36th Annual Meeting

OF THE

MIDWEST AQUATIC PLANT MANAGEMENT SOCIETY

Amway Grand Plaza Hotel and Conference Center
Grand Rapids, Michigan

March 6th - 9th, 2016

Program / Abstracts / Posters

The *Midwest Aquatic Plant Management Society* provides information and assistance required by those who work with the unique ecological, sociological, economic, and regulatory concerns associated with managing aquatic plants in lake systems affected by exotic species, nutrient pollution, use conflicts and intense recreational demands.

MISSION

The purpose of the Midwest Aquatic Plant Management Society (MAPMS) is to:

- Promote sound and appropriate technologies for the management of aquatic resources
- Provide opportunities for educational advancement
- Encourage relevant scientific research in the discipline
- Promote the exchange of information
- Expand and develop public interest in aquatic resources and their sustainable management

VISION

MAPMS vision is to be a relevant, respected and responsive resource for the Aquatic Resource Management Community

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

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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.

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2015	John Goidosik	Indianapolis, IN
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2013	Matt Johnson	Cleveland, OH
2012	Dick Pinagel	Milwaukee, WI
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2010	David Isaacs	Indianapolis, IN
2009	Jason Broekstra	Chicago, IL
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2007	Kevin Dahm	Milwaukee, WI
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2003	Bill Kirkpatrick, Jr.	Ohio
2002	Ray VanGoethem	Milwaukee, WI
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1998	Joe Bondra	Columbus, OH
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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
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1983	Robert Johnson	Ft. Wayne, IN
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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.

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Jim Schmidt (2014)

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)

Robert L. Johnson Memorial Research Grant Recipients

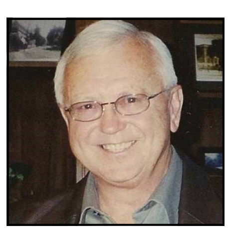
Grants are competitively awarded to qualified graduate students pursuing a degree in aquatic plant management or related field at any accredited university or college, or independent research which contributes to the mission of the Society. MAPMS considers all applications pertaining to research dealing 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.

Kyla Iwinski - Clemson University (2015)

Alyssa Calomeni - Clemson University (2015)

Bradley Sartain - Mississippi State (2014)

Justin Nawrocki - North Carolina State University (2013)



Robert L. Johnson

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1st of 3 year term	2nd of 3 year term	3rd of 3 year term
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2016 MAPMS 36th ANNUAL CONFERENCE

Schedule of Events

March 6th - 9th, 2016

SUNDAY, March 6th, 2016

1:00 pm - 5:00 pm	MAPMS Pre-Conference Board Meeting	(Pearl Room)
1:00 pm - 5:00 pm	Conference Registration	(Center Concourse)
1:00 pm - 5:00 pm	Exhibitor Set-Up	(Ambassador East)
6:30 pm - 10:00 pm	*Presidents Reception with Cash Bar MAPMS Bag Toss Challenge—Proceeds to the Robert L. Johnson Memorial Research Grant*	(Pantlind Ballroom)

MONDAY, March 7th, 2016

6:00 am - 7:00 am	Exhibitor Set-Up	(Ambassador East)
7:00 am - 7:50 am	Continental Breakfast	(Ambassador East)
7:00 am - 5:00 pm	Exhibits Open	(Ambassador East)
7:00 am - 4:00 pm	Conference Registration	(Center Concourse)
8:00 am - 9:30 am	Session 1	(Ambassador West)
9:30 am - 10:00 am	Refreshment Break / Posters- Sponsored	(Ambassador East)
10:00 am - 11:30 am	Session 2	(Ambassador West)
11:30 am - 1:00 pm	Lunch - On your own	
11:30 am - 1:00 pm	Past President Luncheon	(Emerald A Room)
1:00 pm - 3:00 pm	Session 3 ***Starry Stonewart Special Session***	(Ambassador West)
3:00 pm - 3:30 pm	Refreshment Break / Posters - Sponsored	(Ambassador East)
3:30 pm - 4:40 pm	Session 4 ***Starry Stonewart Special Session***	(Ambassador West)
4:40 pm - 5:15 pm	MAPMS Annual Business Meeting	(Ambassador West)

MONDAY March 7th, 2016

SESSION - 1 8:00 am - 9:30 am (Ambassador West)

Moderator: Nate Long , Director MAPMS

8:00 am	Opening announcements and Presidential address. Jacob Meganck, President MAPMS
8:10 am	Procellacor™ A Novel Herbicide Technology in Development for Aquatic Plant Management. Dr. Mark A. Heilman, Senior Aquatic Technology Leader, SePRO Corporation.
8:30 am	Evaluating the Sensitivity of Representative Aquatic Plants to a New Aquatic Herbicide. Dr. Rob Richardson, Associate Professor and Extension Specialist, North Carolina State University.
8:50 am	Comparison of Laboratory and Field Responses of a Microcystin Producing Cyanobacteria to Copper Based Algaecides. Kyla J. Iwinski, M.S., Clemson University. -***Student Presentation***- **2015 MAPMS Robert L. Johnson Memorial Research Grant Recipient**
9:10 am	Invasive Plant Management; Yesterday vs. Today vs. Tomorrow. Jason Broekstra, Vice President of Michigan Operation, Professional Lake Management Corporation.
9:30 am	*BREAK/POSTER VIEWING* (Ambassador East)

MONDAY March 7th, 2016

SESSION 2 10:00 am - 11:30 am (Ambassador West)

Moderator: Paul Hausler, Vice President MAPMS

10:00 am	Aquatic Macrophyte Identification - Tips and Tricks. Paul Skawinski, Statewide Coordinator of Wisconsin Citizen Lake Monitoring Network, University of Wisconsin Extension Lakes Program.
10:20 am	Developing Effective Use Patterns For Peroxide Based Algaecides (GreenClean). Tom Warmuth, Aquatic Technical Representative., BioSafe Systems, Inc.
10:40 am	Aeration's Effect on Algae: A Review of Success and Failures. Patrick Goodwin, Research Biologist, Vertex Water Features.
11:00 am	Factors Influencing Invasion Biology of Monoecious Hydrilla. Joshua Wood, Graduate Student, University of Florida IFAS CAIP. ***-Student Presentation-***
11:30 am	LUNCH (on your own) Past President's Luncheon (Emerald Room)

SESSION 3 1:00 pm - 3:00 pm (Ambassador West)

Starry Stonewart Special Session Speakers

Moderator: Dick Pinagel, President Elect MAPMS

1:00 pm	Sixteen Years with Starry Stonewart? Dr. G. Douglass Pullman, Aquest Corp.
1:30 pm	Starry Stonewort (Nitellopsis obtusa): Research Efforts towards an Integrated Management Plan. Heather Dame, CMU Herbarium, Central Michigan University. ***-Student Presentation-***
1:50 pm	Starry Stonewart - A New Invader of Wisconsin Waters. Paul Skawinski, Statewide Coordinator of Wisconsin Citizen Lake Monitoring Network, University of Wisconsin Extension Lakes Program.
2:20 pm	Control of Starry Stonewart in Small Plots in an Indian Lake: A Demonstration Project. Dr. Ryan Wersal, Aquatic Plant Scientist with Applied Biochemists (A Lonza Business). Presented by Bill Ratajczk.
2:40 pm	Responses of Starry Stonewart from an Indiana Lake to Exposures of Copper-Based Algaecides (Clearigate and Cutrine-Ultra) and Flumioxazin (Clipper). Dr. John Rodgers Jr., Professor, Clemson University.
3:00 pm	*BREAK/POSTER VIEWING* (Ambassador East)

SESSION 4 3:30 pm - 4:40 pm (Ambassador West)

