39th Annual Meeting
OF THE
MIDWEST AQUATIC PLANT MANAGEMENT SOCIETY

The Palmer House
Chicago, IL

February 25-28, 2019

Program / Abstracts / Posters

MISSION

MAPMS is a respected and well organized professional society, providing science-based education and networking opportunities in the management and study of aquatic plants and algae.
The purpose of the Midwest Aquatic Plant Management Society (MAPMS) is to promote science based technologies for the management of aquatic resources by:

- Opportunities for educational advancement
- Relevant scientific research
- Exchange of information
- Promoting the protection and sustainability of aquatic ecosystems
- Expanding and developing public interest in aquatic resources and their sustainable management

VISION

Be the leading regional science-based resource for the sound management of aquatic plants and algae

MAPMS provides information and assistance required by those who work with the unique ecological, sociological, economical and regulatory concerns associated with managing aquatic plants in lake systems affected by exotic species, nutrient pollution, use conflicts and intense recreational demands.

STRATEGIC GOALS

- Improve and expand communication with regulators
- Improve and expand communication with students and academia
- Improve our website and internet presence
- Engage membership
- Fundraising

www.mapms.org

Contents

Facebook Search: mapms

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.

Past Presidents / Meeting Sites

2018	Paul Hausler	Cleveland, OH
2017	Dick Pinagel	Milwaukee, WI
2016	Jacob Meganck	Grand Rapids, MI
2015	John Goidosik	Indianapolis, IN
2014	Tyler Koschnick	Lombard, IL
2013	Matthew Johnson	Cleveland, OH
2012	Dick Pinagel	Milwaukee, WI
2011	Jim Kannenberg	Grand Rapids, MI
2010	David Isaacs	Indianapolis, IN
2009	Jason Broekstra	Lisle, IL
2008	Joe Bondra	Sandusky, OH
2007	Kevin Dahm	Milwaukee, WI
2006	Robert Johnson	Grand Rapids, MI
2005	Bill Ratajczyk	Indianapolis, IN
2004	David Isaacs	Lisle, IL
2003	Bill Kirkpatrick, Jr.	Columbus, OH
2002	Ray VanGoethem	Milwaukee, WI
2001	Edward Braun	Grand Rapids, MI
2000	Bill Ratajczyk	Indianapolis, IN
1999	Robert Johnson	St. Charles, IL
1998	Joe Bondra	Huron, OH
1997	Shane Orr	Madison, WI
1996	Steve Metzer	Battle Creek, MI
1995	Scott Jorgenson	Indianapolis, IN
1994	Greg Cheek	St. Charles, IL
1993	Everett Lienhart	Huron, OH
1992	Gary Johnson	Milwaukee, WI
1991	G. Douglas Pullman	East Lansing, MI
1990	Howard Krosch	Indianapolis, IN
1989	Richard Hinterman	South Bend, IN
1988	James Schmidt	Columbus, OH
1987	Carole Lembi	Grand Rapids, MI
1986	David Eisentrout	Genova Fontana, WI
1985	Nick Gowe	Ft. Wayne, IN
1984	Richard Hinterman	Indianapolis, IN
1983	Robert Johnson	Ft. Wayne, IN
1982	Richard Soper	Midland, MI
1981	Robert Johnson	West Lafayette, IN
1980	Robert Johnson	West Lafayette, IN

HONORARY MEMBERS

Has contributed significantly to the field of aquatic vegetation management. A voting member of the Society for no less than five years. Has actively promoted the Society and its affairs during their membership. Elected by unanimous vote of the Board of Directors. Honorary Members shall hold all rights of active membership in perpetuity.

Robert Hiltibran

Charles Gilbert

Howard Krosch

Ed Braun

Everett Lienhart

Billie Wilson

Gary Johnson

Robert Johnson

Richard Hinterman

Dr. Carole Lembi

Dr. Greg Cheek

Jim Schmidt

David Isaacs

Distinguished Service Award (President's Award) Recipients

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.

Joe Bondra (2012)

David Isaacs (2014)

Leah Rust-Essex (2017)

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 dealing with aquatic plant management, including ecology or biology of aquatic plants, and chemical, mechanical, or biological control of aquatic weeds. Winners are announced at the annual conference each year. Recipients are required to present their research findings at the annual conference the following year.

Gregory Chorak - Montana State University (2018)

Dalton Sink - University of Michigan (2018)

Ryan Van Goethem - Michigan Technological University (2017)

Jeff Pashnick -Montana State University (2016)

Ciera Kinley - Clemson University (2016)

Kyla Iwinski - Clemson University (2015)

Alyssa Calomeni - Clemson University (2015)

Bradley Sartain - Mississippi State University (2014)

Justin Nawrocki - North Carolina State University (2013)

MAPMS BOARD OF DIRECTORS 2018/ 2019

Officers

President
Nate Long
Aquatic Control, Inc.
PO Box 100
Seymour, IN 47274
812-497-2410
natel@aquaticcontrol.com

President-Elect
Jake Britton
Clarke Aquatic Services
3375 N. Gale Rd.
Davison, MI 48423
810-347-0112
jbritton@clarke.com

Vice President
Dr. Ryan Thum
Montana State University
P.O. Box 173150
Bozeman, MT 59717-3150
406-994-4039
ryan.thum@montana.edu

Past President
Paul Hausler
Progressive AE
1811 4 Mile Rd. NE
Grand Rapids, MI 49525-2442
616-447-3376
hauslerp@progressiveae.com

Treasurer (2 of 3)
Steve Zulinski
Michigan Lakefront Solutions
2014 N. Saginaw Rd Suite 160
Midland, MI 48640
989-967-3600
treasurer@mapms.org

Secretary (3 of 3)
John Goidosik
Applied Biochemists
1200 Bluegrass Lakes Parkway
Alpharetta, GA 30004
810-618-5414
john.goidosik@lonza.com

Editor (1 of 3)
Leif Willey
Aquatic Control, Inc.
PO Box 100
Seymour, IN 47274
812-497-2410
admin@mapms.org

Directors

1st of 3 year term

Garrett McClain
Cygnet Enterprises, Inc.
1860 Bagwell St.
Flint, MI 48503
800-359-7531
gmcclain@cygnetenterprises.com

Amy Kay
Clean Lakes Midwest, Inc.
105 Woody Way
Oakwood Hills, IL 60013
715-891-6798
akay@cleanlakesmidwest.com

2nd of 3 year term

Dave Nicholson
Applied Biochemists
1200 Bluegrass Lakes Parkway
Alpharetta, GA 30004
269-832-3595
david.nicholson@lonza.com

Matthew Johnson
Aquatic Control, Inc.
PO Box 100
Seymour, IN 47274
812-497-2410
mattj@aquaticcontrol.com

3rd of 3 year term

Landon Wiet
Naturalake Biosciences
PO Box 8683
Madison, WI 53708
608-515-3527
Landon.W@naturalake.com

Eric Schutman
Syngenta
309 Mason Ave.
Ann Arbor, MI 48301
248-392-8446
eric.schutman@syngenta.com

2018 / 2019 MAPMS Committee Chairs

Nominating:	*Paul Hausler — Chair*
Membership:	*Amy Kay — Chair*
Editorial:	*Leif Willey — Chair*
By Laws:	*Steve Zulinski — Chair*
Internal Audit:	*Eric Schutman — Chair*
Governmental Affairs:	*Matthew Johnson— Chair*
Exhibits:	*Dave Nicholson — Chair*
Publicity:	*Amy Kay — Chair*
Silent Auction/Raffle:	*Landon Wiet— Chair*
Past Presidents Advisory:	*Paul Hausler — Chair*
2019 Program:	*Jake Britton— Chair*
Local Arrangements - Chicago:	*Amy Kay — Chair*
2020 Time and Place - Indianapolis:	*Jake Britton—Chair*
2021 Time and Place - Grand Rapids:	*Dr. Ryan Thum — Chair*
Student Affairs Committee:	*Dr. Ryan Thum — Chair*
Sponsorship:	*Paul Hausler— Chair*
Strategic Planning:	*Eric Schutman — Chair*
Finance:	*Steve Zulinski—Chair*

2019 EVENT CO-SPONSORS

The Midwest Aquatic Plant Management Society thanks the following contributors for their support of the 2019 Conference. Conference events are made possible by their generous contributions!

BANQUET AND PRESIDENT'S RECEPTION CO-SPONSORED BY:

Applied Biochemists
Aquatic Control, Inc.
Cygnet Enterprises, Inc.
SePRO Corporation
Syngenta
UPL NA, Inc.

PAST PRESIDENTS LUNCHEON AND RAFFLE CO-SPONSORED BY:

Airmax , Inc.
Alligare, LLC
Brandt
Easy Pro Pond Products
KeyColour
Nufarm Americas
Outdoor Water Solutions

STUDENT AND GOVERNMENTAL AFFAIRS LUNCHEON SPONSORED BY:

Aquatic Ecosystem Restoration Foundation (AERF)

BREAKS CO-SPONSORED BY:

AquaMaster
Aquatic Biologists, Inc.
Aquatic Enhancement & Survey
Aquatic Management, Inc.
Aquatic Weed Control
Biosafe Systems
Brewer International
Clarke
Clearwater Lake Management
Founders Brewing
Growmark
Michigan Lakefront Solutions
Naturalake Biosciences
Nutrien Solutions
PLM Lake & Land Management
Pond Biologics
Savin Lake Services
Vertex Water Features

2019 SUSTAINING MEMBERS

Special class of membership for institutions and organizations interested in the advancement of the Society and its goals. MAPMS is grateful to these companies for their support!

