

58th Annual Meeting of the Aquatic Plant Management Society



Program & Abstracts

**Hyatt Regency Buffalo
Buffalo, New York
July 15-18, 2018**

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The Aquatic Plant Management Society, Inc. is an international organization of scientists, educators, students, commercial pesticide applicators, administrators, and concerned individuals interested in the management and study of aquatic plants. The membership reflects a diversity of federal, state, and local agencies, universities and colleges around the world, corporations, and small businesses. Membership applications are available at the meeting registration desk and on line at www.apms.org.

The **Vision** of the Aquatic Plant Management Society is to be the leading international organization for scientific information on aquatic plant and algae management.

The **Mission** of the Aquatic Plant Management Society is to provide a forum for the discovery and dissemination of scientific information that advances aquatic plant and algae management policy and practice.

The Aquatic Plant Management Society thanks Duke Energy Carolinas for their generous contribution to print and distribute the Program for the 58th Annual Meeting!



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Board of Directors

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Bozeman, Montana

Deborah Hofstra
Director (1/3)
NIWA
Hamilton, New Zealand

Committee Chairs

Awards	Jason Ferrell
Bylaws and Resolutions	Vernon V. Vandiver, Jr.
Education and Outreach	Jeffrey Schardt
Exhibits	Dean Jones
Finance	John Gardner
Legislative	Robert Richardson
Meeting Planning	Tommy Bowen
Membership	Mark Heilman
Nominating	John Madsen
Past President's Advisory Program	John Madsen
Publications	Craig Aguillard
Regional Chapters	Jay Ferrell
Scholastic Endowment	Mark Heilman
Strategic Planning	Tom Warmuth
Student Affairs	Mark Heilman
Website	Chris Mudge
	TBA

Special Representatives

AERF	Carlton Layne
BASS	Gerald Adrian
CAST	Joe Vassios
NALMS	Terry McNabb
RISE	Sam Barrick
Science Policy Director	Lee Van Wychen
Women in Aquatics	Amy Kay
WSSA	Robert Richardson

APMS Presidents and Meeting Sites

1961	T. Wayne Miller, Jr.	Fort Lauderdale, FL	1991	Joseph C. Joyce	Dearborn, MI
1962	T. Wayne Miller, Jr.	Fort Lauderdale, FL	1992	Randall K. Stocker	Daytona Beach, FL
1963	William Dryden	Tampa, FL	1993	Clarke Hudson	Charleston, SC
1964	Herbert J. Friedman	Tallahassee, FL	1994	S. Joseph Zolczynski	San Antonio, TX
1965	John W. Woods	Palm Beach, FL	1995	Steven J. de Kozlowski	Bellevue, WA
1966	Zeb Grant	Lakeland, FL	1996	Terence M. McNabb	Burlington, VT
1967	James D. Gorman	Fort Myers, FL	1997	Kurt D. Getsinger	Fort Myers, FL
1968	Robert D. Blackburn	Winter Park, FL	1998	Alison M. Fox	Memphis, TN
1969	Frank L. Wilson	West Palm Beach, FL	1999	David F. Spencer	Asheville, NC
1970	Paul R. Cohee	Huntsville, AL	2000	J. Lewis Decell	San Diego, CA
1971	Stanley C. Abramson	Tampa, FL	2001	Jim Schmidt	Minneapolis, MN
1972	Robert J. Gates	Miami Springs, FL	2002	David P. Tarver	Keystone, CO
1973	Brandt G. Watson	New Orleans, LA	2003	Richard M. Hinterman	Portland, ME
1974	Alva P. Burkhalter	Winter Park, FL	2004	Ken L. Manuel	Tampa, FL
1975	Luciano Val Guerra	San Antonio, TX	2005	Eric P. Barkemeyer	San Antonio, TX
1976	Ray A. Spirnock	Fort Lauderdale, FL	2006	Jeffrey D. Schardt	Portland, OR
1977	Robert W. Geiger	Minneapolis, MN	2007	Donald W. Doggett	Nashville, TN
1978	Donald V. Lee	Jacksonville, FL	2008	Jim Petta	Charleston, SC
1979	Julian J. Raynes	Chattanooga, TN	2009	Carlton Layne	Milwaukee, WI
1980	William N. Rushing	Sarasota, FL	2010	Greg MacDonald	Bonita Springs, FL
1981	Nelson Virden	Jackson, MS	2011	Linda S. Nelson	Baltimore, MD
1982	Roy L. Clark	Las Vegas, NV	2012	Tyler Koschnick	Salt Lake City, UT
1983	Emory E. McKeithen	Lake Buena Vista, FL	2013	Terry Goldsby	San Antonio, TX
1984	A. Leon Bates	Richmond, VA	2014	Michael D. Netherland	Savannah, GA
1985	Max C. McCowen	Vancouver, BC	2015	Cody Gray	Myrtle Beach, SC
1986	Lars W. J. Anderson	Sarasota, FL	2016	Rob Richardson	Grand Rapids, MI
1987	Dean F. Martin	Savannah, GA	2017	John D. Madsen	Daytona Beach, FL
1988	Richard D. Comes	New Orleans, LA	2018	John H. Rodgers, Jr.	Buffalo, NY
1989	Richard Couch	Scottsdale, AZ			
1990	David L. Sutton	Mobile, AL			

APMS Award Recipients

Honorary Members

William E. Wunderlich	1967
F. L. Timmons	1970
Walter A. Dun	1976
Frank S. Stafford	1981
Robert J. Gates	1984
Herbert J. Friedman	1987
John E. Gallagher	1988
Luciano “Lou” Guerra	1988
Max C. McCowen	1989
James D. Gorman	1995
T. Wayne Miller, Jr.	1995
A. Leon Bates	1997
Richard Couch	1997
N. Rushing	1997
Alva P. Burkhalter	2002
J. Lewis Decell	2004
Paul C. Myers	2005
David L. Sutton	2006
Dean F. Martin	2007
Robert C. Gunkel, Jr.	2008

Awarded to persons who have been voting members of the Society for no less than ten years, have contributed significantly to the field of aquatic vegetation management, and must have actively promoted the Society and its affairs during their membership.

Allison M. Fox	2010
Randall K. Stocker	2010
Steven J. de Kozlowski	2010
Carole Lembi	2011
Lars W.J. Anderson	2012
David Tarver	2012
Don Doggett	2013
Richard Hinterman	2013
David Spencer	2015
Jim Schmidt	2016
Joseph C. Joyce	2017
Jeffrey D. Schardt	2017

President’s Award

T. O. “Dale” Robson	1984
Gloria Rushing	1991
William T. Haller	1999
David Mitchell	1999
Jeffrey D. Schardt	2002
Jim Schmidt	2003
Robert C. Gunkel, Jr.	2004
Victor A. Ramey	2006
William H. Culpepper	2007
Kurt Getsinger	2008
Richard Hinterman	2009
Steve D. Cockreham	2010
Donald W. Doggett	2012
Carlton Layne	2013
Ken Langeland, Jeff Schardt, Dan Thayer, Bill Zattau	2014
Greg MacDonald	2015
Linda Nelson	2015
John Madsen, Mike Netherland	2016
Jason Ferrell	2017

An individual, designated by the current President, who has displayed "*Many Years of Dedication and Contributions to the Society and the Field of Aquatic Plant Management*".

APMS Award Recipients

Max McCowen Friendship Award

Judy McCowen	1995
John E. Gallagher	1997
Paul C. Myers	2000
William T. Haller	2002
Bill Moore	2006
Vernon V. Vandiver, Jr.	2012
Tommy Bowen	2014
Steve Hoyle	2015
Ken Manuel	2016
David Isaacs	2017

A special recognition given to an APMS member whose demeanor and actions display sincerity and friendship in the spirit of being an ambassador for the APMS. Criteria include warmth and outgoing friendship, sincerity and genuine concern, gracious hospitality, positive attitude and smile.

T. Wayne Miller Distinguished Service Award

Gerald Adrian	2005
Linda Nelson	2007
Surrey Jacobs	2009
Amy Richard	2010
Michael Netherland	2011
John H. Rodgers, Jr.	2012
John Madsen	2013
Jim Schmidt	2014
Jeffrey D. Schardt	2015
Craig Aguillard	2016
Tommy Bowen	2017

An individual recognized for "*Service to the Society and the Profession*". Considerations include completion of a relatively short-term project taking considerable effort resulting in advancement of aquatic plant management; performance beyond the call of duty as an APMS officer, chair, or representative; or non-member achievement leading to the advancement of APMS goals and objectives.

Outstanding Graduate Student Award

Ryan Wersal	Mississippi State University	2010
Joe Vassios	Colorado State University	2011
Sarah True-Meadows	North Carolina State University	2013
Justin Nawrocki	North Carolina State University	2014
Erika Haug	North Carolina State University	2015
Kyla Iwinski	Clemson University	2016
Alyssa Calomeni	Clemson University	2017

A student recognized for outstanding achievement during graduate studies in the field of aquatic plant management.

APMS Award Recipients

Outstanding International Contribution Award

Deborah Hofstra	National Institute of Water and Atmospheric Research	2013
Paul Champion	National Institute of Water and Atmospheric Research	2016
John Clayton	National Institute of Water & Atmospheric Research	2017

An individual or group recognized for completion of research or outreach activities that is international in nature.

Outstanding Journal of Aquatic Plant Management Article Award

James Johnson, Ray Newman	University of Minnesota	2012
Michael D. Netherland and LeeAnn Glomski	U.S. Army Corps of Engineers	2014
Greg Bugbee, M. Gibbons, and M.J. Wells	Connecticut Agricultural Experiment Station	2016
Justin Nawrocki, Robert Richardson and Steve Hoyle	North Carolina State University	2017

An award voted by the Editor and Associate Editors for research published in the JAPM during the previous year.

Outstanding Research/Technical Contributor Award

Michael Netherland, Dean Jones, Jeremy Slade	University of Florida	2010
Kurt Getsinger	U.S. Army Corps of Engineers	2011
Mark Heilman	SePRO Corporation	2013
John Rodgers	Clemson University	2015
Rob Richardson	North Carolina State University	2016
Ryan Thum	Montana State University	2017

An individual or group recognized for completion of a research project or technical contribution related to aquatic plant management that constitutes a significant advancement to the field.

APMS Award Recipients

APMS Graduate Student Research Grant (year and amount of grant)

Student initiatives are among the most important core values of the Aquatic Plant Management Society. High on the list of student support programs is the APMS Graduate Student Research Grant. This \$40,000 academic grant, co-sponsored by APMS and the seven regional APMS chapters, provides funding for a full-time graduate student to conduct research in an area involving aquatic plant management techniques (used alone or integrated with other management approaches) or in aquatic ecology related to the biology or management of regionally or nationally recognized nuisance aquatic vegetation.

Recipient	Affiliation	Year	Amount
Mary Bremigan	Michigan State University	1999	\$34,000
<i>The Indirect Effects of Sonar Application on Lake Food Webs</i>			
Katia Englehardt	University of Maryland	2001	\$40,000
<i>Controlling Non-native Submersed Aquatic Macrophyte Species in Maryland Reservoirs: Plant Competition Mediated by Selective Control</i>			
Susan Wilde	University of South Carolina	2005	\$40,000
<i>Investigating the Role of Invasive Aquatic Plants and Epiphytic Cyanobacteria on Expression of Avian Vacuolar Myelinopathy (AVM)</i>			
John Madsen and Ryan Wersal	Mississippi State University	2007	\$60,000
<i>The Seasonal Phenology, Ecology and Management of Parrotfeather [<i>Myriophyllum aquaticum</i> (Vellozo) Verdecourt]</i>			
Recipient	Affiliation	Year	Amount
Rob Richardson, Sarah True, Steve Hoyle	North Carolina State University	2010	\$40,000
<i>Monoecious Hydrilla: Phenology and Competition</i>			
Ryan Thum	Grand Valley State University	2012	\$40,000
<i>A Quantitative Genetics Approach to Identifying the Genetic Architecture of Herbicide Susceptibility, Tolerance, and Resistance in Hybrid Watermilfoils (<i>Myriophyllum spicatum</i> x <i>sibiricum</i>)</i>			
Scott Nissen	Colorado State University	2014	\$40,000
<i>Exploring the Physiological Basis of 2,4-D Tolerance in Northern Watermilfoil x Eurasian Watermilfoil Hybrids</i>			
Rob Richardson	North Carolina State University	2015	\$40,000
<i>Aspects of Monoecious Hydrilla Physiology and Response to Herbicide Combination Treatments</i>			
Christopher R. Mudge and Bradley T. Sartain	Louisiana State University	2016	\$40,000
<i>Exploring Alternative Giant Salvinia (<i>Salvinia molesta</i> D.S. Mitchell) Management Strategies</i>			
John Rodgers and Tyler Geer	Clemson University	2017	\$60,000
<i>Evaluation of management options for <i>Nitellopsis obtusa</i> (Desvaux in Loiseleur) J. Groves, (1919) (Starry Stonewort) in the United States</i>			

Sustaining Members



Alligare, LLC is a leading supplier in industrial vegetation management and a subsidiary of ADAMA, the world's largest manufacturer of post patent crop protection chemicals. Our markets include vegetation management, forestry, right-of-way, range and pasture, and aquatics. Alligare works directly with manufacturers around the world to bring the highest level of product quality and service to our customers. Alligare Specialists provide product and service faster and more cost effectively than a traditional sales force.



Since 1981, **Applied Aquatic Management, Inc.**, (AAM) has provided innovative and effective water management services, selective vegetation control, wetland management and exotic weed control. AAM has clients throughout Florida including developers, homeowners associations, golf courses, mobile home communities, utilities, local, state and federal government agencies and industry. Our experienced professional staff provides unique knowledge along with advanced equipment to manage all types of waterway, right-of-way, wetland, and upland systems.



Aqua Services, Inc. is a full-service, aquatic resource management company that specializes in aquatic vegetation management. Established in 1983, the company has provided aquatic plant management for entities in the southeastern U.S. that include the Corps of Engineers, Tennessee Valley Authority, Southern Company, and the Tennessee Wildlife Resource Agency. Aqua Services also provides lake management consulting including electro-fishing assessments, water quality analysis and enhancement, and recreational lake design.



At **AquaMaster**, we design and build the highest quality equipment for the care and improvement of pond, lake, or other aquatic environments. We are committed to providing the highest level of service and assistance to our customers. We are equally committed to our employees to whom we will provide an environment where they will have the maximum opportunity to grow and to prosper. Go online to find one of our 1,500 authorized AquaMaster® Distributors to arrange a visit! (<http://www.aquamasterfountains.com/>) "Commitment to Excellence"



AquaTechnex, LLC is a lake and aquatic plant management firm that operates in the Western United States. The company is expert in the use of aerial and boat GIS/GPS technologies to assess aquatic environments. The firm is also expert in the management of invasive aquatic weed species and phosphorous mitigation to suppress toxic cyanobacteria blooms. Our web site is www.aquatechnex.com; please drop by regularly to get news updates as we have moved our blog onto the site.



Aquatic Control, Inc. has been managing aquatic resources since 1966. As a distributor of lake management supplies, floating fountain aerators, and diffused aeration systems, Aquatic Control represents Applied Biochemists, AquaBlok, BioSafe Systems, Brewer International, SePRO, Syngenta, United Phosphorus, AquaMaster, Kasco, and Otterbine. Aquatic Control has five offices that offer aquatic vegetation management plans including vegetation mapping and application services, fountain and aeration system installation, maintenance, and service throughout the Midwest.



Aquatic Vegetation Control, Inc. (AVC) is a Florida corporation founded in 1986 offering vegetation management and general environmental consulting services throughout the southeast. Since its establishment as an exotic/nuisance vegetation management company specializing in the control of invasive wetland, aquatic and upland species, AVC has broadened its scope of capabilities to include; certified lake management, fish stocking, re-vegetation, mitigation and restoration services, mitigation monitoring services, aquatic, roadside, forestry and utility vegetation management, and environmental/ecological consulting. <https://www.avcaquatic.com/>

Sustaining Members



BioSafe Systems LLC has been offering sustainable and effective solutions for lake management, municipal and wastewater treatments and other water resources since 1998. Our uniquely balanced, broad-spectrum chemistries are designed to enhance your water's health, quality and appearance. Alternatives to products that utilize copper, or other harsh and sometimes toxic chemicals, BioSafe Systems' complete line of products are EPA registered, USDA NOP compliant, OMRI listed and effectively alleviate algal issues with minimal impact on the environment.



Brewer International, located in Vero Beach, Florida, has been a chemical manufacturer since 1973. This location is perfect because the company purchases limonene, a low viscosity oil derived from the peel of citrus fruit. This natural ingredient is used in many of Brewer's formulations including two OMRI Listed Organic surfactants: Organic-Kick and Vin-Kick. The company offers aquatic surfactants Cide-Kick, Cide-Kick II, Cygnet Plus, I'Vod, Sun Wet, and Poly Control 2. Check out our web site at www.brewerint.com and visit us on our Facebook page.



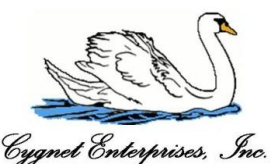
Chem One is a national leader of Organic Copper Sulfate for aquatic management. With eight standard EPA label grades; Fine 20, 25, 30, 100, 200, Small, Medium and Large. Chem One has a grade to meet every customer's needs. With our corporate offices and 78,000+ square foot warehouse in Houston, Texas, Chem One is a national wholesale company that is certified to ISO 9001, ISO 14001, OHSAS 18001.



Clarke Aquatic Services is a global environmental products and services company. Our mission is to make communities around the world more livable, safe, and comfortable. By understanding our customers' needs, we tailor service programs that draw on our unmatched breadth of industry experience, expertise, and resources. We pioneer, develop and deliver environmentally responsible mosquito control and aquatic services to help control nuisances, prevent disease, and create healthy waterways.



Crop Production Services, Inc. (CPS) is a national distributor dedicated to providing innovative solutions and quality products for our customers in the aquatic industry. With our experienced sales force and national warehouse network, CPS provides fast, reliable access to the products our customers need, the services our customers want, and emerging technologies that will address vegetation management needs today and into the future. At CPS, we work closely with customers to develop solutions for their vegetation management programs.



Cygnet Enterprises, Inc. is a national single source distributor of aquatic management products with offices and warehouses in Michigan, Indiana, Pennsylvania, North Carolina, California and Idaho. Cygnet is proud of its reputation for outstanding service, friendly, knowledgeable staff and our unmatched support of the aquatics industry. Cygnet Enterprises is the only aquatic distributor at the Charter Gold Member level in the Aquatic Ecosystem Restoration Foundation (AERF). Please visit www.cygnetenterprises.com.



Diversified Waterscapes, Inc. (DWI) has an extensive knowledge base that includes experienced personnel and seasoned professionals in the management of lakes and ponds. We are dedicated to continually improving our technical and distributor support service, attitude, communication and innovative development of new products and are consistently expanding our knowledge by investigating industry trends, laws and regulations. DWI also manufactures a line of aquatic treatment products that are formulated to be environmentally safe, biodegradable, and non-toxic to aquatic environments.