Starry Stonewart Special Session Speakers

Moderator: Carlton Layne, Aquatic Ecosystem Restoration Foundation (AERF)

3:30 pm	Assessing an Inland Lakes Ability to Support Colonization by Invasive Starry Stonewort. Scott Brown, Executive Director, Michigan Lakes and Streams.
3:50 pm	Chemical Control of Starry Stonewort: Ecology, History, Efficacy. Ben Willis, Aquatic Research Technician, SePRO Corporation.
4:10 pm	Starry Stonewart Panel Discussion / Question and Answer
4:40 pm	**MAPMS ANNUAL MEMBERSHIP BUSINESS MEETING AND ELECTION OF OFFICERS** ***(All members requested to be present)***
5:15 pm	**ADJOURN**

TUESDAY, March 8th, 2016

7:00 am - 7:50 am	Continental Breakfast	(Ambassador East)
7:00 am - 4:00 pm	Exhibits Open	(Ambassador East)
7:00 am - Noon	Conference Registration	(Center Concourse)
8:00 am - 10:00 am	Session 5	(Ambassador West)
10:00 am -10:30 am	Refreshment Break / Posters - Sponsored	(Ambassador East)
10:30 am - Noon	Session 6	(Ambassador West)
Noon - 1:30 pm	Lunch - On your own	
Noon - 1:30 pm	Student/Govt Affairs Luncheon, **Sponsored by AERF**	(Emerald A Room)
1:30 pm - 3:10 pm	Session 7	(Ambassador West)
3:10 pm - 3:30 pm	Refreshment Break / Posters - Sponsored	(Ambassador East)
3:30 pm - 4:50 pm	Session 8	(Ambassador West)
4:00 pm - 5:00 pm	Exhibit Tear-down	(Ambassador East)
6:30 pm - 10:00 pm	**36th Annual MAPMS Awards Banquet**	(Ambassador Ballroom)

SESSION 5 8:00 am - 10:00 am (Ambassador West)

Moderator: Dr. Ryan Thum, Director MAPMS

8:00 am — Opening announcements. Jacob Meganck, President MAPMS

8:05 am — Control of Dreissenid Mussels Through a More Rational Use of Copper. Dr. David G. Hammond, Senior Scientist, Earth Science Labs, Inc.

8:25 am — Invasive Quagga Mussels Threaten a Northern Michigan Inland Lake. Dan Myers Water Resource Specialist, Tip of the Mitt Watershed, Petoskey, MI

8:45 am — Laboratory Studies of Sodium Carbonate Peroxyhydrate Toxicity to Freshwater Organisms. Tyler Geer, Graduate Student, Clemson University. ***-Student Presentation-***

9:05 am — Aquatic Plant Community Dynamics in Long Lake, MI 3 Years After Treatment: Evidence of Milfoil Differentiation. G. Douglas Pullman, Ph.D., Aquest Corporation. Dr. Ryan M. Wersal, Aquatic Plant Scientist, Lonza

9:25 am — Monitoring and Research Advancements of Invasive Milfoil Control. Eddie Heath, Aquatic Ecologist, Onterra, LLC.

10:00 am — *BREAK/POSTER VIEWING* (Ambassador East)

SESSION 6 10:30 am - Noon (Ambassador West)

Moderator: Jake Britton, Director MAPMS

10:30 am — Predicting Copper Bioavailability in Six and Twenty Cove Sediments of Hartwell Lake (Anderson, SC). Alyssa Calomeni, Graduate Research Assistant, Clemson University. ***-Student Presentation-*** ***2015 MAPMS Robert L. Johnson Memorial Research Grant Recipient***

10:50 am — Monitoring Sources of Regrowth of Eurasian Watermilfoil Following Auxinic Herbicide Treatment in Gun Lake, Michigan. Dr. Ryan Thum, Assistant Professor of Plant Sciences, Montana State University Department of Plant Sciences and Plant Pathology.

11:10 am — Mesocosm Evaluations on Hydrid Milfoil from Three Wisconsin Lakes. Scott Provost, Statewide Aquatic Plant Mgt. Coordinator, Wisconsin DNR

11:30 am — Oxygenation and Circulation as Lake Management Tools. Kenneth J. Wagner, Ph.D., CLM, Water Resource Services, Inc., Wilbraham, MA

Noon — LUNCH (on your own)
Student/Govt Affairs Luncheon, ***Sponsored by AERF*** (Emerald Room)

TUESDAY, March 8th, 2016

SESSION 7 1:30 pm - 3:10 pm (Ambassador West)

Moderator: Amy Kay, Director MAPMS

1:30 pm Response of Pure Versus Hybrid Eurasian Watermilfoil Under Operational Management with Auxinic Herbicides and Implications for Adaptive Management Program Planning. Syndell Parks, Chief of Operations, GenPass LLC, Muskegon, MI.

1:50 pm How General is the Trend of Increased Invasiveness of Hybrid Watermilfoil, and Do Hybrid and Eurasian Watermilfoil Show Equal Response to Endothall? Danielle Grimm, Master's Student, Montana State University -**Student Presentation -**

2:10 pm Integrated Management of Nonnative and Hybrid Eurasian Watermilfoil in the Portage Waterway of the Upper Peninsula of Michigan. Dr. Amy Marcarelli, Associate Professor, Michigan Technological University

2:30 pm AERF Update. Carlton Layne, AERF Executive Director,

2:50 pm APMS Update. Dr. Rob Richardson, APMS President.

3:10 pm *BREAK/POSTER VIEWING* (Ambassador East)

SESSION 8 3:30 pm - 4:30 pm (Ambassador West)

Moderator: Eddie Heath, Director MAPMS

3:30 pm Wisconsin Lakes Case Study Evaluations Controlling Eurasian Watermilfoil, Hybrid Watermilfoil and Curlyleaf Pondweed. Dr. Cody J. Gray, UPI, Peyton, CO

3:50 pm Low Rate Sonar Pellet Use Patterns for Control of Hybrid Watermilfoil in Wisconsin. Mark E. Kordus, Stantec, Stevens Point, WI

4:10 pm Managing Hydrilla in Stormwater Retention Ponds, Eric Schutman, Territory Manager, Syngenta Professional Products.

4:30 pm Reducing the Use of Algaecides and Herbicides in Lakes. Kevin Ripp, Aquafix, Inc., Madison, Wisconsin.

4:50 pm **ADJOURN**

BANQUET

6:30 - 10:00 pm **36th ANNUAL MAPMS AWARDS BANQUET** (Ambassador Ballroom)

**Silent Auction * Box Raffle *Cash Bar *Great Food*
**Installation of Officers and Directors*

WEDNESDAY, March 9th, 2016

BOARD MEETING

8:30 am - 2:00 pm Post Conference Board of Directors Meeting (Pearl Room)

MAPMS members welcome to attend. Please notify a Board Member prior to the meeting so that seating arrangements can be made.

Technical Poster Presentations

Title / Author / Contact Information

Sediment Copper Concentrations, in situ Benthic Abundance, and Sediment Toxicity: Comparison of Coves Treated with Copper-Based Algaecides and Untreated Coves in a Southern Reservoir

Kyla J. Iwinski, Andrew D. McQueen, Ciera M. Kinley, Alyssa J. Calomeni, Tyler D. Geer and John H. Rodgers, Clemson University, Clemson, SC, 29631
Tyler D. Geer: (864) 633-7419 tdgeer@g.clemson.edu

Sixberry Lake: Protecting an Oligotrophic Lake from Anthropogenic Eutrophication

Kathleen Marean, Lake Management Masters Candidate, SUNY Oneonta Biological Field Station., Cooperstown, NY 13326. (917)232-4827 marekr55@suny.oneonta.edu

Truesdale Lake and its Fight with Eutrophication

Christian Jenne, SUNY ESF: Aquatics and Fisheries Science (B.S.), SUNY Oneonta: Lake Management M.S. Student. jenncf54@suny.oneonta.edu sfjenne1991@gmail.com

DeRuyter Reservoir, Madison County, NY: A Case Study on Invasive Plant Management Strategies and a Look into the Future

Leah Gorman, Student, SUNY Oneonta Biological Field Station, Cooperstown, NY
(518)-281-2933 gormlm72@suny.oneonta.edu

Managing Eurasian Watermilfoil, Can Pulling Weeds Produce Results?