Company:	*Principle(s):*
Airmax	*Jeff Suttner*
Aqua Doc	*John Wilson*
AquaMaster	*Grant Smith*
Aqua-Weed Control Inc.	*Dick Pinagel*
Aquatic Control, Inc.	*Matthew Johnson*
Aquatic Management, Inc.	*Neil Gerber*
Aquatic Weed Control	*Jim Donahoe*
Blue Water Aquatic	*Kirk Grant*
Brandt	*Debbie Haste*
Brewer International	*Steve Brewer*
Cygnet Enterprises, Inc.	*Joe Bondra*
LakePro	*Paul Dominick*
Lake and Pond Solutions	*Matt Harp*
Lake Restoration, Inc.	*Kevin Kretch*
Nufarm	*Clark Boyd*
Otterbine	*Mike Murphy*
Outdoor Waters Solutions	*John Redd*
PLM Lake and Land Management	*Jason Broekstra*
Savin Lake Services	*Guy Savin*
Syngenta	*Eric Schutman*

MAPMS Affiliates and Contributors

AERF
Aquatic Ecosystem Restoration Foundation

THE AQUATIC PLANT MANAGEMENT SOCIETY, INC.
Established 1961

2019 CONFERENCE SPONSORS

The Midwest Aquatic Plant Management Society extends its gratitude to the following contributors for their cash donations to sponsor the **2019 Conference**. The MAPMS Conference is made possible by their generous support!

Diamond Level ($2,500 +)

Applied Biochemists
Aquatic Control, Inc.
Cygnet Enterprises, Inc.
SePRO Corporation
Syngenta
UPL NA, Inc.

Platinum ($1,000 to $2,499)

Airmax
Alligare
Brandt
EasyPro Pond Products
KeyColour
Nufarm Americas
Outdoor Water Solutions

Gold ($750 to $999)

Aquatic Biologists, Inc
Brewer International
Nutrien Solutions

Silver ($350 to $749)

AquaMaster
BioSafe Systems
Clarke
Founders Brewing
Naturalake Biosciences
PLM Lake and Land Management
Pond Biologics
Savin Lake Services
Vertex Water Features

Bronze ($100 to $349)

Aquatic Management, Inc.
Aquatic Enhancement & Survey
Aquatic Weed Control
Clearwater Management
Growmark
Michigan Lakefront Solutions

2019 CONFERENCE EXHIBITORS

Airmax®
Aeration & Fountains

ALLIGARE
A member of the ADAMA Group

Aqua Master®
FOUNTAINS AND AERATORS
A DIVISION OF ENQUATICS INC.
MASTER THE **POWER** AND **BEAUTY** OF WATER

AQUATIC CONTROL®
Est. 1966

BioSafe Systems®
Simply Sustainable. Always Effective.

BRANDT®

2019 CONFERENCE EXHIBITORS

BREWER International
The Natural Leader In Chemistry

Applied Biochemists

Cygnet Enterprises, Inc.

ESL

EasyPro™ pond products

2019 CONFERENCE EXHIBITORS

KEYCOLOUR™
the colour experts

Kasco®

Naturalake
Biosciences

Nufarm

Nutrien

OTTERBINE AERATORS

2019 CONFERENCE EXHIBITORS

Outdoor™ water solutions

POND BIOLOGICS®
WATER TREATMENT PRODUCTS

SePRO

syngenta

UPI AQUATICS
BALANCING NATURE WITH SCIENCE™

Vertex Water Features
Lake Aeration Systems & Floating Fountains

2019 MAPMS 39th ANNUAL CONFERENCE

MONDAY February 25, 2019

1:00 pm - 5:00 pm	MAPMS Pre-Conference Board Meeting	(Buckingham Room)
3:00 pm - 5:30 pm	Conference Registration	(West Lounge 4th floor)
1:00 pm - 5:00 pm	Exhibitor Set-Up	(Exhibit Hall 4th floor)
5:30 pm - 6:30 pm	Student & New Member Mixer	(Miller's Pub)
6:30 pm - 10:00 pm	*President Long invites you to join him for a catered reception with cash bar and music*	(Miller's Pub)

TUESDAY, February 26, 2019

6:00 am - 7:00 am	Exhibitor Set-Up	(Exhibit Hall)
7:00 am - 8:00 am	Continental Breakfast	(Exhibit Hall)
7:00 am - 5:00 pm	Exhibits Open	(Exhibit Hall)
7:30 am - 4:00 pm	Conference Registration	(West Lounge 4th Floor)
8:00 am - 9:30 am	Session A (HAB)	(Red Lacquer Room)
9:30 am - 10:10 am	Refreshment Break / Posters	(Exhibit Hall)
10:00 am - 11:20 am	Session B (Starry Stonewort)	(Red Lacquer Room)
11:20 am - 1:00 pm	Lunch - On your own	
11:20 am - 1:00 pm	Past President Luncheon	(Price Room 5th floor)
1:00 pm - 2:40 pm	Session C (Invasive Milfoil Management)	(Red Lacquer Room)
2:40 pm - 3:10 pm	Refreshment Break / Posters	(Exhibit Hall)
3:10 pm - 4:50 pm	Session D (General Management Practices)	(Red Lacquer Room)

TUESDAY February 26, 2019

SESSION - A (HAB) 8:00 am - 9:30 am (Red Lacquer Room)

Moderator: David Nicholson, Director MAPMS

8:00 am	Opening announcements and welcome. Nathan Long, President MAPMS
8:10 am	The race to the bottom. Trent Lewis, Pond Medics
8:50 am	A comparative review of management tactics for noxious Algae. Dr. John H. Rodgers Jr., Professor of environmental toxicology, Clemson University
9:10 am	Adaptive water resource management for harmful algal blooms (HABs). Ciera Baird Ph.D. Aquatic Ecotoxicologist: Specializing in HAB Management, Aquatic Control, Inc.
9:30 am	*BREAK/POSTER VIEWING* (Exhibit Hall)

SESSION B (Starry Stonewort) 10:00 am - 11:20 am (Red Lacquer Room)

Moderator: Matthew Johnson, Director MAPMS

10:00 am	APMS Update, Dr. Mark Heilman President-Elect APMS
10:20 am	Starry Stonewort – Twenty years and counting. G. Douglas Pullman, Ph.D., Applied Biochemists

10:40 am	Ongoing management of an infestation of *Nitellopsis obtusa* (Starry Stonewort) infestation in Lake Sylvia, Minnesota, using a Copper-Based algaecide. Tyler D. Geer, Ph.D. student, Clemson University ***Student Presentation***	
11:00 am	Distribution of Starry Stonewort (*Nitellopsis obtusa*) in Wisconsin lakes. Michelle Nault, Lakes and Reservoir Ecologist, Wisconsin Department of Natural Resources	
11:20 am	LUNCH (on your own) Past President's Luncheon, Plated Lunch	(Price Room, 5th Floor)

SESSION C (Invasive Milfoil Management) 1:00 pm - 2:40 pm (Red Lacquer Room)

Moderator: Eric Schutman, Director MAPMS

1:00 pm	Reliance on science proves to be the solution for Hybrid watermilfoil control. A case study. Tim Gardner, Control Consultant, Clarke Aquatic Services, Joe Rush, Professional Lake Manager/Consultant, JadEco	
1:20 pm	Watermilfoil species and Curlyleaf pondweed control using Endothall and Auxin partners. Dr. Cody J Gray, Ph.D., Field Development Representative, UPL NA, Inc.	
1:40 pm	Identifying hybrid watermilfoil gene expression differences to improve adaptive management outcomes for watermilfoil control. Gregory M. Chorak Ph.D, Student, Montana State University, Dr. Ryan A.Thum, Montana State University. ***Student Presentation****, 2018 Robert L. Johnson Memorial Research Grant Recipient*	
2:00 pm	Evaluating Hand-Harvesting control programs for invasive milfoils in Wisconsin. Todd Hanke, Aquatic Field Technician, Onterra, LLC	
2:20 pm	Initial operational success using ProcellaCOR® for selective control of invasive watermilfoils. Dr. Mark Heilman, Senior Aquatic Technology Leader, SePRO	
2:40 pm	*BREAK/POSTER VIEWING*	(Exhibit Hall)

SESSION D (General Management Practices) 3:10 pm - 4:50 pm (Red Lacquer Room)

Moderator: Amy Kay, Director MAPMS

3:10 pm	Development of a novel autonomous aquatic pesticide application system. Dr. Robert J. Richardson, Professor and Extension Specialist, North Carolina State University Steve Hoyle, and Justin Nawrocki	
3:30 pm	Understanding and managing the influence of nutrients in water resources. Michael Hiatt, Aquatic Specialist, Mike Pearce, West Bishop Ph.D. SePRO	
3:50 pm	Why didn't my treatment work? Leif Willey, Lake & Special Project Supervisor, Aquatic Control, Inc.	
4:10 pm	A scientific evaluation of bacterial digesting products in a stormwater pond in Volusia, FL. Patrick Goodwin, Research Scientist, CLM, Vertex Water Features	
4:30 pm	Two Birds, One Stone: EarthTec liquid ionic copper controls both HABs and Zebra Mussels. David G. Hammond Ph.D., Earth Science Labs, Inc.	
4:50 pm	**ADJOURN**	

