTCOMES II

LOCATION: Ambassador West
TIME: 2:20 PM - 3:20 PM Eastern Time
MODERATOR: Casey Thompson, Director MAPMS

- 2:20 PM Implementation of the Control Management Test (CMT) at the Tahoe Keys Lagoons. Justin Nawrocki, PhD;** UPL NA Inc., Raleigh, NC, Lars Anderson, PhD, WaterweedSolutions, Pt. Reyes, CA, Tahoe Keys Property Owners Association, Sierra Ecosystem Resources, CA
- 2:40 PM Comparative AIS Chemical and Biocontrol Outcomes for Fish Habitat Restoration on State-Managed Lakes in the Fort Custer Recreational Area, Battle Creek, MI. Michael E. Foster;** Kieser & Associates, LLC, Kalamazoo, MI
- 3:00 PM Identifying a QTL for Fluridone Resistance in Eurasian Watermilfoil (*Myriophyllum spicatum*) Using an F₁ Cross and Low Coverage Whole Genome Sequencing. Gregory M. Chorak¹, Ryan Thum²;** ¹Montana State University Department of Plant Science, Bozeman, MT, ²Montana State University, Bozeman, MT

3:20 PM – 4:20 PM MAPMS MEMBERSHIP MEETING: AMBASSADOR WEST

- 3:20 PM MAPMS Membership Meeting and Election of Officers. ALL MEMBERS REQUESTED TO ATTEND**
Garrett McClain, President MAPMS
- 4:20 PM Temporarily Adjourn: Reconvene at the 43rd Annual MAPMS Awards Banquet.**

6:30 PM – 10:00 PM RECEPTION AND 43rd ANNUAL MAPMS AWARDS BANQUET

- 6:30 PM Reception and Silent Auction (Crown Foyer)**
- 7:00 PM 43rd Annual MAPMS Awards Banquet (Ambassador West)**
SILENT AUCTION, BOX RAFFLE, CASH BAR, BANQUET DINNER, STUDENT + SPECIAL AWARDS, AND
INSTALLATION OF OFFICERS AND DIRECTORS
- 10:00 PM CONCLUSION OF THE 2023 MAPMS PROGRAM**

THURSDAY MARCH 16, 2023

RISE SPECIAL SESSION

LOCATION: Pantlind Ballroom
TIME: 9:00 AM – 11:30 AM Eastern Time
FACILITATOR: Megan Striegel, RISE (Responsible Industry for a Sound Environment)

PRESENTATION ABSTRACTS

Biotic Interactions as Drivers of Harmful Algal Bloom Ecology and Evolution. Lacey D. Rzedkiewicz, Martin M. Turcotte; University of Pittsburgh, Pittsburgh, PA

Harmful algal blooms are expected to increase in both frequency and intensity under anthropogenic change. These blooms can release dangerous concentrations of cyanotoxins that impact both ecosystem and human health. It is therefore crucial to understand the drivers of bloom formation and toxicity. While previous research has focused on the influence of abiotic factors such as nutrient loading. Nevertheless, prevention of nutrient loading is often difficult. Bioremediation may provide a feasible solution. However, cyanotoxins are also known to mediate competition and predation. In our research, we will describe the impact of floating plant competitors (Greater Duckweed, *S. polyrrhiza*) and zooplankton predators (*Daphnia magna*) on bloom ecology and evolution. First, we will describe how gradients of biotic stress (competition or predation) impact cyanobacteria population size. Then, we will describe ongoing research contrasting the evolution of toxicity among biotic and abiotic stress treatments.

Quantifying the Contribution of Several Transformation Pathways to the Fate of Florpyrauxifen-benzyl, an Emerging Aquatic Herbicide, in Freshwater Environments. Sydney R. Van Frost¹, Amber M. White², Christy Remucal³, Katherine McMahon⁴; ¹University of Wisconsin-Madison Civil and Environmental Engineering Department, Madison, WI, ²University of Wisconsin-Madison Environmental Chemistry & Technology Department, Madison, WI, ³University of Wisconsin-Madison, Madison, WI, ⁴University of Wisconsin-Madison, Madison, WI

The herbicide florpyrauxifen-benzyl (FPB) is commonly applied to surface waters to combat invasive aquatic plants such as Eurasian watermilfoil. While this herbicide is effective at limiting target plant growth, it is important to understand its persistence in the environment to prevent increased tolerance by target species and unintended harm to native vegetation. The transformation of compounds such as FPB can also produce multiple transformation products, the toxicity and persistence of which may not be as well studied as the parent compound yet is important for environmental risk assessment. We investigated the photodegradation, biodegradation, sorption, and hydrolysis of the herbicide florpyrauxifen-benzyl (FPB) in field and laboratory experiments as well as formation and fate of several transformation products. FPB persisted 5 to 7 days after application in five Wisconsin lakes with an in-lake half-life of < 2 days. The transformation product florpyrauxifen was detectable for 20-30 days post-FPB application at high conversion rates from FPB to the product florpyrauxifen. Paired laboratory studies demonstrated that FPB is degraded to florpyrauxifen via base-catalyzed hydrolysis. Other unique degradation products that were detected in the field, such as dechloro-FPB, hydroxy-FPB, and hydroxy-florpyrauxifen, were generated through additional laboratory experiments. Photochemical irradiations of FPB produced dechloro-FPB, indicating that it is a photodegradation product. Microcosm incubations of FPB and florpyrauxifen produced hydroxy-FPB and hydroxy-florpyrauxifen respectively, indicating that these are biodegradation products. Mass balance calculations found FPB undergoing hydrolysis to form florpyrauxifen and then florpyrauxifen being microbially degraded to hydroxy-florpyrauxifen is the dominant transformation pathway, with hydroxy-florpyrauxifen further degrading into an unknown product. Little information is available about these herbicides given their short history of use. Therefore, increased knowledge about their behavior in freshwater environments is critical to adapting application strategies for invasive species control.