Sustaining Members



Duke Energy is one of the largest electric power holding companies in the U.S. Its regulated utility operations serve approximately 7.4 million electric customers located in six states in the Southeast and Midwest, representing a population of approximately 24 million people. Its Commercial Portfolio and International business segments own and operate diverse power generation assets in North America and Latin America, including a growing portfolio of renewable energy assets in the U.S. Headquartered in Charlotte, NC, Duke Energy is an S&P 100 Stock Index company traded on the New York Stock Exchange under the symbol DUK. Visit us at duke-energy.com.



Lake Restoration, located in MN, has specialized in controlling pond weeds, lake weeds, and nuisance algae since 1977. Lake Restoration's product line-up includes: Mizzen, a copper based algacide, Spritflo and Dibrox herbicides, a variety of pond dyes and nutrient reducers. Lake Restoration also manufactures the **TORMADA** product application boat, Vitaflume floating fountains, the retractable Goose D-Fence system, and the patented **LAKEMAID** to eliminate lake weeds automatically. For more information, visit our website www.lakerestoration.com.



The **Lee County Hyacinth Control District** was formed by the Florida Legislature in June 1961 to curtail excessive growths of water hyacinth. That same year, water managers from across the state convened in Lee County and formed the Hyacinth Control Society, now APMS, to share control strategies and develop a comprehensive management approach to Florida's most prolific aquatic plant. T. Wayne Miller, Jr. of Lee County served as the Society's President for the first two years and Lee County has been a supporting member of APMS since its inception.

Lonza

Water Treatment

products to improve the recreational and functional value of water, and quality of life throughout the world.

Applied Biochemists[®] team at Lonza Water Treatment is proud of its active membership and participation with the APMS for over 40 years. As a manufacturer and supplier of algacides, aquatic herbicides and other water management products, we highly value the science and integrity the APMS brings to our industry. We are a leading life sciences company, dedicated to the development, production and application of a wide variety of



Maxunitech is an integrated enterprise focusing on the Research and Development, production, sales of agrochemicals, and relevant intermediates and other fine chemicals. Established in 2000, under the principles of "people oriented, united for innovation and pursue excellence", we have been researching and developing new products, solving commercial issues from the perspective of technology, and fulfilling enterprise value with value added for our clients.



Valent Corporation signed a formal agreement with **Nufarm Americas** giving them exclusive distributorship of its products. All of Valent's Professional Products, including its aquatics products, Clipper and Tradewind, will now be sold by Nufarm. This allows Nufarm to offer a portfolio of 10 products labeled for aquatics. Nufarm provides a wide variety of products labeled for aquatics, both systemic and contact, that can be used selectively or broad spectrum depending on their use.



OASE North America For decades OASE has stood for creative design using water. Worldwide, from private gardens to public spaces, impressive water displays showcase the wide range of possibilities using OASE products. Our quality equipment is backed by innovation and technology to support the maintenance of large bodies of water. Available in North America, our complete family of products includes our line of pond boss PRO water treatments intended to clean, clear, condition, and balance water chemistry so lakes can be enjoyed the way nature intended. Water is our passion. Water is Life. OASE is Living Water.

Sustaining Members



For 23 years, **SePRO Corporation** has developed innovative technologies to advance the science of water management. The SePRO team provides comprehensive assessment, planning and implementation solutions. Our focused disciplines include aquatic plant and algae management, water quality restoration, laboratory analysis, mapping and data management. Whether you are looking to assess a water resource, design a prescription plan or implement a restoration program, SePRO provides expertise and solutions to preserve our most precious natural resource – water. www.sepro.com



SOLitude Lake Management is an environmental firm committed to providing sustainable solutions that improve water quality, enhance beauty, preserve natural resources, educate communities and reduce our environmental footprint. SOLitude's team of Aquatic Biologists, Ecologists and Environmental Scientists specializes in the execution of customized lake, pond, wetland and fisheries management programs that include algae and aquatic weed control, water quality testing and restoration, nutrient remediation, vegetation studies and biological assessments for clients across the United States.



SOX Erosion Solutions™ is an environmental services company that has mastered erosion with innovative products that restore living shorelines and hillsides. For almost two decades, the company has installed its patented, bio-engineered solutions that are stable, long-lasting and compliant with Best Management Practices. Centerpiece products include Shoresox™ and Dredgesox™ Erosion Control. SOX Systems are filled with organic sediment and secured to shorelines with a patented soft-armored anchoring system. Plants grow directly through the mesh creating rooted, vegetated shorelines.



Invasive weeds can devastate both natural and commercial habitats. **Syngenta** provides high performance products to control destructive weeds while helping to restore the habitat of aquatic environments. Syngenta offers proven aquatic herbicides like Reward® and Tribune™ that provide fast burn-down, work well in cool weather and are rainfast in as little as 30 minutes. The active ingredient, diquat dibromide, has been used successfully in sensitive aquatic areas for over 25 years.



UPI manufactures and markets aquatic herbicides and algacides for lakes, ponds and irrigation canals. These products are marketed as Aquathol®, Hydrothol®, AquaStrike®, Current®, Symmetry®, Cascade® and Teton®. UPI is a leader in the development of new uses, techniques and formulations to improve aquatic plant management strategies. UPI is a worldwide producer of crop protection products with U.S. operations based in King of Prussia, PA. For more information, please visit www.upi-usa.com or www.cascadeforcanals.com.



Vertex Water Features is a science and engineering-based aeration system manufacturer that provides custom designed water quality solutions distributed through its lake manager dealer network to interested lake owners, lake managers, developers and government agencies throughout North America and internationally. Website: www.vertexwaterfeatures.com. Phone: 1-844-432-4303, FB : <https://www.facebook.com/VertexWaterFeatures/> Email: info@vertexwaterfeatures.com,

Exhibitors

The Aquatic Plant Management Society thanks the following companies for exhibiting their products and services. This list was current when the Program was submitted for printing on June 12, 2018. Please visit the exhibit hall in Grand Ballroom ABCD for all Exhibitors, including not-for-profit organizations.

Airmax Ecosystems, Inc.
Romeo, Michigan

Alligare, LLC
Davidson, North Carolina

Aquatic Control, Inc.
Seymour, Indiana

C-Map USA BioBase
Minneapolis, Minnesota

BioSafe Systems, LLC
East Hartford, Connecticut

Brandt Consolidated, Inc.
Springfield, Illinois

Brewer International
Vero Beach, Florida

Crop Production Services
Oviedo, Florida

Cygnat Enterprises, Inc.
Flint, Michigan

EasyPro Lake and Pond Products
Grant, Michigan

Keycolour, Inc.
Phoenix, Arizona

Lonza
Alpharetta, Georgia

Nufarm Americas
Raleigh, North Carolina

Pond Biologics LLC
Washington Township, Michigan

SePRO Corporation
Carmel, Indiana

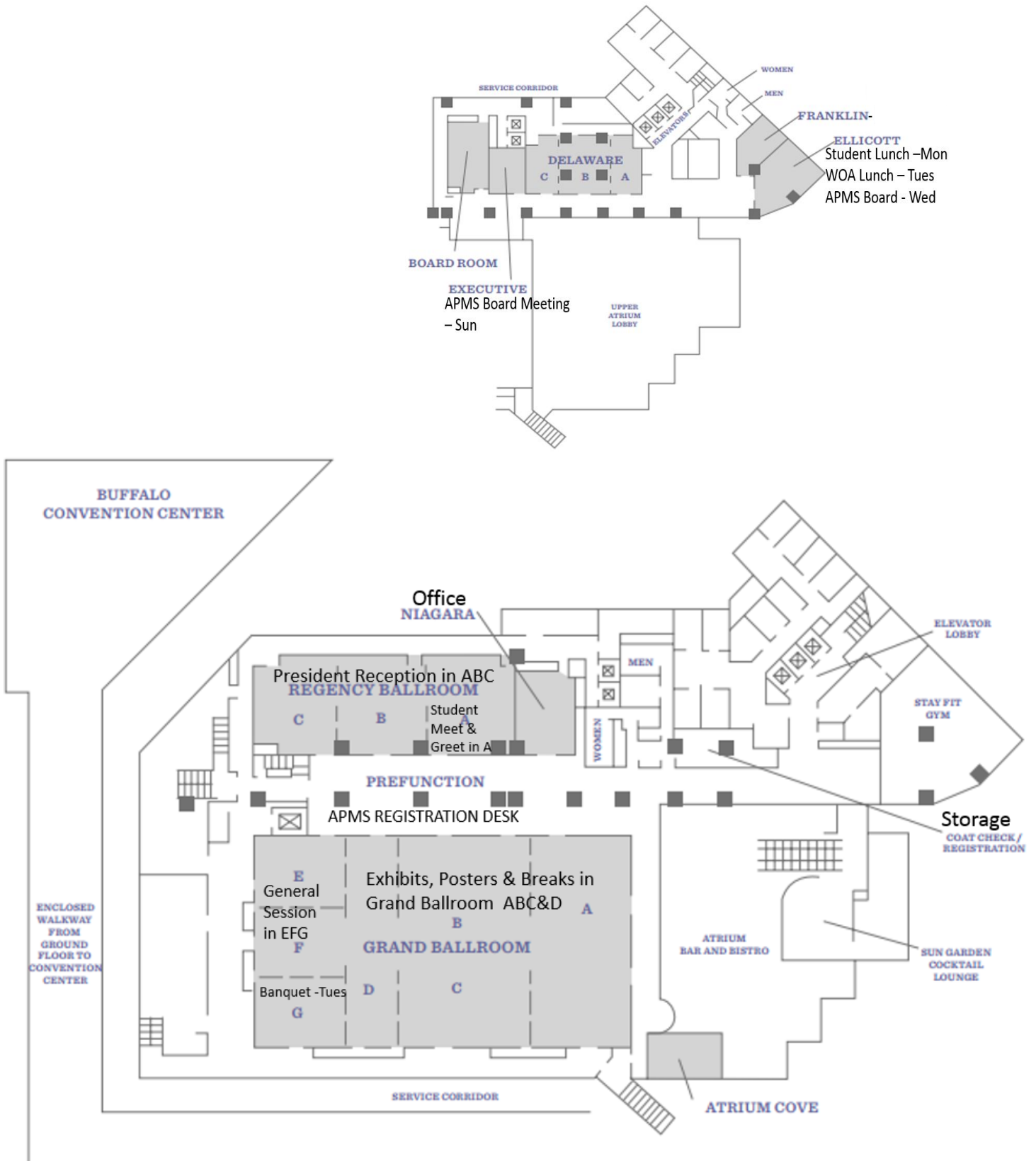
Syngenta
Royal Palm Beach, Florida

UPI
Exton, Pennsylvania

Vertex Water Features
Pompano Beach, Florida

Winfield United
Ville Platte, Louisiana

Hyatt Site Map



General Information and Events

Program Organization

The Agenda is organized by day and time. Posters and abstracts are organized alphabetically by presenting author. For more event information, please see the Agenda-at-a-Glance pages for each day in this Program. Messages will be posted at the meeting registration desk. Most events will take place in the Grand Ballrooms A-G, 2nd Floor. See the hotel site map on page 13 of the Program for event locations.

Name Badges

Your name badge is your ticket for all events at the meeting. Wear it to all activities during the meeting. All individuals participating in meeting events or activities must be registered and have a name badge. Non-registered guests may purchase tickets for the President's Reception, Poster Session Reception, and Awards Banquet at the meeting registration desk.

Meeting Registration Desk

The meeting registration desk will be located in the Pre-function area in front of the Grand Ballroom ABCD, in front of the Exhibit and Poster Hall, opening at 1:00 pm on Sunday, July 15, and running for the duration of the meeting.

Exhibits

Exhibits will be open from 7:00 am Monday to 10:00 am Wednesday in Grand Ballroom ABCD. Exhibitors may start setting up at noon on Sunday, July 15.

Posters

Posters will be open from 7:00 am Monday to 10:00 am Wednesday in Grand Ballroom ABCD. Poster presenters will be on hand during the Monday evening Poster Reception as well as during breaks to answer questions. Poster Presenters may start setting up at noon on Sunday, July 15. All Posters must be set up before 6:00 pm on Monday, July 16.

Continental Breakfasts / Refreshment Breaks

Continental breakfasts and mid-morning and afternoon refreshment breaks will be served each day in Grand Ballroom ABCD. Please see the Agenda-at-a-Glance for specific times. Also, take time to visit with Exhibitors in Grand Ballroom ABCD while enjoying your breakfast or break.

Spur of the Moment Meeting Room

We have a room set up conference style for 25 guests. Please check at the meeting registration desk to reserve.

Student Meet-and-Greet! *Sunday, July 15, 6:00 pm to 7:00 pm, Regency Ballroom A*

All students registered for the meeting are invited to gather in Regency Ballroom A to get to know other students prior to the Presidents' Reception. Beverages and light snacks will be provided. This students-only event is open to all students who are registered for the meeting.

President's Reception: *Sunday, July 15, 7:00 pm to 9:00 pm, Regency Ballroom ABC*

Join your APMS friends and colleagues at the Presidents' Reception in Regency Ballroom ABC to "kick-off" our annual meeting while enjoying hors d'oeuvres and beverages. The President's Reception is open to all registered delegates, guests, and students. Non-registered guests may purchase tickets at the meeting registration desk.

Student Affairs Luncheon: *Monday, July 16, 11:30 am to 1:00 pm, Ellicott Room*

All students registered for the meeting are invited to attend. This luncheon, provided by our sponsors, is a great opportunity to meet other students, interact with guest speakers and APMS leadership, and learn how to become more involved in the Society. Chris Mudge, Student Affairs Committee Chair, will be the moderator. Please contact Chris by noon Sunday, July 15 to confirm your attendance.

Regional Chapters Presidents' Luncheon: *Monday, July 16, 11:30 am to 1:00 pm, Franklin Room*

Two representatives from each APMS regional chapter are invited to attend the Regional Chapter Presidents' Luncheon, provided by APMS sponsors. Mark Heilman, APMS Vice President and Regional Chapters Committee Chair will be the moderator for discussions on aquatic plant management activities in each region. Please contact Mark by noon Sunday, July 15 to confirm your attendance.

Annual Business Meeting: *Monday, July 16, 4:25 pm to 5:00 pm, Grand Ballroom EFG*

All APMS members are encouraged to attend the APMS Annual Business Meeting for Society updates as well as electing new Officers and Directors. Members will also vote on proposed Bylaws changes and an increase in annual Individual Membership dues to help support the APMS Graduate Student Research Grant program. Members can review details on the Officer and Directors Slate and the proposed Bylaws and dues changes in the June 2018 APMS Newsletter.

Poster Session Reception: *Monday, July 16, 6:00 pm to 7:30 pm, Grand Ballroom ABCD*

This reception provides for the viewing of posters and exhibits along with professional interactions and discussions in a casual setting while enjoying light hors d'oeuvres and beverages. The Poster Session Reception is open to all registered delegates, guests, and students. Non-registered guests may purchase tickets for this event at the meeting registration desk. Enjoy the discussions and refreshments before moving on to dining with colleagues or taking in the sights around the Hotel.

Past Presidents' Luncheon: *Tuesday, July 17, 11:30 am to 1:00 pm, Franklin Room*

All APMS Past Presidents are invited to attend the Past Presidents' Luncheon to provide insight into matters facing APMS and aquatic plant managers. John Madsen, Immediate Past President, will be the moderator. Please contact John by noon Monday, July 17 to confirm your attendance.

Women of Aquatics Luncheon: *Tuesday, July 17, 11:30 am to 1:00 pm, Ellicott Room*

Amy Kay will host the APMS Women of Aquatics Luncheon to discuss issues and opportunities for women in the field of aquatic plant management. Please contact Amy by noon Monday, July 17 to confirm your attendance.

Awards Reception / Banquet: *Tuesday, July 17, 6:00 pm to 10:00 pm, Grand Ballroom EFG*

Registered delegates, guests and students are invited to the Awards Banquet in Grand Ballroom EFG. Join us outside the Ballroom, for a pre-banquet reception from 6:00-7:00 pm. After dinner, we will recognize those who have served APMS, welcome new officers and directors, and this year's student paper and poster award participants. Our evening will conclude with a fund-raising raffle for prizes. The raffle supports APMS student and other education initiatives. Raffle tickets may be purchased at the registration desk and during the Awards Banquet.

Student Tour: *Thursday, July 19, 7:00 am to 5:00 pm*

Graduate students attending the annual APMS conference are invited to attend a one-day post-conference hands-on tour of aquatic plant management and restoration projects near Buffalo, NY, on Thursday July 19, 2018. Students will travel from the hotel on the morning after the annual conference concludes and visit sites and projects managed by the U.S. Army Corps of Engineers (USACE) Buffalo District. The Seneca Bluffs Restoration, Times Beach Aquatic Plant Control, Great Lakes Hydrilla Collaborative, and the Unity Island Aquatic Plant Control projects, which are all in close proximity to the Buffalo area, will be tour stops. Students will learn about restoration of the Buffalo and Niagara Rivers as well control of invasive species including Phragmites, hydrilla, and other plants in the Erie Canal. Mr. Michael Greer (USACE) and Dr. Christopher Mudge (USACE ERDC) will guide the one-day tour. Transportation and lunches will be provided by APMS. APMS Sponsors will provide breakfast, lunch and transportation. Students will depart the Hyatt at approximately 7:00 am and return to the conference hotel by 4:00 pm. Please contact Dr. Mudge for additional tour information.

(Christopher.R.Mudge@usace.army.mil)

Events-at-a-Glance

See daily Agenda-at-a-Glance on pages 14-25 of the Program for event times and locations.