Notes

WEDNESDAY February 27, 2018

7:00 am - 8:00 am	Continental Breakfast	(Exhibit Hall)
7:00 am - 4:50 pm	Exhibits Open	(Exhibit Hall)
7:30 am - 11:00 am	Conference Registration	(West Lounge 4th Floor)
8:00 am - 9:30 am	Session E (Invasive Milfoil Management)	(Red Lacquer Room)
9:30 am -10:00 am	Refreshment Break / Posters	(Exhibit Hall)
10:00 am - 11:20 am	Session F (General Management)	(Red Lacquer Room)
11:20 am - 1:00 pm	Lunch - On your own	
11:20 am - 1:00 pm	Student/Govt Affairs Lunch	(Price Room 5th Floor)
1:00 pm - 2:20 pm	Session G (General Management)	(Red Lacquer Room)
2:40 pm - 3:00 pm	Refreshment Break / Posters	(Exhibit Hall)
3:00 pm - 4:00 pm	Session H (Membership Meeting)	(Red Lacquer Room)
3:00 pm - 5:00 pm	Exhibit Tear-down	(Exhibit Hall)
6:30 pm - 10:00 pm	**39th Annual MAPMS Awards Banquet**	(Empire Room)

SESSION E (Invasive Milfoil Management) 8:00 am - 9:30 am (Red Lacquer Room)

Moderator: Garrett McClain, Director MAPMS

8:00 am AERF Update, Carlton Layne, Executive Director, AERF

8:30 am Management implications of genetic similarity and differentiation of Eurasian and hybrid watermilfoil in Michigan and Minnesota lakes. Ryan A. Thum, Assistant Professor, Montana State University Department of Plant Sciences and Plant Pathology, Gregory M. Chorak Ph.D. Student, Montana State University, Ray Newman and Jasmine Eltawely, University of Minnesota, Michigan State University Extension, Jo Latimore and Erick Elgin, Grand Valley State University, James McNair and Syndell Parks

8:50 am Endothall systemic behavior in five aquatic weeds. Dr. Scott J. Nissen, Mirella F. Ortiz, and Dr. Cody J. Gray

9:10 am Planning and evaluating large-scale pelletized fluridone treatment for invasive milfoil control in Wisconsin. Eddie Heath, Aquatic Ecologist, Onterra, LLC

9:30 am *BREAK/POSTER VIEWING* (Exhibit Hall)

SESSION F (General Management) 10:00 am - 11:20 am (Red Lacquer Room)

Moderator: Ryan Thum, Vice President MAPMS

10:00 am RISE Update. Aaron Hobbs, RISE

10:20 am Consumer available sUAS (Small Unmanned Aircraft Systems) for macrophyte mapping and management. Andrew Howell and Dr. Robert J. Richardson North Carolina State University, Crop and Soil Sciences, Raleigh, NC
Student Presentation

10:40 am Adjuvants- "But wait, there's more" Dr. G. Douglas Pullman, Ph.D., Applied Biochemists

11:00 am Preventative submersed aquatic weed control utilizing a preemergence use pattern of Sonar® Aquatic Herbicide (fluridone). Scott Shuler, Regional Manager, SePRO

11:20 am Student/Government Affairs Luncheon, Plated Lunch
Sponsored by AERF (Price Room 5th Floor)

11:20 am LUNCH (on your own)

WEDNESDAY February 27, 2019

SESSION G (General Management) 1:00 pm - 2:20 pm (Red Lacquer Room)

Moderator: Landon Wiet, Director MAPMS

1:00 pm	Line Vs. Point aeration designs: A Cost-Benefit Analysis. Patrick Goodwin, Research Scientist, CLM, Vertex Water Features	
1:20 pm	Aeration success and failures. Bob Robinson Fisheries Biologist/Director of Sales and Marketing - Kasco Marine	
1:40 pm	Herbicide Interactions: 2,4-D plus Endothall (Chinook) behavior in milfoil species. , Dr. Scott J. Nissen, Mirella F. Ortiz and Dr. Cody J. Gray	
2:00 pm	Project Profile: Mechanical dredging avoided at Lake Templene, MI through aeration & bioaugmentation. Jake Bradley, EasyPro Pond Products	
2:20 pm	Building organization capacity through social media. Emily Henrigillis, Watershed Coordinator, Fox-Wolf Watershed Alliance	
2:40 pm	*BREAK/POSTER VIEWING*	(Exhibit Hall)

SESSION H (Membership Meeting) 3:00 pm - 4:00 pm (Red Lacquer Room)

3:00 pm	Exhibitor tear-down	(Exhibit Hall)
3:00 pm	MAPMS Annual Membership Meeting and Election of Officers. ***ALL MEMBERS REQUESTED TO ATTEND***. Nathan Long, President MAPMS	
4:00 pm	Temporarily adjourn, reconvene at banquet	

BANQUET

6:30 - 7:00 pm	Reception/Silent Auction	(Empire Room)
7:00 - 10:00 pm	**39th ANNUAL MAPMS AWARDS BANQUET**	(Empire Room)
	**Silent Auction * Box Raffle *Cash Bar *Great Food* **Installation of Officers and Directors*	

THURSDAY February 28, 2019

MAPMS BOARD OF DIRECTORS MEETING

8:30 am - 1:00 pm	Post Conference Board of Directors Meeting	(Price Room 5th Floor)
	MAPMS members welcome to attend. Please notify a Board Member prior to the meeting so that seating arrangements can be made.	

Notes

Technical Poster Presentations

Assessing the response of Eurasian and hybrid watermilfoil to intensive herbicidal management in Minnesota

Jasmine A Eltawely, Raymond M Newman, Ryan A Thum
eltaw003@umn.edu

Eurasian watermilfoil (*Myriophyllum spicatum*) and its hybrid (*M. spicatum* x *M. sibiricum)* are invasive in the United States, with millions spent annually on control. In waters where Eurasian watermilfoil is present, it forms dense canopies causing negative impacts on native species richness by suppressing native vegetation. Hybrid watermilfoil is more genetically diverse than the parent Eurasian, providing the opportunity for increasingly superior phenotypes. Some hybrid genotypes have been found to be more invasive and less sensitive to c ommonly used herbicides. To assess the response of Eurasian and hybrid watermilfoil to herbicidal management, we surveyed ten lakes in the summer of 2018, five undergoing active large-scale management using herbicides to target Eurasian and hybrid watermilfoil and five unmanaged reference lakes. All lakes contain at least one genotype of hybrid watermilfoil. The managed lakes were treated with large-scale spot treatments 2,4D (1 lake) or, ProcellaCOR (2 lakes), or whole lake treatments with fluridone (2 lakes) during the summer of 2018. These lakes were sampled in the summer of 2018, prior to May or June, and after August treatment using a full point intercept survey with 150 to 300 points per littoral zone to characterize the plant community as well as the occurrence and distribution of milfoil taxa and genotypes. The lakes were also assessed for biovolume and cover using BioBase and ArcGIS. The lake-wide fluridone treatments eliminated almost all milfoil, with less than 2% frequency remaining in both lakes. The lakes treated with 2,4-d and ProcellaCor had more focused treatments, less herbicidal coverage (8-15% of lake area treated) and less overall control. About half of the milfoil was controlled with 2,4-D; milfoil occurrence decreased from 60% to 32% following treatment. There was less control observed with the use of ProcellaCOR, and in one lake milfoil increased following treatment. It is not known if the lesser control was due to ineffective treatment or to present hybrid genotypes because genetic analysis has not yet been completed in these lakes. Further surveys of these managed lakes will occur in future summers to assess presence or absence of milfoil infestations following treatment.

Impacts of Microbes on water quality in Michigan waterbodies

Dalton Sink, University of Michigan - Flint
dalton@aquaweed.com

Eutrophication of waterbodies has been seen across the state of Michigan. This increase in this trophic level has been related to an increase in global temperature[1], cultural eutrophication, and pollution of the waters. These changes lead to a more habitable environment for certain nuisance algae to grow like cyanobacteria, which is not an algae, but commonly known as blue-green algae. When there is a large amount of growth it can be referred to as a harmful algal bloom (HAB). Currently, HAB's are treated with a algaecides to reduce their density. This is problematic due to the size of some of these HAB's. Prevention is another alternative that should be considered. Prevention can be achieved by limiting nutrients and cycling out nutrients to less usable forms within the waterbody. Naturalake Biosciences have probiotic products that aim to manipulate the nitrogen cycle and bind out phosphorous along with other particles (ion, minerals, debris) in the water column, thereby reducing algal density. This study was designed to look at the effects that the probiotic products are having on the water quality.

Comparison of molecular markers to distinguish genotypes of Eurasian watermilfoil, northern watermilfoil, and their hybrids

Jeff Pashnick, Ph D. Student Montana State University
jeff.pashnick@msu.montana.edu

Genetic diversity can affect invasive plant species' responses to management. For example, different genotypes of clonal Eurasian watermilfoil (*Myriophyllum spicatum*), and their hybrids with native northern watermilfoil (*Myriophyllum sibiricum*), can differ in their response to several herbicides commonly used to control them. Therefore, distinguishing genotypes within and among lakes can facilitate the characterization of their growth and herbicide response properties and inform management. For example, when a characterized clone is found in several different lakes, growth and herbicide response information can be applied across those lakes. Implementing such a method relies on having accurate and efficient genotyping methods to distinguish clones, and to identify ramets of the same clone that are shared among lakes. In this study, we compared genet and ramet identities using microsatellites, amplified fragment length polymorphisms, and single-nucleotide polymorphisms generated via genotyping-by-sequencing for 192 individual plants of Eurasian watermilfoil, northern watermilfoil, and hybrids. We found that all three marker types agreed on their identification of genets and ramets. Based on cost, ease, and repeatability, we recommend microsatellite markers as an effective way to distinguish genets and ramets in the short term. However, in the longer term, we believe the development of a single-nucleotide polymorphism assay is appropriate to provide more information and facilitate data sharing while maximizing accuracy, repeatability, and cost-effectiveness for watermilfoil genotyping.