Testing the Application of Two Remote Sensing Platforms for Water Quality Monitoring of Residential Stormwater Ponds in South Carolina. Julia L. Chrisco; College of Charleston, Charleston, SC

Stormwater ponds in the Southeastern United States are prone to eutrophic levels of nitrogen and phosphorus present in stormwater runoff, which can spur growth of algae and algal blooms during warm summer months. Harmful algal blooms (HABs) can be damaging ecologically, economically, and to public health. Previous research has used satellite remote sensing to monitor HABs and water quality in large water bodies such as lakes and oceans; however, this approach is more difficult in smaller water bodies such as stormwater detention ponds. The potential for real-time monitoring of algal blooms over a broad geographic range would provide a tool that can be used for multiple purposes, such as describing temporal trends of algal bloom frequency, or creating a real-time system for rapid public health notification that could help mitigate the negative impacts of the bloom. The objectives of this project are to combine GIS, remote sensing, field sample collection, and *in situ* and lab water quality analyses to: 1) Assess the operating space to apply remote sensing via two different satellite platforms, Sentinel-2 and PlanetScope, to monitor optical water quality for stormwater ponds/lakes and 2) Develop water quality band ratio models to associate remote sensing and in-field water quality data from select residential stormwater ponds (ongoing work). ArcGIS Pro was used to screen an existing South Carolina pond inventory layer based on land use classification and size. Of 3,186 ponds in the residential inventory for the six coastal counties selected for the study, 2.4% have a size and shape that could allow for remote sensing using Sentinel-2 based on a 60m² continuous pixel area. The

application of PlanetScope data, which has a higher spatial resolution (3m compared to Sentinel-2's 10m and 20m), would increase this percentage significantly. Field work was conducted in September 2022 in 14 coastal South Carolina residential ponds on nearly cloudless days corresponding with Sentinel-2 acquisition. Samples were collected from a kayak within the approximate area of a full Sentinel-2 pixel. Established laboratory methods were used for water quality analysis. Research will continue with water quality model development using satellite imagery and the water quality data collected.

A Centralized Database of Watermilfoil Strains Across the United States: Initial Insights, and Utility for Stakeholder Communication. Ashley L. Wolfe¹, Ryan Thum¹, Raymond Newman²; ¹Montana State University, Bozeman, MT, ²University of Minnesota, Minneapolis, MN

Watermilfoil strains, including Eurasian watermilfoil (*Myriophyllum spicatum*), native northern watermilfoil (*M. sibiricum*) and their hybrid offspring (*M. spicatum* x *M. sibiricum*), can differ in their growth, spread, impacts and herbicide response. Several watermilfoil strains (both Eurasian and hybrid) have been identified as resistant or susceptible to specific herbicides (e.g., fluridone). The ability to identify, and track known resistant and susceptible strains can inform managers as to whether a specific herbicide is appropriate for a particular strain. Herbicide response information is missing for many strains and tracking uncharacterized strains over space and time can inform the prioritization of strains to characterize. It also serves to connect stakeholders from different lakes to share their experiences. To track these strains, we created a centralized watermilfoil database. We have collated strain information from thousands of watermilfoil samples from across the United States sent to us by state agencies, aquatic plant management consultants and applicators, and citizen scientists. With this collation of strain information, we want to explore the watermilfoil strain frequency and distribution patterns we have found. We found three Eurasian watermilfoil strains that are common and geographically widespread across the United States. In contrast, hybrid watermilfoil strains have comparatively restricted geographic distributions. We did, however, find an exception to this with a known resistant hybrid watermilfoil strain found in multiple lakes within Michigan. When this database is publicly available, lake managers, property owners, and citizen scientists will be able to connect and pool efforts over shared strains within their lakes and effectively prioritized watermilfoil strain characterization.

Integrating Selective Herbicides with Phosphorus Mitigation to Enhance Habitat and Water Quality. Byran Fuhrmann, Ph.D., MBA¹, Mark A. Heilman, Ph.D.¹, Chase Kilgore¹, West Bishop, Ph.D., CLP²; ¹SePRO Corporation, Carmel, IN, ²SePRO, Whitakers, NC

Invasive aquatic plants have rapidly spread throughout the country and there is no end in sight. Exotic plants are enhancing the overall productivity of our waterways and interacting with other eutrophication processes such as nutrient pollution. Amplified by a warming climate, productive systems can teeter on the edge of either invasive weed dominance or poor water quality from excessive algae growth typically driven by phosphorus. Aquatic plants play an important if perhaps underappreciated role in phosphorus cycling in aquatic systems. They can contain up to 1% phosphorus by dry weight, and management of aquatic plants can make this phosphorus more available in the environment. When managing aquatic plants, techniques can be selected to maximize selectivity of control to enhance desirable aquatic vegetation for high quality habitat and also to promote high water quality through uptake of nutrients released from controlled vegetation. New phosphorus mitigation tools can also be efficiently used to sorb released phosphorus from managed target plants to maintain and enhance water quality. This presentation will review the importance of aquatic plants and their management relative to phosphorus cycling and present initial research showing how aquatic plant management and phosphorus inactivation can be further integrated for more comprehensive resource management.

Low-dose Fluridone as a Management Tool Produces 7 Years of Control in a Metro Minnesota Lake. April R. Londo, Keegan Lund, Wendy Crowell; Minnesota Department of Natural Resources, Saint Paul, MN

Eurasian watermilfoil (*Myriophyllum spicatum*; EWM) was first discovered in Minnesota in a large metropolitan lake in 1987. Invasive milfoils (*Myriophyllum spicatum* and *Myriophyllum spicatum* x *M. sibiricum* hybrids) can create dense monotypic mats making it difficult to navigate through and outcompete native plant species, ultimately, changing how users recreate on Minnesota waters. The primary methods for controlling EWM in Minnesota are auxin mimic herbicides such as 2,4-D and Triclopyr, which control plants in limited, specific parts of bays or lakes where nuisances occur. An alternative to these standard methods is the use of fluridone herbicide in lakes with widespread milfoil occurrences. Fluridone was first used in Minnesota to control EWM in the early 1990's. Those

treatments achieved rates of 15 to 20 ppb. These rates were much lower than the maximum label rate of 150 ppb, yet they still caused significant lakewide non-target plant damage. In an attempt to reduce non-target damage, a follow up study was done in 2002 with rates of 4 to 5 ppb fluridone. These treatments produced good control with less non target damage. Based on the current literature and numerous case studies, the current dosing recommendations for fluridone applications in Minnesota is to maintain a low dose rate of 2-4 ppb for approximately 90 days to control EWM. The use of an herbicide at a bay-wide or lake-wide level requires a variance to Minnesota rules and are generally reserved for lakes with EWM > 30-40% frequency of occurrence (FOO) demonstrating a lake-wide problem. Crooked Lake in Andover is situated 16 miles north-west of Minneapolis, Minnesota. In 2016 EWM FOO was 59.6% and a management plan was written for Crooked Lake to treat the entire lake with fluridone (Sonar One®) at 2-4 ppb. Point intercept surveys in subsequent years show minimal non-target damage and significant reductions in EWM. Small areas of EWM regrowth in subsequent years have been managed using diquat and ProcellaCOR® spot treatments, resulting in seven years of EWM suppression. Additional lakes managing with fluridone in Minnesota show similar multi-year reductions in EWM with minimal impact to native plants and sometimes increases following treatment. MnDNR makes decisions about whole lake fluridone treatments on a case-by-case basis. With that said, fluridone may be one of our most promising tools for large scale EWM occurrences.