Alejandro Reyes and Willard Harman, SUNY Oneonta Biological Field Station
Cooperstown, NY 13326. 845-661-0824 ajreyes1022@gmail.com

Effects of Stamp Sands Deposits on Aquatic Macrophyte Communities in the Portage Waterway, MI

Ryan Van Goethem, Michigan Technological University, Houghton, MI 49931
(989) 240-7576 rrvangoe@mtu.edu

Millsite Lake: A Case Study of Aquatic Plant Management

Luke J. Gervase, SUNY Oneonta Biological Field Station, Cooperstown, NY
Gervlj85@suny.oneonta.edu

Three Lakes, One Management Plan

Maxine Verteramo/ SUNY Oneonta, Biological Field Station, Oneonta, NY
413-427-3489/ MaxineVerteramo@gmail.com

A Laboratory Study of Mycoleptodiscus Terrestris Fungus as a Tool for Integrated Control of Eurasian Watermilfoil and its Effect on Native Macrophytes

Carmen Leguizamo, Michigan Tech University, Houghton, MI
269-330-2042 cmleguiz@mtu.edu

Categorical Regression Analysis of Stakeholder Rake Toss Survey Data as a Means to Evaluate Drawdown

Jenna Leskovec, SUNY Oneonta Biological Field Station, Cooperstown, NY
(518) 926-8828, LESKJC44@suny.oneonta.edu

A Master of Science in Lake Management: A New Program for an Emerging Discipline

Patrick Goodwin, M.S. Candidate at SUNY Oneonta, Oneonta, NY, 904-434-6799

Oral Presentations

Title / Author / Contact Information / Abstract

Sessions 1 thru 4 Monday, March 7th
Sessions 5 thru 8 Tuesday, March 8th

SESSION 1

Procellacor™– A Novel Herbicide Technology in Development for Aquatic Plant Management

Dr. Mark A. Heilman, Senior Aquatic Technology Leader, SePRO Corporation
11550 N. Meridian St. #600
317-775-3309 markh@sepro.com

Aquatic weed control is challenged by the low numbers of herbicides registered for aquatic use. History has shown that discovery and registration of new herbicide actives suitable for direct application to water is a difficult process. It is extremely rare to discover a candidate product with sufficient herbicidal activity on one or more key aquatic weeds and strong environmental profile necessary to pursue aquatic registration. With increasing regulation of herbicide use and growing technical challenges with herbicide resistance, new weed species introductions, threatened and endangered species and infestations in higher exchange systems, new herbicide technology is much-needed to sustain the long-term success of past and current management efforts.

Procellacor™ is a brand new active ingredient under development as an aquatic herbicide. Procellacor has unique, low-rate, systemic activity on the major submersed weeds hydrilla (Hydrilla verticillata) and Eurasian watermilfoil (Myriophyllum spicatum). It also has strong activity on new weed threats such as crested floating heart (Nymphoides cristata) and several other difficult-to-control species through either in-water or foliar application. Procellacor has an excellent environmental profile for use in water with registration studies indicating wide margins of safety to fish and wildlife and development efforts demonstrating strong selectivity to native aquatic plants. The technical properties of Procellacor for its major weed control uses and its developmental status will be reviewed.

Evaluating the Sensitivity of Representative Aquatic Plants to a New Aquatic Herbicide

Rob Richardson[1] Associate Professor and Extension Specialist, North Carolina State University
Mike Netherland, Erika Haug, and Mark Heilman
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Procellacor™ (herbicide common name pending; experimental code SX-1552) is a new herbicide technology currently under development for aquatic weed management. Growth chamber and greenhouse research was conducted to evaluate the effect of this herbicide on 12 different aquatic plants: dioecious and monoecious hydrilla (Hydrilla verticillata), Eurasian watermilfoil (Myriophyllum spicatum), parrotfeather (M. aquaticum), variable watermilfoil (M. heterophyllum), crested floating heart (Nymphoides cristata), elodea (Elodea canadensis), water marigold (Bidens beckii), alligatorweed (Alternanthera philoxeroides), bacopa (Bacopa caroliniana), fanwort (Caboma caroliniana), and American waterwillow (Justicia americana). Procellacor was applied as in-water, static exposures at rates of 0 to 81 µg/L to small, rooted plants of each species. Hydrilla (both biotypes), Eurasian watermilfoil, variable watermilfoil, parrotfeather, and alligatorweed were highly sensitive. Crested floating heart was also sensitive. The native plants water marigold, elodea, water willow, and bacopa showed greater tolerance to Procellacor than key potential target weeds species. Fanwort was not controlled at the rates evaluated. Procellacor appears promising as future technology for selective control of major US aquatic weeds, but further research is needed on additional species as well as concentration exposure time determination for the species evaluated here.

Comparison of Laboratory and Field Responses of a Microcystin Producing Cyanobacteria (Microcystis aeruginosa) to a Copper-Based Algaecides.

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Laboratory evaluations of copper algaecide exposures and subsequent organism responses can be used to inform field applications in terms of algaecide effectiveness (i.e. control of target algae) and potential risks. A perceived risk associated with treating microcystin (MC)-producing algae with copper algaecides is the potential release of intracellular toxin. This study investigated whether laboratory responses of a field collected, MC-producing alga to copper algaecide exposures were representative of field responses of the same alga in terms of MC release and persistence. The objective of this study was to compare laboratory and field responses of MC-producing Microcystis aeruginosa to copper algaecide (Cutrine Plus®) exposures in terms of 1) extent of microcystin-LR release, 2) persistence of aqueous microcystin-LR following release (i.e. time to pre-treatment aqueous MC-LR concentrations), and 3) algal viability as indicated by chlorophyll a concentrations and cell density. Field collected M. aeruginosa and site water from a South Carolina pond were used for laboratory analyses. Field exposures were conducted in the same South Carolina pond in mesocosm enclosures as well as in a partial pond treatment. Effective copper concentrations, as indicated by chlorophyll a concentrations and cell density, were 0.3-1.0 mg Cu/L in laboratory exposures and 0.5-1.0 mg Cu/L in field enclosures. MC release in laboratory and field exposures occurred within 24 hours after copper treatment. Extent of MC release was dependent on copper concentrations in both laboratory and field exposures. As copper exposure concentrations decreased, the extent of MC release concomitantly decreased. Lowest effective copper exposures in the laboratory (0.3 mg Cu/L) and field enclosures (0.5 mg Cu/L) resulted in 56% and 39% MC release, respectively. Maximum exposure concentrations in the laboratory and field enclosures (1.0 mg Cu/L) resulted in 83% and 96% MC release, respectively. Released aqueous MC decreased to pre-treatment concentrations in approximately 4 days in laboratory exposures and 5 to 6 days in field enclosures, depending on copper exposure concentration. Released aqueous MC in the partial pond treatment decreased to pretreatment concentrations in less than 24 hours. Results of this study highlight the utility of laboratory analyses to inform field exposures in terms of M. aeruginosa responses, as well as emphasize the influence of the concentration of copper algaecides on responses of MC producing M. aeruginosa.

Invasive Plant Management; Yesterday vs. Today vs. Tomorrow.

