Aquatic Plant Management Society
Greenville, SC / July 18-22, 2022

62nd Annual Meeting

Greenville, South Carolina

July 18-22, 2022

Meeting Sponsors

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Raleigh, NC

Committee Chairs

Awards	John Madsen
Bylaws and Resolutions	James Leary
Education and Outreach	Brett Hartis
Exhibits	Dean Jones
Finance	Andy Fuhrman
Legislative	Rob Richardson
Meeting Planning	Rob Richardson
Membership	Marc Bellaud
Nominating	Ryan Wersal
Past President’s Advisory	Ryan Wersal
Program	Brett Hartis
Publications	Ramon Leon
Regional Chapters	Gray Turnage
Scholastic Endowment	Erika Haug
Strategic Planning	Mark Heilman
Student Affairs	Sam Sardes
Website	Brett Hartis

Special Representatives

AERF	Carlton Layne
BASS	Jeremy Slade
CAST	Lyn Gettys
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
1962	T. Wayne Miller, Jr.	Fort Lauderdale, FL
1963	William Dryden	Tampa, FL
1964	Herbert J. Friedman	Tallahassee, FL
1965	John W. Woods	Palm Beach, FL
1966	Zeb Grant	Lakeland, FL
1967	James D. Gorman	Fort Myers, FL
1968	Robert D. Blackburn	Winter Park, FL
1969	Frank L. Wilson	West Palm Beach, FL
1970	Paul R. Cohee	Huntsville, AL
1971	Stanley C. Abramson	Tampa, FL
1972	Robert J. Gates	Miami Springs, FL
1973	Brandt G. Watson	New Orleans, LA
1974	Alva P. Burkhalter	Winter Park, FL
1975	Luciano Val Guerra	San Antonio, TX
1976	Ray A. Spirnock	Fort Lauderdale, FL
1977	Robert W. Geiger	Minneapolis, MN
1978	Donald V. Lee	Jacksonville, FL
1979	Julian J. Raynes	Chattanooga, TN
1980	William N. Rushing	Sarasota, FL
1981	Nelson Virden	Jackson, MS
1982	Roy L. Clark	Las Vegas, NV
1983	Emory E. McKeithen	Lake Buena Vista, FL
1984	A. Leon Bates	Richmond, VA
1985	Max C. McCowen	Vancouver, BC
1986	Lars W. J. Anderson	Sarasota, FL
1987	Dean F. Martin	Savannah, GA
1988	Richard D. Comes	New Orleans, LA
1989	Richard Couch	Scottsdale, AZ
1990	David L. Sutton	Mobile, AL
1991	Joseph C. Joyce	Dearborn, MI
1992	Randall K. Stocker	Daytona Beach, FL
1993	Clarke Hudson	Charleston, SC
1994	S. Joseph Zolczynski	San Antonio, TX
1995	Steven J. de Kozlowski	Bellevue, WA
1996	Terence M. McNabb	Burlington, VT
1997	Kurt D. Getsinger	Fort Myers, FL
1998	Alison M. Fox	Memphis, TN
1999	David F. Spencer	Asheville, NC
2000	J. Lewis Decell	San Diego, CA
2001	Jim Schmidt	Minneapolis, MN
2002	David P. Tarver	Keystone, CO
2003	Richard M. Hinterman	Portland, ME
2004	Ken L. Manuel	Tampa, FL
2005	Eric P. Barkemeyer	San Antonio, TX
2006	Jeffrey D. Schardt	Portland, OR
2007	Donald W. Doggett	Nashville, TN
2008	Jim Petta	Charleston, SC
2009	Carlton Layne	Milwaukee, WI
2010	Greg MacDonald	Bonita Springs, FL
2011	Linda S. Nelson	Baltimore, MD
2012	Tyler Koschnick	Salt Lake City, UT
2013	Terry Goldsby	San Antonio, TX
2014	Michael D. Netherland	Savannah, GA
2015	Cody Gray	Myrtle Beach, SC
2016	Rob Richardson	Grand Rapids, MI
2017	John D. Madsen	Daytona Beach, FL
2018	John H. Rodgers, Jr.	Buffalo, NY
2019	Craig Aguillard	San Diego, CA
2020	Mark Heilman	*Canceled*
2021	Ryan Wersal	New Orleans, LA

APMS Award Recipients

Honorary Members

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.

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, Luciano “Lou” Guerra	1988
Max C. McCowen	1989
James D. Gorman, T. Wayne Miller, Jr.	1995
A. Leon Bates, 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
Allison M. Fox, Randall K. Stocker, Steven J. de Kozlowski	2010
Carole Lembi	2011
Lars W.J. Anderson, David Tarver	2012
Don Doggett, Richard Hinterman	2013
David Spencer	2015
Jim Schmidt	2016
Joseph C. Joyce, Jeff Schardt	2017
David A. Issacs, Vernon V. Vandiver	2018
Eric P. Barkemeyer	2019
Linda Nelson, Ken Manuel, Steve Brewer	2020
Kurt Getsinger, John Rogers, Jr., Terry Goldsby	2021

President’s Award

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*".

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
Robert Blackburn	2018
Sherry Whittaker	2018
Eric P. Barkemeyer	2019
Dave Petty, Bill Torres, Rob Richardson	2020
Mark Heilman	2021

APMS Award Recipients

Max McCowen Friendship Award

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.

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
John Gardner	2018
William A. Ratajczyk	2019
Tom Warmuth	2020
Todd Olson	2021

T. Wayne Miller Distinguished Service Award

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.