Controlling Nuisance Woody Growth in Exposed Lake Bottomlands Following a Catastrophic Dam Failure. Paul J. Hausler; Progressive AE, Grand Rapids, MI

On May 19, 2020, an unprecedented storm event caused the failure of the Edenville Dam on the 1,600 acre Wixom Lake in Gladwin and Midland Counties, Michigan. The aftermath of the failure left approximate 940 acres of bottomlands exposed. The timing of this exposure resulted in successful germination of millions of cottonwood and willow seeds. By the summer of 2021, large stands of woody vegetation occupied the majority of the lake's bottomlands. If these pioneer, opportunistic species were allowed to continue to expand their area and height, concerns about future recreational and habitat loss (once the dam is rebuilt and the impoundment re-filled) were realized. An integrated control plan using a combination of herbicide treatments and mowing and removal of woody debris was developed, permits secured, and trial plot treatments were conducted in the fall of 2022. The results of these strategies will be presented.

Identifying a QTL for Fluridone Resistance in Eurasian Watermilfoil (*Myriophyllum spicatum*) Using an F₁ Cross and Low Coverage Whole Genome Sequencing. Gregory M. Chorak¹, Ryan Thum²; ¹Montana State University Department of Plant Science, Bozeman, MT, ²Montana State University, Bozeman, MT

The herbicide fluridone (WSSA group 12) has been an effective management tool for aquatic plants since 1986. Nearly 20 years after its registration, a case of resistance to fluridone was documented in the aquatic plant *Hydrilla verticillata*. Fluridone acts by inhibiting the phytoene desaturase (PDS) enzyme, an important step in the production of carotenoids. Target-site mutations in the PDS gene has repeatedly been found as the cause of resistance to PDS inhibiting herbicides. Therefore, when fluridone resistance in the invasive aquatic macrophyte, Eurasian watermilfoil (*Myriophyllum spicatum*) was documented, we hypothesized that mutations in PDS was the cause. In this study, we aimed to identify the alleles responsible for fluridone resistance in Eurasian watermilfoil by crossing resistant and susceptible genotypes of watermilfoil to build a family that segregates for fluridone resistance. Because we started with naturally occurring genotypes (not inbred lines), and because we hypothesized that resistance may be due to large effect mutations in the PDS gene, we screened the F₁ cross. Indeed, we found that the F₁ cross was segregating for fluridone resistance. Eurasian watermilfoil is an allohexaploid, which makes mapping of genes difficult because of mismatching of sequencing reads between the sub genomes. To solve this, we low coverage sequenced the whole genomes of the individuals of the segregating family and used a proprietary genotyping method for complex genomes known as Khufu (Hudson Alpha Institute). As hypothesized, we did find a large effect quantitative trait locus (QTL) associated with fluridone resistance. However, this large effect QTL is not located in the PDS gene. Eurasian watermilfoil is heavily managed in the United States, and fluridone treatments are an effective management tool which needs to be preserved. The ability to detect and track fluridone resistance alleles in populations of managed watermilfoil would be an invaluable tool for resistance management and the ultimate goal of this research is to build diagnostic genetic markers for fluridone resistance.

Mesocosm Evaluation of Diquat and Florypyrauxifen-Benzyl Alone and in Combination to Improve Control of a Unique Hybrid Watermilfoil Genotype in an Indiana Lake. Leif N. Willey; Aquatic Control, Inc., Seymour, IN

Eurasian watermilfoil (*Myriophyllum spicatum* L.; EWM) is a frequently encountered invasive submerged aquatic plant in lakes throughout the State of Indiana. In the northern quarter of the State, it is also common to encounter the invasive EWM growing in close proximity with native Northern watermilfoil (*Myriophyllum sibiricum* Kom.; NWM). While not widely documented at the present time in Indiana, there are a few lakes where the EWM populations are suspect of hybridizing with native NWM and resulting in a hybrid watermilfoil (*Myriophyllum spicatum* L. x *Myriophyllum sibiricum* Kom.; HWM). HWM is a concern to aquatic plant managers due to reports of increased herbicide tolerance (reduced efficacy) across several modes of action, including those of the synthetic auxins encouraged for use by the Indiana Department of Natural Resources when managing EWM. Koontz Lake is a public access lake located in Marshall and Starke counties, IN and has been undergoing aggressive EWM management since 2008. In 2017, managers and residents of the lake began observing a lack of herbicide response in the milfoil following treatment with 2,4-D. Single gene sequencing completed in 2020 identified these plants as NWM, however genetic rapid assays suggested some EWM DNA was present in the plants. A follow up Principal Coordinates Analysis (PCoA) was completed on samples collected in 2021 and confirmed that all samples submitted were HWM and two unique genotypes were identified. A study was designed to evaluate alternative herbicide use patterns for control of the HWM using combinations of florypyrauxifen-benzyl (2-pyridinecarboxylic acid, 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxy-phenyl)-5-fluoro-,phenyl methyl ester) (3.9-7.8 µg ai L⁻¹), and diquat (6,7-dihydrodipyrido [1,2-a:2',1'-c] pyrazinedium dibromide) (92.5-277.5 µg ai L⁻¹) at 6 hour (2, 3 hour flow through half lives) and static concentration exposure time (CET) on well-established plants collected from Koontz Lake. Results showed that the HWM is sensitive to both herbicides at static exposures. Plants were less sensitive to diquat alone for 6 hour exposures and the lowest concentration of ProcellaCOR EC at a 6 hour exposure. Combinations of the two herbicides resulted in peak visual control within 1-2 WAT. These data suggest that reductions of the nuisance population may be achieved in Koontz lake concentrations of these two fast acting chemistries to enhance control, selectivity and economics of management efforts, especially in areas where curly-leaf pondweed may also grow densely.