Sunday:

- APMS Board of Directors Meeting
- Exhibits and Poster Setup
- Registration
- Student Meet-and-Greet
- Presidents' Reception

Monday:

- Meeting Opens – Keynote - General Session - Student Presentations
- Student Affairs Luncheon
- Regional Chapters Presidents' Luncheon
- APMS Annual Business Meeting
- Poster Session & Reception

Tuesday:

- General Session - Student Presentations
- APMS Past Presidents' Luncheon
- Women of Aquatics Luncheon
- Awards Reception
- Awards Banquet - APMS Awards Presentations

Wednesday:

- Special Sessions on Plant and Algae Issues and Management in Florida
- General Meeting Adjourns – 12:00 p.m.
- APMS Board of Directors Meeting

Thursday:

- Student Tour

Agenda

Sunday, July 15

Sunday's Agenda-at-a-Glance

7:30 am	-	5:00 pm	APMS Board of Directors Meeting (<i>Executive Board Room</i>)
12:00 pm	-	5:00 pm	Exhibits and Posters Setup (<i>Grand Ballroom ABCD</i>)
1:00 pm	-	5:00 pm	Registration (<i>Foyer - Grand Ballroom ABCD</i>)
6:00 pm	-	7:00 pm	Student Meet-and-Greet (<i>Regency Ballroom A</i>)
7:00 pm	-	9:00 pm	President's Reception (<i>Regency Ballroom ABC</i>)

Monday, July 16

Monday's Agenda-at-a-Glance

7:00 am	-	8:00 am	Continental Breakfast (<i>Grand Ballroom ABCD</i>)
7:00 am	-	7:30 pm	Exhibits and Posters Open (<i>Grand Ballroom ABCD</i>)
7:30 am	-	5:00 pm	Registration (<i>Foyer - Grand Ballroom ABCD</i>)
8:00 am	-	11:30 am	Session I – Keynote, General Session (<i>Grand Ballroom EFG</i>)
9:20 am	-	9:50 am	Refreshment Break (<i>Grand Ballroom ABCD</i>)
11:30 am	-	1:00 pm	Lunch on your own
11:30 am	-	1:00 pm	APMS Student Affairs Luncheon (<i>Ellicott Room</i>)
11:30 am	-	1:00 pm	Regional Chapters Presidents' Luncheon (<i>Franklin Room</i>)
1:00 pm	-	4:25 pm	Session II - General Session, Student Presentations, Chapter Updates (<i>Grand Ballroom EFG</i>)
2:40 pm	-	3:10 pm	Refreshment Break (<i>Grand Ballroom ABCD</i>)
4:25 pm	-	5:00 pm	APMS Annual Business Meeting (<i>Grand Ballroom EFG</i>)
6:00 pm	-	7:30 pm	Poster Session and Reception (<i>Grand Ballroom ABCD</i>)

Session I – Keynote, General Session, Student Presentations

8:00 am - 11:30 am
Grand Ballroom EFG

Moderator: Mark Heilman – APMS Vice President

SePRO Corporation, Carmel, IN

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|---------|---|
| 8:00 am | Call to Order - Announcements
Craig Aguiard – APMS Program Committee Chair
<i>Winfield United, Ville Platte, LA</i> |
| 8:05 am | Presidential Address
John H. Rodgers, Jr.
<i>Clemson University, Department of Forestry and Environmental Conservation, Clemson, SC</i> |
| 8:15 am | Knowledge to Action on Global to Local Invasions
David Lodge
<i>Cornell University, Atkinson Center for a Sustainable Future, Ithaca, NY</i> |
| 8:40 am | Aquatic Plant Control Program Past and Present
Jeremy Crossland
<i>U.S. Army Corps of Engineers, Land Use and Natural Resources, Washington, DC</i> |
| 9:00 am | Circling the Wagons: Implementing New York State's Aquatic Invasive Species Management Plan
Catherine A. McGlynn
<i>New York State Department of Conservation, Albany, NY</i> |

- 9:20 am **Refreshment Break** (*Grand Ballroom ABCD*)
- 9:50 am **Status of Aquatic Plant Management in the Northeast U.S.**
Meg Modley
Lake Champlain Basin Program, and NEAPMS Chapter President, Grand Isle, VT
- 10:10 am **Hydrilla Management in the Croton River (Westchester County, NY): Results from Year 1 of a 5-Year Control Program**
Chris J. Doyle
SOLitude Lake Management, Washington, NJ
- 10:30 am **Evaluating ProcellaCOR for Control of Five Target Aquatic Weeds in New Zealand**
 Andrew Howell¹, **Deborah E. Hofstra**², Robert J. Richardson¹, Mark A. Heilman³, and Paul Champion²
¹*North Carolina State University, Crop and Soil Sciences, Raleigh, NC*
²*National Institute of Water and Atmospheric Research, Freshwater and Estuaries Centre, Hamilton, NZ*
³*SePRO Corporation, Carmel, IN*
- 10:50 am **Absorption and Translocation of Florpyrauxifen-benzyl (Procellacor™) in Selected Aquatic Plant Species**
Erika J. Haug¹, Mark A. Heilman², Travis Gannon¹, and Robert J. Richardson¹
¹*North Carolina State University, Crop and Soil Sciences, Raleigh, NC*
²*SePRO Corporation, Carmel, IN*
- 11:10 am **Invasive Aquatic Plants in Connecticut, USA: The State of the State**
Greg Bugbee
Connecticut Agricultural Experiment Station, Department of Environmental Sciences, New Haven, CT
- 11:30 am **Morning Wrap-up and Announcements - Lunch on your own**

Session II – General Session, Student Presentations, Chapter Updates

1:00 pm – 4:25 pm

Grand Ballroom EFG

Moderator: Amy Kay – APMS Director

Clean Lakes Midwest, Inc., Oakwood Hills, IL

- 1:00 pm **Nozzle and Speed Selection for Site-Specific Herbicide Applications Using an Unmanned Aerial Sprayer (Student Presentation)**
Joseph Hunter¹, Travis Gannon¹, Robert J. Richardson¹, Joe Neal², and Ramon Leon¹
¹*North Carolina State University, Crop and Soil Sciences, Raleigh, NC*
²*North Carolina State University, Horticulture, Raleigh, NC*
- 1:20 pm **Incorporating Advanced Robotics into Aquatic Plant Management: Development of an Autonomous Aquatic Application System**
Robert J. Richardson¹, Greg Buckner², Scott Ferguson², Staphan Jernigan², Steve T. Hoyle¹, and Justin J. Nawrocki³
¹*North Carolina State University, Crop and Soil Sciences, Raleigh, NC*
²*North Carolina State University, Mechanical and Aerospace Engineering, Raleigh, NC*
³*UPI Incorporated, Holly Springs, NC*
- 1:40 pm **Efficacy of Twelve Non-aquatic Herbicides for Managing Giant Salvinia (Student Presentation)**
Bradley T. Sartain¹ and Christopher R. Mudge²
¹*Louisiana State University, School of Plant, Environmental and Soil Sciences, Baton Rouge, LA*
²*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Baton Rouge, LA*

- 2:00 pm **Field Demonstration of Improvements to Salvinia Weevil Establishment and Giant Salvinia Management as a Result of Nitrogen Amendments**
Julie G. Nachtrieb¹, William Finkbeiner², and Wesley Maddox³
¹*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
²*Louisiana Department of Wildlife and Fisheries, Inland Fisheries Aquatic Plant Division, Monroe, LA*
³*Louisiana Department of Wildlife and Fisheries, Inland Fisheries Aquatic Plant Division, Forest Hill, LA*
- 2:20 pm **Mechanical Control of Flowering Rush (*Butomus umbellatus* L.) (Student Presentation)**
Lee G. Turnage¹, John D. Byrd², Ryan M. Wersal³, and John D. Madsen⁴
¹*Mississippi State University, Geosystems Research Institute, Starkville, MS*
²*Mississippi State University, Plant and Soil Sciences, Starkville, MS*
³*Lonza, Alpharetta, GA*
⁴*U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research Unit, Davis, CA*
- 2:40 pm **Refreshment Break** (*Grand Ballroom ABCD*)
- 3:10 pm **Chemical Control of Two Grass Species Under Different Salinity Regimes (Student Presentation)**
Candice Prince and Gregory MacDonald
University of Florida, Agronomy Department, Gainesville, FL
- 3:30 pm **Field Evaluation of Graminicides on *Hymenachne amplexicaulis*, West Indian Marsh Grass: Control and Non-target Effects (Student Presentation)**
Stephen Enloe and **Kaitlyn Quincy**
University of Florida, Agronomy Department, Center for Aquatic and Invasive Plants, Gainesville, FL
- 3:50 pm **APMS Regional Chapters: An Update on Key Initiatives within Each Region**

Western	South Carolina	Midwest	Florida
Texas	Northeast	MidSouth	
- 4:25 pm **Adjourn Session II**
- 4:25 pm **APMS Annual Business Meeting** (*Grand Ballroom EFG*)
- 5:00 pm **Adjourn Annual Business Meeting**
- 6:00 pm **Poster Session and Reception** (*Grand Ballroom ABCD*)

Poster Session

6:00 pm - 7:30 pm

Grand Ballroom ABCD

Control of Algal Growth on Irrigated Greenhouse Surfaces using Commercial Algaecides (Student Presentation)

David E. Berthold¹, Ariel Elazar², Forrest Lefler², Chris Marble³, and Haywood D. Laughinghouse²

¹University of Florida, Fort Lauderdale Research and Education Center, Miami, FL

²University of Florida, Fort Lauderdale Research and Education Center, Davie, FL

³University of Florida, Mid-Florida Research and Education Center, Apopka, FL

Management of Problematic Native Aquatic Vegetation to Enhance Multi-user Benefits in Southeastern Waterbodies (Student Presentation)

Kennedy Calhoun¹, Gary N. Ervin², and Lee G. Turnage¹

¹Mississippi State University, Geosystems Research Institute Starkville, MS

²Mississippi State University, Department of Biological Sciences, Starkville, MS

A Cryptic Introduction of *Trapa* in the Northeastern United States

Greg M. Chorak and Ryan A. Thum

Montana State University, Plant Science Plant Pathology, Bozeman, MT

Investigations into Possible Mechanisms of Selectivity of Endothall Herbicide in Submersed Aquatic Macrophytes (Student Presentation)

Michael W. Durham and Gregory MacDonald

University of Florida, Agronomy Department, Gainesville, FL

Aeration of a Shallow Eutrophic Lake: What to Expect

Patrick M. Goodwin

State University of New York Oneonta, Jacksonville, Beach, FL

Monoecious *Hydrilla verticillata* Tuber Respiration

Erika J. Haug, Tyler J. Harris, and Robert J. Richardson

North Carolina State University, Crop and Soil Sciences, Raleigh, NC

Potential Spread of *Hydrilla (Hydrilla verticillata)* in the Great Lakes Basin (Student Presentation)

Kristen M. Hebebrand and Jonathan M. Bossenbroek

The University of Toledo, Environmental Sciences, Toledo Ohio

Utilization of Dual Transducers Improves Hydroacoustic Survey Efficiency (Student Presentation)

Andrew Howell, Steve T. Hoyle, Tyler J. Harris, and Robert J. Richardson

North Carolina State University, Crop and Soil Sciences, Raleigh, NC

Mapping Waterhyacinth (*Eichhornia crassipes*) Drift and Dispersal in the San Joaquin Delta Using GPS Drogues

John Miskella and **John D. Madsen**

U.S. Department of Agriculture, Agricultural Research Service, Invasive Species and Pollinator Health Research Unit, Davis, CA

Implementing Monitoring Techniques of *Hydrilla verticillata* in the New Jersey, Delaware and Raritan Canal (Student Presentation)

Emily R. Mayer¹ and Amanda Mahaney²

¹SOLitude Lake Management, Washington, NJ and University of Florida, Gainesville, FL

²SOLitude Lake Management, Shrewsbury, MA

New Hampshire Variable Leaf Milfoil (*Myriophyllum heterophyllum*) Response to Florpyrauxifen-benzyl (ProcellacorTM) Concentration Exposure Times (Student Presentation)

Eryn Molloy, Kara J. Foley, Erika J. Haug, and Robert J. Richardson

North Carolina State University, Crop and Soil Sciences, Raleigh, NC

Field Evaluations of Herbicide Efficacy on Invasive *Scleria* Species (*S. lacustris* and *S. microcarpa*) in Florida (Student Presentation)

Alexandra L. Onisko¹, Gregory MacDonald², Candice Prince², Ellen Allen³, and LeRoy Rodgers³

¹University of Florida, Agronomy Department, Jensen Beach, FL

²University of Florida, Agronomy Department, Gainesville, FL

³South Florida Water Management District, West Palm Beach, FL

A Workshop Summary: Prioritizing Research for Management of the *Nitellopsis obtusa* (starry stonewort)

Kaytee L. Pokrzywinski¹, Kurt D. Getsinger¹, and Bradley Steckart²

¹U.S. Army Engineer Research and Development Center, Vicksburg, MS

²Washington and Waukesha Counties, Land and Water Conservation Division, West Bend, WI

Evaluation of a Foliar Endothall Use Pattern for Controlling Crested Floating Heart (*Nymphoides cristata*) and Giant Salvinia (*Salvinia molesta*) (Student Presentation)

William J. Prevost¹, Christopher R. Mudge², and Michael D. Netherland³

¹Louisiana State University, School of Plant, Environmental, and Soil Sciences, Baton Rouge, LA

²U.S. Army Engineer Research and Development Center, Environmental Laboratory, Baton Rouge, LA

³U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL

Efficacy of Waterhyacinth Weevils (*Neochetina* sp.) and the Herbicides Glyphosate, Diquat, and Carfentrazone for Integrated Management of Waterhyacinth (Student Presentation)

Sam Sardes¹, Lyn Gettys¹, Stephen Enloe², William H. Kern¹, and Carey Minter-Killian³

¹University of Florida, Fort Lauderdale Research and Education Center, Davie, FL

²University of Florida, Agronomy Department, Gainesville, FL

³University of Florida, Entomology Department, Fort Pierce, FL

A Comparison of Filamentous Algae Herbicide Treatments in Arkansas Ponds

George L. Selden

University of Arkansas at Pine Bluff, Aquaculture/Fisheries Center, Jonesboro, AR

New Stocking Rates for Triploid Grass Carp (*Ctenopharyngodon idella*)

Anita Kelly, Scott Jones, and **George L. Selden**

University of Arkansas at Pine Bluff, Aquaculture/Fisheries Center, Jonesboro, AR

Sequential Applications of Diquat to Control Flowering Rush (*Butomus umbellatus* L.) (Student Presentation)

Lee G. Turnage¹, John D. Byrd², Ryan M. Wersal³, and John D. Madsen⁴

¹Mississippi State University, Geosystems Research Institute, Starkville, MS

²Mississippi State University, Plant and Soil Sciences, Starkville, MS

³Lonza, Alpharetta, GA

⁴U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research Unit, Davis, CA

Short-term Control of Cuban Bulrush (*Oxycaryum cubense*) Through Submersed Herbicide Applications

Lee G. Turnage (Student Presentation)

Mississippi State University, Geosystems Research Institute, Starkville, MS

Tuesday, July 17

Tuesday's Agenda-at-a-Glance

7:00 am	-	8:00 am	Continental Breakfast (<i>Grand Ballroom ABCD</i>)
7:00 am	-	5:00 pm	Exhibits and Posters Open (<i>Grand Ballroom ABCD</i>)
7:30 am	-	5:00 pm	Registration (<i>Foyer - Grand Ballroom ABCD</i>)
8:00 am	-	11:30 am	Session III – General Session and Student Presentations (<i>Grand Ballroom EFG</i>)
9:40 am	-	10:10 am	Refreshment Break (<i>Grand Ballroom ABCD</i>)
11:30 am	-	1:00 pm	Lunch on your own
11:30 am	-	1:00 pm	APMS Past Presidents' Luncheon (<i>Franklin Room</i>)
11:30 am	-	1:00 pm	Women of Aquatics Luncheon (<i>Ellicott Room</i>)
1:00 pm	-	5:00 pm	Session IV – General Session and Student Presentations (<i>Grand Ballroom EFG</i>)
2:40 pm	-	3:10 pm	Refreshment Break (<i>Grand Ballroom ABCD</i>)
6:00 pm	-	7:00 pm	Awards Reception (<i>Foyer – Grand Ballroom EFG</i>)
7:00 pm	-	10:00 pm	Awards Banquet (<i>Grand Ballroom EFG</i>)
8:30 pm	-	10:00 pm	APMS Awards Presentations – Raffle (<i>Grand Ballroom EFG</i>)

Session III – General Session and Student Presentations

8:00 am - 11:30 am

Grand Ballroom EFG

Moderator: Jason Ferrell – APMS Editor

University of Florida, Center for Aquatic and Invasive Plants, Gainesville, FL

- 8:00 am **Harmful Algal Blooms in New York Lakes: Monitoring and Research**
Rebecca Gorney
New York Department of Environmental Conservation, Division of Water, New York, NY
- 8:20 am **Microcystin-LR Degradation Following Copper-based Algaecide Exposures (*Student Presentation*)**
Maas Hendrikse¹, Ciera Kinley¹, Kyla Iwinski-Wood², Tyler Geer¹, Andrew McQueen³, Alyssa Calomeni¹,
Jenny Liang⁴, Vanessa Friesen⁴, Monique Simair⁴, John H. Rodgers, Jr.¹
¹*Clemson University, Department of Forestry and Environmental Conservation, Clemson, SC*
²*Applied Polymer Systems, Woodstock, GA*
³*U.S. Army Corps of Engineers, Vicksburg, MS*
⁴*Contango Strategies Ltd., Saskatoon, Saskatchewan, Canada*
- 8:40 pm **Desiccation Tolerance of the Invasive Alga Starry Stonewort (*Nitellopsis obtusa*) (*Student Presentation*)**
Carli K. Wagner¹, Wesley Glisson¹, Michael Verhoeven¹, Rafael Contreras-Rangel¹,
Ranjan Muthukrishnan¹, and Daniel J. Larkin²
¹*Minnesota Aquatic Invasive Species Research Center, University of Minnesota Twin Cities, Minneapolis, MN*
²*Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota Twin Cities, Minneapolis MN*
- 9:00 am **Rapid Response to an Early Detection of *Nitellopsis obtusa* (Starry Stonewort) in Lake Sylvania, Minnesota, Using a Copper-Based Algaecide (*Student Presentation*)**
Tyler Geer¹, Steve McComas², and John H. Rodgers, Jr.¹
¹*Clemson University, Department of Forestry and Environmental Conservation, Clemson, SC*
²*Blue Water Science, Saint Paul, MN*
- 9:20 am **Response of Native and Invasive Submersed Aquatic Macrophytes in Three Minnesota Lakes to Carp Removal and Management**
Raymond M. Newman and Melaney A. Dunne
University of Minnesota, Fisheries, Wildlife, and Conservation Biology, Saint Paul, MN
- 9:40 am **Refreshment Break (*Grand Ballroom ABCD*)**

- 10:10 am **Comparing Efficacy of Endothall + Diquat and Endothall + Copper Formulations for *Egeria densa* Control (Student Presentation)**
Kristen R. Tanz¹, Mirella F. Ortiz¹, Scott J. Nissen¹, and Cody J. Gray²
¹Colorado State University, Bioagricultural Sciences & Pest Management, Fort Collins, CO
²UPI, Field Development Representative, Peyton, CO
- 10:30 am **Evaluation of Diquat (Reward) for Submersed Flowering Rush Control in Lake Pend Oreille, ID**
Kurt D. Getsinger¹, John D. Madsen², John Skogerboe³, **Steve T. Hoyle⁴**, and Robert J. Richardson⁴
¹U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS
²U.S. Department of Agriculture, Agricultural Research Service, Invasive Species and Pollinator Health Research Unit, Davis, CA
³Coldwater Environmental, Minneapolis, MN
⁴North Carolina State University, Crop and Soil Sciences, Raleigh, NC
- 10:50 am **Accuracy of Visual Identification of Hybrid Watermilfoil (Student Presentation)**
Jasmine A. Eltawely¹ Ryan A. Thum², Raymond M. Newman³, and Jeff Pashnick²
¹University of Minnesota, Water Resources Science, Saint Paul, MN
²Montana State University, Plant Sciences and Plant Pathology, Bozeman, MT
³University of Minnesota, Fisheries Wildlife Conservation Biology, Saint Paul, MN
- 11:10 am **Platinum Level Sponsor Presentation – UPI**
- 11:20 am **Gold Level Sponsor Presentation – SePRO Corporation**
- 11:25 am **Gold Level Sponsor Presentation – Syngenta**
- 11:30 am **Morning Wrap-up and Announcements - Lunch on your own**