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
Tyler Koschnick	2018
Robert J. Richardson	2019
Jeremy Slade	2020
Jason Ferrell	2021

Outstanding Graduate Student Award

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

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
Andrew Howell	North Carolina State University	2018
Tyler Geer	Clemson University	2019
Gray Turnage	Mississippi State University	2020
Mirella Ortiz	Colorado State University	2021

Outstanding International Contribution Award

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

Deborah Hofstra	National Institute of Water & Atmospheric Research	2013
Paul Champion	National Institute of Water & Atmospheric Research	2016
John Clayton	National Institute of Water & Atmospheric Research	2017
Tony Dugdale	Agriculture Victoria	2018

Outstanding Journal of Aquatic Plant Management Article Award

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

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
Ryan A. Thum, Syndell Parks, James N. Mcnair, Pam Tyning, Paul Hausler, Lindsay Chadderton, Andrew Tucker, and Anna Monfils	Montana State University	2018
Alyssa J. Calomeni, Ciera M. Kinley, Tyler D. Geer, Maas Hendrikse, and John H. Rodgers Jr	Clemson University	2019
Melaney Dunne and Raymond Newman	University of Minnesota	2020

Outstanding Research/Technical Contributor Award

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.

Michael Netherland, Dean Jones, and 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
Scott Nissen	Colorado State University	2018
John D. Madsen	Unites States Department of Agriculture	2019
Patrick Moran and the DRAAWP	Unites States Department of Agriculture	2020
Tera Guetter	Pelican River Watershed Dist.	2021

APMS Graduate Student Research 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
The Indirect Effects of Sonar Application on Lake Food Webs			
Katia Englehardt	University of Maryland	2001	$40,000
Controlling Non-native Submersed Aquatic Macrophyte Species in Maryland Reservoirs: Plant Competition Mediated by Selective Control			
Susan Wilde	University of South Carolina	2005	$40,000
Investigating the Role of Invasive Aquatic Plants and Epiphytic Cyanobacteria on Expression of Avian Vacuolar Myelinopathy (AVM)			
John Madsen and Ryan Wersal	Mississippi State University	2007	$60,000
The Seasonal Phenology, Ecology and Management of Parrotfeather [Myriophyllum aquaticum (Vellozo) Verdecourt]			
Rob Richardson, Sarah True, Steve Hoyle	North Carolina State University	2010	$40,000
Monoecious Hydrilla: Phenology and Competition			

Ryan Thum	Grand Valley State University	2012	$40,000
A Quantitative Genetics Approach to Identifying the Genetic Architecture of Herbicide Susceptibility, Tolerance, and Resistance in Hybrid Watermilfoils (Myriophyllum spicatum x sibiricum)			
Scott Nissen	Colorado State University	2014	$40,000
Exploring the Physiological Basis of 2,4-D Tolerance in Northern Watermilfoil x Eurasian Watermilfoil Hybrids			
Rob Richardson	North Carolina State University	2015	$40,000
Aspects of Monoecious Hydrilla Physiology and Response to Herbicide Combination Treatments			
Christopher R. Mudge and Bradley T. Sartain	Louisiana State University	2016	$40,000
Exploring Alternative Giant Salvinia (Salvinia molesta D.S. Mitchell) Management Strategies			
John Rodgers and Tyler Geer	Clemson University	2017	$60,000
Evaluation of Management Options for Nitellopsis obtusa (Desvaux in Loiseleur) J. Groves, (1919) (Starry Stonewort) in the United States			
Ryan A. Thum and Greg M. Chorak	Montana State University	2018	$40,000
Identifying Eurasian and Hybrid Watermilfoil Gene Expression Differences in Response to Frequently Used Herbicides for Improved Adaptive Management			
Rob Richardson and Jens Beets	North Carolina State University	2020	$40,000
Evaluation of Effect of Biotype on Biology and Response to Herbicides of Aquatic Macrophyte Species			

Sustaining Members

AgroShield has been serving the Agriculture and Aquatic industries since 2015. Our Vodaguard product was developed to cure infections in the upper water column. Vodaguard's unique follow the bloom technology concentrates the cure where it is needed the most. Vodaguard C is a copper sulphate pentahydrate product. Vodaguard O is a sodium percarbonate that becomes hydrogen peroxide when introduced to water. Both products have a patented formulation that allows them to be buoyant for 24 to 36 hours. Reduces manpower, machinery, and un-necessary product which reduces cost. Please visit us at: https://www.agro-shield.com/our-products/algaecides.

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.

AquaMaster Fountains and Aerators is the industry leader for quality and dependable Fountains and Aerators for all your aquatic requirements. Awareness of water quality management has never been higher. In our environmentally conscious world, today's successful aquatic managers are making aeration equipment the foundation of their aquatic management programs. Their goal is to increase the dissolved oxygen level, which stimulates the natural cleanup process, resulting in an aesthetically pleasing, healthy body of water.

Aqua Services, Inc. is a full-service water resource management company that has operated continuously in business for 40 years. In addition to its original focus on aquatic weed management operations for federal, state, and private entities, Aqua Services now provides superior fisheries population management, HAB and cyanobacteria control, lake design services, aeration design and installation, and soil sealant services to mitigate lake and pond seepage. Our experienced biologists and technicians work throughout the Southeast and Midwest to provide critical services to numerous clients. Successful projects have also been completed internationally, including the countries of Mexico and The Bahamas.

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.

BioSafe Systems 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.