Utilization of Dual Transducers Improves Hydroacoustic Survey Efficiency

Andrew Howell, Steve T. Hoyle, Tyler J. Harris, and Robert J. Richardson
North Carolina State University, Crop and Soil Sciences, Raleigh, NC
ahowell@ncsu.edu

Utilization of hydroacoustic sensing techniques has been commonly employed in aquatic plant surveys. Traditionally, a single transducer would be utilized; however, utilizing two transducers could potentially result in far greater data collection with the same effort. To evaluate the effectiveness of a dual transducer system, surveys were conducted of Roanoke Rapids Lake. Two transducer datasets were joined to delineate acoustically derived data. Transect data merged two transducers expanded the mapping capability of littoral components among three areas of interest and reduced the overall variance among biovolume, depth, and percent area coverage. Combining the georeferenced records from both transducers also provided an average increase of approximately 20% in swath coverage. Based on the limnologic properties of Roanoke Rapids Lake, our findings indicate improved performance of littoral estimates when incorporating two transducers. Extending sonar swath provided comprehensive estimates of water column dynamics, with greater spatial detail and ultimately reducing variation among littoral parameters compared to operating one transducer mounted to the stern. Although we saw minute deviation in terms of depth contours and biovolume in this experiment, we hypothesize that study sites containing irregular and patchy plant distributions would benefit from the dual transducer configuration; especially in scenarios with wide or erratic littoral gradients.

Variable Leaf Milfoil (Myriophyllum heterophyllum) Response to Florpyrauxifen-benzyl Concentration Exposure Times

Kara Foley, Erika Haug, and Robert J. Richardson
North Carolina State University, Crop and Soil Sciences, Raleigh, NC
kjfoley@ncsu.edu

Variable leaf milfoil (*Myriophyllum heterophyllum*) is a submersed aquatic weed that is a major concern for freshwater ecosystems in the northern United States. Herbicide treatments are commonly used as a method for controlling the growth and spread of this invasive species. Concentration exposure time experimental trials were conducted on M. heterophyllum collected from Turtle Pond (Concord, NH) using auxin-mimic herbicide florpyrauxifen-benzyl (Procellacor©) at rates of 5, 10 and 20 ppb at pH 6.84 ± 0.05, 7.98 ± 0.09 mg/L D.O. and 23.46 ± 0.36 °C. Exposure times to the product were 1, 3 and 9 hours. Plants were rated weekly for % control and were harvested 4 weeks after treatment. At 4 weeks after treatment, aboveground growth of *M. heterophyllum* was effectively controlled (91.7 ± 6.8%) with rates of florpyrauxifen-benzyl as low as 5 ppb with at least a 3-hour exposure time.

Evaluation of Eurasian and hybrid watermilfoil accessions following exposure to different environmental conditions and herbicides

Jens Beets[1], Mike Netherland[2], and Robert J. Richardson[1]
[1] North Carolina State University, Crop and Soil Sciences, Raleigh, NC
[2] University of Florida, Gainsville, FL
jbeets@ncsu.edu

Eurasian watermilfoil (EWM) and Hybrid watermilfoil (HWM) are problematic submerged aquatic invasive plants in many waterways of the Northern states. Auxin-mimic herbicides, such as 2,4-D and triclopyr, are commonly used herbicides for management to control invasive populations of EWM and HWM. The development of the novel arylpicolinate herbicide florpyrauxifen-benzyl provides a new tool to augment control options of problematic aquatic weedy species including EWM and HWM. To better understand the efficacy of florpyrauxifen-benzyl on EWM and HWM and differences between HWM accessions, we performed experiments in growth chambers as well as large-scale experiments in mesocosms. Objectives of these studies were to: 1) investigate potential for increased herbicide tolerance of HWM, and 2) document differences in growth and response of three herbicides between populations of EWM and HWM. Growth chamber results indicated strong response to florpyrauxifen-benzyl in both EWM and HWM, with differences observed in response between the Hayden HWM accession and other accessions. In addition to growth differences between HWM accessions, there were differences in herbicide response between accessions observed in the large-scale mesocosms.

Oral Presentations

Session A
HAB

The Race to the bottom
Trent Lewis, Pond Medics
trent@pondmedics.com

If you're only competitive advantage is lowest price, you're racing to the bottom and it's a race you can't win. In this session, you'll learn how to implement and use competitive advantages that promote profitability and sustainability in your business. Take home sales and pricing tools you can start using right away. You're better than you give yourself credit for. Identify your core strengths and start selling on those. It's time to race, but race to win!

A Comparative Review of Management Tactics for Noxious Algae
John H. Rodgers Jr., Professor of environmental toxicology, Clemson University
jrodger@clemson.edu

The objective of this presentation is to strategically review available management tactics for noxious algae. This review is populated from scientific (peer reviewed) literature that provides information regarding critical attributes of the management tactics. In order to accomplish integrated targeted noxious algal management, all available and applicable tactics must be considered for development of an adaptive management plan. This review is an initial effort to synthesize the information required to accomplish this task.

Adaptive water resource management for harmful algal blooms (HABs)
Ciera Baird, Ph.D., Aquatic Ecotoxicologist: Specializing in HAB Management, Aquatic Control, Inc.
cierab@aquaticcontrol.com

Harmful algal blooms (HABs) are a prominent issue in critical freshwater resources across the United States and globally. As HABs become more frequent, no management decision (or a decision not to intervene) can result in loss of services provided directly and indirectly by the water resource, and exposures of people and other organisms to endotoxins. Alternatively, the principles of adaptive water resource management can be utilized to intervene against HABs. First, the problem and management goal(s) must be defined. Then, a management plan can be developed to achieve the goal based on site-specific characteristics including designated uses of the water resource, cyanobacterial species present, and spatial and temporal dynamics of the bloom(s). Successful risk management will be a function of achieving control of the toxin-producing cyanobacteria and/or toxin exposures specifically. Critical to the process of adaptive water resource management is the ability to learn and adapt management plans with time, that may be prompted by changes in water uses, spatial or temporal distribution of HABs, or additional contributions of data to the peer-reviewed literature regarding human-health risks, ecological risks, or risk management approaches. With public awareness, stakeholder support, and persistent efforts, unnecessary exposures of humans, animals, and plants to endotoxins can be minimized or avoided, critical uses of freshwater resources can be maintained, and significant financial losses can be prevented.

Session B

Starry Stonewort

APMS Update

Mark Heilman, President-Elect APMS
markh@sepro.com

Starry Stonewort – Twenty Years and Counting

G. Douglas Pullman, Ph.D., Applied Biochemists
doug.pullman@lonza.com

Goal directed lake management programs are challenged when lake ecosystems are disturbed by invasive and opportunistic species that compromise biological diversity, habitat complexity, and ecosystem stability. Starry stonewort can represent very significant challenge, but not an insurmountable hurdle to northern lake managers. Understanding can be a key component for success. The most predictable characteristic of starry stonewort (Nitellopsis obsusa) is that it is incredibly unpredictable. As an opportunistic invasive species, it is known to bloom and crash, but it is difficult to predict when this might happen. This unpredictability seems to be related to the reasons that this nuisance alga can "suddenly" become so weedy and why it can be so difficult to treat. It is critical to understand how a non-vascular plant can grow 8 ft tall or more, why do starry stonewort meadows boom and crash and when they do crash, what the impact will be to other aquatic plant species. Nuanced control is possible, and programs may be directed by unexpected expectations.

Ongoing Management of an Infestation of *Nitellopsis obtusa* (Starry Stonewort) Infestation in Lake Sylvia, Minnesota, Using a Copper-Based Algaecide

Tyler D. Geer, PhD student, Clemson University
tdgeer@g.clemson.edu

Nitellopsis obtusa (Starry Stonewort) is an invasive species of Eurasian origin that has spread rapidly among inland lakes in the Great Lakes region of the United States. Initiating an aggressive control plan as soon as possible after discovery of *N. obtusa* is important for efficient and effective management. In West Lake Sylvia (Wright Co. MN), *N. obtusa* was first confirmed in September of 2016 in the vicinity of the public boat access. In response, algaecide applications to control *N. obtusa* began early in the summer of 2017, and continued throughout the year to control and contain regrowth and potential recolonization or re-infestation of the area. This situation provided an opportunity to measure the effectiveness of algaecide applications as a tactic for rapidly responding to an Infestation of *N. obtusa.* To target growth and regrowth of *N. obtusa*, the copper-based algaecide Cutrine®-Plus was applied four times between June and October 2017 in the initially colonized area adjacent to the public boat access. Post-treatment *N. obtusa* surveys by an independent auditor confirmed that the spatial extent of *N. obtusa* and the frequency of *N. obtusa* at sample sites declined in the treated area from June to December. In 2018, management of *N. obtusa* in the immediate vicinity of the boat access was continued: four applications of Cutrine® -Plus targeting growth and regrowth of *N. obtusa* occurred in the infested area between July and October 2018. Results from the ongoing study indicate that algaecide treatments are effective for control of incipient *N. obtusa*

Distribution and management of starry stonewort (*Nitellopsis obtusa*) in Wisconsin lakes

Michelle Nault, Lakes and Reservoir Ecologist, Wisconsin Department of Natural Resources
michelle.nault@wisconsin.gov

Starry stonewort (*Nitellopsis obtusa*; SSW) was first reported in the U.S. in the 1970's and has since been documented in portions of the eastern Great Lakes as well as various inland lakes throughout the Midwest. In September 2014, Wisconsin DNR staff conducting a routine aquatic plant point-intercept (PI) survey on Little Muskego Lake, Waukesha Co. discovered a small established population of SSW, marking the first time this non-native macroalgae had been reported in Wisconsin. Since then, SSW has been verified in nine inland lakes in southeast Wisconsin, as well as coastal portions of Green Bay and northern Lake Michigan. This presentation will highlight both statewide and within lake monitoring and educational efforts which have occurred after the initial discovery, as well as preliminary efficacy results following the implementation of a variety of different management techniques to control this new invader.