Keeping the "I" in Aquatic Plant Management: Legislation and Regulation Impacting the Industry. Megan Striegel; RISE (Responsible Industry for a Sound Environment), Arlington, VA

What do people really think about pesticide use and how pesticides are regulated at the federal and state level? By reviewing RISE's 2022 National Survey and state specific opinion research, attendees will understand more about how their neighbors, customers and friends may perceive pesticide use and its federal and state regulatory framework. What messages work for aquatic applicator professionals when talking with a range of stakeholders about their practices, tools, and necessity of integrated vegetation management? Walking through RISE's Aquatics toolkit, we'll focus on messages that are specific to aquatic plant management professionals in the importance of treating waterbodies. In addition to public perception, we will focus on regulatory actions being tracked at the federal level within the Environmental Protection Agency, the current rulemaking process with the Waters of the United States, which could change the scope and permitting requirements under the Clean Water Act. We'll cover ongoing U.S. EPA regulatory actions under the Federal Insecticide Fungicide and Rodenticide Act, which can impact the available products for applicators to be using. We'll also look at trending policies and state regulatory actions impacting aquatic plant management and pesticide applicators across the United States, and what to do if it pops up in a pond near you! This presentation will cover state and federal issues that may impact the ability to utilize pesticide products in managing waterbodies.

Exploring the Optimal Submersed Aquatic Vegetation Cover for Inland Lakes and its Relationship to Lake Health. Jennifer L. Jermalowicz-Jones; Restorative Lake Sciences, Spring Lake, MI

Adequate SAV communities are critical for lake balance and especially for a sustainable fishery. There is a scarcity of research on the optimum cover of submersed aquatic vegetation (SAV) needed for sustainable lake health. This presentation includes analysis of inland lake case studies throughout the Midwest that show correlations between lakes with larger SAV communities and higher water clarity. Based on several case studies conducted throughout the Midwest on inland lakes, there is strong evidence that urban lakes with high conductivity and chlorophyll-a possess less SAV than lakes with lower conductivity and chlorophyll-a ($p < .05$). This finding is supported with reduce native submersed and invasive submersed aquatic plant communities. Additionally, lakes that receive substantial

runoff and nutrient and sediment loads are also likely to have reduced SAV cover ($p < .05$) due to increased turbidity and resultant algal blooms. Other factors that may reduce SAV cover include the presence of shoreline erosion and poor shoreline land uses, the presence of excessive carp populations in shallow waters, and excessive turbulence that may prevent germination. Based on previous research by lake scholars and modernized SAV data and impacting variables, recommendations are made for the optimal SAV community in lakes of varying bathymetry and trophic status as a potential means for restoring impaired lake systems to a more favorable, clear-water alternative stable state.

Public Participation in Aquatic Plant Monitoring: A Pathway to Management Success. Jo A. Latimore¹, Erick L. Elgin²; ¹Michigan State University, East Lansing, MI, ²Michigan State University Extension, East Lansing, MI

Aquatic scientists and managers are increasingly recognizing the value of engaging the public in all stages of research and management activity. Specifically, public participation can result in more relevant research questions, produce a richer set of data and knowledge, generate innovative solutions to complex conservation problems, and increase scientific literacy, nature appreciation, and public support for aquatic research and management efforts. These outcomes are not universal, however; they depend to a great extent on engagement program design and execution. We lead a volunteer aquatic plant monitoring program in Michigan that has generated 317 high-quality surveys of native and invasive aquatic plants in lakes statewide. Our program is designed to empower volunteers to detect invasive species early and to recognize changes in their lake's aquatic plant community over time, informing management decisions. Drawing on recent scholarship on public participation in science, including citizen and community science, and our experience leading a statewide volunteer monitoring program, we will demonstrate the potential of public participation in aquatic plant monitoring as a pathway to successful management and stewardship.

Progress Toward Eradication of Parrot Feather and Yellow Floating Heart in Michigan. William Keiper; MI Dept. of Environment, Great Lakes, and Energy, Lansing, MI

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) has been actively working to address populations of watch list aquatic invasive species since 2016. The goal of this work is to prevent the establishment and spread of aquatic invasive plants on Michigan's watch list and pursue local eradication, when possible and practical. EGLE staff will share experiences on responses to over 20 locations of Yellow floating heart (*Nymphoides peltata*) and Parrot Feather (*Myriophyllum aquaticum*) that have resulted in 7 local eradications to date. We will present lessons learned including information on herbicide and hand pulling methods and efficacy.

What is the Desired Oxygen Level in the Water and at the Sediment-water Interface in a Lake? A Literature Review and Possible New Paradigm Shift. Patrick Goodwin; Naturalake Biosciences, Madison, WI

Oxygen is an important water quality parameter that governs many chemical, biological, and physical aspects of lakes. Managing desired oxygen levels has become a common lake restoration practice worldwide. Desired oxygen levels to address water quality issues in the literature and for lake projects have varied substantially from 1 to 20 mg/L dissolved oxygen (DO) in water or right above the sediment-water interface. Desired oxygen levels for lake projects are often set based on published peer-review papers or regulatory agency websites. However, there is a wide range of recommended oxygen levels reported, and many do not reflect recent advances in our understanding of oxygen and its role in an aquatic ecosystem. For example, literature as recent as 2015 has stated that 2 mg/L DO is needed to prevent sediment release of reduced metals and nutrients to the overlying water. This is, however, an oversimplification that 1) has not held true in numerous oxygen management projects attempting to reduce metals and sediment nutrient release to the water and 2) does not reflect recent advances in our understanding of sediment features and redox chemistry. In this presentation, a literature review will be presented discussing the desired oxygen levels to meet a specific water quality goal, current methods used to determine the efficacy of oxygen management, and methods to achieve it.

Developing an Aquatic Macrophyte Survey Protocol for Michigan Inland Lakes: Findings from Summer 2022. Molly C. Engelman¹, Jeremy A. Harsock¹, Jo A. Latimore², Erick L. Elgin³; ¹Michigan State University Department of Fisheries and Wildlife, East Lansing, MI, ²Michigan State University, East Lansing, MI, ³Michigan State University Extension, East Lansing, MI

Aquatic macrophytes play important roles in inland lakes by providing food and habitat for aquatic organisms. Additional services that benefit lake users and residents include increased water clarity, wave energy reduction, and sediment stabilization. The introduction of non-native aquatic species, eutrophication, and intensive shoreline development, however, has affected aquatic macrophyte structure and function in many inland lakes. Because of the numerous ecosystem services aquatic plants provide, obtaining baseline information about the status of these communities is essential for conservation prioritization and direct management efforts. To that effect, our study aims to sample 70 to 100 inland lakes in Northeast Michigan and the Northern Upper Peninsula to determine the status of aquatic macrophytes in these areas. Priority lakes to be surveyed were selected in part by Michigan Department of Natural Resources biologists. In addition to obtaining baseline data in an understudied region, we are field testing a modified point-intercept survey protocol for potential adoption as a standardized, state-wide inland lake survey method. From 20 lakes sampled in 2022, with few exceptions, the initial point-intercept survey trial proved effective for capturing the distribution and frequency of occurrence of aquatic plants. In brief, we identified a total of 46 species, with the most species rich lake (Lake May, Presque Isle County) having a plant community comprised of 25 species. The invasive species Eurasian Watermilfoil (*Myriophyllum spicatum*) and Starry Stonewort (*Nitellopsis obtuse*) were found at 4 and 1 of the 20 lakes, respectively. Lastly, our study tests the benefits of one versus two rake tosses per sampling point.