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. Clarke pioneers, develops, and delivers environmentally responsible mosquito control and aquatic services to help control nuisances, prevent disease, and create healthy waterways.

Compliance Services International (CSI) is a leading regulatory consultancy providing innovative solutions for organizations faced with regulatory and environmental challenges. CSI's experienced scientists and regulatory specialists in the USA and the EU provide innovative approaches to solving regulatory and environmental challenges – combining traditional sciences with developing technologies to deliver economically sensible and scientifically sound results.

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).

Since 1973, **Diversified Waterscapes, Inc**. has offered lake management services and ecological products to professional applicators. Our proven field experience in pond and lake cleaning enabled us to develop an eco-friendly line of products that show dramatic results in any aquatic environment. With more than 45 years of experience, we have been providing aquatic treatment products and maintenance service for some of the world's best water features, including the famous Bellagio Fountain in Las Vegas – delivering clearly better results without harming the environment. Our mission is to combine extensive industry experience, mechanical aptitude and scientific knowledge to bring clarity, cleanliness and beauty to water features across the country.

Duke Energy "*Building a **smarter** energy future*". Duke Energy (NYSE: DUK), a Fortune 150 company headquartered in Charlotte, N.C., is one of the largest energy-holding companies in the U.S. It employs 30,000 people and has an electric generating capacity of 51,000 megawatts through its regulated utilities, and 3,000 megawatts through its nonregulated Duke Energy Renewables unit. Duke Energy is transforming its customers' experience, modernizing the energy grid, generating cleaner energy, and expanding natural gas infrastructure to create a smarter energy future for the people and communities it serves. More information about the company is available at duke-energy.com. Follow Duke Energy on Twitter, LinkedIn, Instagram and Facebook.

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 algaecide, 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.

The Lee County Hyacinth Control District was formed by the Florida Legislature in June 1961to 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.

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.

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.

UPL NA, Inc. is a premier supplier of crop protection products and technologies designed for the agricultural, specialty, fumigation and aquatic markets. The Aquatics Division is part of the Environmental Solutions group which has manufactured aquatic herbicides and algaecides for the management of lakes, ponds, rivers and irrigation canals for more than 40 years. These products are marketed as Aquathol®, Hydrothol®, AquaStrike®, Current®, Symmetry®, Cascade®, Teton®, and Top Deck™. Most recently the development and commercialization of the ADAPT aquatic drone boat for improved application accuracy and efficiency was launched. With a customer-centric focus, UPL is committed to providing product stewardship and technical support to ensure your plant management operations are successful. Visit us at: https://uplaquatics.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. Please visit the exhibit hall in the Gallery for all Exhibitors, including not-for-profit organizations.