Session C

Invasive Milfoil Management

Reliance on science proves to be the solution for Hybrid watermilfoil control. A case study

Tim Gardner, Control Consultant, Clarke Aquatic Services, Joe Rush, Professional Lake Manager/Consultant, JadEco
jrush@jadecoconsulting.com
tgardner@clarke.com

Candlewick Lake in Northeastern Illinois is a 210-acre man-made impoundment within a 2,896-acre watershed surround by a planned 2,206 residence gated community. Created in late 1970, the lake achieved full pool in 1975 serving as an aesthetic and recreational asset for the community. This lake has a history of having a delicate balance, shifting between a planktonic and a macrophyte dominated community. Lake management has been working diligently to maintain a diverse, quality native plant community while also maintaining recreational access for boating and swimming. Late in 2016 a surprising and significant incursion of an invasive hybridized milfoil appeared. Unsettled by its presence, the more challenging question for the lake management association was how to manage the situation most effectively while not negatively impacting the overall native plant community. Through a very methodical, science based approach coupled with communications to homeowners, a plan and patience paid off. The 100-day post treatment survey confirmed excellent control results. This paper will review the approach and steps taken that led to the successful execution for control of this highly invasive species.

Watermilfoil species and Curlyleaf pondweed control using Endothall and Auxin partners.

Dr. Cody J Gray, Ph.D., Field Development Representative, UPL
cody.gray@uniphos.com

Eurasian watermilfoil and curlyleaf pondweed have long been problematic invasive aquatic species across the northern tier of the United States. Water managers have battled these species for decades using a variety of techniques including herbicide applications, mechanical techniques, and biological control. Endothall became a staple in many manager's herbicide programs once it was determined that endothall could be used in water colder than 65 F. Currently, endothall is commonly used with auxin partners to control various milfoil species. Additionally, UPL released a new product, Chinook Aquatic Herbicide, which includes endothall plus 2,4-D. This presentation will outline endothall research conducted to combat Eurasian and hybrid watermilfoil, curlyleaf pondweed and other aquatic invasive species.

Identifying hybrid watermilfoil gene expression differences to improve adaptive management outcomes for watermilfoil control.

Gregory M. Chorak Ph.D, Student, Ryan A. Thum, Montana State University
gregory.chorak@student.montana.edu

Aquatic plant managers are increasingly concerned about herbicide tolerance and resistance. Identifying the genetic basis of herbicide tolerance is tricky because it could be due to genetic mutations that impact either the gene or genes in a functional process that the herbicide targets (target site), or genes that are not directly targeted by the herbicide (non-target genes; e.g. uptake, translocation, metabolism, detoxification). One promising approach when the basis of tolerance is unknown is RNA-Seq, which quantifies the levels of all genes actively being used by an organism in a set of conditions.
This project focused specifically on Eurasian watermilfoil (*Myriophyllum spicatum* L.; including hybrids with northern watermilfoil, *Myriophyllum sibiricum* Komarov), one of the most highly managed invasive aquatic weeds in the Midwest and Great Lakes region. We aimed to identify gene expression differences between control and 500ppb 2,4-D treatment, between times after treatment, and between two clones varying in their apparent sensitivity to 2,4-D. This approach has potential to lead to genetic assays that predict herbicide control outcomes, allowing managers to adapt control tactics to specific populations.

Evaluating Hand-Harvesting Control Programs for Invasive Milfoils in Wisconsin

Todd Hanke, Aquatic Field Technician, Onterra, LLC
thanke@onterra-eco.com

Manual removal or hand-harvesting of Eurasian watermilfoil has gained favor in recent years as part of an Integrated Pest Management (IPM) strategy. Hand-harvesting is often employed as an early response measure when populations are small, as supplemental management following herbicide treatment, and/or in instances where there is not public support for herbicide use. Professional hand-harvesting firms can be contracted for these efforts and can either use basic snorkeling or scuba divers, whereas others might employ the use of a Diver Assisted Suction Harvest (DASH) which involves divers removing plants and feeding them into a suctioned hose for delivery to the deck of the harvesting vessel. Resource managers continue to collect data on the efficacy, selectivity, and costs of this approach. This presentation highlights the planning, monitoring and results of case studies for coordinated hand-harvesting control programs in select Wisconsin lakes.

Initial operational success using ProcellaCOR® for selective control of invasive watermilfoils.

Dr. Mark Heilman, Senior Aquatic Technology Leader, SePRO
markh@sepro.com

In early 2018, USEPA approved the reduced-risk aquatic herbicide ProcellaCOR® (a.i. florpyrauxifen-benzyl). ProcellaCOR has excellent activity on a variety of aquatic invasive plants including Eurasian watermilfoil (Myriophyllum spicatum) and hybrid Eurasian accessions. The new arylpicolinate herbicide reduces use rates by several orders of magnitude versus older selective spot herbicide strategies for invasive watermilfoil management. Research studies prior to registration and initial use since its federal approval have confirmed excellent, short-exposure activity on invasive watermilfoils with selectivity to most common native aquatic plant species in the Midwest such as pondweeds (Potamogeton spp.), naiads (Najas spp.), tapegrass (Vallisneria americana), and bulrush (Schoenoplectus spp.). In this paper, results from several representative 2018 field efforts with ProcellaCOR for invasive watermilfoil management will be reviewed including pre- and post-treatment, quantitative point-intercept vegetation surveys and herbicide dissipation monitoring.

Session D

General Management Practices

Development of a novel autonomous aquatic pesticide application system.

Dr. Robert J. Richardson, Professor and Extension Specialist, North Carolina State University Steve Hoyle, and Justin Nawrocki
rob_richardson@ncsu.edu

Aquatic vegetation surveys and aquatic herbicide applications are integral components of vegetation management programs that protect water resources. However, surveys and herbicide applications can be labor intensive and provide opportunities for introducing cost saving measures. The goal of this project was to design, prototype, and demonstrate a small fleet of autonomous aquatic vehicles (AAVs) capable of detecting, quantifying, and selectively applying herbicide to manage invasive aquatic weed infestations. To date, three AAVs have been developed to evaluate performance, durability, and operational capacity. Field testing of these units has been conducted. Utilization of a trolling motor provided approximately 9x increased thrust over an air propeller and also improved turning radius. Incorporation of a lithium iron phosphate battery significantly reduced weight and increased carrying capacity while also allowing for rapid charging. Autonomous tracking of two AAVs concurrently has been implemented and demonstrated. Successful collection of hydroacoustic data as well as herbicide application through the AAVs has also been verified. Further research is being conducted to optimize the current systems prior to commercialization.

Understanding and managing the influence of nutrients in water resources.

Michael Hiatt, Aquatic Specialist, Mike Pearce, Dr. West Bishop Ph.D. SePRO
michaelh@sepro.com

Algal blooms are increasingly impacting water resources throughout the United States and globally. A preventative approach to addressing these blooms is gaining social and regulatory favor. Managing nutrient sources, concentrations and ratios is can be an effective approach to help offset or direct bloom formation. Specifically mitigating in situ water and sediment phosphorus can positively shift nutrient ratios and govern algal types/densities. In this presentation, information regarding nutrients and how they align with algal ecology and consequent growth patterns will be provided. Additionally, results of nutrient mitigation programs and case studies will be provided to apply these concepts. Strategically incorporating preventative technologies focused on nutrient mitigation will be needed to offset the growing threat of algal blooms.

Why Didn't my treatment work?

Leif Willey, Lake & Special Project Supervisor, Aquatic Control, Inc.
leifw@aquaticcontrol.com

If you have been in the aquatic plant management industry for any amount of time, chances are you have experienced a failed treatment, or a treatment where the results just were not as good as expected. Often the cause of this is easy to see, but sometimes we are left scratching our heads looking for answers. The purpose of this presentation is to educate applicators to the unseen factors that impact our daily operations and how considering these aspects can make us better stewards of the herbicides and algaecides we have available.