Session IV – General Session and Student Presentations

1:00 pm - 5:00 pm

Grand Ballroom EFG

Moderator: Todd Olson – APMS Director

Aquatic Vegetation Control, Inc., Riviera Beach, FL

- 1:00 pm **Aquatic Plant Management in the U.S. Army Corps of Engineers - Wilmington District Lakes (Student Presentation)**
Kara J. Foley, Steve T. Hoyle, Tyler J. Harris, and Robert J. Richardson
North Carolina State University, Crop and Soil Sciences, Raleigh, NC
- 1:20 pm **Marsh Madness: Lessons from a Swamp (Student Presentation)**
Sonja L. Wixom¹ and Jeffrey Heilveil²
¹State University of New York, Biology Department, Cooperstown, NY
²State University of New York, Biology Department, Oneonta, NY
- 1:40 pm **Laboratory and Mesocosm Evaluation of Growth and Herbicide Response in Eurasian Watermilfoil and Four Accessions of Hybrid Watermilfoil (Student Presentation)**
Jens Beets¹ and Michael D. Netherland²
¹University of Florida, Agronomy Department, Gainesville, FL
²U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL
- 2:00 pm **Temperature as a Driver of Waterhyacinth (*Eichhornia crassipes*) Growth in the Sacramento / San Joaquin River Delta**
John D. Madsen
U.S. Department of Agriculture, Agricultural Research Service, Invasive Species and Pollinator Health Research Unit, Davis, CA

- 2:20 pm **Effects of Repeated Herbicidal Control and Environmental Conditions on Curlyleaf Pondweed**
(*Student Presentation*)
Michael R. Verhoeven¹, Daniel J. Larkin², and Raymond M. Newman²
¹*University of Minnesota, Aquatic Invasive Species Research Center, Saint Paul, MN*
²*University of Minnesota, Fisheries, Wildlife and Conservation Biology, Saint Paul, MN*
- 2:40 pm **Refreshment Break** (*Grand Ballroom ABCD*)
- 3:10 pm **Consumer Available sUAS (Small Unmanned Aircraft Systems) for Macrophyte Mapping and Management** (*Student Presentation*)
Andrew Howell and Robert J. Richardson
North Carolina State University, Crop and Soil Sciences, Raleigh, NC
- 3:30 pm **Deep in the Weeds of Aquatic Plant Management in New Jersey's Delaware and Raritan Canal**
Jon Gosselin¹, Heather Desko², Emily R. Mayer³, Chris J. Doyle⁴, and Mark A. Heilman⁵
¹*SePRO Corporation, Manchester, NH*
²*New Jersey Water Supply Authority, Clinton, NJ*
³*SOLitude Lake Management, Washington, NJ and University of Florida, Gainesville, FL*
⁴*SOLitude Lake Management, Washington, NJ*
⁵*SePRO Corporation, Carmel, IN*
- 3:50 pm **Effectiveness of Canopeo in Quantification of Photosynthetic Colors for Macrophyte Monitoring**
(*Student Presentation*)
Eric White, Andrew Howell, Steve T. Hoyle, and Robert J. Richardson
North Carolina State University, Crop and Soil Sciences, Raleigh, NC
- 4:10 pm **Colorimetric Detection of Invasive Plant Species in Environmental DNA Samples**
Paul Czechowski¹, Jose Andres¹, and David Lodge²
¹*Cornell University, Department of Ecology and Evolutionary Biology, Ithaca, NY*
²*Cornell University, Atkinson Center for a Sustainable Future, Ithaca, NY*
- 4:30 pm **Integrated Weed Management Solution for the Invasive Aquatic Weed Hydrilla**
James P. Cuda¹, Emma Weeks¹, Jennifer Gillett-Kaufman¹, Mark Hoyer², and Mark Jackson³
¹*University of Florida, Entomology and Nematology Department, Gainesville, FL*
²*University of Florida, School of Forest Resources and Conservation, Fisheries and Aquatic Sciences, Gainesville, FL*
³*U.S. Department of Agriculture, Agriculture Research Service (Retired), Peoria, IL*
- 4:50 pm **Afternoon Wrap-up and Announcements**
- 6:00 pm **Awards Reception** (*Foyer – Grand Ballroom EFG*)
- 7:00 pm **Awards Banquet** (*Grand Ballroom EFG*)

Wednesday, July 18

Wednesday's Agenda-at-a-Glance

7:00 am	-	8:00 am	Continental Breakfast (<i>Grand Ballroom ABCD</i>)
7:00 am	-	10:00 pm	Exhibits and Posters Open (<i>Grand Ballroom ABCD</i>)
7:30 am	-	12:00 pm	Registration (<i>Foyer - Grand Ballroom ABCD</i>)
8:00 am	-	12:20 pm	Session V – General Session (<i>Grand Ballroom EFG</i>)
9:40 am	-	10:00 am	Refreshment Break (<i>Grand Ballroom ABCD</i>)
12:20 pm	-	12:30 pm	Wrap-up and Adjourn 58 th Annual Meeting
12:45 pm	-	1:30 pm	APMS Board of Directors Lunch (<i>Ellicott Room</i>)
1:30 pm	-	5:00 pm	APMS Board of Directors Meeting (<i>Ellicott Room</i>)

Session V – General Session

8:00 am - 12:20 pm

Grand Ballroom EFG

Moderator: John H Rodgers, Jr. - APMS President

Clemson University, Department of Forestry and Environmental Conservation, Clemson, SC

- 8:00 am **Comparing Efficacy Between Generic vs. Proprietary Aquatic Herbicides for Control of Floating Plants**
Christopher R. Mudge¹ and Kurt D. Getsinger²
¹*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Baton Rouge, LA*
²*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
- 8:20 am **Lake Cayuga Monoecious Hydrilla Demonstration Project, Aurora, New York**
Dean Jones¹, Richard J. Ruby², Michael J. Greer², and Michael D. Netherland³
¹*University of Florida, Center for Aquatic and Invasive Plants, Lake Alfred, FL*
²*U.S. Army Corps of Engineers, Buffalo District, Buffalo, NY*
³*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL*
- 8:40 am **Erie Canal Monoecious Hydrilla Demonstration Control Project, Buffalo, New York**
Richard J. Ruby¹, Michael J. Greer¹, Dean Jones², and Michael D. Netherland³
¹*U.S. Army Corps of Engineers, Buffalo District, Buffalo, NY*
²*University of Florida, Center for Aquatic and Invasive Plants, Lake Alfred, FL*
³*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL*
- 9:00 am **Evaluation of Herbicides and Combinations for Management of the Submersed Weeds Hygrophila and Fanwort**
Lyn A. Gettys, Kyle L. Thayer, Ian J. Markovich, and Mohsen Tootoonchi
University of Florida, Fort Lauderdale Research and Education Center, Davie, FL
- 9:20 am **Great Lakes Hydrilla Risk Assessment**
Carl E. Mach
Ecology and Environment, Inc., Lancaster, NY
- 9:40 am **Refreshment Break** (*Grand Ballroom ABCD*)
- 10:00 am **Evaluating Long-term Effectiveness of Phoslock® in Water Resource Restoration**
West M. Bishop¹, Tim S. Epe², Karin Finsterle², Said Yasseri²
¹*SePRO Corporation, Whitakers, NC*
²*Institut Dr. Nowak GmbH & Co. KG – Limnology, Ottersberg, Germany*

- 10:20 am **Fate of Microcystins in Nearshore and Upland Environments: A Dredged Material Management Perspective**
Andrew D. McQueen¹, Mike W. Habberfield², Karen G. Keil², and Burton C. Suedel¹
¹*U.S. Army Engineer Research and Development Center, Vicksburg, MS*
²*U.S. Army Corps of Engineers, Buffalo District, Buffalo, NY*
- 10:40 am **Assessing Physiological Stress and Changes in Toxin Quota in Harmful Cyanobacteria using Hyperspectral Imaging**
Kaytee L. Pokrzywinski¹, Steven Everman¹, Kenneth Matheson¹, Gary Blakeney¹, Shea Hammond¹, Scott Bourne¹, Cliff Morgan¹, and Molly Reif²
¹*U.S. Army Engineer Research and Development Center, Vicksburg, MS*
²*Joint Airborne Lidar Bathymetry Technical Center of Expertise, Kiln, MS*
- 11:00 am **Cyanotoxins in Drinking Water Resources: Best Management Practices and Regulations**
Brad A. Bartelme
EnviroScience, Incorporated, Cleveland, OH
- 11:20 am **Biosecurity Partnership in Action**
Marcus Girvan
Boffa Miskell Ltd., Christchurch, NZ
- 11:40 am **Mapping of Emergent and Floating-leaf Aquatic Vegetation Using a Machine Learning Process with Satellite Imagery (EcoSat): Experiences in Florida**
Ray D. Valley¹, Marcus Bindel², Hendrik Bernert², and Kevin Johnson³
¹*C-MAP USA, BioBase, Minneapolis, MN*
²*EOMAP GmbH & Co. KG, Seefeld, Germany*
³*Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Gainesville, FL*
- 12:00 pm **Koronis Lake Association Fights Starry Stonewort “To Infinity and Beyond”**
Kevin Farnum
Koronis Lake Association, Delano, MN
- 12:20 pm **Wrap-up and Adjourn 58th Annual Meeting**

59th Annual Meeting
Doubletree San Diego Mission Valley
San Diego, California
July 14-17, 2019



60th Annual Meeting
Hyatt Regency San Antonio Riverwalk
San Antonio, Texas
July 18-23, 2020



61st Annual Meeting
New Orleans Riverside Hilton
New Orleans, Louisiana
July 11-14, 2021



Abstracts - General Sessions and Poster Session

Abstracts are listed alphabetically by presenting author - appears in **bold**.

Cyanotoxins in Drinking Water Resources: Best Management Practices and Regulations

Brad A. Bartelme

EnviroScience, Incorporated, Cleveland, OH

Global drinking water resources are greatly threatened by cyanotoxins produced by Harmful Algal Blooms (HABs). These cyanotoxins degrade aquatic habitats, affect human and animal health, and restrict recreational activities. Proper monitoring and management of these toxins is crucial in recognizing the underlying cause and remedial measures required for prevention and removal. Best management practices must be employed to target the correct toxin(s), reduce exposure, and meet current regulations. In 2016 the state of Ohio enacted the Ohio Administrative Code (OAC) Rule 3745-90-03, outlining mandatory routine surface water monitoring which includes cyanobacteria and microcystin screening. Since then, Ohio's Public Water System (PWS) response strategy continues to be improved, providing monitoring guidelines, sampling protocols, identifying acceptable analytical methods, and recommending treatment optimization and development for public water resources. Cyanotoxin management strategies continue to be developed for drinking water supplies and most include a multifaceted approach to toxin treatment. While it is important to develop these treatment systems, a functional watershed approach may be more suited to achieving the ultimate goal of non-point source nutrient reduction, which is a major contributor to the formation of HABs and the associated toxins.

Laboratory and Mesocosm Evaluation of Growth and Herbicide Response in Eurasian Watermilfoil and Four Accessions of Hybrid Watermilfoil (Student Oral Presentation)

Jens Beets¹ and Michael D. Netherland²

¹*University of Florida, Agronomy Department, Gainesville, FL*

²*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL*

Eurasian watermilfoil (EWM) and Hybrid watermilfoil (HWM) are problematic submerged aquatic invasive plants in many waterways of the Northern tier 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) evaluate HWM and EWM response to several auxin mimic herbicides under static, environmentally controlled conditions, using EC₅₀ values derived from length and weight of treated plants, 2) investigate potential for increased herbicide tolerance of HWM, 3) evaluate a wide range of CET conditions to determine the effect of florpyrauxifen-benzyl on well-established EWM, HWM, and several native species under large-scale mesocosm condition, and 4) document differences in growth and response of three herbicides between populations of EWM and HWM under large-scale mesocosm conditions. Growth chamber results indicate strong response to florpyrauxifen-benzyl in both EWM and HWM, with differences in response between EWM and HWM for all of the auxin-mimic herbicides based on EC₅₀ values. This complemented our results in large-scale mesocosm trials, with significant reduction in EWM across all CET scenarios and significant reduction of HWM in all but one CET scenario. In addition to growth differences between HWM accessions, there were differences in herbicide response between accessions.

Control of Algal Growth on Irrigated Greenhouse Surfaces Using Commercial Algaecides (Student Poster Presentation)

David E. Berthold¹, Ariel Elazar¹, Forrest Lefler¹, Chris Marble², and Haywood D. Laughinghouse¹

¹*University of Florida, Fort Lauderdale Research and Education Center, Davie, FL*

³*University of Florida, Mid-Florida Research and Education Center, Apopka, FL*

Irrigated greenhouses and nurseries provide ideal environments that facilitate the formation of nuisance algal mats with detrimental effects. Algal growth poses safety concerns for horticulturists and stimulates the propagation of

unwanted plant pests and pathogens. To date, there is a limited extent of strategies and data available to effectively manage the algal problem. The effectiveness of five algaecides was tested on two varying surfaces of greenhouses *in situ* to elucidate the efficacy of chemical methods of removing algae. Moreover, *Nostoc commune* (Vaucher ex Bornet & Flahault) was treated on ceramic tiles *in vitro*, as it is a common alga in greenhouses and nurseries. Results indicate that each algaecide provided different results, dependent on the applied chemical, the surface in which the chemical is applied, and finally the types of algae that are targeted. Algaecides across the surfaces tested demonstrated that algal cell characteristics and communal makeup plays a large role in algaecide efficacy. We found sodium carbonate peroxyhydrate to be the most effective chemical in terms of controlling specifically *Nostoc* on tarp, gravel, and ceramic surfaces.

Evaluating Long-term Effectiveness of Phoslock® in Water Resource Restoration

West M. Bishop¹, Tim S. Epe², Karin Finsterle², Said Yasseri²

¹*SePRO Corporation, Whitakers, NC*

²*Institut Dr. Nowak GmbH & Co. KG – Limnology, Ottersberg, Germany*

Accumulation of phosphorus (P) in water resources can induce harmful algal blooms and water quality degradation with consequent negative ecological and economic ramifications. Phoslock is a P mitigation technology specifically designed to mitigate water column and sediment associated P. This research evaluated the impact of Phoslock in water resource management programs. Specifically, long-term (9-year) evaluations on Lake Bärensee in Germany revealed a positive impact on water quality and trophic state by programmatic applications of Phoslock. Before Phoslock application, the lake was characterized by high nutrient levels, chronic cyanobacterial blooms and frequent swimming bans. Phoslock treatment significantly decreased both chlorophyll *a* and total phosphorus concentrations at many time points post-treatment and maintained low levels of soluble reactive phosphorus. Subsequently the nitrogen balance was also positively affected in this intensely used recreational lake. Bärensee serves as an example for the targeted use of Phoslock as a management tool to control eutrophication. Specific targeting of *in situ* P sources is important to consider in water resource management programs. Phoslock is a novel phosphorus locking technology that provides an effective approach to combat the eutrophication process and restore water quality, especially in shallow lakes which suffer from exceeding anthropogenic pressure.

Invasive Aquatic Plants in Connecticut, USA: The State of the State

Greg Bugbee

Connecticut Agricultural Experiment Station, Department of Environmental Sciences, New Haven, CT

Connecticut's lakes and ponds are among the State's most important natural resources. They provide wildlife habitat, drinking water, irrigation, hydroelectric power, scenic views, recreation, and highly desired waterfront real estate. Revenues associated with boating, fishing, and other purchases aid the State's economy. Value-added real estate taxes provide working capital for towns. In recent decades, invasive aquatic plants have spread to Connecticut's lakes and ponds severely threatening their water quality, ecosystems and economic value. Since 2004, the Connecticut Agricultural Experiment Station Invasive Aquatic Plant Program (CAES IAPP) has assessed the severity of this problem through detailed vegetation surveys of over 350 water bodies. We have documented over 100 native and 14 invasive plant species. Approximately two-thirds of the lakes and ponds contained one or more invasive species and likely making Connecticut the most heavily infested New England state. Eurasian watermilfoil (*Myriophyllum spicatum*), variable watermilfoil (*Myriophyllum heterophyllum*), fanwort (*Cabomba caroliniana*), curly leaf pondweed (*Potamogeton crispus*) and minor naiad (*Najas minor*) are the most frequently found invasive species. New arrivals to the State include; hydrilla (*Hydrilla verticillata*), Water chestnut (*Trapa natans*) and Brazilian waterweed (*Egeria densa*). Statewide control efforts rely on prevention, detection and scientifically based management options. Our work has determined susceptible lakes based on water chemistry and tested novel control methods such as reduced risk herbicides, biological agents, water level drawdowns and short-term placement of benthic barriers. This work is readily available via the CAES IAPP website www.ct.gov/caes/iapp.

Management of Problematic Native Aquatic Vegetation to Enhance Multi-user Benefits in Southeastern Waterbodies (Student Poster Presentation)

Kennedy Calhoun¹, Gary N. Ervin², and Lee G. Turnage¹

¹Mississippi State University, Geosystems Research Institute Starkville, MS

²Mississippi State University, Department of Biological Sciences, Starkville, MS

¹Mississippi State University, Geosystems Research Institute, Starkville, MS

Resource managers of public lands, such as national wildlife refuges, are tasked with meeting multiple use needs of the fish and wildlife that reside on these lands, as well as the people who utilize those lands for recreational activities such as fishing and boating. Biologists at the Noxubee National Wildlife Refuge (NNWR) have identified the dominance of certain problematic native aquatic plants (American lotus, white water lily, and water shield) as a key obstacle to achieving these multiple use needs in lakes on this and other southeastern wildlife refuges. Few methods are currently known that allow the control of some of the problematic aquatic plant species that they encounter while simultaneously enhancing the diversity of desirable plant species, maintaining water quality, and providing diverse aquatic habitats that are needed for many species of wildlife and for human users of these facilities. This work aims to determine effective methods of managing problematic aquatic plants to enhance aquatic plant diversity in a way that improves the quality of lakes as wildlife habitat and sources of recreational use, while also minimizing potential negative impacts on water quality and desirable plant species. This research will explore chemical control (herbicides) to reduce the abundance of key nuisance plant species, while maintaining diversity of desirable species and also minimizing negative impacts on key water quality parameters (e.g., dissolved oxygen, nitrogen, and phosphorus). We will assess the efficacy of six systemic herbicides and one contact herbicide in a mesocosm trial at MSU's Aquatic Plant Research Facility. These trials will use two different concentrations of each herbicide and will assess impact on multiple aspects of plant growth, as well as potential impacts on water quality during the study. The most effective herbicides will then be used in field trials at NNWR during a second year of research.