Alligare, LLC
Opelika, AL

AquaRealTime
Boulder, CO

Aquarius Systems
North Prairie, WI

Aquatic Control, Inc.
Seymour, IN

AquaMaster Fountains
Kiel, WI

BioSafe Systems
East Hartford, CT

Brandt Consolidated, Inc.
Springfield, IL

Brewer International
Vero Beach, Florida

Clarke
St. Charles, IL

Cygnet Enterprises
Flint, MI

Key Colour
Phoenix, AZ

Midwest APMS

Moleaer
Carson, CA

Nutrien Solutions
Loveland, CO

NuFarm Americas
Alsip, IL

Orion Solutions
Rocky Mount, VA

Outdoor Water Solutions
Springdale, AR

Phoslock Environmental Solutions
Cullman, AL

SePRO
Carmel, IN

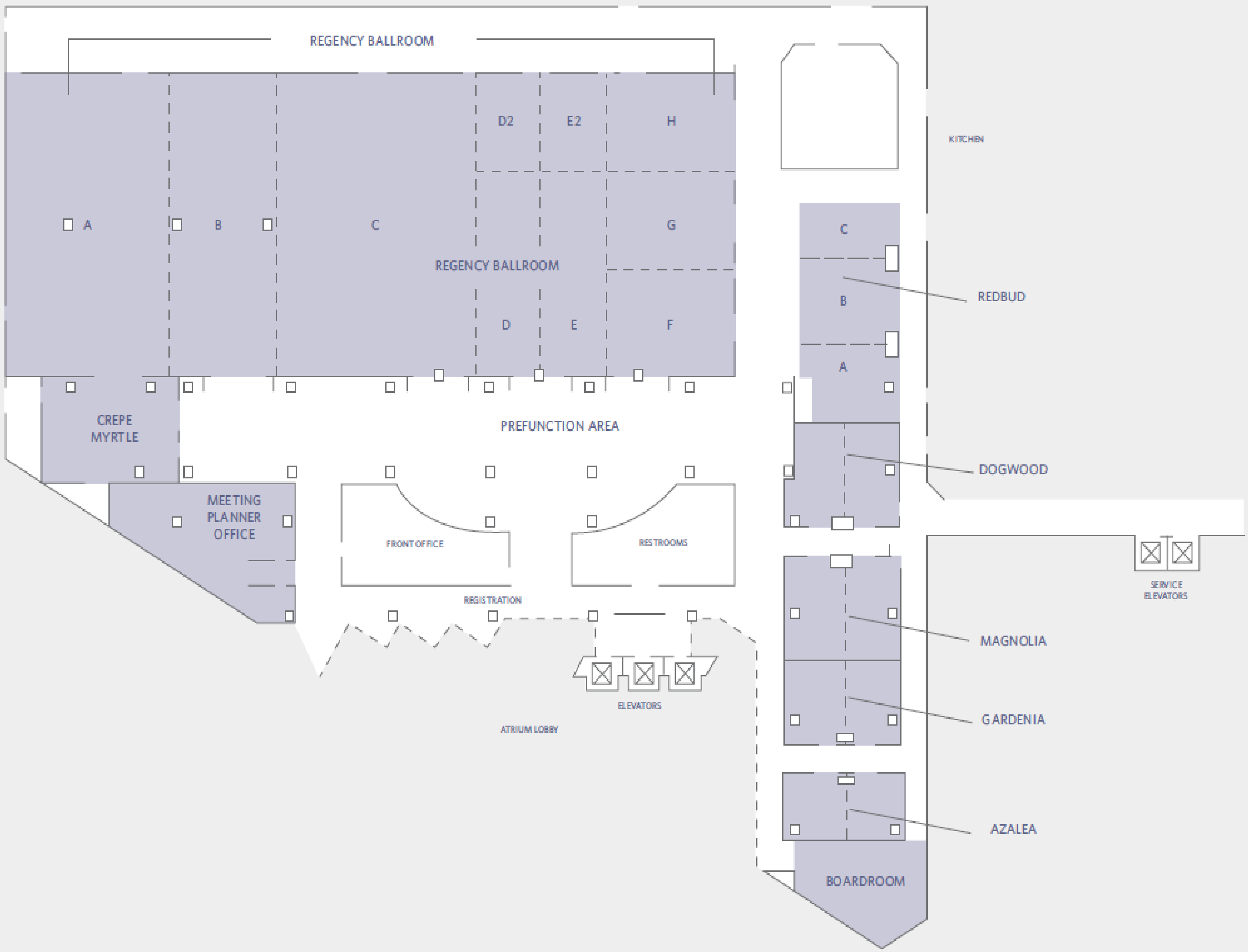
Syngenta
Greensboro, NC

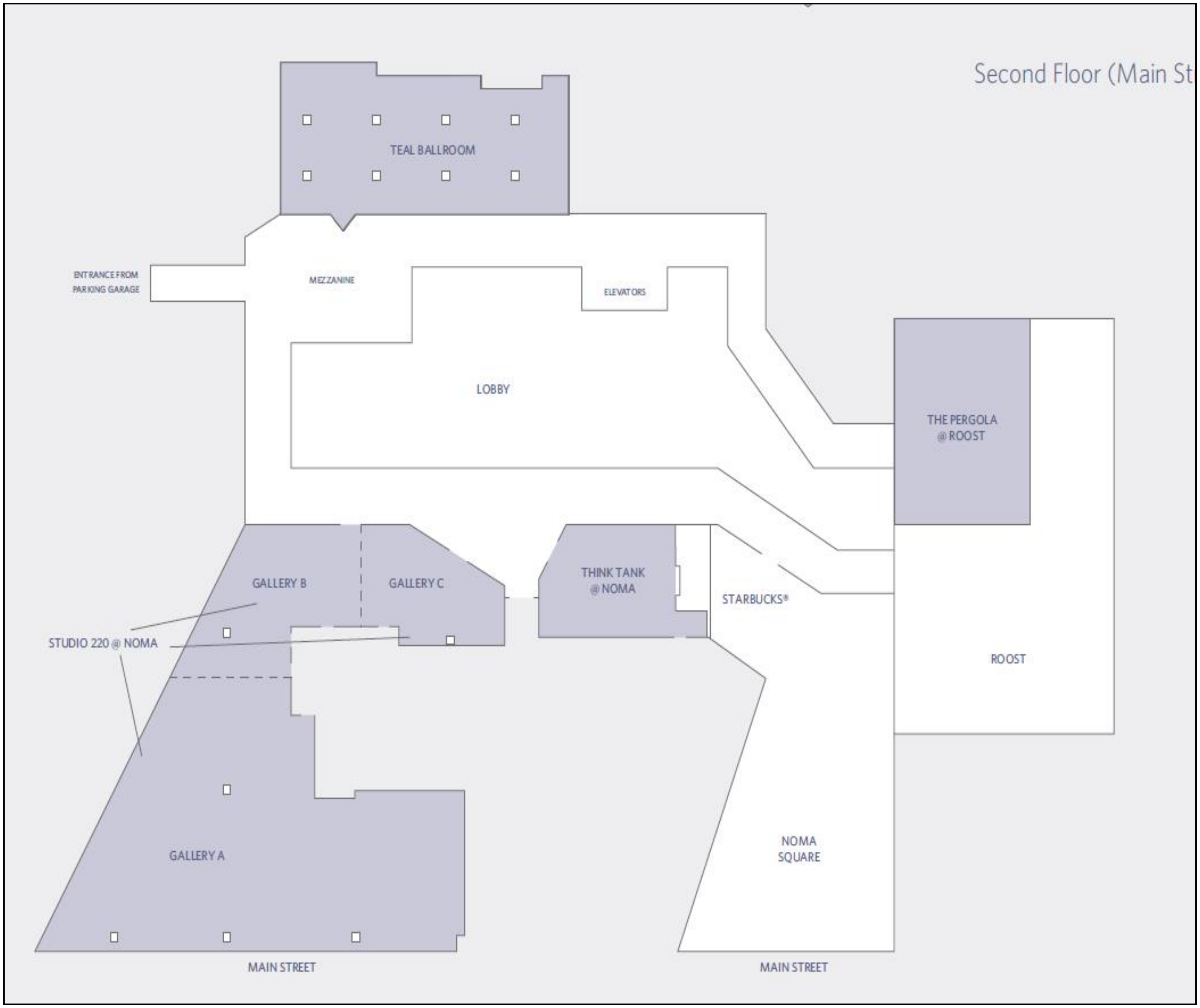
UPL OpenAg ® Environmental Solutions
King of Prussia, PA