A scientific evaluation of bacterial digesting products in a stormwater pond in Volusia, FL

Patrick Goodwin, Research Scientist, CLM, Vertex Water Features
patrick.goodwin@aquaticsystems.com

In this study, three products: BioZyme Nitrifiers ™, BioZyme Powder Formula ™, and BioZyme Activator ™ were added according to manufactures instructions to a stormwater pond in Volusia County Florida in order to asses these products efficacy in reducing accumulated sediment organics. Unconsolidated sediment depths and sediment composition (n = 14) were measured before and after 27 weekly bacterial treatments. Sediments inoculated with bacteria were not associated with significant reductions in mean unconsolidated sediment depths. However, sediment composition after treated with bacteria showed a significant decrease in percent sediment organic content and an increase in water weight. This study suggests that lake sediments with low sediment organic matter (< 25 %) relative to the unconsolidated sediment depth (0.31 m; 1 ft.) will not exhibit significant reductions in mean unconsolidated sediment depths when using these bacterial digesting products. Determining a lake's mean sediment organic content and unconsolidated sediment depth are useful metrics in assessing the feasibility of bacterial products for sediment reduction. An overview of the application process and cost is also provided for applied lake managers looking to utilize this technique

Two Birds, One Stone: EarthTec Liquid Ionic Copper Controls both HABs and Zebra Mussels

David Hammond Ph.D., Senior Scientist, Earth Science Labs
dhammond@earthsciencelabs.com

Frequency and severity of Harmful Algae Blooms (HABs) across the U.S. have increased markedly in recent years, affecting plant operations and even forcing temporary closure of several WTPs as a result of taste and odor issues and/or fear of cyanotoxins. Copper-based algaecides have been an important tool for many decades in management of source water – to the extent that in some jurisdictions copper has been over-used and there has been a backlash against it. But recent advances have led to more efficient formulations of copper, permitting superior performance with less chemical applied and less impact on the environment. Data from real world case studies will be presented, illustrating that a formulation of liquid copper delivered as cupric ions yields superior results, superior pest control, and better cost-effectiveness at lower doses of active ingredient. The data to be presented suggest that in most instances, managers switching from conventional copper to liquid copper are able to achieve similar results by applying only 20% of the elemental copper previously applied, reducing cost and the impact on the environment. One such liquid copper product, EarthTec, is also labeled for use against zebra and quagga mussels and has been used successfully in states across the U.S. as part of Rapid Response efforts and also to protect against biofouling of vital infrastructure. In fall of 2017 EarthTec was used in a project to eradicate quagga mussels from an entire Pennsylvania lake, and that project's most up-to-date results will be shared.

Session E

Invasive Milfoil Management

AERF Update

Carlton Layne, Aquatic Ecosystem Restoration Foundation
layn1111@bellsouth.net

Management implications of genetic similarity and differentiation of Eurasian and hybrid watermilfoil in Michigan and Minnesota lakes.

Ryan A. Thum, Assistant Professor, Montana State University Department of Plant Sciences and Plant Pathology, Gregory M. Chorak Ph.D, Student, Montana State University, Ray Newman and Jasmine Eltawely, University of Minnesota, Michigan State University Extension, Jo Latimore and Erick Elgin, Grand Valley State University, James McNair and Syndell Parks

It is clear that Eurasian and hybrid watermilfoils exhibit genetic variation for growth and herbicide response, and this variation is of interest to managers charged with developing and evaluating control tactics. How genetic variation is structured within and among populations is unclear. For example, do populations consist largely of single genotypes that vegetatively (clonally) propagate, or are they genetically diverse? Similarly, do individual clones have widespread distributions indicative of extensive dispersal of asexual propagules, or do they have restricted, local distributions? These questions have important management implications regarding the adaptive potential of populations, and whether the same management tactics in different lakes will have similar efficacy. We studied patterns of within- and among-lake genetic variation in 80 lakes in Michigan and Minnesota using a combination of microsatellites, amplified fragment length polymorphisms, and single nucleotide polymorphisms generated from genotyping by sequencing. We found that within-lake genetic diversity was generally low for Eurasian and hybrid watermilfoil, indicating that the majority of reproduction within lakes occurs via vegetative (clonal) propagation. However, there were several notable exceptions to this pattern, suggesting that sexual reproduction occurs within at least some lakes some of the time. In contrast, among-lake genetic diversity was relatively high, meaning that lakes tended to harbor different genotypes from one another. However, several genotypes were shared among lakes, including one genotype with known herbicide response properties. This pattern of relatively low within-lake diversity and high among-lake diversity is common in aquatic plants, and may be related to seed dispersal and recruitment, colonization by one or a few genotypes, or adaptive responses to local selection pressures. As a practical matter for Eurasian and hybrid watermilfoil management, that lakes are commonly composed of different genotypes means that managers should explicitly consider and evaluate genetic variation as a potential explanation for variation in observed efficacy of the same control tactics in different lakes. At the same time, that some lakes share genotypes provides opportunities for efficiency in collecting and sharing genotype-specific growth and herbicide response information to inform management decisions.

Endothall systemic behavior in five aquatic weeds.

Mirella F. Ortiz, Dr. Scott J. Nissen* and Dr. Cody J. Gray
scott.nissen@colostate.edu

Endothall is one of the original aquatic herbicides, being used primarily to control submersed plants since 1960. Endothall is considered a contact herbicide and is in a chemical class of its own. It is a serine/threonine protein phosphatase inhibitor which has broad-spectrum control and is effective in controlling both monocotyledons and dicotyledons. Eurasian watermilfoil (*Myriophyllum spicatum* L.) (EWM), hydrilla (*Hydrilla verticillata* (L.f.) Royle), curlyleaf pondweed (*Potamogeton crispus* L.) (CLP), and sago pondweed (*Potamogeton pectinatus* L.) (SPW) are submersed aquatic species considered troublesome throughout the United States which can be controlled with endothall. Although endothall is considered a contact herbicide, many field observations suggest that it might have systemic activity. The goals of this research were to (1) determine herbicide maximum absorption and absorption rate, (2) evaluate herbicide translocation from shoots to roots in EWM, two hydrilla biotypes, CLP, and sago pondweed, and (3) evaluate herbicide desorption in EWM and two hydrilla biotypes. Each weed was clonally propagated from apical shoot cutting or turions/tubers when present. For herbicide absorption and translocation, plants of each species with developed roots and 15 cm of shoot growth were transferred to test tubes and sealed at the top with a low melting point eicosane wax to isolate the root system from the water column. Plants were exposed to the herbicide over a 192 h time course. Herbicide desorption was evaluated over a time course of 96 hours. Hydrilla showed a linear increase in endothall absorption, while endothall absorption in EWM, CLP and sago pondweed best fit an asymptotic rise function. Translocation to EWM, CLP, and SPW roots was limited, reaching a maximum translocation of 8%, 3% and 1% of total absorbed radioactivity, respectively. Monoecious and dioecious hydrilla showed a linear increase without reaching maximum absorption or translocation 192 HAT. Endothall translocation to monoecious and dioecious hydrilla roots was 18% and 16% of total absorbed radioactivity, respectively. Herbicide desorption was less than 30% for all the three species evaluated. These data provide strong evidence that endothall behaves as a systemic herbicide

Planning and Evaluating Large-Scale Pelletized Fluridone Treatment for Invasive Milfoil Control in Wisconsin

Eddie Heath, Aquatic Ecologist, Onterra, LLC

Resource managers in Wisconsin are currently studying various strategically employed management techniques that have a goal of reducing invasive milfoil populations while maintaining the health of the native ecosystem. In many scenarios, this is attempted by implementing early-season herbicide control strategies; either as spatially targeted small-scale spot treatments or low-concentration, large-scale (whole lake) treatments. This presentation will focus on the planning and evaluation of large-scale pelletized fluridone treatment strategies in Wisconsin. This presentation couples quantitative aquatic plant monitoring with field-collected herbicide concentration data to evaluate efficacy, selectivity, and longevity of chemical control strategies implemented on a subset of Wisconsin waterbodies.

Session F

General Management

RISE Update

Aaron Hobbs, RISE

Consumer available sUAS (Small Unmanned Aircraft Systems) for macrophyte mapping and management.

Andrew Howell and Dr. Robert J. Richardson
North Carolina State University, Crop and Soil Sciences, Raleigh, NC
ahowell@ncsu.edu

Invasive exotic macrophytes, such as *Hydrilla verticillata* and *Zizania latifolia*, often have undesirable effects on native aquatic ecology and the associated local economy within invaded regions. It is well accepted that timely monitoring and mapping strategies are essential for evaluating native and exotic aquatic vegetation, and also provide management direction for rapid response or gauge management effort success. While many aquatic plant survey techniques are well-established, most assessments require a skilled workforce and there is often subjectivity among surveyors which can lower survey accuracy and efficiency. Likewise, these methods require considerable labor and time inputs, as the extent of waterway evaluations are correlated with the precision, spatial coverage, and duration spent evaluating each monitoring location. The recent popularity of low-cost off-the-shelf sUAS generate multiple paths for aquatic plant researchers and managers to explore. In addition to providing a platform for small optical imagers, sUAS potentially provide opportunities to remotely deliver herbicide applications. This research describes the use of consumer available sUAS to summarize varying macrophyte components among waterways in North and South Carolina, and New Zealand and discusses how unmanned equipment may be incorporated in treatment programs and post-treatment monitoring.