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A few years ago, invasive plant management was primarily focused on Curlyleaf pondweed and Eurasian watermilfoil control. Presentations related to, the selectivity of herbicides; dose, active ingredient and timing of applications. Focusing on, how low of a dose can be applied to control the invasive plants but ensure that not even a leaf falls of a broadleaf pondweed. Research on, Eurasian watermilfoil root crowns, seed bank and carbohydrate reserves. Understanding Curlyleaf pondweed turion production and how early season and/or annual spring application can reduce future infestations. All these topics of “Yesterday” are still applicable, but “Today” it even appears to be more challenging. In today’s world, Eurasian watermilfoil just blends in with an unknown diversity of Hybrid watermilfoil (HWM) genotypes. We know different genotypes of HWM exist; each having different growth characteristics, herbicide susceptibilities and reproduction variances. We know that “we don’t know” when and where HWM plants are present and therefore we have to assume the worst. Until science or new technology is developed, we must manage HWM with the intent to control ALL potential unknown genotypes to ensure “Tomorrow”…

SESSION 2

Aquatic Macrophyte Identification – Tips and Tricks

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Over 150 species of aquatic macrophytes occur in the Midwest, and it takes a great dedication to be able to distinguish all of them. Because each species has its own ecological values and behaves in its own way, it is essential for lake managers to identify plants as specifically as possible. While learning 150 species in 20 minutes is unlikely, it is easy to learn how to distinguish common genera, and which traits to look for when identifying unknown plants to the species level.

Developing effective use patterns for GreenClean algaecides

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As use and regulatory restrictions on copper algaecides increase and some local governments have banned the use, it is becoming ever more important to find and develop alternative treatments for control of nuisance algae growth. Biosafe Systems offers several peroxide based algaecides that give applicators alternatives to copper where restrictions are in place, however the labeled usage rates are very broad, making selection of an appropriate rate difficult. The objective of this project was to begin developing effective usage patterns for GreenClean algaecides to target benthic and floating filamentous, blue-green algae). Two sites of similar size and algae community were selected for the treatment. One received a high label rate of GreenClean Pro (85% sodium carbonate peroxyhydrate) followed by a mid-label rate of GreenClean 5.0 (5% peroxy acetic acid). The second site was treated with a mid-label rate of GreenClean Pro followed by a lower-label rate of GreenClean 5.0. Both treatments were followed up 48 HAT by treatments with the lower label rate of GreenClean 5.0. Efficacy was assessed by percent algal coverage of both benthic sediments and the water surface at weekly intervals after the treatment until regrowth was observed.

Aeration's Effect on Algae: a review of success and failures

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Bottom aeration is a restoration tool commonly used for improving multiple aspects of lake health, including the occurrence of algal blooms and the quality of algal assemblages.

The intense mixing brought about by artificially aerating a lake can affect an algal community by: (i) increasing dissolved oxygen concentrations and changing the lake's water chemistry (pH, carbon dioxide and alkalinity), which can lead to a more desirable shift in an algal community; (ii) reducing levels of internal nutrient cycling within a lake, which reduces the large amount of nutrients used to sustain algal blooms; (iii) decreasing the amount of solar energy available for photosynthesis; (iv) favoring algal species that tend to sink quickly and need mixing currents to remain suspended in the upper water column (e.g. diatoms); and (v) mixing algae-eating zooplankton into deeper, darker waters, thereby reducing their predation by sight-feeding fish, and increasing their ability to graze on algae cells.

This presentation discusses the current literature regarding aeration's effect on lake algal communities and outlines successes and failures associated with this lake management approach, along with the major factors that tend to influence the outcome of any aeration based management strategy.

Factors Influencing Invasion Biology of Monoecious Hydrilla (Hydrilla verticillata)

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The monoecious biotype of hydrilla (Hydrilla verticillata) is an invasive submersed plant that is spreading into the northern tier states. This biotype of hydrilla has not been as intensively studied when compared to its dioecious counterpart in the southern states. To improve our understanding of the invasion biology of this species in northern tier states we compared monoecious hydrilla to the dioecious biotype and two northern, cold adapted perennial species (Eurasian watermilfoil and Elodea) and focused on the effect of temperature, photoperiod, and light intensities on the short-term growth of these species. Results suggest that monoecious hydrilla does not grow well in cooler water, but undergoes a rapid spurt of growth as water temperatures warm from 21 to 25C. Growth of monoecious hydrilla in comparison to the other species will be discussed. In order to improve information for invasive plant dispersal models, we also evaluated the length of time required for newly created fragments of hydrilla and Eurasian watermilfoil to sink to the bottom sediments. Study results suggest shoot fragments generally sink within 24 to 48 hours. Lastly, lab data from studies evaluating the influence of cold stratification on synchronicity of hydrilla tuber sprouting will be discussed in the context of management programs in northern tier states.

Session 3

Starry Stonewart Special Sessions

Sixteen Years with Starry Stonewort?

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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 has a profound effect on the lakes where it is found and presents a very significant challenge to northern lake managers. 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 nearly impossible to predict when this might happen. This unpredictability seems to be related to the reasons that this nuisance alga can become so weedy and why it can be so difficult to control. 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, why is all other plant growth frequently eliminated from the crash zone? Is it possible to predict when and where starry stonewort will grow to nuisance levels? Why is it so easy to kill but so difficult to treat. Is it possible to selectively control starry stonewort and what are realistic expectations for the outcomes associated with selective control strategies? Data and videos will be presented that provide a strong argument to support the role of temperature gradients in the support and collapse of starry stonewort populations. It will also become clear why it may be so difficult to control starry stonewort in some situations.

Starry Stonewort (Nitellopsis obtusa): Research Efforts towards an Integrated Management Plan

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Starry stonewort (Nitellopsis obtusa; SSW) is of widespread interest and concern among water resource managers in the United States. It has been actively managed in Michigan for several years, but has been identified in an increasing number of lakes in the northeastern and Midwestern United States. Concern over its potential for spread and impact is high, and is exacerbated by an apparent absence of effective control tools and the very limited knowledge of its basic biology. Our team has undertaken a field-based experimental approach to optimize herbicide control and test the efficacy of biodegradable benthic barriers in controlling SSW. The goal of this project is to develop an integrated, adaptive weed management plan that will provide a better understanding of the mechanisms behind successful and failed herbicide treatments, and provide additional treatment options and improved best management practices. In summer of 2015, SSW-dominated zones in Gun Lake (Barry/Allegan Co) were identified, and experimental control and treatment sites were selected. Site characteristics were measured, and plant communities and SSW abundance were quantified before and after at both herbicide treatments and benthic mat deployments sites. Preliminary results of herbicide treatment monitoring indicate both chelated copper and copper sulfate with Endothall treatment plots had an initial decrease of SSW mat height over 3 week period; this coincided with a decrease of SSW in control plots. Three natural fiber benthic barriers of varying thickness were deployed in two different vegetation zones (one with Starry Stonewort monoculture, and another with a more diverse plant community). No new plant growth was noted on the mats two weeks after deployment. We will present preliminary results, discuss on-going research efforts, and propose some actionable items to consolidate and disseminate current knowledge of SSW and build on on-going efforts to form a SSW working group.

Starry stonewort – a new invader of Wisconsin waters

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Starry stonewort (Nitellopsis obtusa (N.A. Desvaux) J. Groves) was first documented in Southeastern Wisconsin waters in Fall 2014 during a routine point-intercept aquatic macrophyte survey. The Department of Natural Resources (WDNR) crew leading the survey found N. obtusa at five locations, all within a shallow bay and in close proximity to each other. WDNR staff, citizen volunteers, and other partners quickly developed strategies to monitor and control this population, while also discovering four additional populations in Southeastern Wisconsin. Development of several identification resources have enabled staff and citizens to more effectively recognize and report additional N. obtusa populations, while several management techniques have been attempted on those already documented.