Women of Aquatics

FLOOR PL

First Floor (Lobby Le




Second Floor (Main St
TEAL BALLROOM
ENTRANCE FROM
PARKING GARAGE
MEZZANINE
ELEVATORS
LOBBY
THE PERGOLA
@ ROOST
ROOST
GALLERY B
GALLERY C
THINK TANK
@ NOMA
STARBUCKS®
STUDIO 220 @ NOMA
GALLERY A
NOMA
SQUARE
MAIN STREET
MAIN STREET

General Information and Events

Program Organization
The agenda is organized by day and time. 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 Regency A, B, and C rooms. See the hotel site map on previous pages 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 in the Meeting Planning Office from noon to 5:00 pm on Monday and will continue from 7:00 am – 5:00 pm on Tuesday and Wednesday, and 7:00 am – noon on Thursday.

Exhibits
Exhibits will be open from 7:00am Tuesday through 5:00pm Wednesday in Regency A&B.

Continental Breakfasts / Refreshment Breaks
Continental breakfasts and mid-morning and afternoon refreshment breaks will be served each day in Regency A&B Please see the Agenda-at-a-Glance for specific times. Also, take time to visit with Exhibitors while enjoying your breakfast or break.

Spur of the Moment Meeting Room
We have a room set up for break out discussion and conference needs. Check at the meeting registration desk to reserve.

Student Meet-and-Greet:
Monday, July 18th, 6:00 pm to 7:00 pm, Ink N Ivy
All students registered for the meeting are invited to gather at *Ink N Ivy* 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.

Presidents' Reception:
Monday, July 18, 7:00 pm to 9:00 pm, Ink N Ivy
Join your APMS friends and colleagues at the Presidents' Reception to "kick-off" our annual meeting while enjoying southern style cuisine 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.

Past Presidents' Luncheon:
Tuesday, July 19, 12:00 pm to 1:30 pm, Dogwood
All APMS Past Presidents are invited to attend the Past Presidents' Luncheon to provide insight into matters facing APMS and aquatic plant managers. Ryan Wersal, Immediate Past President, will be the moderator. Please contact Ryan by noon Monday, July 18 to confirm your attendance.

Student Affairs Luncheon:
Tuesday, July 19, 12:00 pm to 1:30 pm, Magnolia
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. Sam Sardes, Student Affairs Committee Chair, will be the moderator. Please contact Sam by noon Monday, July 18 to confirm your attendance.

Poster Session Reception:
Tuesday, July 19th, 6:00 pm to 7:00 pm, Regency A&B.
Posters will be available for viewing from 8:00 am Monday to noon Wednesday in *Regency A&B.* Poster presenters will be on hand during the Evening Poster Reception on Tuesday, July 19th, 6:00 pm to 7:00 pm in Regency A&B.

Regional Chapters Presidents' Evening Discussion:
Tuesday, July 19, 6:00 pm to 7:00 pm, Azaela
Two representatives from each APMS regional chapter are invited to attend the Regional Chapter Presidents' Evening Discussion, provided by APMS sponsors. Regional Chapters Committee Chair Gray Turnage will be the moderator for discussions on aquatic plant management activities in each region. Please contact Gray by noon Monday, July 18 to confirm your attendance.

Women of Aquatics Luncheon:
Wednesday, July 20, noon to 1:30 pm, Magnolia
Amy Kay will host the APMS Women of Aquatics Luncheon to discuss opportunities for women in the field of aquatic plant management. Please contact Amy by noon Monday, July 18 to confirm your attendance.

SCAPMS Duck Race:
Wednesday, July 20, 5:00 pm to 6:00 pm, Hyatt Regency Atrium
Guests are invited to participate in the South Carolina Aquatic Plant Management Society Duck Race to support student scholarship opportunities. Ducks will be sold at the registration desk throughout the meeting at $10 each.

Awards Reception/Banquet:
Wednesday, July 20, 6:00 pm to 10:00 pm, Studio 220 @ NOMA A
Registered delegates, guests and students are invited to the Awards Banquet to be held at Studio 220 in the hotel. After dinner, we will recognize those who have served APMS, welcome new officers and directors. SCAPMS will also recognize those who have served the hosting regional chapter. Our evening will conclude with a fund-raising raffle to support APMS student and other education initiatives.

APMS/SCAPMS Post-Conference Board of Directors Meetings:
Newly elected officers, directors, and committee members will attend the post-conference board of directors meeting. Members will be provided a web link for the meetings which will be held virtually following the conference.