Bottom Diffused Aeration vs Surface Aeration: What We've Learned and What We Are Still Learning. Cory R. Richmond, Bob Robinson, Chris Cartwright; Kasco, Prescott, WI

Bottom diffused aeration is a very effective tool when managing a body of water. But is it always the best? Are there scenarios where surface aeration could and should be utilized instead. This presentation shows zone of influence and water quality parameters impacted by these two different forms of aeration. Parameters include temperature, dissolved oxygen, water clarity, nutrient available and more.

Invasive European Frog-bit Monitoring and Control: Progress by the EFB Collaborative and Early Detection and Response Initiative. Tom G. Alwin, Billy Keiper, Sarah LeSage; EGLE, Lansing, MI

European frog-bit (*Hydrocharis morsus-ranae* L.; EFB), an aquatic invasive plant, was first observed in the United States in 1974. This free-floating plant can form dense surface mats, capable of causing environmental and economic harm, continues to expand across the Great Lakes basin. Come learn about EFB monitoring and management efforts by The State of Michigan's Early Detection and Response Initiative and the EFB Collaborative.

Designing and Monitoring Florpyrauxifen-benzyl (ProcellaCOR™) Treatment Strategies in Wisconsin Lakes. Todd W. Hanke, Eddie J. Heath, Tim Hoyman; Onterra, LLC, De Pere, WI

Onterra has prescribed and monitored over 50 florpyrauxifen-benzyl (ProcellaCOR™) treatments targeting invasive watermilfoils in Wisconsin Lakes between 2019-2022. This presentation will discuss spot-treatment and intentional lake-wide treatment strategy designs while also investigating the longevity of control from past treatments. A review of post-treatment herbicide concentration monitoring data will further the understanding of the herbicide's dissipation and degradation within the lake during the days and weeks after treatment. These monitoring results will aid in the understanding and development of future aquatic plant management strategies that utilize ProcellaCOR™.

Investigating Quantitative Aquatic Plant Response to ProcellaCOR™ Treatments Targeting Invasive Watermilfoil Across Multiple Wisconsin Lakes. Eddie J. Heath, Todd W. Hanke, Tim Hoyman; Onterra, LLC, De Pere, WI (15)

Onterra has prescribed and monitored over 50 florpyrauxifen-benzyl (ProcellaCOR™) treatments targeting invasive watermilfoil (Eurasian watermilfoil and hybrid watermilfoil) between 2019-2022, including spot and whole-lake/whole-basin treatments. Aquatic plant monitoring of the application sites occurred through sub-sample point-intercept surveys *before treatment*, the *year of treatment*, and the *year after treatment*. This presentation compiles these quantitative data from dozens of case studies to better understand if Eurasian watermilfoil control goals were met, how long the results lasted, and what was the collateral impact to native aquatic plants. This information is valuable to lake managers in setting expectations for their clients, and to regulators making permitting decisions.

Selective Control of Curly-leaf Pondweed in Central Minnesota with Galleon SC. Michael Hiatt; SePRO Corporation, Noblesville, IN (16)

Lake Irene is a 640-acre lake in Central Minnesota. The Lake Irene Preservation Association has been managing the submersed invasive plant curly-leaf pondweed (CLP) since it reached nuisance levels in 2015. CLP has infested over 70% of the littoral zone causing major issues with boating and fishing as well as heavy deposition of uprooted CLP biomass along the lake shoreline. In 2022, the Association sought an innovative control grant for the use of Galleon SC (a.i., penoxsulam) to treat the entire lake perimeter dominated by CLP. Galleon SC was applied at 20 ppb within the treatment area. A lake-wide concentration projected to slightly less than 2 ppb. Following treatment, the once-dominant CLP decreased to a frequency of occurrence of just 14% with little change to the native plant population. The CLP detected post-treatment was all noted as new growth following successful control of more established biomass. The results further document that Galleon SC provides a selective alternative for the control of this common nuisance invasive plant in the Midwest.

Comparative AIS Chemical and Biocontrol Outcomes for Fish Habitat Restoration on State-Managed Lakes in the Fort Custer Recreational Area, Battle Creek, MI. Michael E. Foster; Kieser & Associates, LLC, Kalamazoo, MI

Abstract: From 2018-2021, the Michigan Department of Natural Resources (MDNR) and the Fort Custer Recreation Area (FCRA) engaged Kieser & Associates, LLC (K&A) to develop and implement efforts to enhance FCRA lakes by controlling aquatic invasive species (AIS). Three previously untreated Fort Custer lakes – Eagle Lake, Whitford-Lawler Lake, and Jackson Hole Lake – were addressed by this three-year project. Funding was provided as part of the Natural Resource Damage Assessment from Enbridge oil spill compensation for injuries to the Kalamazoo River related to 2010 discharges. Objectives for the project included assessing aquatic plant communities and presence of AIS, developing a management strategy for AIS control, developing an AIS educational outreach program, and monitoring AIS and native species conditions before and after management actions. Chemical treatments of Eurasian watermilfoil showed resounding success throughout the project, with statistically significant differences in the plant community composition being observed before and after treatments, and year-to-year. These treatments resulted in making available over 40 acres of nearshore fish habitat that were observed to contain high amounts of coarse woody debris overrun by AIS. This represented an 80% recovery of this available habitat. Alternative methods of AIS control were also tested, particularly that of weevil biocontrols for Eurasian watermilfoil, though this method did not result in statistically significant population control differences. The outcomes of the project are a blueprint for AIS management and monitoring methods for state-managed lakes that have seen their ecosystem value decline over time. This paper will present comparative results of chemical and biological controls, ecological and recreational improvements, and future management challenges for state-managed lakes lacking AIS control funding.