Control of Starry Stonewort (Nitellopsis obtusa) in Small Plots in an Indiana Lake: A Demonstration Project

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Starry stonewort is a non-native macro-alga resembling the native chara spp. Starry stonewort is a fairly recent invader of the Midwestern United States with significant nuisance populations being reported in Michigan and Indiana. The species is reported to colonize deeper water than native charoid species, develop thick mats on bottom substrate, grow later, and persist longer in the growing season that other native vegetation. Current management approaches have relied on emulsified copper algaecides alone or in combination with contact aquatic herbicides. To date, operational control programs have had limited success in reducing starry stonewort populations. Therefore it is imperative develop reliable recommendations in order to make informed decisions for the management of lake populations. In the spring of 2015 starry stonewort was shipped to Clemson University where an Algal Challenge Test (ACT) was conducted to determine the most effective treatment. Following the ACT, two five acre plots were established in an Indiana lake to verify the ACT results. One plot served as the untreated reference and the other plot received an application of Clearigate® herbicide/algaecide (Clearigate®) at 2.2 gal/acre ft. Pretreatment mass of starry stonewort in the untreated reference plot was 571.6 ± 137.1 g/DW/sample. At 5 WAT, starry stonewort mass did not change ($p=0.23$) in the untreated reference plot and was estimated to be 400.6 ± 93.9 g/DW/sample. The pretreatment mass in the Clearigate® plot was 266.7 ± 59.1 g/DW/sample, and after 5 weeks post treatment biomass decreased ($p<0.01$) to 33.3 ± 17.6 g/DW/sample; which represents a change of 87.5% from the beginning of the study. The use of the ACT provided a reliable and effective treatment recommendation for the population of starry stonewort used in this study. Future studies need to evaluate application timing to maximize treatment efficacy as the current study represented a worse case treatment scenario in that the treatment was made late in the season when starry stonewort biomass was at or near peak levels.

Responses of Starry Stonewort (Nitellopsis obtusa) from an Indiana Lake to exposures of copper-based algaecides (Clearigate and Cutrine-Ultra) and flumioxazin (Clipper)

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Starry Stonewort (Nitellopsis obtusa) is a relatively recent invader of the Midwestern United States with significant nuisance populations reported in Michigan, Minnesota, Wisconsin and Indiana. This algal species develops thick mats that can decrease densities of native plant species and interfere with propagation of fish and wildlife as well as recreation (i.e. swimming and boating). When problematic algae such as Starry Stonewort interfere with designated water resource uses, mitigation options are often sought. If the use of an algaecide is indicated, the algaecide selected should be efficacious and compatible with the uses of the water resource (e.g. drinking water). Growth of N. obtusa in an Indiana Lake provided an opportunity to identify an effective treatment for this alga. The objective of this research was to measure responses of N. obtusa to exposures of Clearigate® (1mg Cu/g algae), Cutrine-Ultra® (1mg Cu/g algae), Clipper® (0.2 mg Clipper/g algae) and combinations of Clearigate® and Cutrine-Ultra® with Clipper®. Two replicate exposures were conducted with 1 g of algae in 200mL of site water. Responses were measured 7d after initial exposure in terms of visual observations and chlorophyll a concentrations. Clearigate® at 2.2 gal/acre-ft decreased the chlorophyll a concentration in N. obtusa by 40% in 7 days and was the most effective algaecide tested. Based on the current results, N. obtusa is relatively sensitive to Clearigate® as the maximum label rate for Nitella is 7.1 gal/acre-ft. Important considerations for scaling of results from this experiment to the field include factors such as the in situ density of the algal mass (i.e. copper concentration/g algae) and contact time. Successful control of N. obtusa will involve site specific adaptive management.

Session 4

Starry Stonewart Special Sessions

Assessing an Inland Lakes Ability to Support Colonization by Invasive Starry Stonewort

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Starry stonewort (scientific name: Nitellopsis obtusa, (Desvaux in Loiseleur-Deslongchamps) J. Groves (1919), (Charophyceae, Charales, Characeae), a submerged macrophyte native to Europe and Asia, is capable of creating extraordinarily dense meadows that may significantly modify host freshwater ecosystems. An increasingly rare bio-indicator of healthy aquatic ecosystems within its native range, abundant colonies of Starry stonewort that once flourished in the lakes of Europe and Asia have now largely disappeared due to the effects of cultural eutrophication. In the past ten years, invasive Starry stonewort has successfully colonized hundreds of inland lakes within Michigan and the Great Lakes region. This presentation will explore the various physical, chemical, and biological factors that make so many northern temperate inland lakes particularly susceptible to colonization by invasive Starry stonewort.

Chemical Control of Starry Stonewort: Ecology, History, Efficacy

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Understanding the background biology, growth characteristics and ecological impacts of Starry Stonewort (SSW; Nitellopsis obtusa), is crucial in aligning with effective chemical control strategies. This presentation will review some of the characteristics of SSW biology and growth, in particular as it pertains to effectiveness and longevity of chemical control approaches. Algaecide formulations targeting rhizoidal tissue of SSW have the potential to greatly improve control, specifically by increasing longevity of control. Bench scale testing has indicated the ethylene diamine copper complex as a potent active ingredient for interacting with toxic sites of action and achieving control. The granular chelated copper (i.e. Komeen Crystal®), can provide a targeted and enhanced exposure of the ethylene diamine copper complex on SSW rhizoidal tissue, and appears as an ideal candidate for increased extent and longevity of SSW control.

Session 5

Control of Dreissenid Mussels through a more Rational Use of Copper.

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Since the time zebra and quagga mussels were introduced to North America in the mid 1980's they have had profound impacts on native species and the aquatic environment in general. They have also caused tremendous economic damage by fouling infrastructure such as pipelines, intakes, screens, pumps, cooling systems and other systems. Managers and maintenance crews in many areas have responded by using various forms of chlorine and/or permanganate to discourage infestation, despite significant drawbacks. In 2013 a liquid formulation of copper ions was approved by the EPA for control of Dreissenids in lakes and open waters, and subsequently the label was expanded to include pipelines and flowing waters, making it the only product that is both NSF-certified for drinking water and legally labeled as a Molluscicide. EarthTec QZ has been used successfully in the Rapid Response plans of 3 Minnesota lakes. It has also been selected by municipal WTPs across the U.S. to control zebras and quaggas in pipelines, intakes and pump stations. The latest field data from these projects will be presented.

Invasive quagga mussels threaten a Northern Michigan inland lake.

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Quagga mussels are an invasive species which have caused widespread ecological changes in the Great Lakes. During an aquatic plant survey in summer 2015, quagga mussels were documented for the first time in Crooked Lake (Emmet County, MI). How are these mussels identified, what will they do to the Lake, and what can be done to combat their invasion?