A Cryptic Introduction of *Trapa* in the Northeastern United States

Greg M. Chorak and Ryan A. Thum

Montana State University, Plant Science Plant Pathology, Bozeman, MT

Cryptic invasions occur when introduced taxa go undetected because they appear similar to native or other non-native taxa already established in that range. *Trapa natans*, an annual aquatic plant, has been recognized as an invasive species in the northeastern U.S. since the 1920's. However, in 2014 a new morphotype of *Trapa* was discovered in the Potomac River, Virginia. This morphotype is distinguished by having two-horned fruits, compared to the four-horned characteristic of established invasive *Trapa* (*T. natans*). As such, we hypothesize that the new two-horned *Trapa* represents a cryptic introduction of a *Trapa* taxon that is distinct from the four-horned *Trapa* previously identified in North America. We tested this hypothesis by sampling *Trapa* from across the northeastern U.S. and collaborated with scientists from Asia and Africa for collections of *Trapa* from its native range. We genotyped 308 *Trapa* individuals at 129 amplified fragment length polymorphism loci in an effort to distinguish the two morphotypes and identify their origin. Indeed, the two-horned and four-horned varieties are genetically distinct. The two-horned *Trapa* taxon was most genetically and morphologically similar to samples from Taiwan identified as *T. bispinosa* Roxb. var. *iinumai* Nakano. The U.S. four-horned *Trapa*, previously identified as *T. natans* L. is most genetically similar to *T. natans* collected from Japan. However, our data show that the U.S. four-horned *Trapa* and *T. natans* from Japan are genetically distinct. Therefore, it is unclear whether the U.S. four-horned *Trapa* was introduced from a source not captured in our sampling, or whether the genetic differences result from genetic divergence following introduction from Japan. Further, we found *Trapa* recognized under the same species name that are genetically distinct groups. Therefore, we recommend a more thorough investigation into *Trapa* taxonomy. A similar study with more thorough sampling of *Trapa*'s native range and more detailed genetic markers may be able to resolve the taxonomy and origins of the invasive U.S. morphotypes.

Integrated Weed Management Solution for the Invasive Aquatic Weed Hydrilla

James P. Cuda¹, Emma Weeks¹, Jennifer Gillett-Kaufman¹, Mark Hoyer², and Mark Jackson³

¹University of Florida, Entomology and Nematology Department, Gainesville, FL

²University of Florida, School of Forest Resources and Conservation, Fisheries and Aquatic Sciences, Gainesville, FL

³U.S. Department of Agriculture, Agriculture Research Service (Retired), Peoria, IL

Hydrilla [*Hydrilla verticillata* (L. f.) Royle] causes serious environmental and economic impacts in aquatic ecosystems. When left unmanaged, hydrilla creates damaging infestations that choke out native plants, clog flood control structures, and impede navigation and recreation. In Florida, millions of dollars are spent annually to control large infestations of hydrilla. During the past 15 years, hydrilla developed resistance to fluridone and endothal, two of the most commonly used herbicides approved for aquatic use. A novel IWM system was developed that integrates selective insect herbivory by the hydrilla tip miner *Cricotopus lebetis* Sublette (Diptera: Chironomidae) with a native disease causing fungal pathogen [*Mycoleptodiscus terrestris* Gerd.) Ostaz.] (Mt), and low concentrations of the herbicide imazamox, an acetolactate synthase (ALS) inhibitor recently registered for aquatic use. Field testing was performed in limnocorrals (1 m diam. x 1 m depth) installed in three ponds at the UF/IFAS Center for Aquatic and Invasive Plants. Over two years, all possible combinations of the three described tactics were tested to determine the most effective combination for developing an IWM plan. Although results varied seasonally, the tip miner and Mt together or in combination with imazamox significantly reduced hydrilla biomass compared to untreated controls. Midge specific tip damage was evident in all treatments inoculated with the midge, which confirmed the insect was compatible with the Mt and the herbicide. A significant reduction in turions also was observed in all treatment combinations during the fall season. These findings indicate that a combination of different biological and chemical tactics can be used to effectively manage hydrilla.

Colorimetric Detection of Invasive Plant Species in Environmental DNA Samples

Paul Czechowski¹, Jose Andres¹, and David Lodge²

¹Cornell University, Department of Ecology and Evolutionary Biology, Ithaca, NY

²Cornell University, Atkinson Center for a Sustainable Future, Ithaca, NY

Aquatic ecosystems worldwide remain vulnerable to damage from the invasion of aquatic plant species. On-site, reliable, methods for the early detection of such species are critical to inform management and control decisions aim to protect native ecosystems. Here we present a novel approach based on the loop-mediated isothermal amplification (LAMP) of environmental DNA to detect the presence of invasive aquatic plants in natural water bodies. We demonstrate the potential of this technique using *Hydrilla verticillata*, one of the most common invasive plants in North America. With further development for on-site application, this technology could lead to real-time screening of ecosystems at risk.

Hydrilla Management in the Croton River (Westchester County, NY): Results from Year 1 of a 5 Year Control Program

Chris J. Doyle

SOLitude Lake Management, Washington, NJ

In late 2013, hydrilla (*Hydrilla verticillata*) was discovered in the Croton River (Westchester County, New York), a tributary that flows into the Hudson River. In 2014, additional surveys employing the Point Intercept Methodology, modified for river habitats, delineated the extent of hydrilla throughout the entire length of the river, including the freshwater wetlands near the Hudson River. In 2015, monitoring effort focused on 46 locations up and down the Hudson River to determine if the infestation had spread. In 2017, the New York State Department of Environmental Conservation initiated a 5-year plan to control hydrilla using a low-dose herbicide (fluridone) injection system. We shall present a summary of the 2017 treatment program, including a comprehensive monitoring program that includes pre and post aquatic plant monitoring, aquatic plant collections for independent research efforts, monitoring of 21 High Priority Hudson River locations (classified in 2015), extensive river and drinking water well monitoring for herbicide dosing, and education/outreach. Alterations to the program for 2018, and the impacts of the infestation in the New Croton Reservoir shall also be discussed.

Investigations into Possible Mechanisms of Selectivity of Endothall Herbicide in Submersed Aquatic Macrophytes (Student Poster Presentation)

Michael W. Durham and Gregory MacDonald

University of Florida, Agronomy Department, Gainesville, FL

The mode of action of endothall has been linked to cell membrane disruption and rapid tissue necrosis through a host of mechanisms. There have also been several studies examining the sensitivity of many plant species to endothall from a selectivity standpoint, but few have looked at the mechanisms of selectivity between very similar plant species. For example, hydrilla [*Hydrilla verticillata* (L.f.) Royle] is readily controlled with endothall, while elodea is not affected. To determine possible reasons for these selectivity differences, we used radiolabeled ¹⁴C-endothall to examine uptake kinetics and metabolism within similar submersed aquatic plants. The species of plants used were *Hydrilla verticillata*, *Vallisneria americana* Michx., and *Egeria densa* Planch. Each species was clonally propagated using 8 cm apical cuttings submersed in culture tubes containing 50 ml of D.I. water. These were allowed to acclimate for 7 days in a growth chamber set at 30°C day/20°C night temperatures on a 12:12 light:dark cycle. After acclimation, water was replaced with a 50 ml solution containing 3 ppm dipotassium salt of endothall and 1205 Bq ¹⁴C-endothall. Plants were harvested 3, 6, 12, 24, 48, and 96 hours after exposure to the herbicide solution. Individual plants were triple rinsed with D.I. water, blotted to remove excess moisture and dried at 70°C. Dried plants were oxidized and radioactivity quantified through liquid scintillation spectroscopy. The data was subjected to non-linear regression analysis to determine uptake kinetics. Initial studies suggest similar uptake rates, although *Vallisneria* appeared to be less in terms of uptake between 12 and 48 hours compared to hydrilla and *Egeria*. However, at 96 hours after treatment, the levels of ¹⁴C endothall were similar in all three species, suggesting differential uptake is the not mechanism of tolerance for these species. Additional studies on metabolism using thin-layer chromatography are underway and will also be presented.

Accuracy of Visual Identification of Hybrid Watermilfoil (Student Presentation)

Jasmine A. Eltawely¹, Ryan A. Thum², Raymond M. Newman³, and Jeff Pashnick²

¹*University of Minnesota, Water Resources Science, Saint Paul, MN*

²*Montana State University, Plant Sciences and Plant Pathology, Bozeman, MT*

³*University of Minnesota, Fisheries Wildlife Conservation Biology, Saint Paul, MN*

Eurasian watermilfoil (*Myriophyllum spicatum*) is a problematic aquatic weed due to its rampant spread throughout waterbodies and development of surface mats that shade native plants and disrupt recreation. Eurasian watermilfoil hybridizes with the native northern watermilfoil (*M. sibiricum*), which raises new issues regarding management strategies to control infestations. The genetic variation and geographic distribution of hybrid watermilfoil in Minnesota is currently unknown. As part of a larger project to describe hybrid distribution in Minnesota we sampled 33 lakes with a range of sizes and durations of infestation in 2017. At each lake we sampled plants at 100 points, visually identified plants by taxa, (based on morphology and leaflet count), and collected one or two plants of each taxon from each site. We completed genetic identification using Internal Transcribed Spacer (ITS) analysis for a subset of up to 20 plants per lake. Based on visual estimates from the 33 lakes, 79% contained Eurasian, 48% contained hybrid, 39% contained northern, and 15% contained all three taxa. Based on ITS marker genetic identifications, 58% contained Eurasian, 55% contained hybrid, 33% contained northern, and 6% contained all three taxa. Overall, our visual and genetic IDs matched up 80% of the time. Our visual identifications misidentified hybrids 41% of the time. Overall, 89% of the mismatches were hybrids misidentified as Eurasian or vice versa and 11% were hybrids misidentified as northern or vice versa. We tended to misidentify plants in particular lakes; for example, in one lake we visually mis-identified almost all hybrid plants as Eurasian and in another lake almost all Eurasian plants as hybrids. We plan to further analyze these samples using microsatellites to determine the genetic diversity within and among taxa. In the summer of 2018 we plan to sample 20 more lakes throughout the state.

Koronis Lake Association Fights Starry Stonewort “To Infinity and Beyond”

Kevin Farnum

Koronis Lake Association, Delano, MN

Koronis Lake Association in central Minnesota is in year a five- year pilot project to evaluate a management protocol for Starry Stonewort. Lake Koronis has approximately 250 acres of Starry Stonewort. In 2016 and 2017, a protocol

was tested integrating mechanical pulling and chemical treatment. In 2017, studies confirmed that both mechanical pulling, mechanically pulling with algaecide treatments, or just algaecide treatments can effectively manage large areas of Starry Stonewort infestation. We also demonstrated that with the use of algaecides in the deeper areas when applied early in the summer can keep the depth of the invasive lower. Starry Stonewort produces a star shaped structure called a bulbil that can grow into a new plant. The University of Minnesota completed a bulbil viability study and found that the algaecide used didn't impact bulbil viability. We suspect these bulbils had been protected by the lake sediment since other laboratory testing showed that the algaecides were very effective in killing the bulbils when exposed directly. Our plans for 2018 is to take advantage of the integrated approach developed, use mechanical pulling and algaecide treatment where it is most beneficial and cost effective and use algaecide treatment where and when it will deliver the best results. In 2018 and into the future this integrated protocol based on what is believed to be important factors, mechanical pulling, and algaecide treating will be put in place. Pulling can start in early June in the shallow areas. Algaecide treatments can be used to augment the pulling and can vary depending on needs and personnel preferences.

Aquatic Plant Management in the U.S. Army Corps of Engineers - Wilmington District Lakes (Student Oral Presentation)

Kara J. Foley, Steve T. Hoyle, Tyler J. Harris, and Robert J. Richardson
North Carolina State University, Crop and Soil Sciences, Raleigh, NC

This project aims to identify and manage aquatic invasive plant populations as well as promote the establishment of native aquatic plant communities in the U.S. Army Corps of Engineers, Wilmington District Lakes. These reservoirs include: Philpott Lake (Bassett, VA), Falls Lake (Wake Forest, NC), B. Everett Jordan Lake (Raleigh, NC), and W. Kerr Scott Lake (Wilkesboro, NC). Detecting and mapping SAV species at these reservoirs was accomplished through integrated point intercept surveys and BioBase© technology. At Philpott Lake, the northernmost reservoir in this group of study sites, dioecious Hydrilla (*Hydrilla verticillata* (L.f.) Royle) was positively identified at 38% of the surveyed points in 2017. Integrated aquatic plant management techniques that incorporate biological and chemical control methods and native plant restoration have been implemented at the Wilmington District Lakes and will be discussed. With this research, we hope to achieve effective management techniques and long-term monitoring methods that can be applied to other waterbodies within the piedmont ecoregion that face similar challenges.

Rapid Response to an Early Detection of *Nitellopsis obtusa* (Starry Stonewort) in Lake Sylvia, Minnesota, Using a Copper-Based Algaecide (Student Oral Presentation)

Tyler Geer¹, Steve McComas², and John H. Rodgers, Jr.¹

¹*Clemson University, Department of Forestry and Environmental Conservation, Clemson, SC*

²*Blue Water Science, Saint Paul, MN*

Nitellopsis obtusa (Desvaux in Loiseleur) J. Groves, commonly known as starry stonewort, is an invasive species of Eurasian origin that was likely transported and introduced to the U.S. in ballast water. Since it was identified along the St. Lawrence River, *N. obtusa* has spread rapidly among inland lakes across the Great Lakes region of the U.S. 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 initially confirmed in September of 2016 in the vicinity of the public boat access. Management of *N. obtusa* in the immediate vicinity of the boat access was initiated early in the summer of 2017. The goal of this effort was to control *N. obtusa* throughout the year and contain regrowth and any potential recolonization or re-infestation of the area. This situation provided an opportunity to measure the responses of *N. obtusa* to algaecide exposures. To target growth and regrowth of *N. obtusa*, the copper-based algaecide Cutrine®-Plus was applied on June 21, 2017, and 3 additional times between July and October 2017 in the vicinity of the public boat access. Algaecide applications were triggered by sprouting of bulbils. Weighted drop hoses were used for algaecide treatments to target an initial concentration of 1000 µg Cu/L in the bottom two feet of the water column. Analysis of samples collected after each treatment confirmed that >90% of the targeted initial exposure was achieved. Aqueous copper concentrations dissipated to background concentrations (i.e. pre-treatment aqueous copper concentrations) within 4-days following each treatment. Post-treatment *N. obtusa* surveys by an independent auditor confirmed that the spatial extent of *N. obtusa*, the frequency of *N. obtusa* at sample sites, and the density of *N. obtusa* bulbils declined in the treated area from June to December. These initial results indicate that algaecide treatments can be used control and contain infestations of *N. obtusa* in recently infested lakes.

Evaluation of Diquat (Reward) for Submersed Flowering Rush Control in Lake Pend Oreille, ID

Kurt D. Getsinger¹, John D. Madsen², John Skogerboe³, **Steve T. Hoyle⁴**, and Robert J. Richardson⁴

¹*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*

²*U.S. Department of Agriculture, Agricultural Research Service, Invasive Species and Pollinator Health Research Unit, Davis, CA*

³*Coldwater Environmental, Minneapolis, MN*

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The invasive plant flowering rush was first observed in Lake Pend Oreille, ID, in 2008, spreading to infest several hundred hectares by 2012. This perennial weed inhabits shores, riverbanks, marshes, ditches, seasonally flooded fields, and other wet places. In 2016, field trials were initiated to evaluate the herbicide diquat dibromide (Reward) for controlling submersed flowering rush, and to provide guidance for future operational-scale management strategies. An untreated reference plot was also established in the bay. The herbicide was applied evenly across the treated plot using a sub-surface injection assembly. Bulk water exchange processes were measured in the treated plot in 2017 by using rhodamine WT dye. Water quality parameters (temperature, dissolved oxygen, pH, turbidity, and conductivity) were monitored through 4.5 weeks after treatment (WAT). Quantitative vegetation assessments were conducted at pretreatment and 5 WAT in both years. After initial application, flowering rush control was 87% at 5 WAT. Pretreatment density level of 1.94 (~25% coverage) declined to 0.07 (virtually 0% coverage) during the same period. Flowering rush growth had partially recovered 1 year after treatment (YAT) with control at 29% and plant density at 1.58. Following the second diquat application, flowering rush control was 100% and plant density was zero at 5 WAT. In the untreated reference plot, flowering rush frequency of occurrence increased from pretreatment level of 59.9% to 94.7% in 2017. Plant density was measured at 2.67 and 1.58 for 2016 and 2017, respectively. Frequency of occurrence of all other submersed plants (non-target species) in 2016 diquat-treated plot was lower at 5 WAT, but recovered to near pre-treatment levels by 1 YAT. Levels of non-target plants declined in the treated plot at 5 WAT in 2017. Levels of non-target plants followed similar trends in the untreated reference plot during 2016 and 2017. Water quality parameters remained within normal levels.

Evaluation of Herbicides and Combinations for Management of the Submersed Weeds *Hygrophila* and *Fanwort*

Lyn A. Gettys, Kyle L. Thayer, Ian J. Markovich, and Mohsen Tootoonchi

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Hygrophila (*Hygrophila polysperma*) and fanwort (*Cabomba caroliniana*) are canal weeds in south Florida that grow densely enough to interfere with water movement, which can increase the risk of flooding of nearby areas during storm events. We conducted replicated greenhouse mesocosm experiments to evaluate a number of aquatic herbicides alone or in combination to identify management options for these species. Plants were subjected to a single water column treatment and maintained for 16 weeks after treatment, scored for visual quality, then destructively harvested to determine reduction in biomass compared to untreated control plants. Most of the 35 treatments reduced visual quality and biomass, but the only ones that reduced visual quality and biomass by 95% in both species were 2.5 ppm triclopyr (alone or with 0.37 ppm diquat); 100 ppb carfentrazone (alone or with 370 ppb diquat), 250 ppb imazamox + 370 ppb diquat; and 10 ppb ProcellaCOR. Additional studies should be conducted to determine whether these greenhouse results can be replicated in the field.

Biosecurity Partnership in Action

Marcus Girvan

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New Zealand's unique native biodiversity and ecosystems are central to our national identity and therefore effective biosecurity is essential for the overall benefit of New Zealand. The Strategic Biosecurity Partnership between Land Information New Zealand (LINZ) and Boffa Miskell Limited is driving innovation into the critical biosecurity sector. This public/private partnership is widely regarded as the first of its kind in New Zealand and is realising benefits unable to be achieved through the traditional buyer/supplier relationship. The efficiencies, benefits, advocacy and investment in innovation all contribute to the partnership being widely considered a successful model that allows both parties to achieve their business objectives and one that can be replicated within other government

departments. LINZ, who is responsible for managing aquatic weeds in many of New Zealand's major lakes, partnered with Boffa Miskell in 2014 after five years in a traditional contractual relationship. The outcomes and tangible benefits realized after four years in the partnership include an increase in stakeholder satisfaction, more efficient and effective delivery of biosecurity services, an expansion of Boffa Miskell's biosecurity capabilities and an intentional focus on seeking out innovative solutions.