Adjuvants- "But wait, there's more"

Dr. G. Douglas Pullman, Ph.D., Applied Biochemists
doug.pullman@lonza.com

Very little “field time” is required to see he alchemy that is a part of nearly all effective aquatic herbicide applications. Most experienced aquatic applicators recognize the importance of creating mixtures of control agents and adjuvants to improve treatment outcomes. Pretreatment with algaecides to “remove plant-surface algae interference to control agent combinations that enhance effectiveness are all a part of the applicator tool chest. Adjuvants are described as additives to herbicide mixtures and dilutions that enhance the activity and performance of the herbicide. Today, the line has become blurred between applications that include adjuvants or applications of herbicide/algaecide combinations where different chemistries play complicated roles in bringing about acceptable outcomes. Enhanced aquatic biocide combinations (e-ABC’s) improve performance outcomes in a variety of ways from modifying water chemistry to stimulating a target plant to make it more susceptible to the herbicidal impacts of the e-ABC. AMP considered to be a biological adjuvant because it is a mixture of microbes, proteins, and enzymes. It also represents a new class of adjuvants that seem to stimulate physiological responses to the herbicidal effect of auxinic herbicides to improve treatment outcomes. Field studies will help to elucidate our understanding of these important types of adjuvants and improve the performance of e-ABC’s in the future

Preventative submersed aquatic weed control utilizing a preemergence use pattern of Sonar® Aquatic Herbicide (fluridone).

Scott Shuler, Regional Manager, SePRO
scotts@sepro.com

Fluridone research has been conducted on preemergence use patterns in terrestrial environments since the late 1970s. Typical small-waterbody management for submersed aquatic weeds has utilized contact herbicide applications as a reactive management approach to nuisance conditions. This management strategy may require increased labor, has risks associated with dissolved oxygen depletion and nutrient release from decaying vegetation that may exacerbate nuisance algal growth. ECOS® is a preemergence use pattern utilizing SonarOne® Aquatic Herbicide to provide preventative submersed aquatic weed control. Over 3,500 ponds managed under the ECOS Program were evaluated for efficacy, spectrum of control, length of control, herbicide and algaecide inputs and operational efficiency during a two year period. Season-long, broad-spectrum submersed weed control was achieved on 77-99% of the ponds depending on geography, plant community and timing of nitial application. Algaecide inputs were reduced on the ECOS ponds by 17-25% depending on the year. Evaluation of the 3,500 ECOS ponds shows this preemergence program provides effective broad-spectrum, season -long control of submersed aquatic weeds and reduced labor and algaecide inputs.

Session G

General Management

Line Vs. Point Aeration Designs: A Cost-Benefit Analysis

Patrick Goodwin, Research Scientist, CLM, Vertex Water Features
patrick.goodwin@aquaticsystems.com

In this study, a cost-benefit analysis is presented for line and point aeration designs. The metrics compared include % water moved or turnover per day, oxygen transfer efficiency's, chlorophyll a (chl. a) reduction, labor, capital costs, and operation costs. Published equations for calculating turnover and oxygen transfer were used to compare the efficacy of line and point aeration diffusers at varying depths and densities. Current aeration models were used to assess the efficacy of line and point aeration designs concerning lake chl. a. Case studies were used to compare labor, capital, and operational costs. Results indicate that both line and point aeration designs can meet desired aeration objectives. Turnover and oxygen transfer were superior with line diffusers at shallow depths (< 3 m), while point diffusers were superior at deeper depths (> 3 m). Point aeration designs provided greater reductions in chl. a at lesser airflow than line aeration designs. Initial capital savings may be provided using line aeration, but long-term maintenance and electrical costs are likely greater. Both line and point aeration designs should be considered on a site by site basis and should account for lakes physical attributes and the aeration objectives at hand. Multiple designs should be presented to stakeholders such that best management practices can be fostered.

Aeration Successes and Failures

Bob Robinson - Fisheries Biologist/Director of Sales and Marketing - Kasco Marine
bob.r@kascomarine.com

Aeration is not a panacea for all water quality issues and should be not sold as such. It is one of the tools in the tool box. An overview of aeration technique choices as well as what to expect with a properly designed and applied aeration choice will be discussed. Examples of numerous successes as well as failures will be presented.

Herbicide Interactions: 2,4-D plus Endothall (Chinook) behavior in milfoil species.

Mirella F. Ortiz, Dr. Scott J. Nissen* and Dr. Cody J. Gray
scott.nissen@colostate.edu

Hybrid watermilfoil (HWM) is becoming more prevalent in many lakes where Eurasian (EWM; *Myriophyllum spicatum*) and Northern watermilfoil (*M. sibiricum*) co-occur. These hybrids between Eurasian and the native Northern watermilfoil have a 30% faster growth rate and in many cases are less sensitive to 2,4-D than either parent. Endothall is one of the original aquatic herbicides, being used primarily to control submersed plants since 1960. In order to delay possible HWM resistant to 2,4-D we investigated 2,4-D and endothall absorption and translocation in EWM and HWM when applied alone and in combination by using radiolabeled herbicide. Although 2,4-D total absorption was the same, the absorption rate was faster in HWM when applied in combination with endothall, and endothall total absorption was significantly higher in HWM when applied in combination with 2,4-D. Endothall translocation to the roots was the same in EWM and HWM with and without 2,4-D, while 2,4-D translocation was the same for both species, but significantly higher when applied alone. Chinook, endothall plus 2,4-D, represents an excellent resistance management tool in areas where HWM has not shown reduced sensitivity to 2,4-D and applying the two herbicides together appears to have no antagonistic effects on herbicide absorption or translocation.

Project Profile: Mechanical dredging avoided at Lake Templene, MI through aeration & bioaugmentation.

Jake Bradley, EasyPro Pond Products
jake@easypro.com

Learn how nearly 5 million cubic feet of sediment, heavily composed of fibrous peat, was removed in shallow, problematic bays in Lake Templene through the means of Aeration and Bio-Augmentation alone. This exciting project has shown incredible results in the now 165 acres of aerated bays that are treated monthly through the summer with a specialized beneficial microbe program. Lake Templene, which totals 1,050 acres, has been impressed with sediment removal rates beyond expectations at approximately 1/4 of the cost of mechanical dredging. Based on independent test data gathered with low and high density sonar, the Lake Templene Board now anticipates a clean lake bottom by 2023! Come learn how these incredible results were achieved

Building organization capacity through social media.

Emily Henrigillis, Watershed Coordinator, Fox-Wolf Watershed Alliance
emily@fwwa.org

Building organizational capacity is new name for an old concept. Social media has changed how we interact with our clients and how we advertise our business. Scientists are notoriously poor at sharing their information in an easily digestible format. Social media has helped change some of that. Having a recognizable brand can help build your organization's capacity. When hired on at the Fox-Wolf Watershed Alliance, we were tasked with created a logo/brand for the partnership between Fox-Wolf and a local organization, the Waterways Association of Menominee and Shawano Counties (WAMSCO). This branding has allowed us to build the capacity of all three groups. We have been able to build relationships with previously uninterested partners as well as strengthen our relationships with already invested partners. We will discuss how to use social media more effectively to build your brand, some insights into making the use of social media easier, and how to work through those tough to make relationships.

Session H

Membership Meeting

Annual Business Meeting 2018

Call to order (3:10p.m.) – Hausler

Roll Call – Goidosik

Paul Hausler (President) Dick Pinagel (Past President) Nate Long (President Elect) Jake Britton (Vice President) Steve Zulinski (Treasurer) Leif Willey (Editor) John Goidosik (Secretary) Amy Kay (Director) Eric Schutman (Director) Matt Johnson (Director) Dave Nicholson (Director) Ryan Thum (Director) not present Landon Wiet (Director) 1. Additions/deletions to agenda (motion to accept the agenda) Review of previous annual business meeting minutes – 2017 minutes in the program: Long – first, Pinagel = second, Motion Carries

2. Financial Report (Zulinski) – Treasurer (motion to approve): Checking account = $49,843.44, savings account = $45,197.22. RLJ Memorial Research Grant Fund = $14,187.56. Kannenberg = first, Wilson = second, Motion Carries

3. Standing Committee Reports: a. Nominating (Pinagel): distribute ballots and collect (nominations from the floor if any) (motion to accept the ballot) No nominations from the floor. Bondra = first, Jorgensen = second, Motion Carries -Pinagel = Distributed ballots for the vote, winners to be announced at the banquet.

b. Membership (Kay): -Kay = Updated the group regarding this year's registration and announced a survey regarding the conference would be sent out via survey monkey.

c. Editorial (Willey): -Willey = Cleaned up membership list, had email account authenticated and will be supplying regular website updates.

d. By Laws (Zulinski): -Zulinski = No report.

e. Internal Audit (Schutman): -Schutman = No report (Hausler mentioned to the group that a report was given at the pre-con and that the books are in order).

f. Governmental Affairs (Johnson): -Johnson = Provided a Waters of the US update, (currently sitting in a holding pattern). NPDES update, (asked that the group please be sure to comment when asked). Asked members to keep him informed regarding any local Governmental issues.

g. Exhibits (Schutman): -Schutman = 27 exhibitors this year. Wedooboats, first time exhibitor. Excellent exhibitor award to be announced at the banquet.

h. Publicity (Kay): -Kay = Plant ID chart recently revised and 5,000 printed. They are at the MAPMS booth. Use these charts as you attend various meetings/exhibits.

i. Past Presidents Advisory (Pinagel): -Pinagel = No report.

j. Program (Long): -Long = Thanked all speakers, mentioned that a number of our regular presenters were in New Zealand for a different conference. 29 total presentations and 1 poster.

k. Local Arrangements (Johnson): -Johnson = Asked the group for comments regarding this year's event so that we can improve future events.

l. Student Affairs Committee (Thum): Heath for Thum -Heath for Thum = We had 2 submissions for the RLJ Memorial Research Grant. 8 students attending the conference, 6 giving oral presentations and 1 giving a poster. A student representative will be appointed to the BOD prior to the completion of the conference.