Hydroacoustic Technology for Lake Management: Techniques for Bathymetry, Plant Management, and Substrate Monitoring. Ashlee Haviland; Solitude Lake Management, Goshen, IN

Hydroacoustic technology has become important for assessing lake ecosystems, monitoring fish movement, and lake and stream health. The Biosonics Echosounder system consists of hydroacoustic equipment, which operates from a slow-moving boat and records bottom depth, submerged vegetation height, and submerged vegetation density. This information is coupled with geographic location coordinates from a Global Positioning System (GPS) and stored together in digital files, representing submerged aquatic vegetation (SAV) status and fish densities at points along transect lines. Surveys are completed using Biosonics DT-X™ Echosounder and Visual Acquisition Software that provide data images and reports regarding depth, vegetation, and fish measurements within a body of water. Adequate spatial interpolation was used to present the SAV information, including density, height, and water depth, as spatially continuous data for mapping bathymetry and littoral zones, which are important habitats for fish communities. The data collected are a result of recent technology that makes data collection more efficient, thus allowing the collection of many more data points than those of comparable methods. To better understand the relationship between a waterbody and its ecosystem, hydroacoustics have been utilized in a variety of ways to evaluate SAV, bathymetry, and the accumulation of substrate, as well as the type of substrate present. This study evaluated multiple lake conditions throughout the midwest.

Evaluation of Unoccupied Aerial Systems (UAS) for Aquatic Weed Management. Robert J. Richardson¹, Andrew W. Howell²; ¹North Carolina State University, Raleigh, NC, ²North Carolina State University, Pittsboro, NC

Unoccupied aerial systems (UAS) are gaining popularity for both remote sensing as well as direct weed management. Several studies have documented UAS application strategies and procedures for weed control in terrestrial settings, yet literature describing remote spray technology for use in aquatics remains limited. Additional research is needed to determine UAS deployment strategies for aquatic weed management in order to overcome site access restrictions, environmental limitations, and to improve ground-based applicator safety in hazardous treatment scenarios. We evaluated a consumer available UAS to deliver the herbicide, flupyraxifen-benzyl, as both foliar and directed in-water spray applications. The first case study showed the invasive floating-leaved plant, yellow floatingheart (*Nymphoides peltata*), was visually controlled 80 to 99% by 6 wk after treatment (WAT) following UAS foliar herbicide treatments. The second case study demonstrated UAS directed in-water herbicide application from UAS reduced variable-leaf watermilfoil (*Myriophyllum heterophyllum*) visible plant material by 94% at 5 WAT. Likewise, directed in-water applications from UAS eliminated the need to deploy watercraft which improved overall operational efficiency. In conclusion, UAS can provide an effective and efficient treatment strategy for floating-leaved and submersed plant control within specific application strategies, but do have limitations for wide scale use.

Implementation of the Control Management Test (CMT) at the Tahoe Keys Lagoons. Justin Nawrocki, PhD; UPL NA, Inc., Raleigh, NC, Lars Anderson, PhD, WaterweedSolutions, Pt. Reyes, CA, Tahoe Keys Property Owners Association, Sierra Ecosystem Resources, CA

The planning, design, and implementation of the CMT is the result of a 5-year sustained collaboration among Tahoe Keys homeowners (Tahoe Keys Property Owners Association), regulatory agencies (Lahontan Regional Water Quality Control Board and Tahoe Regional Planning Agency), The League to Save Lake Tahoe and other stakeholders, and with a high-level of public input and interest. Implementation of the CMT required coordination of multiple contractors coupled with necessary compliance with extensive regulatory requirements. This has achieved a successful multi-method management test that included the herbicides endothall and triclopyr applied in a tank mix with Rhodamine WT dye, as well as UV-C light and combinations of herbicides and UV-C. These treatments were applied in three replicates per treatment, including control sites. Double turbidity curtains were installed at strategic locations to mitigate movement of herbicides or degradant to Lake Tahoe proper. In addition to the extensive water quality and aquatic plant monitoring, herbicide residues were monitored pre-treatment and several weeks after application. The results of the first year (2022) will determine where and how the second and third year will be conducted as non-herbicide treatments “Group B” methods. The Group B methods include diver-assisted suction removal, bottom barriers, UV-C light treatments. Monitoring will continue as in year 1; however, since no herbicides will be used in years 2 or 3, monitoring will not include monitoring for herbicides or degradants in the water.



2022 MAPMS BUSINESS MEETING MINUTES



2022 MAPMS Business Meeting Minutes Grand Geneva Resort & Spa – Lake Geneva, WI March 2, 2022 (3:15 – 4:15)

Call to order (3:15pm) – Johnson - Reminder to all that all conference registrants are members!!

Roll Call – Goidosik (Thum not present) (Eddie Heath = special guest)

Matthew Johnson (**President**) Ryan Thum (**Past-President**)
Garrett McClain (**President-Elect**) Amy Kay (**Vice-President**)
Steve Zulinski (**Treasurer**) Leif Willey (**Editor**)
John Goidosik (**Secretary**) Peter Filpansick (**Director**)
Landon Wiet (**Director**) Dave Nicholson (**Director**)
Ed Spanopoulos (**Director**) Casey Thompson (**Director**)
Reid Morehouse (**Director**) Michael Verhoeven (**Student Representative**)

Addition/deletions to agenda (*motion to approve*):

No additions or deletions. **Nicholson, Amy** = second, ***Motion carries***.

Review of minutes from 2021 Virtual Business Meeting (see minutes in program – motion to accept)

Those in attendance reviewed the minutes. **Hausler, Thompson** = second, ***Motion carries***.

Presidential Report (if any)

Thanked the Board Members, was very pleased with the event and outcome.

Financial Report – Treasurer (*motion to accept financial report*):

Thanked all for their donations through the trials of COVID. General Fund beginning balance (10/1/20) = \$50,763.92, ending balance (9/31/21) = \$61,354.09 for a yearly change of \$10,590.17. Robert L. Johnson Memorial Research Grant beginning balance (10/1/20) = \$15,135.26, ending balance (9/30/21) = \$16,982.67 for a yearly change of \$1,847.41.

Thompson, Nicholson = second, ***Motion carries***.

Standing Committee Reports:

Nominating (Johnson for Thum):

Landon Weit = VP, Peter Filpansick = Secretary, Emily Henrigillis and Jason Euchner for Director. No nominations from the floor All nominees stood and introduced themselves. Ballots were distributed.

Bondra, Zulinski = second, ***Motion carries***.