Laboratory Studies of Sodium Carbonate Peroxyhydrate Toxicity to Freshwater Organisms

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To make informed decisions regarding management of noxious algal growths, water resource managers require information regarding responses of target and non-target species to algaecide exposures. Hydrogen peroxide (H2O2) is the active ingredient in sodium carbonate peroxyhydrate (SCP) algaecides used to control growths of noxious algae that interfere with intended uses of water resources. Efficacious algaecide treatments maximize effects on target algal species, while minimizing risks for non-target organisms. To achieve these goals, sensitivities of common target and non-target organisms to SCP exposures can be measured. The objective of this study was to measure and compare responses among a target noxious alga (cyanobacterium Microcystis eruginosa) and non-target organisms including a eukaryotic alga (Pseudokirchneriella subcapitata), fathead minnow (Pimephales promelas), microcrustacean (Ceriodaphnia dubia) and benthic amphipod (Hyalella azteca) to exposures of hydrogen peroxide as SCP. Hydrogen peroxide exposures were confirmed using the I3- method. Responses of algae in terms of cell densities and chlorophyll-a concentrations were used to estimate the concentrations at which 50% of the populations were affected (EC50s) and potency slopes (change in response with incremental change in algaecide concentration). Mortality was used to estimate LC50s and potency slopes for animal species. SCP toxicity values for these organisms were also compared with published toxicity data to put SCP in context with other commonly used algaecides and herbicides (e.g., copper formulations, endothall, and diquat dibromide). Responses of P. subcapitata to environmentally relevant concentrations of H2O2 were not manifested in 96-h; therefore, 7-d EC50s were estimated. Despite a shorter test duration, M. aeruginosa was more sensitive to hydrogen peroxide from SCP (96-h EC50: 2.14 mg H2O2/L) than the eukaryotic alga P. subcapitata (7-d EC50: 5.23 mg H2O2/L), indicating potential for selective control of prokaryotic algae. For the three non-target animals evaluated, measured 96-h LC50s ranged from 0.966 to 19.7 mg H2O2/L. C. dubia was the most sensitive species, and the least sensitive species was P. promelas, which is not likely to be affected by concentrations of hydrogen peroxide from SCP that would be used to control a noxious alga (e.g. M. aeruginosa). Based on information from peer-reviewed literature, other algaecides were similarly selective for cyanobacteria. Of the algaecides compared, SCP may offer the greatest margin of safety for fish. The results of this study indicate that SCP is a useful chemical option for mitigating risks associated with noxious cyanobacterial growths (e.g., M. aeruginosa) while providing a margin of safety for non-target species.

Aquatic Plant Community Dynamics in Long Lake, MI 3 Years After Treatment: Evidence of Milfoil Differentiation

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Long Lake is 493 acre lake in Iosco County, MI. Given the large littoral area, this lake can support the growth of aquatic plants. Long Lake has a species rich plant community, though Eurasian watermilfoil (Myriophyllum spicatum) had invaded large areas of the littoral zone. In June of 2013, 280 acres of Eurasian watermilfoil were pre-treated with select algaecides followed by auxin herbicides. Subsequent biomass (0, 10 WAT, 1 YAT) and lake survey (10 WAT, 1 YAT, 2 YAT) evaluations were conducted. In June of 2014 (1 YAT), native species biomass was 19.0 ± 3.1 g DW m-2 a 76% increase over pretreatment levels and Eurasian watermilfoil biomass remained at 0 g DW m-2 in the sample locations, though it was observed in other areas of the lake,. LakeScan™ surveys indicated that outcomes were considered to be highly satisfactory the first and second years post treatment. Surveys indicated that by late 2015 milfoil was found in scattered areas throughout most of the lake, but some sample data (genetic analyses) indicated that the milfoil was comprised of distinctly different genotypes. Long-term (3 years) plant community quality, species richness, and biodiversity did not appear to be impacted by the herbicide application. These data do suggest however that there is a shift in milfoil genotypes after the herbicide application from Eurasian watermilfoil to a genetically different hybrid.

Monitoring and Research Advancements of Invasive Milfoil Control

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A Cooperative Research and Development Agreement between the Wisconsin Department of Natural Resources and U.S. Army Corps of Engineers Research and Development Center in conjunction with significant participation by private lake management consultants have coupled 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. This largely consists of implementing early-season herbicide control strategies targeting Eurasian water milfoil (Myriophyllum spicatum, EWM) and hybrid water milfoil (Myriophyllum spicatum x M. sibiricum, HWM), either as spatially targeted small-scale spot treatments or low-dose, large-scale (whole lake) treatments.

This presentation will examine a subset of the research findings, including variability in observed herbicide degradation patterns, in lake movement of herbicides, and differing responses of EWM and HWM to treatment strategies. Further, this presentation will highlight several case studies to understand how this current research is being applied in practice, including longer-tem monitoring of several WI lakes in which whole lake use patterns of fluridone and combination 2,4-D/endothall targeting HWM were conducted.

Session 6

Predicting Copper Bioavailability in Six and Twenty Creek Cove Sediments of Hartwell Lake (Anderson, SC)

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Partitioning of copper to sediments and subsequent bioavailability to non-target sediment dwelling organisms are perceived risks associated with repeated applications of copper-based algaecides. Mass balance models may be used to predict the potential accumulation of copper in sediments following repeat algaecide applications. A mass balance model and predicted adverse effects concentrations for sediments may be used to inform management decisions regarding copper-based algaecide use. Repeat copper-based algaecide applications in the Six and Twenty Mile Creek Cove of Lake Hartwell in Anderson, SC provided the opportunity to predict the bioavailability of copper residuals from algaecide treatments to non-target organisms (Hyalella azteca) and confirm those predictions with measured sediment copper concentrations. The specific objectives of this experiment were to 1) measure sediment characteristics within the treatment area, 2) measure responses of an epibenthic invertebrate (Hyalella azteca) in terms of survival to copper-amended sediments in 10d laboratory toxicity experiments and 3) develop a mass balance model to provide conservative predictions about the number of applications to elicit adverse effects to benthic invertebrates. Five sediment samples were collected from areas within the treatment site to capture the expected heterogeneity of the sediments in terms of characteristics that influence bioavailability (i.e. ligands). Measured ligands for copper binding included acid volatile sulfides (AVS), organic matter concentration (OM), cation exchange capacity (CEC) and particle size distribution. Sediment was amended with copper concentrations and a 10d sediment toxicity test was conducted using Hyalella azteca. The lowest copper concentration that elicited a response from the organisms (LOEC) was 27.84 mg Cu/kg for a sediment with limited ligands (i.e. sand) and 353 mg Cu/kg for a sediment with relatively high ligands (i.e. silt). Copper concentrations were measured in sediment samples collected from traps post-treatment. Measured sediment copper concentrations post-treatment were compared with predicted copper concentrations to assess the accuracy of the mass balance model. Predicted copper concentrations were conservative (i.e. overestimated) compared to measured copper concentrations post-treatment by 36-86%. Using this conservative mass balance model model and assumptions (e.g. no sedimentation), 29 (sandy sediment) to 235 (silty sediment) applications could occur before adverse effects would be anticipated. This study provides predictions regarding risks associated with copper residuals in sediment and can be used for adaptive water resource management in this reservoir.

Monitoring sources of regrowth of Eurasian watermilfoil following auxinic herbicide treatment in Gun Lake, MI

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In many cases, herbicide treatments of Eurasian watermilfoil are successful at reducing the standing crop in the short term, but regrowth subsequently occurs, sometimes in the same season. Most lakes require annual applications to provide periodic relief from nuisance conditions. However, the source(s) of inevitable Eurasian watermilfoil regrowth remain unclear. Potential sources of regrowth include surviving plants that regenerate from root crowns and/or injured shoots, recruitment from seeds, and recolonization of treated areas by plant fragments. The relative inputs from these sources has implications for management strategies. For example, if regrowth occurs from incomplete kill of roots or shoots, then new application patterns may be warranted, whereas if regrowth occurs from seed, then management strategies that reduce seed production or exhaust the seedbank may improve control. We will present results from post-treatment monitoring of 10 quadrats established in portions of Gun Lake, Michigan that were treated with auxinic herbicides in 2015. For two weeks post treatment, we observed severe injury and an initial decrease in the standing crop of watermilfoil. By week four, we observed regrowth from axillary buds located on stems that otherwise appeared to be dead. We observed a large number of fragments that settled at the bottom of the quadrats and began to root, but it is unclear whether these fragments fell from plants inside versus outside of the quadrats. During the monitoring period we did not observe any seedlings in our quadrats. These results indicate that although Eurasian watermilfoil stands appear to be dead during qualitative, visual post-treatment evaluations of systemic auxinic herbicides, they remain viable. This warrants careful consideration of alternative systemic herbicide treatment strategies for watermilfoil management programs.