Events-at-a-Glance

Sunday – July 17:

APMS Strategic Planning Session (*Crepe Myrtle*)

Monday – July 18:

APMS Board of Directors Meeting (*THINK TANK @ NOMA*)
Exhibits and Poster Setup (*Regency A&B*)
Registration (*Meeting Planning Room*)
Student Meet & Greet (*Ink N Ivy*)
Presidents' Reception (*Ink N Ivy*)

Tuesday – July 19:

Registration (*Meeting Planning Room*)
Continental Breakfast (*Regency A&B*)
Exhibits (*Regency A&B*)
Session 1 (*Regency C*)
Lunch on your own
Past Presidents' Luncheon (*Dogwood*)
Student Affair Luncheon *(Magnolia)*
Session 2 (*Regency C)*
APMS Annual Business Meeting
Regional Chapters Evening Discussion (*THINK TANK @ NOMA*)
Poster Session (*Regency A&B*)

Wednesday – July 20:

Registration (*Meeting Planning Room*)
Continental Breakfast (*Regency A&B*)
Exhibits (*Regency A&B)*
Session 3 (*Regency C*)
Lunch on your own
Women of Aquatics Luncheon (*Magnolia)*
Session 4 (*Regency C*)
SCAPMS Duck Race (*Hyatt Regency Atrium*)
APMS Awards Banquet Reception (*Studio 220 @ NOMA A*)
APMS Awards Banquet (*Studio 220 @ NOMA A*)

Thursday – July 21:

Registration (*Meeting Planning Room*)
Continental Breakfast (*Regency A&B*)
Exhibits (*Regency A&B)*
Session 5 (*Regency C*)
Conference Adjourns
Lunch on your own

Agenda

Sunday, July 17

Sunday's Agenda-at-a-Glance

10am – 4pm	APMS Strategic Planning Meeting (*Crepe Myrtle)*

Monday, July 18

Monday's Agenda-at-a-Glance

10am – 4pm	APMS Board of Directors Meeting (*THINK TANK @ NOMA*)
12pm – 5pm	Exhibits Setup (*Regency A&B*)
12pm – 5pm	Registration (*Meeting Planning*)
6pm – 7pm	Student Meet & Greet (*Ink N Ivy*)
7pm – 9pm	Presidents' Reception (*Ink N Ivy*)

Tuesday, July 19

Tuesday's Agenda-at-a-Glance

7am – 5pm	Registration (*Meeting Planning Office*)
7am-8am	Continental Breakfast (*Regency A&B*)
7am – 5pm	Exhibits (*Regency A&B*)
8am – 12pm	Special Session – Harmful Algal Blooms (*Regency C*)
1005am - 1020am	Break
12pm– 130pm	Lunch on your own
12pm– 130pm	Past Presidents' Luncheon (*Dogwood*)
12pm– 130pm	Student Affairs Luncheon (*Magnolia*)
130pm – 450pm	Session II (*Regency C*)
310pm – 330pm	Break
450pm – 530pm	APMS/SCAPMS Annual Business Meetings
6pm – 7pm	Regional Chapter Evening Discussion (*Azalea*)
6pm – 7pm	Poster Session & Reception (*Regency A&B*)

Session I – Opening Remarks, Special Session – Status and Future Outlook of Harmful Algal Blooms
8:00am – 12:00pm
Regency C
Moderator: Dr. Brett Hartis – APMS President Elect (*Duke Energy Corporation, Charlotte, NC*)

08:00 AM **Welcome and Opening Remarks**

08:05 AM **Presidential Address**
Dr. Ryan Thum
Montana State University, Bozeman, MT

08:15 AM **Controlling Freshwater Harmful Algal Blooms? the "Elephant in the Room".**
JoAnn M. Burkholder
North Carolina State University, Raleigh, NC

08:45 AM **Human Health Effects of Freshwater HABs: A One Health Issue.**
Geoffrey I. Scott
University of South Carolina, Columbia, SC

09:05 AM **Transforming Our Approach to Harmful Algal Bloom Management.**
West Bishop[1], Mark A. Heilman[2]
[1]SePRO Corporation, Whitakers, NC
[2]SePRO Corporation, Carmel, IN

09:25 AM **Environmental Conditions Triggering Germination of Overwintering Cyanobacteria: A Review.**
Alyssa J. Calomeni[1], Andrew D. McQueen[1], Ciera M. Kinley-Baird[2], Gerard A. Clyde[3]
[1]US Army Corps of Engineers - Engineer Research and Development Center, Vicksburg, MS
[2]Aquatic Control, Inc., Seymour, IN
[3]US Army Corps of Engineers, Tulsa District, Tulsa, OK

09:45 AM **Monitoring Overwintering Cyanobacteria in Sediments from Three HAB Impacted Waterbodies.**
Andrew D. McQueen[1], Alyssa J. Calomeni[1], Ciera M. Kinley-Baird[2], Gerard (Tony) A. Clyde[3]
[1]US Army Corps of Engineers - Engineer Research and Development Center, Vicksburg, MS
[2]Aquatic Control, Inc., Seymour, IN
[3]US Army Corps of Engineers, Tulsa District, Tulsa, OK

10:05 AM **Break**

10:20 AM **Integration of Preventative Algaecide Treatments into Current Harmful Algal Bloom Management Strategies.**
Ciera M. Kinley-Baird[1], Andrew D. McQueen[2], Alyssa J. Calomeni[2], Gerard A. Clyde[3]
[1]Aquatic Control, Inc., Seymour, IN
[2]US Army Corps of Engineers - Engineer Research and Development Center, Vicksburg, MS
[3]US Army Corps of Engineers, Tulsa District, Tulsa, OK

10:40 AM **A Role for Legacy Phosphorous in Driving *Microseira* (Lyngbya) Growth.**
Tryston Metz, Samuel P. Putnam, Timothy J. Shaw, Geoff I. Scott, **John L. Ferry**
University of South Carolina, Columbia, SC

11:00 AM **Mitigating HAB Blooms in the Western United States.**
Terence M. McNabb
Aquatechnex, LLC, Bellingham, WA

11:20 AM **Recent Chemical Management of *Microseira* (Lyngbya) on Lake Gaston, NC/VA.**
Jessica R. Baumann, Robert J. Richardson
North Carolina State University, Raleigh, NC