Aeration of a Shallow Eutrophic Lake: What to Expect

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Aeration is a commonly recommended technique used to meet a variety of lake management goals including: (i) habitat improvement by eliminating thermal gradients and improving water chemistry, which allows for a more diverse and robust food web, and/or (ii) reducing symptoms associated with eutrophication, especially in regard to Harmful Algal Blooms (HABs), taste and odor issues, and water clarity. An evaluation of this technique was conducted on Lake Mohegan, a shallow (3.7m) 100-acre lake, located in the suburbs of northern Westchester County, New York. Even with the operation of an aeration system, Lake Mohegan exhibited weak to strong (episodic) stratification and anoxia at the sediment-water interface, HAB's, poor zooplankton community composition, and poor transparency. Some of these results were possibly caused and exacerbated by inadequate mixing/design of the system. Other, more explainable factors were due to lake characteristics (i.e., iron deficiencies and mixing depth). However, the aeration approach did result in some benefits. Increased zooplankton abundance, improved fish habitat, nitrate to ammonium ratios, and changes in phytoplankton species composition suggested direct benefits of aeration. Modifications of the aeration approach, maximizing benefits while minimizing impacts, offer substantial improvement potential. This presentation will discuss aeration as a management approach and its applicability to Lake Mohegan and other problematic lakes.

Harmful Algal Blooms in New York Lakes: Monitoring and Research

Rebecca Gorney

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Harmful Algal Blooms (HABs) in freshwater systems are primarily comprised of cyanobacteria and can occasionally produce toxins. Exposure to any cyanobacteria HABs can cause health effects in people and animals when water with blooms are touched, swallowed, or when airborne droplets are inhaled. This is true regardless of toxin levels; some blue-green algae produce toxins, while others do not. Exposure to blooms and toxins can cause symptoms such as diarrhea, nausea or vomiting; skin, eye or throat irritation and allergic reactions or breathing difficulties. New York State has one of the most comprehensive and extensive HAB monitoring programs in the nation. The Department of Environmental Conservation oversees monitoring, sampling and outreach regarding HABs in hundreds of lakes annually. The program consists of DEC staff within the Lake Monitoring and Assessment Section who work to identify bloom status, oversee HAB monitoring and surveillance activities, communicate public health risks, and conduct outreach, education, and research. The bloom status is a system unique to New York and relies on a combination of visual surveillance, measures of cyanobacteria density and toxin concentrations. Since the program began in 2012, nearly 350 waterbodies throughout the state have had a documented bloom. In 2018, efforts to address bloom causes and solutions have ramped up as a result of a recent Governor's Initiative to address the topic, particularly in waterbodies that serve as drinking water supplies.

Deep in the Weeds of Aquatic Plant Management in New Jersey's Delaware and Raritan Canal

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Dense aquatic vegetation growth affects the ability of New Jersey's Delaware and Raritan Canal to transfer 100 mgd from the Delaware River to meet the demands of drinking water treatment facilities and golf courses on its way to

the Raritan River. In 2016, the vegetation was so dense, the NJ Water Supply Authority contracted for conventional mechanical harvesting, only to discover several miles of dense *Hydrilla verticillata*. This finding led to the development of an aquatic plant management plan, 60 miles of submersed aquatic vegetation mapping, a low-dose herbicide application, and an intensive monitoring plan. This presentation will cover the treatment, mapping, and monitoring response that the New Jersey Water Supply Authority initiated in 2017. The Authority's management efforts focus on invasive and native plants, including *Hydrilla verticillata*, *Heteranthera dubia*, *Cabomba caroliniana*, and *Vallisneria americana*.

Absorption and Translocation of Florpyrauxifen-benzyl (Procellacor™) in Selected Aquatic Plant Species

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There is a need for the registration of more active ingredients for use in aquatic systems in order to respond to new threats or treatment scenarios, enhance selectivity, reduce use rates, and to mitigate the risk of potential herbicide resistance. Florpyrauxifen-benzyl is a new synthetic auxin, currently undergoing the registration process for use as an aquatic herbicide. In 2017, a study was conducted at North Carolina State University, in which 10 µg L⁻¹ radiolabeled florpyrauxifen-benzyl was applied to the isolated shoot tissue of ten different aquatic plant species in order to elucidate absorption and translocation patterns in these species and thus infer the potential for systemic control. Extremely high levels of shoot absorption were observed for all species tested and the uptake observed was rapid. The highest shoot absorptions were observed for crested floating heart (A 192 =20 µg g⁻¹), dioecious hydrilla (A 192 =25.3 µg g⁻¹), variable watermilfoil (A 192 =40.1 µg g⁻¹) and Eurasian watermilfoil (A 192 =25.3 µg g⁻¹). Evidence of translocation was observed in all rooted species tested. The highest amount of herbicide translocated was observed for crested floating heart with a predicted absorption of 1.28 µg g⁻¹ at 192 hours after treatments. Given the high level of relative activity of this herbicide, the herbicide translocated to the roots should be sufficient to provide control of root tissues.

Monoecious *Hydrilla verticillata* Tuber Respiration

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The primary means of reproduction for monoecious hydrilla is through the prolific production of vegetative propagules, including subterranean and axillary turions. A study was conducted to elucidate changes in respiration rates of subterranean turions over the course of a winter season. Depletion of dissolved oxygen in deionized water, containing 10 tubers, was measured in an airtight biological oxygen demand (BOD) bottle utilizing an optical BOD probe with built-in agitation. Tuber respiration rate was measured in the light and dark and under varying temperatures each month from January through July. The light level that the tubers were exposed to did not affect respiration rate. Respiration rate and Q10 (temperature dependence coefficient) value did not differ from one month to another. Significantly higher respiration rates were observed for tubers maintained in a warm water-bath (-0.159 mgO 2 hr⁻¹ g⁻¹) as compared to those maintained in a cold water-bath (-0.084 mgO 2 hr⁻¹ g⁻¹). These results indicate that temperature may be an important factor in determining the respiration rate of subterranean tubers and thereby may impact the potential longevity of these tubers in the sediment and hydrilla population dynamics.

Potential Spread of Hydrilla (*Hydrilla verticillata*) in the Great Lakes Basin (Student Poster Presentation)

Kristen M. Hebebrand and Jonathan M. Bossenbroek

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Hydrilla (*Hydrilla verticillata*), an aquatic invasive plant, threatens to invade the Great Lakes basin. Hydrilla creates dense webs that choke out native vegetation, reduce flow in canals, clog intakes, and interfere with navigation of watercrafts. Recreational boating has acted as a primary vector of spread for other aquatic invasive species and is expected to be a primary vector for hydrilla spread as well. The goal of this project is to predict spread of hydrilla via recreational boating to Great Lakes Basin using a gravity model. The model used boater registration, hydrilla occurrence data, waterbody data, road data, and watershed data to predict which water bodies will attract recreational boaters. MaxEnt results from Barnes and Soto (Unpublished niche model results) were incorporated with the gravity

model. Incorporating the results from the MaxEnt model allowed for habitat suitability to be reflected in the model. The MaxEnt results gave the probability hydrilla could inhabit based on the parameters used in Barnes and Soto (Unpublished niche model results). We parameterized our model based on the historical distribution of hydrilla. Based on 2015 distribution of hydrilla the model predicted the spread of hydrilla for 10 years in the continental United States. We expect the area of hydrilla infestation to increase by approximately 46% by 2025. The results of this model will contribute to a larger risk assessment and help prioritize management efforts.

Microcystin-LR Degradation Following Copper-based Algaecide Exposures (*Student Oral Presentation*)

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Copper-based algaecides are used in aquatic systems to decrease densities of cyanobacteria. The fate of endotoxins (e.g. microcystins; MCs) after an algaecide application is often of concern due to their potential for human health and ecological risks. Due to oxygen depletion by microbial oxidation of algal detritus after treatment, episodic low dissolved oxygen (DO) concentrations ($< 2 \text{ mg L}^{-1}$) are possible, which may alter rates of MC degradation. In this study, the influence of rapid onset of low DO conditions on resident bacterial assemblages, and potential for altered rates of microcystin-LR (MC-LR) degradation were evaluated. Densities of cyanobacteria were expected to positively correlate with rates and extents of DO decline given the mass of DO required for microbial degradation of cyanobacteria detritus following an algaecide exposure. Since each cyanobacterial cell should produce a specific amount of MC-LR, total MC-LR concentrations (sum of aqueous and cellular) were also anticipated to correlate with cell density of cyanobacteria. Mesocosm experiments were conducted in a pond in Anderson, SC that frequently experiences cyanobacteria blooms. Three densities of cyanobacteria (1×10^6 [low], 5×10^6 [medium], and 1×10^7 [high] cells mL^{-1}) were exposed to a copper ethanamine algaecide. DO and total MC-LR concentrations were measured with time following algaecide exposures to determine rates and extents of declines. DO concentrations had the highest rate of decline in the highest cell density treatment, followed by medium and low cell densities, and DO concentrations remained $< 2 \text{ mg L}^{-1}$ through the duration of MC-LR degradation in all treatments. MC-LR degradation occurred at similar rates (half-lives 1 to 1.9-d) among the range of initial cell densities. *Acinetobacter* and *Aeromonas* were dominant bacteria in treatments following copper exposures, yet, occupied minimal fractions of bacterial assemblages in untreated controls, indicating these genera may be able to utilize MCs for carbon and energy, especially in low DO (i.e. $< 2 \text{ mg L}^{-1}$) conditions. MC-LR half-lives were comparable to measured half-lives in previous studies under both aerobic and anaerobic conditions. Although half-lives of degradation were similar, at higher cell densities, MC-LR concentrations increased, confirming the benefits of taking action in early growth stages to minimize densities of cyanobacteria and concentrations of MCs.

Evaluating ProcettaCOR for Control of Five Target Aquatic Weeds in New Zealand

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The presence of invasive weeds invariably has a detrimental effect on native biodiversity, and the uses and values of our freshwaters. Removal of invasive weed beds may enable the recovery and restoration of native vegetation. The methods or tools available for weed control include habitat manipulation; biological, chemical, mechanical, manual and integrated weed control. The use of herbicides to control aquatic weeds has always been controversial, with many perceived risks posed by their use including toxicity to humans and other animals, non-target plants and the aquatic environment in general. However, many of the gains made in the management of aquatic weeds have been due to the availability of selective herbicides permitting their control without damage to native species. One of our goals is to provide solutions for weed issues by assessing new products that are registered in the U.S. for their performance on target weeds in New Zealand, always aiming for smarter tools and use profiles to minimize environmental load, costs and off target impacts. This talk presents findings from trial work this summer that

evaluated ProcellaCOR on *Lagarosiphon major*, *Egeria densa*, *Ceratophyllum demersum*, *Myriophyllum aquaticum* and *Alternanthera philoxeroides*.

Consumer Available sUAS (Small Unmanned Aircraft Systems) for Macrophyte Mapping and Management (Student Oral Presentation)

Andrew Howell and Robert J. Richardson

North Carolina State University, Crop and Soil Sciences, Raleigh, NC

Invasive exotic macrophytes, such as *Hydrilla verticillata* and *Salvinia molesta*, often have undesirable effects on native aquatic ecology and the associated local economy within invaded regions. It is well accepted that timely monitoring and efficient 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 platforms 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 Carolina and New Zealand and discuss how unmanned equipment may be incorporated in treatment programs and post-treatment monitoring.

Utilization of Dual Transducers Improves Hydroacoustic Survey Efficiency (Student Poster Presentation)

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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.

Nozzle and Speed Selection for Site-Specific Herbicide Applications Using an Unmanned Aerial Sprayer (Student Oral Presentation)

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Unmanned aerial vehicles (UAVs) and imaging sensors are making it possible to detect and map weedy areas easily, quickly and at a low cost particularly in areas with limited access. New UAVs sprayers now provide similar benefits for site-specific herbicide applications. However, there is limited information about how accurate and uniform UAV-herbicide applications are. The present study was conducted to characterize the spray pattern of a UAV-sprayer with four nozzles and eight propellers. The spray patterns of three nozzle types with different droplet sizes were evaluated at four different speeds. The results indicated that XR nozzles provided the highest coverage followed by AIXR and TTI. However, increasing application speed greatly decreased cover for XR nozzles due to off-target drift. AIXR

and TTI nozzles maintained coverage more consistently than XR nozzles and increasing flying speeds. All nozzles exhibited consistent coverage along the flying path, but applications must be initiated at least 2 m before targets to ensure coverage uniformity. The results of the present study indicate that nozzle selection and flying speed and pattern are critical for site-specific herbicide applications with UAV-sprayers to minimize drift and off-target movement.

Lake Cayuga Monoecious Hydrilla Demonstration Project, Aurora, New York

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Lake Cayuga is one of 11 pristine Finger Lakes located in central New York. On September 13, 2016, *Hydrilla verticillata* fragments were found near the Wells College dock in Aurora, New York. A subsequent point intercept survey detected 57% frequency of occurrence of hydrilla in a 27-acre area. Although hydrilla has been managed in the south end of the lake near Ithaca, New York for several years, it was particularly alarming to find a new infestation 27 miles away in a much more open and exposed area of the lake. The location of this infestation and unique circumstances involving a potable water intake make management exceptionally challenging. Nevertheless, the relatively small size of the project creates an opportunity to learn a great deal about managing new and small infestations in large, deep waterbodies. Combining bi-monthly point intercept and hydroacoustic surveys, tuber sampling and herbicide residue analysis produces a strong suite of quantitative data that lends itself nicely to adaptive management. Results for year 1 of the demonstration project using a combination of fluridone and copper point to a sound management plan despite getting a late start. The hydrilla frequency of occurrence in September 2017 was reduced to 2.4%. The treatment strategy for year 2 has been modified in order to maximize efficacy and selectivity while providing an opportunity to learn more about pairing granular fluridone and copper. The findings of this demonstration project will be used to provide guidance for rapid response management of new hydrilla infestations in the deeper lakes of the northeast United States.

Knowledge to Action on Global to Local Invasions

David Lodge

Cornell University, Atkinson Center for a Sustainable Future, Ithaca, NY

The invasive subset of almost 200 nonindigenous species in the North American Great Lakes cause at least \$200M in annual damages. Those and the many other damages from invasive species throughout North America, including very substantial damages from aquatic plants, have mostly been accepted as a necessary by-product of global trade. Such fatalism is however unnecessary and financially foolish. Recent innovations are reducing invasions from ships, and from commerce in living organisms, while simultaneously increasing net economic benefits. Aquatic plant management has been a partial exception for decades--an arena in which substantial investments have been made in control technologies; as in other arenas, however, little has been invested in early detection or prevention. New DNA-based technologies provide improved early detection tools, which, if combined with large-scale eradication and control technologies, open the door to a virtuous cycle of innovation, business opportunity, and environmental protection. Such a virtuous cycle will be hastened and enhanced by co-creation of research with decision-makers in the public and private sectors.

Great Lakes Hydrilla Risk Assessment

Carl E. Mach

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Hydrilla verticillata (Hydrilla) is one of the world's most invasive aquatic plants with the ability to grow and spread rapidly, thereby impacting water quality, native aquatic communities, and human uses of waterbodies. The monoecious biotype, which is better adapted to survive at higher latitudes than the dioecious biotype, has been found in several locations in New York and Ohio, raising concerns about its spread throughout the Great Lakes Basin (GLB). To address these concerns, a team led by the U.S. Army Corps of Engineers Aquatic Plant Control Research Program (APCRP) conducted a risk assessment to understand the potential for introduction and establishment of

monoecious Hydrilla in other areas of the GLB. Funded under the Great Lakes Restoration Initiative (GLRI), the objective of the project was to identify areas most vulnerable to invasion based on likelihood of introduction and habitat suitability. Distributional modeling and Great Lakes water temperature and depth information were used to identify suitable habitats for Hydrilla in the GLB. Dispersal modeling was used to evaluate the likelihood of Hydrilla spreading to new areas from where it is now. Other project components included: 1) assessing socio-cultural, economic, and environmental impacts of Hydrilla establishment in the GLB; 2) evaluating effects of photoperiod, temperature, and interspecies competition on monoecious Hydrilla growth in northern waters through laboratory and field mesocosm studies; 3) developing recommendations for prevention, early detection, and rapid response to reduce risk of Hydrilla spread; and 4) identifying best management practices (BMPs) for Hydrilla control. This presentation will provide a summary of the risk assessment results, including identifying areas in the GLB most vulnerable to invasion based on likelihood of introduction and habitat suitability.

Mapping Waterhyacinth (*Eichhornia crassipes*) Drift and Dispersal in the San Joaquin Delta Using GPS Drogues

John Miskella and **John D. Madsen**

U.S. Department of Agriculture, Agricultural Research Service, Invasive Species and Pollinator Health Research Unit, Davis, CA

Waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) is a perennial free-floating aquatic plant species native to South America that has become invasive around the world, including the Sacramento-San Joaquin Delta in California. From June 2016 to February 2018, the effect of wind, tidal movement, and mass flow on the dispersal of waterhyacinth mats in the Delta was studied. Drogues were deployed to track the movement of waterhyacinth mats. Each drogue was comprised of a 2000mL Nalgene bottle containing a radio collar and a GPS-based recording device. Drogue location and movement was recorded at 15-second intervals during a 2 to 4 hour run on a Trackstick GPS device and downloaded into Trackstick Manager 3.1.1 Rev 13 (Telespatial Systems, 2011). The data were tested to determine whether the size (m²) of a plant mat had a significant effect on the distance traveled (miles), using ANOVA to detect differences ($P \leq 0.05$), with significant effects evaluated with Tukey's HSD test ($P \leq 0.05$). There was no significant difference in distance between plant mats of different sizes ($F = 1.88$, $p = .0867$). The water discharge, in ft³/s, was obtained from USGS stream gages located throughout the Delta. The movement of each drogue was compared to the wind and water movement during the period the drogue was deployed. The plant mat direction, recorded as a compass heading, was compared to the direction of the water movement using simple linear regression (SAS 9.4, 2012). The direction of water movement explained a significant proportion of the variance in direction ($R^2 = 0.8218$, $F(1, 77) = 355.07$, $p < .0001$). The plant mat direction was also compared to the heading of the wind movement using simple linear regression. The direction of wind movement failed to explain a significant proportion of the variance in direction ($R^2 = .0163$, $F(1,77) = 1.28$, $p < .2617$).