Membership (Kay):

243 in-person attendees and 30 online = 273 total. Very pleased with the outcome. New Member and Student mixer went very well = 94 people.

Editorial (Willey):

Happy with the outcome of operating the hybrid option to include Zoom capabilities. Updates will be made to the website as needed as well as working on the plant ID chart and incorporating it into the website. Spring newsletter to come out the beginning of April

By Laws (Spanopoulos): (*Motion to approve by-law changes if any*)

No report

Internal Audit (McClain):

Bank statements were reviewed and everything is in line.

Governmental Affairs (Johnson):

Discussed WOTUS Stakeholder roundtables, 2021 NPDES Pesticide General Permit lawsuit, EPA& Army Corp proposed Rule change announcement. Supreme Court Case (Sackett v. EPA) Hearing, Letters of Support, and current State News. One of the best Student/Government luncheons to date. Great discussions had.

Exhibits (Nicholson):

Thanked all the exhibitors for their support.

Publicity (Kay):

Talked about the new MAPMS panel and indicated a second would be worked on to mirror the website. Updated membership on what Amy Giannotti does for MAPMS as it relates to Social Media. MAPMS is co-sponsoring JSMN Summer of 2022.

Past Presidents Advisory (Johnson for Thum):

Very productive discussion on the Robert L. Johnson Memorial Research Grant as well as a bank account balance to cover the cost of 2 years of Conference activity. APMS request for monetary support for their Research Grant. Continue to advertise the Robert L. Johnson Grant fund via as many avenues as possible.

2022 Program (McClain):

25 presenters, 4 of them were students. Thanked them all.

2022 Local Arrangements (Nicholson):

No Report.

Student Affairs Committee (Heath):

Asked the membership to help spread the word on the opportunities to participate. Thanked Michael Verhoeven for his participation as the Student Representative on the BOD. All 4 Student presentations were from past Robert L. Johnson Memorial Research Grant winners.

Finance (Zulinski):

MAPMS Longevity Fund balance (1/31/22) = \$78,543.74. Robert L. Johnson Memorial Research Grant Longevity Fund balance (1/31/22) = \$16,258.35. 501c3 = Waiting on the IRS at this point.

Special Committee Reports:**Silent Auction/Raffle (Thompson):**

Asked the membership for new fundraising ideas. Over 30 silent auction items, thanked all for their donations and support. Encouraged all to buy raffle tickets.

2023 Time and Place (McClain):

Grand Rapids (March 13th – March 16th).

2024 Time and Place (Kay):

Columbus and Cincinnati Ohio will be evaluated for our 2024 venue.

Strategic planning (Filpansick):

Every 5 years the BOD conducts a strategic planning session. Therefore, in combination with the Fall BOD meeting this planning session will take place.

Sponsorship (Johnson for Thum):

Thanked all those that sponsored the event. Highlighted all the Diamond level sponsors.

Call for motion to accept committee reports:

Thompson, Willey = second, *Motion carries*.

Call for old business:

No old business.

Call for new business:

No new business from the floor

Additional comments from President:

None.

Motion to temporarily adjourn until the banquet meeting:

Willie, Kay = second = 3:57pm

Johnson = Called meeting back to order at (8:01pm).

Kay = Read Joe Bondra's bio and presented him the Honorary Member Award.

Johnson = Thanked Bondra for his years of service to MAPMS and proceeded to recognize all Honorary Members, Past President's, Sustaining Members & all Committee Members in attendance. Gave a special thanks to Local Arrangements and the hotel staff.

Johnson = Recognized outgoing Board of Directors and presented them with their plaques. Announced the newly appointed Board Members (Landon Wiet = VP, Peter Filpansick = Secretary, Emily Henrigillis and Jason Euchner.

Nicholson = Awarded the Exhibitor Excellence Award to In-Situ. (Not present to accept).

Johnson = Awarded all Diamond Level Sponsors their plaques.

Heath = Awarded the Student Paper winners:

1. \$300 Hannah Hoff, Montana State University. *Hybridization and Invasiveness in Eurasian Watermilfoil (Myriophyllum Spicatum): Is Prioritizing Hybrids in Management Justified?*
2. \$200 Michael Verhoeven, University of Minnesota for *The Need for Seed: Untangling the Roles of Turbidity, Invader Removals, and Reseeding in Native Macrophyte Restoration*.

Awarded Robert L. Johnson Memorial Research Grant winners:

- \$4,000 Lacey Rzedkiewicz, University of Pittsburgh for *Biotic interactions as drivers of harmful algal bloom ecology and evolution*.
- \$6,000 Sydney Van Frost, University of Wisconsin for *Characterizing the fate and transport of florpyrauxifen, the primary degradation product of emerging aquatic herbicide florpyrauxifen-benzyl*.

Johnson = Read Carlton Layne's bio and presented him with the Distinguished Service Award.

Johnson = Welcomed McClain as new MAPMS President.

McClain = Thanked Johnson for his service and awarded him the President's plaque.

Motion to adjourn:

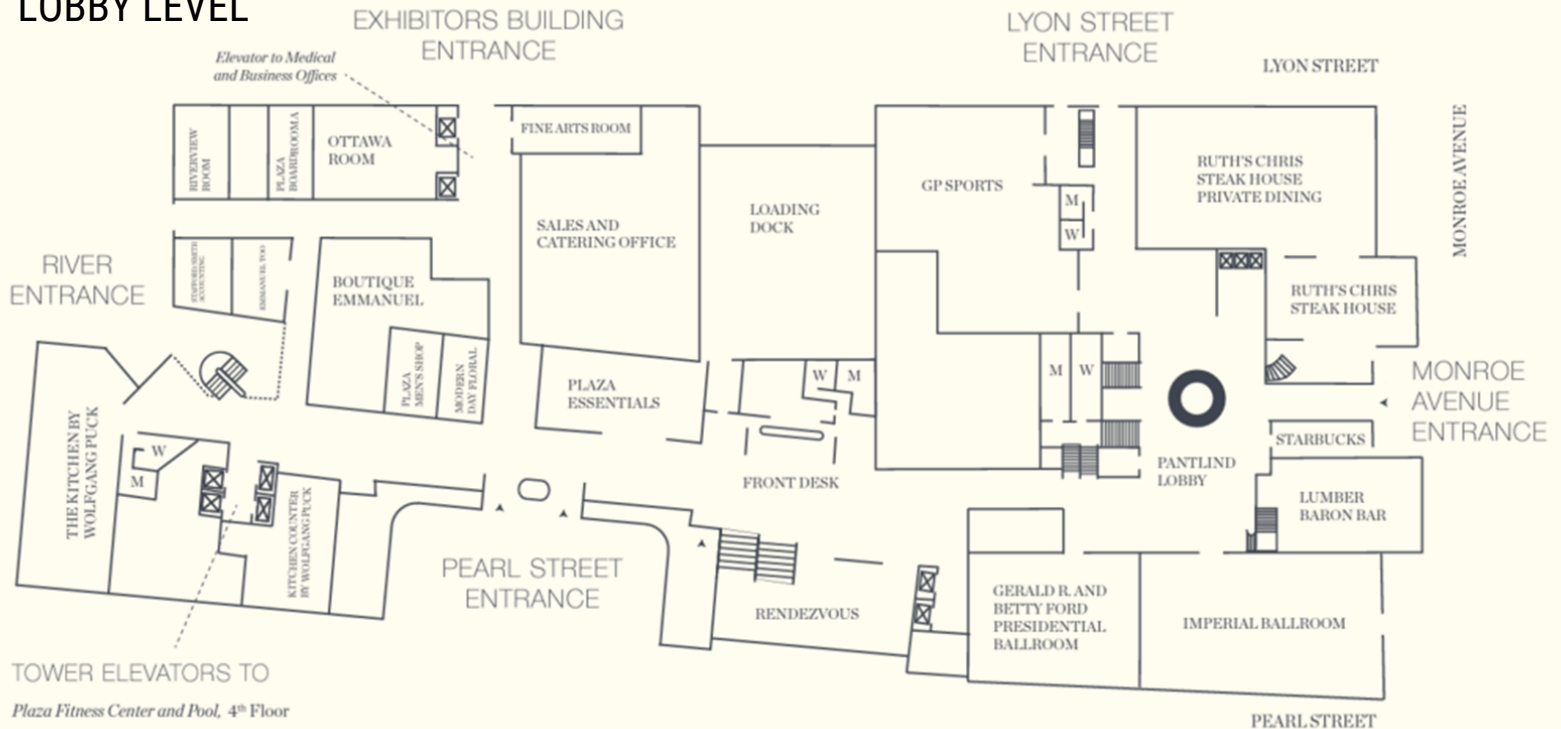
Thompson (8:33pm)



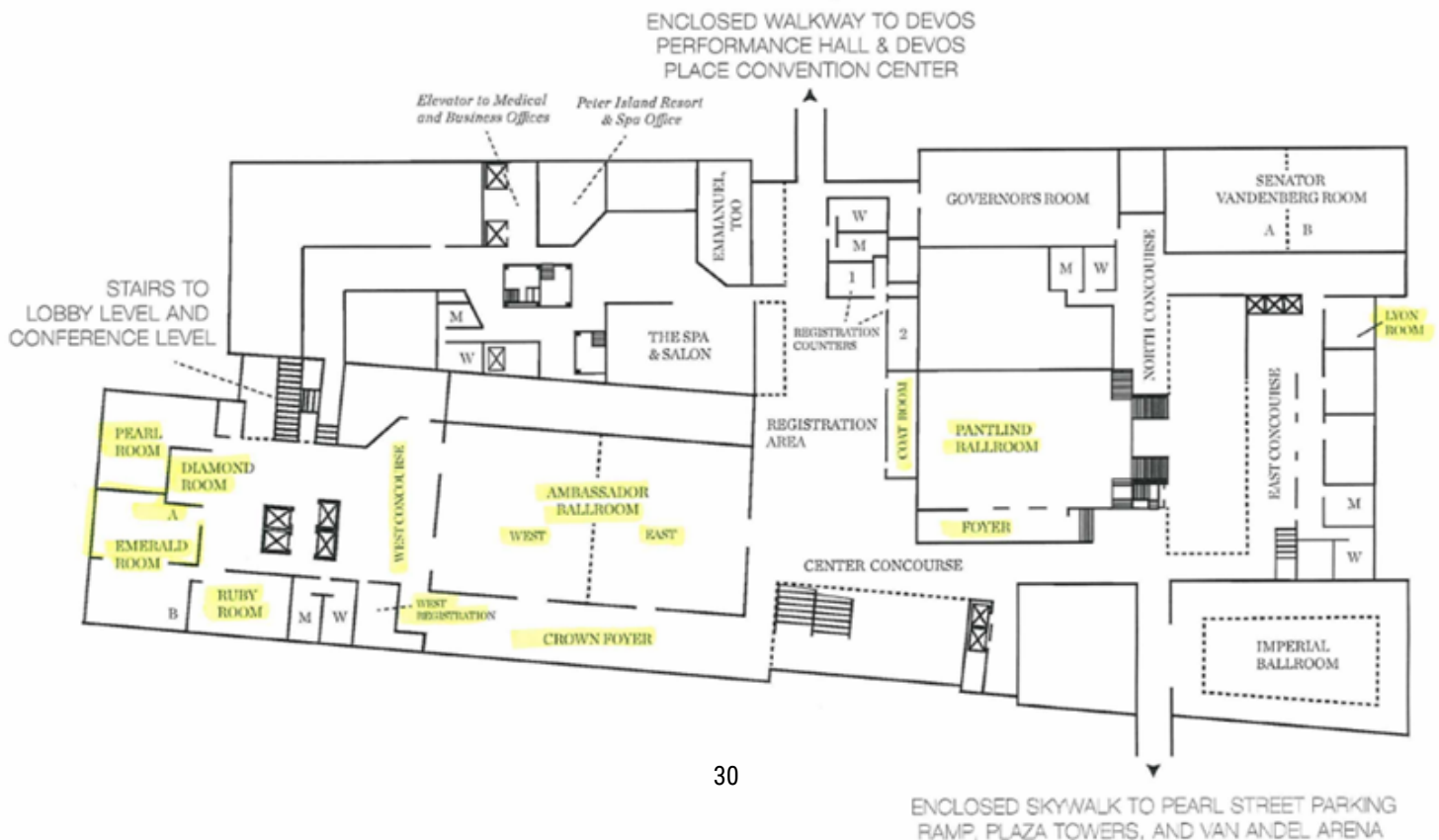
AMWAY GRAND PLAZA FLOOR PLAN



LOBBY LEVEL



CONCOURSE LEVEL – 2ND FLOOR





UPCOMING MAPMS ANNUAL CONFERENCES



2024

COLUMBUS, OHIO
February 26th-29th
Hyatt Regency Columbus



2025

CHICAGO, ILLINOIS
February 24th-27th
Palmer House





2023
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