11:40 AM **SCDHEC and Harmful Algal Blooms.**
Taylor V. Shearer
South Carolina Department of Health and Environmental Control, Columbia, SC

Lunch on Your Own
12:00 pm – 1:30 pm

Past President's Luncheon
12:00 pm – 1:30 pm
Dogwood

Student Affairs Luncheon
12:00 pm – 1:30 pm
Magnolia

Session II – General Session & Student Presentations

1:30 pm – 4:50 pm
Regency C
Moderator: Dr. Jay Ferrell (*University of Florida, Gainesville, FL*)

† STUDENT CONTEST

01:30 PM **Using Long-Term Datasets to Understand Impacts of Aquatic Plant Management.**
Candice M. Prince[1], Amy E. Kendig[1], S. Luke Flory[1], Mark Hoyer[1], James Leary[2]
[1]University of Florida, Gainesville, FL
[2]Center Aquatic and Invasive Plants, UF/IFAS, Gainesville, FL

01:50 PM **†Life History of Diploid Flowering Rush (*Butomus umbellatus*) from Field Populations in New York and Ohio.**
Maxwell G. Gebhart[1], Ryan M. Wersal[1], Bradley T. Sartain[2], Nathan E. Harms[3]
[1]Minnesota State University, Mankato, Mankato, MN
[2]US Army Corps of Engineers - Engineer Research and Development Center, Vicksburg, MS
[3]US Army Corps of Engineers - Engineer Research and Development Center, Lewisville, TX

02:10 PM **†Invasive Alligator Weed (*Alternanthera philoxeroides*) in the Southeastern United States: A Future Research Plan.**
Samuel A. Schmid, Gary N. Ervin, Gray Turnage
Mississippi State University, Starkville, MS

02:30 PM **†Hydrilla Fragment Tolerance to Desiccation in Simulated Boat Bunk Conditions.**
Taylor L. Darnell[1], Benjamin P. Sperry[2], Candice M. Prince[3]
[1]University of Florida/ Center for Aquatic Invasive Plants, Gainesville, FL
[2]US Army Corps of Engineers, Gainesville, FL
[3]University of Florida, Gainesville, FL

02:50 PM **Industry Updates**

03:10 PM **Break**

03:30 PM **Observations of Submersed Aquatic Vegetation Community Shifts with Selective Hydrilla Management in Lake Sampson Florida.**
Jacob Thayer[1], **James Leary**[1], Kelli Gladding[2], Jonathan Glueckert[3], Amber Riner[1]
[1]Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL
[2]Center for Aquatic and Invasive Plants, University of Florida, New Smyrna Beach, FL
[3]Center for Aquatic and Invasive Plants, University of Florida, Loxahatchee, FL

03:50 PM **†Common nursery evaluation of eight ecotypes of Illinois pondweed (*Potamogeton illinoensis*).**
Joseph W. Sigmon, Kyle L. Thayer, Jennifer H. Bishop, Lyn A. Gettys
University of Florida Ft Lauderdale Research and Education Center, Davie, FL

04:10 PM **2021 Survey Results for the Most Common and Troublesome Aquatic Weeds (and Washington DC Update).**
Lee Van Wychen
WSSA, Alexandria, VA

04:30 PM **†Automated Classification of Aquatic Invasive Plants using Deep Learning AI and Visible Spectrum Imagery.**
Ashutosh Shah, Sathishkumar Samiappan, Gray Turnage, Cary Daniel McCraine
Mississippi State University, Starkville, MS

APMS/SCAPMS Annual Business Meetings
4:50 pm – 5:30 pm
Regency C

Regional Chapters Evening Discussion
6:00 pm – 7:00 pm
Azalea

Poster Session & Reception
6:00 pm – 7:00 pm
Regency A&B

Wednesday, July 20

Wednesday's Agenda-at-a-Glance

7am – 5pm	Registration (*Meeting Planning Room*)
7am-8am	Continental Breakfast (*Regency A&B*)
7am – 5pm	Exhibits (*Regency A&B*)
8am – 12pm	Session III (*Regency C*)
10am - 1020am	Break
12pm– 130pm	Lunch on your own
12pm– 130pm	Women of Aquatics Luncheon (*Magnolia*)
130pm – 430pm	Session IV (*Regency C*)
250pm – 310pm	Break
5pm – 6pm	SCAPMS Duck Race (*Hyatt Regency Atrium*)
6pm – 7pm	APMS Awards Banquet Reception (*Studio 220 @ NOMA A*)
7pm – 9pm	APMS Awards Banquet (*Studio 220 @ NOMA A*)

Session III – General Session
8:00 am – 12:00 pm
Regency C
Moderator: Christopher R. Mudge (*U.S. Army Engineer Research & Development Center, Baton Rouge, LA***)**

† STUDENT CONTEST

08:00 AM **Herbicide Trials with Brazilian Egeria (*Egeria densa)* for Management in the Sacramento - San Joaquin River Delta.**
John D. Madsen, John Miskella
USDA-ARS, Davis, CA

08:20 AM **†Utilizing the Propagule Pressure Hypothesis to Optimize the Impact of *Cyrtobagous salviniae* on *Salvinia molesta* in Louisiana.**
Korey D. Pham[1], Rodrigo Diaz[1], Christopher R. Mudge[2]
[1]Louisiana State University, Department of Entomology, Baton Rouge, LA
[2]U.S. Army Corps of Engineers - Engineer Research & Development Center, Baton Rouge, LA