Mesocosm Evaluations on Hybrid Milfoil from Three Wisconsin Lakes

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Hyrid milfoil (Myriophyllum spicatum X Myriophyllum sibiricum) is becoming more and more dominant in Midwestern lakes given the effective management of Eurasian watermilfoil (Myriophyllum spicatum). It has been reported under laboratory conditions that hybrid milfoil is more tolerant to 2,4-D and fluridone than the parental Eurasian watermilfoil species. The tolerance to select herbicides has not been quantitatively verified under field conditions; however an increasing number of anecdotal reports and of treatment failures suggests that the hybrid milfoil may be tolerant to 2,4-D. To date reliable management techniques for this hybrid have been elusive. To address failed applications it would be advantageous to develop new recommendations under mesocosm conditions that utilize target plants from specific lakes.. During the growing season of 2015 milfoil was harvested from Hancock Lake, Legend Lake, and Forest Lake in Wisconsin and shipped to Lonza's Aquatic Plant Research Facility in Alpharetta, GA. Additional samples were shipped to Grand Valley State University to verify hybridity of the milfoil. Plants from each lake were subjected to a replicated mesocosm study using select treatments of herbicides, algaecides, and adjuvants. Rresults show biomass of hybrid watermilfoil from Hancock Lake treated 2,4-D alone and with combinations of endothall or copper, reduced hybrid watermilfoil biomass by 96-100% when compared to untreated reference plants. The hybrid watermilfoil from Hancock Lake was also sensitive to 2,4-D as concentrations as low as 0.3 mg/L applied alone were effective when using a 7 d exposure. Other results will be shared in this presentation.

Oxygenation and Circulation as Lake Management Tools.

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Loss of oxygen in the bottom water layer of a lake or even just at the sediment-water interface in a shallow lake can result in many undesirable consequences. Addition of oxygen as air or pure oxygen can counter these effects and greatly enhance both water quality and available habitat for fish and invertebrates. Circulation usually adds oxygen, and can also homogenize water quality beneficially and move algae vertically in a manner that may disrupt growth. There are four major approaches to oxygenation and three major ways to circulate water, and each has advantages and disadvantages that must be considered when making management decisions. Experience with oxygenation and circulation has provided mixed results. In the vast majority of cases where results were unsatisfactory, problems were caused by undersizing and/or under-implementation of the techniques. That is, the system was not designed to add enough oxygen or sufficiently mix the water, or it was not operated in a manner that would achieve the goal. In successful cases of oxygenation, oxygen demand has been countered by adequately distributing enough oxygen, which easier to recommend than to implement. In successful cases of circulation, at least 20% of the target water volume has been moved per day, with more preferable and sometimes essential. Circulation may alter the algal community, but may not reduce total biomass unless mixing is deep. Oxygenation and circulation are not one-time application approaches; they require a substantial capital investment and an ongoing operation and maintenance budget to continue to provide benefits. Unknown or uncontrollable factors are still sufficient to require professional help in designing an effective and efficient system, and to necessitate some adjustment in the first few years of use even when professional recommendations and designs are followed. Costs vary substantially, such that no one technique will be most advantageous in all situations, and the most successful projects tend to combine oxygenation and circulation techniques to provide a multi-pronged approach.

Session 7

Response of pure versus hybrid Eurasian watermilfoil under operational management with auxinic herbicides and implications for adaptive management program planning.

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It is well documented that hybrid watermilfoil (Myriophyllum spicatum x M. sibiricum) is widespread and abundant across Michigan and a major management concern. Laboratory studies demonstrate that hybrid watermilfoil can grow faster than pure Eurasian watermilfoil, including when treated with the commonly used herbicide, 2,4-D. Yet, there is still uncertainty about differences in growth and response to operational management in situ between the two taxa. Our knowledge about these issues is limited by the lack of rigorous quantitative assessments of growth and treatment efficacy of hybrid versus Eurasian watermilfoil in active watermilfoil management programs. Here, we share results from lake management programs where genetic distinction of pure versus hybrid Eurasian watermilfoil has been assessed. Results from this research is used to quantitatively distinguish the responses of pure versus hybrid Eurasian watermilfoil to auxinic herbicides. We discuss the value of incorporating genetic identifications into adaptive management programs for Eurasian watermilfoil, and identify important knowledge gaps that need to be addressed by future research.

How general is the trend of increased invasiveness of hybrid watermilfoil, and do hybrid and Eurasian watermilfoil show equal response to Endothall?

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Invasive Eurasian watermilfoil in North America consists of pure and hybrid lineages that are not routinely distinguished when developing lake management programs or evaluating the efficacy of site-specific control techniques. Recent studies show that hybrid watermilfoil can exhibit relatively faster vegetative growth rates and reduced control efficacy and/or relatively higher biomass remaining after treatment with auxinic herbicides compared to pure EWM. These recent studies beg the question of how generalizable the results are for geographically and/or genetically distinct populations of Eurasian and hybrid watermilfoil, and for different herbicides. For example, Eurasian watermilfoil recently invaded Montana, and hybrid populations have also been discovered there. Endothall has been proposed as a potential tool to reduce watermilfoil biomass in some Montana waterbodies. To date however, there have been no comparisons of Eurasian versus hybrid watermilfoil growth or response to endothall in these systems. In this greenhouse study, we explicitly compare vegetative growth of pure and hybrid Eurasian watermilfoil collected from the Jefferson Slough in southwestern Montana, including when exposed to 3ppm and 5ppm endothall.

Integrated management of nonnative and hybrid Eurasian Watermilfoil in the Portage Waterway of the Upper Peninsula of Michigan

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Casey Huckins, Professor, Michigan Technological University
Kevyn Juneau, Assistant Professor, University of Wisconsin-River Falls
Colin Brooks, Senior Research Scientist, Michigan Tech Research Institute
Rod Chimner, Associate Professor, Michigan Technological University
Erika Hersch-Green, Assistant Professor, Michigan Technological University
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Eurasian watermilfoil is a widespread aquatic invasive macrophyte, which recently has emerged as a management concern in sheltered and connected waterways in the Upper Great Lakes region. For example, in summer 2012 spreading populations of Eurasian watermilfoil and hybrids (Eurasian x Northern watermilfoil) were identified in the Portage Waterway of Lake Superior, which bisects the Keweenaw Peninsula of Michigan's Upper Peninsula. Over the last two years of this study, we have partnered with local townships actively surveying and managing these populations to quantify the efficacy of herbicide treatments, while also assessing possible effects on non-target species. In both years we found that herbicide treatments reduced the abundance and biomass of Eurasian watermilfoil immediately following treatment, but over the two years of treatment hybrid water milfoil persisted and established high abundances, perhaps due to reduced sensitivity to herbicides by these hybrids. We found no decreases in the total biomass of off-target species; however, when analyzed separately from dicots, the monocot showed a significant increase in biomass. We are now studying alternate management approaches such as native species replanting that could be used in combination with herbicides to improve the long-term efficacy of treatment efforts. To monitor the effectiveness of these treatments and to improve early detection, we are testing novel tools to map the presence and extent of invasive watermilfoil in shallow waters, including imagery obtained using unmanned aerial vehicles and side-scan sonar. Finally, we will describe integrated pest management and how it could be used as a framework for planning and resource allocation for the management of invasive watermilfoils and other aquatic invasive species.

Session 8

Wisconsin Lakes Case Study Evaluations Controlling Eurasian Watermilfoil, Hybrid Watermilfoil and Curlyleaf Pondweed.