4. Special Committee Reports: a. Silent Auction/Raffle (Britton): -Britton = Went with 3 higher dollar items vs. 5 lesser dollar items as in years past. $1,000.00 cash, a crossbow and a drone. Money goes to the RLJ Memorial Research Grant Fund.

b. 2020 Time and Place: Downtown Indianapolis (Britton) -Britton = Mentioned the 2020 meeting will be February 9th -13th due to the lack of hotel rooms available because of the NFL combine being hosted in Downtown Indiana.

c. Strategic Planning: Presentation by Eric Schutman -Schutman = Gave a breakdown of our Strategic Plan process from start to finish. Plan will be posted in PDF format on the MAPMS website.

d. Sponsorship (Pinagel): -Pinagel = Thanked all sponsors for their support. Asked membership to recognize them. We are slightly up on sponsorship from 2017.

e. Finance (Pinagel): -Pinagel = 2 accounts at The State Bank; RLJ Memorial Research Grant Fund, Initial investment = $15,000.00. Estimated annual income = $112.50. MAPMS Fund, Initial investment = $50,000.00. Value as of 12/31/17 = $58,115.17.

Motion = Johnson, Second = Thompson, motion carries.

5. Old Business:
No old business.

6. New business:
No new business.

7. Temporally Adjourn until Banquet (motion to temporarily adjourn):
Pinagel = first, Shuler = second, (Temporarily Adjourned, 3:48pm)

Reconvene meeting at 8:05pm

-**Hausler** = Recognized all Honorary members, Past Presidents and Sustaining members in attendance. Awarded plaques to all outgoing Board members; Amy Kay, Ryan Thum, Dick Pinagel & Leif Willey.

Announced winners of the vote earlier in the day. Ryan Thum = Vice President, Leif Willey = Editor, Amy Kay = Board of Directors, Garrett McClain = Board of Directors Photo taken of new board.

-**Pinagel** = Awarded Diamond level sponsorship plagues. Aquatic Control, Inc., Cygnet Enterprises, Inc., Lonza, SePRO Corporation, Syngenta & UPI.

-**Thum** = Announced Student paper winners. First place ($300) = Tyler Geer, Clemson University, Second place ($200) = Ciera Kinley, Clemson University, Third place ($100) = Kristen Tanz, Colorado State University.

-**Heath for Thum** = Announced Robert L. Johnson Memorial Research Grant winners: First place ($7,500) = Greg Chorak, Montana State University, Second place ($2,500) = Dalton Sink, University of Michigan – Flint.

-**Schutman** = Announced Exhibitor excellence winner: Outdoor Water Solutions

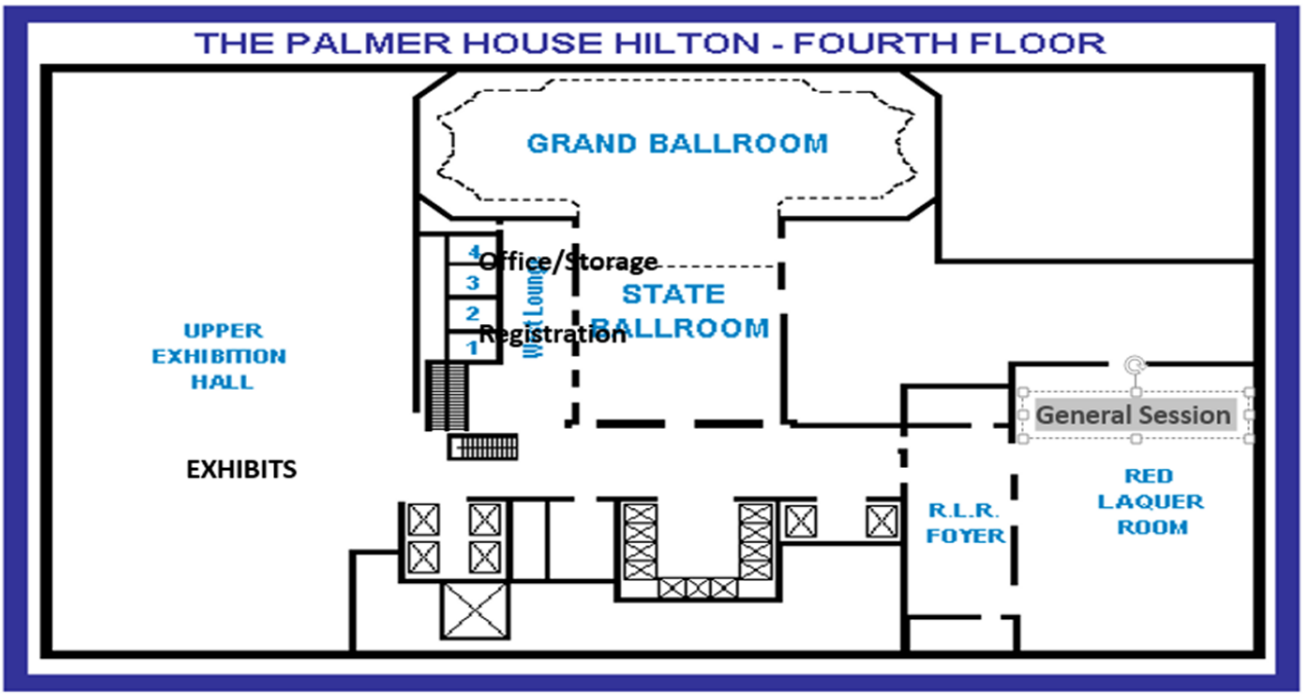
-**Hausler** = Read bio/announced the recipient of the MAPMS Honorary Member award. David Isaacs, Aquatic Control, Inc.

-**Hausler** = Read bio/introduced new MAPMS President. Nate Long, Aquatic Control, Inc.

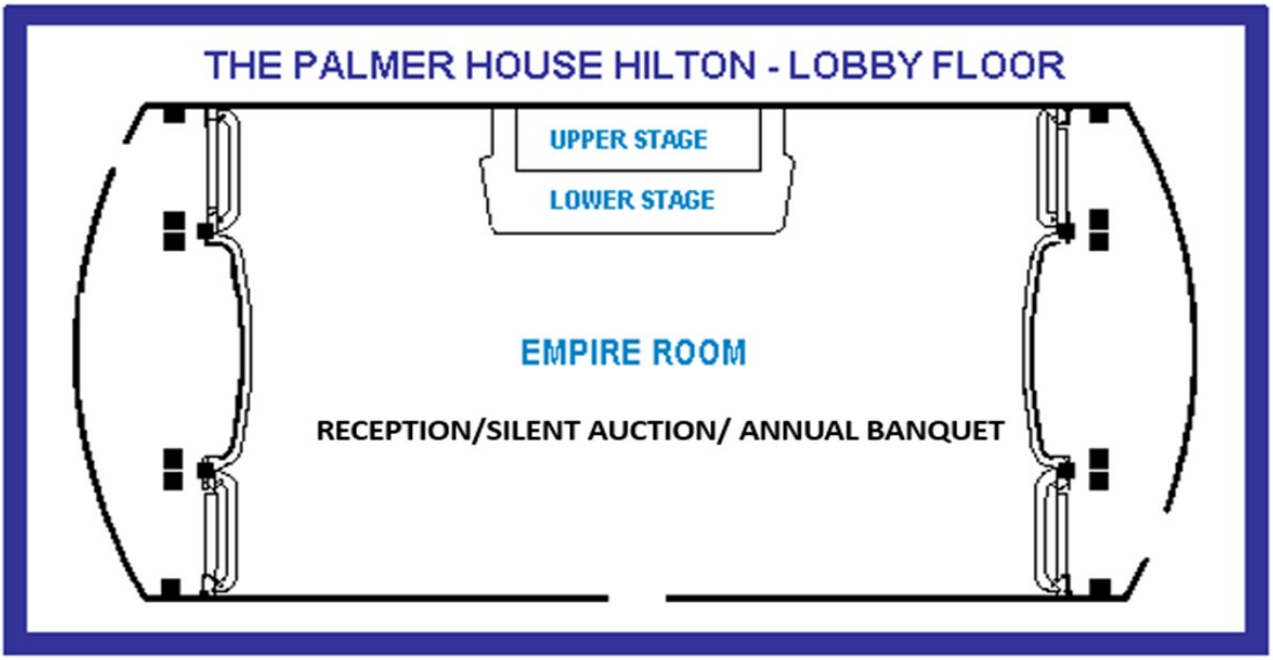
-**Long** = Thanked all in attendance and awarded outgoing President Paul Hausler with the Presidents plaque. Called for motion to adjourn, B. Issacs made a motion, meeting adjourned at 8:32pm.

Palmer House Floor Plans

Palmer House a Hilton Hotel - 4TH FLOOR FLOOR PLAN



Palmer House a Hilton Hotel - LOBBY LEVEL FLOOR PLAN



Upcoming MAPMS Conferences

40th Annual Conference

Hyatt Regency Indianapolis

Indianapolis, IN

February 10, 2020 to February 13, 2020

41st Annual Conference

Amway Grand Hotel

Grand Rapids, MI

February 22, 2021 to February 25, 2021

MIDWEST AQUATIC PLANT MANAGEMENT SOCIETY