Temperature as a Driver of Waterhyacinth (*Eichhornia crassipes*) Growth in the Sacramento/San Joaquin River Delta

John D. Madsen

U.S. Department of Agriculture, Agricultural Research Service, Invasive Species and Pollinator Health Research Unit, Davis, CA

Waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) has been rated as the worst aquatic weed worldwide. It is a recurring management issue in tropical and subtropical freshwater bodies in the United States. A 26,000 ha (65,000 acre) freshwater estuary, the California Sacramento / San Joaquin River Delta has had recurring problematic infestations that interfere with commercial and recreational navigation and disrupt pumping of irrigation and domestic water into the California Water Project. The rapid growth rate and vegetative reproduction drive the nuisance problem. A 16-tank greenhouse study was performed in which waterhyacinth was grown under controlled temperatures of 15, 20, 25, and 30°C. Each tank was subdivided into six cells of 0.1 m² and each temperature was replicated four times. Two rosettes of similar size were planted into each cell, with pretreatment weight measured. Every week after initiation, one cell per tank was harvested, the number of rosettes counted, and the plants dried to determine dry weight. Relative growth rate (RGR) was calculated for all treatments at each harvest interval. Waterhyacinth growth is significantly increased by water temperatures of 25°C to 30°C. Relative growth rate was likewise highest at 25° and 30°C, with a doubling time of 10 days estimated. These experimental findings support

field growth measurements, with annual growth initiating at 15°C and rapid growth with warm water temperatures. Relative growth rate calculated from field data indicates positive growth from April through November of most years, with high variability.

Implementing Monitoring Techniques of *Hydrilla verticillata* in the New Jersey Delaware and Raritan Canal (Student Poster Presentation)

Emily R. Mayer¹ and Amanda Mahaney²

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The Delaware and Raritan Canal serves as crucial water resource managed by the New Jersey Water Supply Authority. The canal is approximately 60 miles long and is utilized as a potable water supply, cooling water and irrigation. In addition, the canal serves as a historical site, state park, a navigable waterway and is heavily used in recreational purposes. As a raw water transmission system, thick growth of submersed aquatic vegetation (SAV) is detrimental to the water quality and velocity delivering water on a daily basis. In 2016, hydrilla (*Hydrilla verticillata*) was discovered in the canal. In response to the discovery, this prompted the New Jersey Water Supply Authority to acquire an aquatic consultant to conduct SAV monitoring, using modified Point Intercept Methods (PIM), in order to support the treatment control plan. The treatment plan includes a low dose herbicide injection system. Extensive submersed aquatic vegetation surveys, herbicide treatment, herbicide residue sampling, and hydrilla tuber monitoring are being utilized for the management of hydrilla and residual nuisance vegetation.

Circling the Wagons: Implementing New York State's Aquatic Invasive Species Management Plan

Catherine A. McGlynn

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The updated New York State AIS Management Plan was released in July 2015. The focus is on prevention through regulation, education and outreach, and risk assessments that focus on pathways of introduction. The top priority of plan implementation is expanding boat steward programs throughout New York to support existing regulations and to promote behavior change. Additional programs are being developed and New York is expanding partnerships beyond its borders to have a more regional focus on addressing particular priorit invasive species. Future plans will be discussed.

Fate of Microcystins in Nearshore and Upland Environments: A Dredged Material Management Perspective

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To appropriately manage the 200 - 300 million CY of dredged material collected annually in the U.S., beneficial use programs are increasingly being favored over traditional disposal practices due to the economic, social, and ecological benefits along with the lack of capacity in confined disposal facilities. Recently, there have been concerns regarding dredged material impacted by harmful algal blooms (HABs). HABs occurring in aquatic systems where bottom sediments are routinely dredged potentially introduces exposures of algal toxins (e.g., microcystins [MCs]) to dredged material which is beneficially used for nearshore and upland placement for land and habitat improvements. The objective of this study was to conduct a literature review of the current information related to the fate and transport of MCs in upland environments. The study also focused on detailing pathways for potential human exposures of MCs relevant to confined disposal facilities and nearshore or upland placement sites for beneficial use. To date, there are limited peer-reviewed data indicating potential exposures of MCs from dredged material beneficially used in terrestrial environments. Predominate transfer and transformation pathways of MCs in soils include microbial degradation, aqueous transfers (e.g., hydraulic mobility in soils), and biotic uptake. Potential routes of MC exposures to humans in upland environments include ingestion and inhalation, while dermal contact is estimated to be a minor (or incomplete) pathway. Based on existing published studies reporting relevant exposure factors (i.e., concentration, duration, forms, etc.) of MCs in sediments, adverse effects of MCs in dredged material used beneficially in upland environments to either ecological or human receptors are largely unknown at this time.

New Hampshire Variable Leaf Milfoil (*Myriophyllum heterophyllum*) Response to Florpyrauxifen-benzyl (Procellacor™) Concentration Exposure Times (Student Poster Presentation)

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Variable leaf milfoil (*Myriophyllum heterophyllum*) is a submersed aquatic weed that is a major concern for freshwater ecosystems in the northeastern U.S. In New Hampshire, 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 ($91.7 \pm 6.8\%$) with rates of florpyrauxifen-benzyl as low as 5 ppb with at least a 3-hour exposure time.

Comparing Efficacy Between Generic vs. Proprietary Aquatic Herbicides for Control of Floating Plants **Christopher R. Mudge¹** and Kurt D. Getsinger²

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When managing invasive aquatic plants, agency personnel are faced with critical decisions to select herbicides appropriate for use in public water bodies. Factors impacting these decisions include quality and consistency of herbicide performance, technical support and guidance from manufacturers, and economics. To date, limited research has been conducted to compare the efficacy of proprietary vs. generic products in head-to-head trials. At the request of the USACE Jacksonville District, a series of mesocosm trials were conducted and repeated to evaluate commonly used 2,4-D, glyphosate, diquat, and triclopyr products against the floating plants, giant salvinia (*Salvinia molesta* Mitchell), water hyacinth (*Eichhornia crassipes* (Mart.) Solms), and water lettuce (*Pistia stratiotes* L.). Visual observations indicated that all generic and proprietary herbicides within a given trial and active ingredient performed similarly with regard to degree and progression of injury symptoms. There were no significant differences in efficacy for 2,4-D vs. water hyacinth, diquat vs. water lettuce, glyphosate vs. giant salvinia, and triclopyr vs. water hyacinth. However, differences existed between products in glyphosate vs. water hyacinth and diquat vs. giant salvinia trials.

Field Demonstration of Improvements to Salvinia Weevil Establishment and Giant Salvinia Management as a Result of Nitrogen Amendments

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Equal densities of Brazil ecotype salvinia weevils (*Cyrtobagous salviniae* Calder and Sands), 45 adults and 160 larvae per m², were released onto ten replicate 19m² plots of tertiary giant salvinia (*Salvinia molesta* D.S. Mitchell) on Saline Lake, Louisiana, U.S. Plots were evenly separated into five control and fertilized plots. Fertilized plots received nitrogen amendments every four weeks, for a total of four treatments, via foliar application of a water-soluble fertilizer (24-8-16). Salvinia weevil densities, giant salvinia nitrogen content, and percent coverage were monitored approximately every four weeks for nine months post-weevil release. Fertilizer applications significantly increased plant nitrogen content in fertilized plots for the duration of the study. Difference between control and fertilized plots peaked 16 weeks post-initial fertilizer amendments in which fertilized plots had an average of 2.24% dry weight plant nitrogen content, a value two-fold greater than control plots. Within four weeks of salvinia weevil release and initial fertilizer treatments, larval densities were three-fold greater in fertilized plots. Significant increases to adult densities were not achieved until week 16, most likely due to a delay in new adult emergence. Adult densities in fertilized plots remained significantly greater than control plots for the 24 final weeks of the study. Additionally, giant salvinia was present in control plots at 96 to 100% for the duration of the study. In fertilized plots, in which adult and larval salvinia weevils successfully established, giant salvinia was reduced to approximately 20% coverage for the last 19 weeks of the study.

Response of Native and Invasive Submersed Aquatic Macrophytes in Three Minnesota Lakes to Carp Removal and Management

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We assessed the response of submersed macrophytes to carp removal and subsequent management in three lakes in central Minnesota; two shallow lakes (Staring and Susan) and one deep lake (Riley). Carp were reduced in all three lakes from damaging levels (> 300kg/ha) to 10- 40kg/ha in Riley and Susan and 100kg/ha in Lake Staring. The number of species and frequency of occurrence of submersed plants increased during the first years after removal in all three lakes, however the abundance of invasives such as curlyleaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*) also increased. Curlyleaf pondweed abundance increased to levels (>40-50% occurrence) requiring herbicidal control within 2-3 years in Lake Riley and Staring and 3-4 years in Lake Susan. Eurasian watermilfoil failed to increase to nuisance levels in Lake Susan, only recently appeared in Staring but reached nuisance levels in Riley 2-3 years after carp removal. Herbicidal control generally reduced the invasive plants and natives were generally not impacted but native plants only incrementally increased after invasive control. Carp removal in all three lakes appeared to mainly enhance native plants by eliminating uprooting; improvements in water clarity were limited to May and June and did not extend into summer. The poor mid-June to September water clarity (Secchi depths < 1m) limited the occurrence and expansion of native plant taxa. Transplanting in Lake Susan helped increase the number of submersed native taxa from 5 to 11 but these plants failed to expand beyond 1.5m depth. Native submersed plants in Lake Riley increased from 6 right after carp removal to 12 in 2015 but further increased to 14 after an alum treatment in 2016. Measures to control invasive species and approaches to sustain water clarity may be key to native plant restoration after carp removal.

Field Evaluations of Herbicide Efficacy on Invasive *Scleria* Species (*S. lacustris* and *S. microcarpa*) in Florida (Student Poster Presentation)

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Scleria lacustris is an annual invasive wetland sedge that has been documented to displace native species and change community structure and ecological functions in Central and South Florida (FLEPPC category I species). Natural resource managers are faced with many challenges when controlling this species. The seasonal nature of this species combined with its dependence on hydrological conditions to germinate can lead to missed treatment windows and difficulties accessing sites where infestations are present or are a threat. Additional non-native species of the same genus have been discovered in Florida, *Scleria microcarpa* (2015) and *Scleria eggersiana* (2017). Both species are perennial and inhabit the shaded understory of hardwood swamps. *Scleria microcarpa* has been documented in 3 counties in Central Florida aggressively infesting hundreds of acres of cypress swamps. These newer *Scleria* species will require a different set of management strategies and considerations. Both species are listed as Early Detection and Rapid Response species within their respective Cooperative Invasive Species Management Areas (CISMA). Field trials have been established for both *S. lacustris* and *S. microcarpa* to evaluate the efficacy of non-selective and sedge specific herbicides. Herbicide trials on *Scleria lacustris* were implemented at Audubon Corkscrew Swamp Sanctuary in Southwest Florida while trials on *Scleria microcarpa* were implemented at the Williamsburg Tract of Shingle Creek in Central Florida. Initial observations suggest both species can be effectively controlled with glyphosate, but other, more selective materials also provided control. Additional trials to link seasonal water fluctuation and intermingled desirable native flora are also underway. Ongoing research of all three species is imperative in order to develop the best management practices that consider the size of the infestations, stage of growth of the plants, and the natural habitats where the infestations occur.

Assessing Physiological Stress and Changes in Toxin Quota in Harmful Cyanobacteria Using Hyperspectral Imaging

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To assist U.S. Army Corps of Engineer resource managers in managing cyanobacteria blooms more effectively we are using hyperspectral imaging for species level detection and identification. Hyperspectral imaging of laboratory monocultures of cyanobacteria revealed a difference in spectral signatures, based on unique qualities of the photosynthetic absorbance spectrum, that may be used for identification. To use this technique in the field we need to understand how these signatures change with stress. Therefore, we induced varying degrees of stress (N, P, Mg and Fe limitation) in *Microcystis aeruginosa* and *Anabaena* sp. cultures to identify physiological ranges of each species and record their associated hyperspectral signatures using a Resonon hyperspectral camera (400-1000nm). Concurrently we evaluated these samples for cyanotoxins to align changes in cell health with toxin production. Laboratory experiments showed a lateral shift in spectra with nitrogen limitation and a vertical shift in spectra with phosphorous limitation. Vertical shifts also corresponded with increased toxin production. Collectively these results suggest we may be able to use hyperspectral imaging to gather lake-wide cyanotoxin information. We are currently performing lake-wide assessments for comparison to laboratory information. To scale-up, we are using a Headwall nano-hyperspectral sensor (400-1000nm) mounted on a UAS (unmanned aircraft system) for aerial imaging. This platform will enable routine whole-lake monitoring and rapid identification of cyanobacteria and potentially cyanotoxins at low-levels for the prevention and/or early management of cyanoHAB events.

A Workshop Summary: Prioritizing Research for Management of the *Nitellopsis obtusa* (starry stonewort)

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To assist U.S. Army Corps of Engineers resource managers in controlling the invasive macroalga, starry stonewort (SSW) (*Nitellopsis obtusa*), the ERDC in partnership with Washington and Waukesha counties hosted a regional workshop in September 2017. The workshop was held in Oconomowoc, WI, and was supported by the Aquatic Plant Control Research Program (APCRP) and the Great Lakes Restoration Initiative (GLRI). Specific goals of the SSW workshop were to: 1) Review current research efforts in biology, invasion ecology, and management of the macroalga, and determine key knowledge gaps in those areas that should be elucidated; 2) Discuss current distribution and spread of the organism and why it poses a significant threat to the Great Lakes ecosystem; 3) Identify and prioritize research, monitoring, and management requirements; 4) Coordinate personnel from government, academia and industry to develop a clearing house for addressing SSW issues with a focus on minimizing duplication of efforts and stimulating new collaborations; and 5) Produce a summary report that highlights research and management priorities and details key points that can be used to educate resource managers, stakeholders, and legislators in the Great Lakes Region. The workshop consisted of approximately 35 people across 11 states and Canada and was attended by experts from academics; federal, state and local government agencies; private industry and non-profit organizations.

Evaluation of a Foliar Endothall Use Pattern for Controlling Crested Floating Heart (*Nymphoides cristata*) and Giant Salvinia (*Salvinia molesta*) (Student Poster Presentation)

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Endothall (dipotassium salt) is primarily applied subsurface to manage submersed aquatic vegetation but is also efficacious against the floating-leaved plant crested floating heart if higher concentrations and exposure times are maintained. In 2016, Santee Cooper aerially applied liquid endothall with no water carrier (i.e. 0 gallons per acre (GPA), no diluent) to the foliage of surface-matted crested floating heart in Lake Marion, SC. The non-traditional

application technique targeted an in-water herbicide concentration of 4 mg L⁻¹ to control parent plants and ramets. As a result of the highly efficacious operational treatment, a mesocosm trial was conducted to evaluate foliar use of endothall targeting 3 mg L⁻¹ with water carrier volumes 0 to 100 GPA for 24 hr. exposures, as well as 3 mg L⁻¹ subsurface (static and 24 hr. exposure). In addition, the invasive fern giant salvinia was recently found in the Santee Cooper system; therefore, a foliar endothall use pattern was also investigated against giant salvinia. All foliar treatments injured crested floating heart <6 hours after treatment, but treatments at ≥5 GPA recovered 2 to 6 days after treatment. All treatments, except endothall applied with 100 GPA diluent, provided 42 to 100% control. There were no differences in control (99 to 100%) for endothall applied between 0 and 5 GPA. In particular, the 0 GPA treatment resulted in 100% control and supports previous operational efforts. The 1, 3, and 5 GPA applications would also provide acceptable control if a diluent (water) was required. The 10 to 100 GPA and 24 hr. subsurface treatments provided unacceptable control and would not be recommended for control of crested floating heart. Plants exposed to the subsurface static treatment were reduced in biomass by 84%, but regrowth was observed <2 weeks after treatment. All endothall treatments, regardless of application technique or GPA, reduced giant salvinia biomass 32 to 95% of the non-treated control. There were no differences in control (78 to 95%) among treatments applied at ≤5 GPA. These data provide evidence that lower GPA applications of endothall can be utilized to manage crested floating heart and giant salvinia. Future research should investigate endothall at 1 or 2 mg L⁻¹ to determine if control can be achieved from lower herbicide concentrations.

Chemical Control of Two Grass Species Under Different Salinity Regimes (*Student Oral Presentation*)

Candice Prince and Gregory MacDonald

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Environmental conditions (salinity, flooding, drought, etc.) have an effect on morphological and physiological features of plants, including leaf traits, biomass allocation, and growth rate. Changes in these features can impact how herbicide is absorbed and translocated by plants. This may present management challenges for species that can grow in a variety of environmental conditions, such as *Panicum repens* (torpedograss) and *Phragmites australis* (common reed). To understand how salinity affects herbicide efficacy, we grew plants of each species in freshwater (0.7 ppt) or saline (15 ppt) conditions in a greenhouse. After 2 weeks of growth, we measured height, stem number, leaf number, leaf area, and above- and below-ground biomass. We then treated plants with either imazapyr (0.125, 0.25, 0.5, or 1 lb. a.e. per acre) or glyphosate (0.5, 1, 2, or 4 lb. a.e. per acre) (4 replications per treatment, plus an untreated control, per salinity regime). Thirty days after treatment (DAT), we measured injury, height, stem number, and aboveground biomass. Sixty DAT, we measured height, stem number, as well as above- and below-ground biomass. Torpedograss showed reductions in height, leaf number, stem number, biomass, and growth rate under high salinity conditions. In addition, torpedograss showed lowered susceptibility to herbicide treatments (particularly for glyphosate) under these conditions, likely due to lower growth rate and leaf number. Common reed was unaffected by our salinity treatments, and salinity had little effect on herbicide efficacy for this species.

Field Evaluation of Graminicides on *Hymenachne amplexicaulis*, West Indian Marsh Grass: Control and Non-target Effects (*Student Oral Presentation*)

Stephen Enloe and **Kaitlyn Quincy**

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West Indian marsh grass, *Hymenachne amplexicaulis*, is a perennial, stoloniferous species that forms monocultures in freshwater marshes in Florida. Typically, broad-spectrum herbicides such as glyphosate and imazapyr are used for control, however these herbicides do not conserve native grasses. The availability of the grass specific herbicides sethoxydim and fluazifop-p-butyl prompted this study to test their efficacy on *Hymenachne* and non-target impacts on native plant species in littoral marshes of a central Florida lake. Plots were treated in the fall of 2017 with 24 oz/A fluazifop, 64 oz/A fluazifop, or 3 gal/A sethoxydim, each with 1% v/v MSO. At 30 DAT and 90 DAT, all graminicide treatments showed a significant decline in *Hymenachne* cover compared to the untreated control with no differences between treatments. The graminicides provided at least 90% WIMG control at 30 DAT and 90 DAT when compared to the untreated control. At 90 DAT, 62 to 84% decline was recorded in native grass species cover monitored at the site (*Leersia hexandra*, *Luziola fluitans*, and *Paspalum distichum*). Preliminary results indicate the graminicides tested provide good short-term control of *Hymenachne* and an observable impact on the native community. Spring-

time monitoring at 180 DAT is expected to reveal the longer-term responses of both target and non-target grass species and will determine the need for retreatment.

Incorporating Advanced Robotics into Aquatic Plant Management: Development of an Autonomous Aquatic Application System

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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.