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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 multiple years using a variety of techniques including herbicide applications, mechanical techniques, and biological control. Recently, a new species has started to become extremely problematic, hybrid watermilfoil. Hybrid watermilfoil is a hybrid cross between the non-native Eurasian watermilfoil and the native Northern watermilfoil. The hybrid species takes on characteristics of both parent species. Research has found many traditional applications using auxin herbicides has not been effective in controlling hybrid watermilfoil. This presentation will outline multiple lake management strategies from Wisconsin targeting Eurasian watermilfoil, hybrid watermilfoil and curlyleaf pondweed.

Low rate Sonar pellet use patterns for control of hybrid watermilfoil in Wisconsin

Mark E. Kordus, Stantec, Stevens Point, WI , Jake Britton, SePRO, Carmel, IN

Eurasian water-milfoil was introduced to the state of Wisconsin in the 1980's. In recent years the hybrid plant species (Eurasian x Northern) has created management challenges in many Wisconsin lakes. Silver Lake in Kenosha County, Wisconsin has a 10+ year history of managing Eurasian, and recently, hybid milfoil. In 2012 a whole lake treatment with liquid 2,4-D yielded poor control of the hybrid milfoil population. In 2015 a whole lake, low rate management plan utilizing SonarONE® (fluridone 5% pellets) was implemented. Control of the target hybrid milfoil population was achieved by late summer with hybrid milfoil being 100% absent, while having minimal impacts to the native plant population during the year of treatment. In 2016 the plant community in the lake will be closely monitored as we continue to refine this low rate SonarONE® management tool.

Managing Hydrilla in Stormwater Retention Ponds

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Purpose: Managing hydrilla in community stormwater retention ponds. During any storm event, turnover rate is extremely high. Hydrilla was most likely imported by bird deposits or water garden plants from the community. These ponds are also part of a scenic area in the neighborhood; playgrounds, swimming pools, soccer fields and walking trails. Herbicides with a short contact time were needed to control hydrilla and other invasive weeds. Traditional methods of control requiring extended periods of contact time would not be effective in this situation. The trial combination herbicides chosen were, Reward® and Stringray®. Rates were selected based on trials conducted by NC State University.

Approach: Hydrilla typically appears around early to mid June. Water temperatures at this time are around 800F. Treatments are planned during a 24 hour window with no rain events. Rates of Reward are 0.5 gal/A-ft and Stringray 100 ppb and were applied as a combination. The application was a subsurface spray. The two ponds are respectively 0.35 acres and 0.2 acres. No copper products were added, as Reward's algicidal properties managed the existing algae growing on the hydrilla.

Results: Two weeks after the initial application the hydrilla was 100% controlled. The combination of Reward and Stringray resulted in a fast acting control method with a rapid decomposition rate. The one treatment controlled hydrilla in the two retention ponds for the entire season. This is the second successful season with this combination in controlling hydrilla in these water bodies.

Reducing the use of algaecides and herbicides in lakes and ponds

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In treating lakes and ponds, we usually focus our time and energy on killing what is growing in the water body. At Aquafix, we try to save some of that effort by teaching applicators how to address growth habits and limiting factors of Pithophora, Lyngbya, Oscillatoria, and others. This presentation will focus on the role of ammonia, phosphate, nitrates and nitrites, silica, and calcium in the growth of each plant and based on this information how to best treat them. Like taking Vitamin C during cold season, our approach is all about creating a stronger, healthier water body. We will reference a completed study on improving the treatment of Pithophora and new methods for using adjuvants and algaecides to better control it. This study was done by our lab in the University of Wisconsin Research Park and is the culmination of hundreds of tests on samples of Pithophora.

Another ongoing study conducted in our lab will be used to talk about the physical morphology of Lyngbya and the role of its protective microbiota. Finally, we will address Oscillatoria, cyanobacteria, aquatic plants, and other studies we are involved with. All of these topics go hand-in-hand with discussing the importance of using blends of herbicides and algaecides with synergistic benefits. In this way we can use fewer herbicides, slow the return of aquatic plants and alga, and improve the environment through looking at the pond as a whole.

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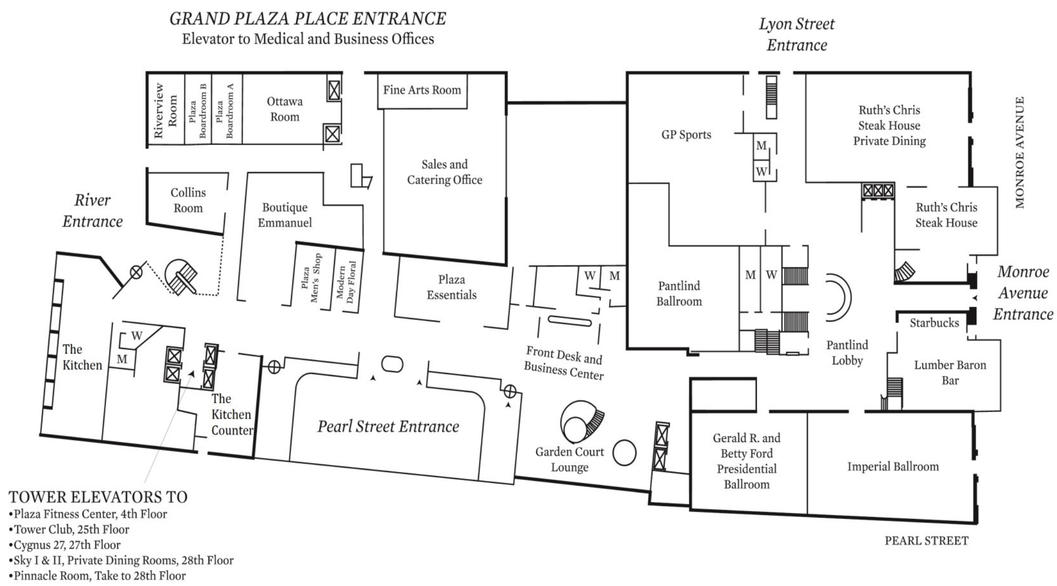

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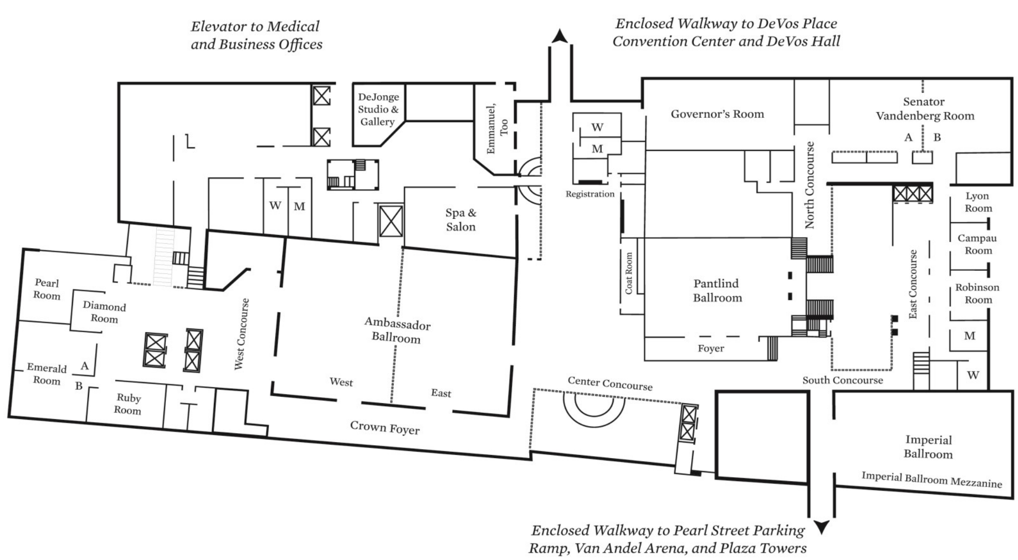

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