Erie Canal Monoecious Hydrilla Demonstration Control Project, Buffalo, New York

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The invasive submersed plant *Hydrilla verticillata* was discovered by U.S. Fish and Wildlife Service personnel in multiple sites within Tonawanda Creek/Erie Canal near Buffalo, New York in the late summer of 2012. Following confirmation as the monoecious biotype of hydrilla, additional sampling and delineation efforts in 2013, the proximity of the infestation to the Niagara River and the potential for further spread of hydrilla eastward through the canal to numerous key water bodies across New York were primary factors that drove the decision to initiate a demonstration control project for a 15-mile portion of the Erie Canal. A number of key findings associated with control of monoecious hydrilla can be attributed to this project. Monoecious hydrilla tubers were documented to have synchronous sprouting and growth at this latitude based on increasing water temperatures in the late spring. This phenomenon allowed for a large single application of a contact herbicide to address the vast majority of the hydrilla present in this flowing system. Late-season tuber sprouting was not observed. Large-scale endothall treatments conducted in 2014 and 2015 have significantly reduced hydrilla frequency from 31% to less than 1%. Overall herbicide use has been reduced by over 50% compared to the first two years of treatment. Tuber numbers were also significantly reduced during the 2014 treatment by more than 90%, and now approximately 99% with additional reductions in tuber numbers noted in 2015, 2016 and 2017. Impacts on native plants were much greater than predicted the first year of the treatment, and in many areas native plants have not recovered. Although efforts are now focused on how to control the last 1% of hydrilla in this project area, it is important to remember the number of hydrilla fragments observed in the canal has been reduced from thousands per day in 2014 to a rare observation during surveys in 2016 and 2017. The immediate threat of further spread from this site has been greatly reduced.

Efficacy of Waterhyacinth Weevils (*Neochetina* sp.) and the Herbicides Glyphosate, Diquat, and Carfentrazone for Integrated Management of Waterhyacinth (Student Poster Presentation)

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Waterhyacinth (Pontederiaceae: *Eichhornia crassipes*) is one of the world's worst invasive plants. According to the Invasive Species Specialist Group, a part of the IUCN (International Union for Conservation of Nature), waterhyacinth ranks number 32 on their list of top 100 invasive species (including animals and fungi), globally. Integrated pest management (IPM) has been applied to waterhyacinth through a variety of control measures, including, but not limited to, chemical and biological control. Diquat, glyphosate, and carfentrazone are three herbicides used for chemical control of waterhyacinth. Two weevils that are considered moderately successful biocontrol agents are *Neochetina eichhorniae* and *N. bruchi* (Coleoptera: Curculionidae). Both species were released in the 1970s by the USDA. Previously, a study demonstrated that herbivory pressure from biocontrol agents allowed 2,4-D rates to be reduced without losing control efficacy. This study shows that at least one more herbicide can have treatment rates reduced with the herbivory pressure from biocontrol agents. Weevil presence increased efficacy of carfentrazone on waterhyacinth at half the maximum labeled rate, but no insect effect was noted in other herbicides and rates evaluated. This experiment revealed that biocontrol agents may influence waterhyacinth herbicide efficacy.

Efficacy of Twelve Non-aquatic Herbicides for Managing Giant Salvinia (Student Oral Presentation)

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Dense infestations of the free-floating aquatic fern giant salvinia (*Salvinia molesta* D.S. Mitchell) have been expanding across the Southeastern United States since 1998. Small-scale research and field operations have shown that aquatic herbicides are capable of managing giant salvinia. However, only a few of these products are efficacious and economically feasible for large scale management, which has led to repeated use of glyphosate and/or glyphosate + diquat tank mixes as the primary tool for managing giant salvinia for more than a decade. Although this combination has been highly effective in Louisiana and Texas, the annual use of one herbicide or one spray mixture will be detrimental if giant salvinia were to develop resistance to either herbicide in the future. Therefore, outdoor mesocosm trials were conducted to evaluate non-aquatic herbicides for activity against giant salvinia. In the first trial, two ALS herbicides were the most effective. Both treatments caused plants to become necrotic, lose buoyancy, and desiccate as early as 2 weeks after treatment (WAT) and 100% plant mortality was documented by 8 WAT. In addition, clomazone, halosulfuron, and bensulfuron provided 69, 76, and 77% control, respectively. Herbicide treatments that provided $\geq 30\%$ control in trial 1 (with the exception of clomazone) were re-evaluated in trial 2 at additional rates. All herbicide treatments in trial 2 significantly reduced giant salvinia biomass compared to the non-treated reference. In addition, all three rates of the two most effective ALS herbicides in trial 1, provided 98 to 99% control in trial 2. Although they did not provide 100% giant salvinia control in trial 2 at 12 WAT, no new frond growth was observed, and harvested material consisted of small rhizome fragments that had little to no viability. The results of these studies conclude that giant salvinia is sensitive to low use rates of several ALS herbicides and regrowth of treated plant material is minimal.

A Comparison of Filamentous Algae Herbicide Treatments in Arkansas Ponds

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Filamentous algae is consistently cited as one of the leading nuisance aquatic plants in Arkansas. In ponds with water alkalinity above 50ppm CaCO₃, the treatment most often suggested is a copper sulfate solution. In ponds with alkalinities below 50ppm CaCO₃, one of the formulations of chelated copper is recommended. There have been reports that adding diquat dibromide to the copper sulfate solution can provide enhanced control for filamentous algae. The relatively new active ingredient flumioxazin (Clipper) has been rated as providing good to excellent control for filamentous algae. A demonstration was conducted where filamentous algae was treated with either a

copper sulfate solution, a combination of copper sulfate/diquat, a chelated form of copper, or flumioxazin. The results were then compared in order to be better able to make treatment recommendations to pond owners.

New Stocking Rates for Triploid Grass Carp (*Ctenopharyngodon idella*)

Anita Kelly, Scott Jones, and **George L. Selden**

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For many years, grass carp have been used extensively in both private and public waterbodies for nuisance aquatic plant control. Typical stocking recommendations can vary widely due to waterbody size and the amount of aquatic vegetation but tend to be around five fish per acre. Much of the previous research to determine stocking rates was performed with diploid (fertile) grass carp. Currently, most states require that any grass carp stocked must be triploids, to ensure that there is no reproduction. Research conducted by University of Arkansas at Pine Bluff Aquaculture/Fisheries personnel indicate that the recommended stocking rates for triploid grass carp should be higher than previously thought.

Comparing Efficacy of Endothall+Diquat and Endothall+Copper Formulations for *Egeria densa* Control (Student Oral Presentation)

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Brazilian Elodea (*Egeria densa*) is a fast-growing invasive aquatic plant that can form dense canopies at the water surface. Past studies in the literature show that treating *Egeria* with endothall alone has limited effect. *Egeria* infestations frequently occur alongside other nuisance species, making it important to identify whether herbicide combinations used to target multiple species could have potential antagonistic effects on *Egeria densa* control. This study compares the efficacy of a pre-mixed formulation of endothall+diquat (AquaStrike®) to separate treatments of endothall, diquat and copper sulfate pentahydrate (CSP) as well as dual applications of endothall+diquat and endothall+CSP. *Egeria* plants were propagated from 10cm apical tip cuttings that were rooted for 3 weeks and then transplanted into 50mL falcon tubes containing field soil, slow-release fertilizer and capped with play sand. Five-gallon mesocosms filled with 15L of dechlorinated tap water were treated with one of ten treatments. Three plants were exposed for 1, 3, 5 or 7 days to each treatment, triple-rinsed in clean tap water and transferred to a 1000L tank containing non-treated water. Visual control ratings were taken at 7, 14, 21 and 28 days after treatment (DAT) and biomass was collected at 28 DAT. Results indicate that endothall does not appear to have a significant antagonistic effect on *Egeria* control when used in combination with diquat or copper. Copper and endothall+copper combinations resulted in more rapid symptom development than other treatments.

Mechanical Control of Flowering Rush (*Butomus umbellatus* L.) (Student Oral Presentation)

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Butomus umbellatus L. (flowering rush) is an aggressive invader capable of displacing many native aquatic/wetland plants for resources while simultaneously disrupting ecosystem processes and human uses of waterbodies. Flowering rush can grow as a wetland plant around margins of waterbodies, as an emergent plant in shallow waters (depth < 1.2 m), or as a fully submersed plant in deeper waters. Currently, two submersed applications of diquat per growing season usually provide >80% control of the flowering rush tissues and propagule bank. However, in some areas that have threatened or endangered species, pesticide (i.e., herbicide) use may be heavily regulated or banned entirely. In areas such as these other strategies are needed for control of flowering rush. This study investigated clipping/harvesting flowering rush biomass as a control strategy. Sequential clippings were compared to non-treated flowering rush and two sequential diquat applications to flowering rush. Plants were clipped one, two (every two months), four (monthly), or eight times (every two weeks) per growing season or treated twice with diquat (0.19 ppm) per growing season. Plant tissues were harvested 16 weeks after treatment, placed in labeled paper bags, dried

at 70°C for five days, and weighed. An analysis of variance was used to test for differences among treatment means; a Fishers Least Significant Difference test was used to separate means if differences were detected. Eight clippings and the sequential diquat applications were the only treatments that consistently reduced belowground plant tissues and propagule density when compared to untreated reference plants ($p < 0.001$). However, no treatment consistently reduced aboveground tissue weights when compared to untreated reference plants. The lack of emergent flowering rush control or potential costs associated with clipping strategies suggest that further treatment options, including integrated control measures should be investigated for flowering rush growing in areas that restrict pesticide use.

Sequential Applications of Diquat to Control Flowering Rush (*Butomus umbellatus* L.) (Student Poster Presentation)

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Butomus umbellatus (flowering rush) is an aggressive aquatic invasive plant species in the northern U.S. and southern Canada. Flowering rush is capable of displacing many native aquatic/wetland plants which can disrupt ecosystem processes and affect human uses of waterbodies. Flowering rush has three growth forms: wetland plants along the margins of waterbodies, emergent plants in shallow waters (depth < 1.2 m), and fully submersed plants in deeper waters. Currently, operational control protocols utilizing two submersed applications of diquat (0.37 ppm) per growing season have achieved >80% control of the overall flowering rush tissues and propagule bank in the Detroit Lakes, MN system. However, at some local sites within the Detroit Lakes it has taken multiple years for this protocol to control flowering rush. In areas such as these a more aggressive control strategy may control flowering rush. This mesocosm study investigated sequential diquat applications every two weeks for flowering rush control. Plants were treated with diquat (0.37 ppm) once, two, three, or four times. Plant tissues were harvested at eight weeks after treatment, placed in labeled paper bags, dried at 70°C for five days, and weighed. An analysis of variance was used to test for differences among treatment means; a Fishers Least Significant Difference test was used to separate means if any differences were detected. All treatments reduced flowering rush tissues and propagules when compared to reference plants ($p < 0.001$). Additionally, all treatments reduced flowering rush at the same level of significance, thus there was no difference in any of the diquat treatments. This work suggests that a more aggressive treatment protocol than that already in use will not benefit resource managers; however, these results need to be verified via field trials before resource managers alter existing treatment protocols that have been documented to control flowering rush.

Short-term Control of Cuban Bulrush (*Oxycaryum cubense*) Through Submersed Herbicide Applications

Lee G. Turnage (Student Poster Presentation)

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Cuban bulrush (*Oxycaryum cubense* (Poepp. & Kunth) Lye) is a perennial invasive aquatic plant species native to South America that is spreading across Florida and the Southeastern U.S. Cuban bulrush is known to form large floating islands (tussocks) that can block boat launches, impede navigation along river channels, negatively affect drainage canals, and degrade fishery habitat by lowering dissolved oxygen under the tussock. Portions of these tussocks can break off, float away, and start new infestations of Cuban bulrush elsewhere. Limited data exist concerning selective chemical control (herbicides) methods that are effective at controlling Cuban bulrush. This work was conducted to investigate short and long-term selective submersed chemical control options for Cuban bulrush. Results reported here are only for the short-term portion of this study. Cuban bulrush was grown in outdoor mesocosms with American lotus (*Nelumbo lutea*), a native species that it co-occurs with in natural areas. There were 10 herbicide treatments and a non-treated reference for a total of 11 treatments. Eight weeks after treatment (WAT), harvested tissues were placed in labeled paper bags, dried in a forced air oven for five days at 70°C, and then weighed. None of the herbicides significantly reduced belowground (lotus) or submersed (Cuban bulrush) tissues at eight WAT for either species. However, all herbicides reduced aboveground biomass of American lotus when compared to reference plants. All herbicides except imazamox significantly reduced Cuban bulrush emergent tissues when compared to reference plants. Imazamox had the same level of control as diquat, endothall, flumioxazin, 2,4-D,

penoxsulam, bispyribac-sodium, and carfentrazone-ethyl. Triclopyr and fluridone yielded greater control than imazamox but not the other herbicides. This work suggests that submersed herbicide applications can control populations of Cuban bulrush but may also harm desirable plant species in the short term. However, plants may recover from herbicide damage via remaining tissues.

Mapping of Emergent and Floating-leaf Aquatic Vegetation using a Machine Learning Process with Satellite Imagery (EcoSat): Experiences in Florida

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Advancements in satellite sensor technology and cloud computing have created new opportunities for aquatic plant and fisheries managers. In 2016-17, the Florida Fish and Wildlife Conservation Commission (FWC), partnered with EOMAP GmbH & Co. KG and C-MAP (makers of BioBase automated aquatic vegetation mapping system) to develop vegetation detection algorithms and cloud processing to map fish habitat in Florida's large lakes as part of their long-term monitoring program. The process led to the creation of the product EcoSat which C-MAP launched in June 2017. This talk describes the calibration and verification of random forest classification algorithms using Digital Globe World View 2 and Airbus Pléiades imagery from 2016 and 2017 on several lakes in Florida. We present comparisons of EOMAP classifications against training and validation data collected by FWC. We found strong time-of-year effects with much poorer accuracy during spring or times of the year when vegetation is a mix of green and brown than in summer when vegetation is peak biomass and greenness. We often found substantial agreement between satellite-classified vegetation and *in situ* data points (Cohen's Kappa > 0.6) using lower-cost Pléiades imagery across all lakes. We also found decisions regarding Minimum Mapping Unit (MMU) significantly affected agreement and interpretability of images. When the MMU was increased from the sensor resolution of 4m² to 40m², the image was less "noisy" and overall classification accuracy was higher. However, a 40 m² MMU was still too detailed for the scale that FWC programs operate. A MMU of 1000 m² appeared to give the best balance of detail, accuracy, and interpretability. FWC currently has another tasking run set for 2018 to meet statewide emergent vegetation monitoring objectives.

Effects of Repeated Herbicidal Control and Environmental Conditions on Curlyleaf Pondweed (Student Oral Presentation)

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Curlyleaf pondweed (*Potamogeton crispus*) is one of the most widespread and problematic invasive aquatic plants in the Great Lakes region. Despite decades of research and treatment efforts, there is still uncertainty about best practices for treating curlyleaf pondweed and the influence of environmental factors, such as trophic state and winter conditions, on curlyleaf populations. To address these gaps, we synthesized and analyzed data from 252 point-intercept surveys of 51 lakes collected by a variety of surveyors from 2006-2015. Nineteen lakes had data for years treated with herbicide (65 treatment lake-years) and 41 lakes had data for untreated years (116 untreated lake-years). We used generalized linear mixed models to estimate the influence of environmental drivers and herbicidal treatments on curlyleaf lake-level distribution (frequency of occurrence) and abundance (relative rake density). We found that greater winter snow cover, water clarity, and herbicide treatment were associated with reductions in lake-wide distribution of curlyleaf pondweed. We parsed the effects of herbicides based on three temporal windows and found that curlyleaf pondweed distribution was reduced within the year of treatment, the year following treatment, and by cumulative years of treatment. In contrast, curlyleaf pondweed abundance was not affected by environmental variables, and only by a within-year effect of herbicide treatment. Managers can use information about lake level trends in water clarity and annual variation in snow cover to optimize allocation of management efforts over space and time. Our results also show that increasing long-term consistency of herbicide-based management may allow for lower annual management inputs. This project highlights the power of combining monitoring data from across organizations to support collective learning and adaptive management.

Desiccation Tolerance of the Invasive Alga Starry Stonewort (*Nitellopsis obtusa*) (Student Oral Presentation)
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Human-assisted movement is a primary vector for spread of aquatic invasive species (AIS). Desiccation tolerances determine how long AIS can remain viable out of water and invade new waterbodies following overland transport. Starry stonewort (*Nitellopsis obtusa*) is an invasive macroalga spreading across the Great Lakes basin, posing challenges for aquatic plant managers, lake users, and other stakeholders. Improved spread prevention is imperative because environmental conditions suitable for *Nitellopsis* are widely available and once established, successful control has proven difficult. We investigated desiccation tolerance of *Nitellopsis* aboveground thalli (analogous to stems/leaves) and bulbils (asexual reproductive structures found in sediment) under laboratory conditions. Single fragments, small and large clumps, and bulbils were dried for treatment lengths of 0.25, 0.5, 1, 2, 4, 6, 12, 24, 48, 72, and 120 h, then rehydrated. Viability was assessed by comparing pre and post-desiccation condition (biomass, bulbil sprouting ability, appearance) of dried material to negative and positive controls that were never desiccated or that were fully desiccated in a drying oven, respectively. Single fragments were no longer viable after ≥ 2 hours of desiccation, small clumps after ≥ 24 hours of desiccation, and large clumps after ≥ 72 hours of desiccation. Sprouting was observed in bulbils dried for up to 2h but not in any bulbils dried for ≥ 4 h. Our laboratory results are likely conservative estimates of *Nitellopsis*' desiccation tolerance, given that it could be transported under conditions more humid or protected from moisture loss during boating season in northern-tier states. Nonetheless, our results indicate *Nitellopsis* is relatively sensitive to desiccation and probability of transmission is likely to decrease substantially with distance traveled and time spent out of water. These findings could be used to prioritize placement of boater education efforts, inspection stations, and other interventions.

Effectiveness of Canopeo in Quantification of Photosynthetic Colors for Macrophyte Monitoring (Student Oral Presentation)

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Canopeo is a free smartphone application that was developed to allow determination of canopy coverage of field crops. This app has previously been shown to have utility in determining the coverage of aquatic vegetation over water. The app converts green pixels to white and non-green pixels to black to allow for determination of percentage of white pixels or green canopy. Research was conducted to determine the effectiveness of this conversion in representing photosynthetic tissue and to provide guidance for standardization of practices for using this app in aquatic plant management.

Marsh Madness: Lessons from a Swamp (Student Oral Presentation)

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Koinonia is a Lutheran campground located in Sullivan County, New York. The camp was settled in the early 1960s, shortly after a small dam was constructed to deepen the bodies of water on site; collectively known as Koinonia Lake (surface area = 0.341 km², mean depth ~ 1 m, maximum depth ~ 2 m). Stakeholders consider this freshwater resource to be a lake; however, intensive monitoring of Koinonia Lake revealed that it is actually a deep marsh. This reclassification is based on the Ecological Communities of New York, which identifies a deep marsh as having high abundance of submergent, emergent, and floating vegetation (Edinger 2014). Wetland delineation was performed to confirm the cataloging of Koinonia within the National Wetlands Inventory and to provide an appropriate management plan to stakeholders. The management plan will have a major educational component that includes ideas and concepts experienced during University of Florida's 2018 Plant Camp.