08:40 AM **Trending Legislative and Regulatory Issues Impacting the Aquatics Industry.**
Megan Provost
RISE (Responsible Industry for a Sound Environment), Arlington, VA

09:00 AM **†Small Plot Evaluations of Aquatic Pesticides for Control of Starry Stonewort (*Nitellopsis obtusa*) in Lake Koronis, MN.**
Patrick Carver[1], Ryan M. Wersal[1], Bradley T. Sartain[2]
[1]Minnesota State University, Mankato, Mankato, MN
[2]US Army Corps of Engineers Engineer Research and Development Center, Vicksburg, MS

09:20 AM **†Assessing the compatibility of Metsulfuron-methyl and *Cyrtobagous salviniae* for the control of *Salvinia molesta* .**
Samantha L. Prinsloo[1], Christopher R. Mudge[2], Rodrigo Diaz[1]
[1]Louisiana State University, Department of Entomology, Baton Rouge, LA
[2]U.S. Army Corps of Engineers - Engineer Research & Development Center, Baton Rouge, LA

09:40 AM **†Unmanned Aerial Systems Support Giant Salvinia Research and Eradication Activities in North Carolina.**
Andrew W. Howell, Erika J. Haug, Robert J. Richardson
North Carolina State University, Raleigh, NC

10:00 AM **Break**

10:20 AM **The Rest of the Story: More Selectivity and Efficacy Trials to Evaluate "Natural" Products for Aquatic Weed Control.**
Lyn A. Gettys, Kyle L. Thayer, Joseph W Sigmon
University of Florida Ft Lauderdale Research and Education Center, Davie, FL

10:40 AM **†Evaluating the Efficacy of Florpyrauxifen-benzyl on North Carolina Noxious Weeds.**
Kara J. Foley, Jens P. Beets, Erika J. Haug, Robert J. Richardson
North Carolina State University, Raleigh, NC

11:00 AM **Herbicide Spray Loss: Influence of Spray Trajectory Angle, Spray Pattern Type and Application Equipment.**
Christopher R. Mudge[1], Benjamin P. Sperry[2], Michael W. Durham[3], Kurt D. Getsinger[4]
[1]U.S. Army Corps of Engineers - Engineer Research & Development Center, Baton Rouge, LA
[2]US Army Corps of Engineers, Gainesville, FL
[3]University of Florida Center for Aquatic and Invasive Plants, Gainesville, FL
[4]United States Army Corps of Engineers - Engineering Research and Development Center, Vicksburg, MS

11:20 AM **†Development of Non-Chemical Management Recommendations for Starry Stonewort (*Nitellopsis obtusa*).**
Alyssa M. Haram, Ryan M. Wersal
Minnesota State University, Mankato, Mankato, MN

11:40 PM **Influence of Temperature on Water Hyacinth Control with Florpyrauxifen-benzyl.**
Michael W. Durham[1], Benjamin P. Sperry[2], Christopher R. Mudge[3]
[1]University of Florida Center for Aquatic and Invasive Plants, Gainesville, FL
[2]US Army Corps of Engineers, Gainesville, FL
[3]U.S. Army Corps of Engineers - Engineer Research & Development Center, Baton Rouge, LA

Lunch on Your Own

12:00 pm – 1:30 pm

Women of Aquatics Luncheon

12:00 pm – 1:30 pm
Magnolia

Session IV – General Session

1:30 pm – 4:30 pm
Regency C
Moderator: Dr. Erika Haug (*North Carolina State University, Raleigh, NC*)

† STUDENT CONTEST

01:30 PM **†Evaluating the Response of Invasive Flowering Rush (Butomus umbellatus) Cytotypes to Chemical Control Measures.**
Jacob A. Hockensmith[1], Gray Turnage[1], Cory Shoemaker[2]
[1]Mississippi State University, Starkville, MS
[2]Slippery Rock University, Slippery Rock, PA

01:50 PM **†Herbicide Efficacy on Floating Hearts in Florida.**
Ian J. Markovich, Kyle L. Thayer, Joseph W. Sigmon, Jennifer H. Bishop, Lyn A. Gettys
University of Florida Ft Lauderdale Research and Education Center, Davie, FL

02:10 PM **†Non-target Impacts of Florpyrauxifen-benzyl Treatments Using Split Applications and Herbicide Combinations.**
Jens P. Beets[1], Erika J. Haug[1], Benjamin P. Sperry[2], Robert J. Richardson[1]
[1]North Carolina State University, Raleigh, NC
[2]US Army Corps of Engineers, Gainesville, FL

02:30 PM **†Chemical Control of Brazilian Peppertree (*Schinus terebenthifolia*) in Areas of Freshwater and Brackish Inundation.**
Conrad A. Oberweger[1], Candice M. Prince[2], Stephen F. Enloe[2], James Leary
[1]Center for Aquatic and Invasive Plants - University of Florida, Gainesville, FL
[2]University of Florida, Gainesville, FL
[3]Center Aquatic and Invasive Plants, UF/IFAS, Gainesville, FL

02:50 PM **Break**

03:10 PM **Evaluation of Granular Endothall Concentration-Exposure Times for Vallisneria Control.**
Grace Bell[1], Benjamin P. Sperry[2], Michael W. Durham[1]
[1]Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL
[2]US Army Corps of Engineers, Gainesville, FL

03:30 PM **Multi-metric Cold Tolerance Evaluation of Established Agent Populations to Improve Biological Control of Weeds.**
Ian A. Knight[1], Nathan E. Harms[2], Paul Pratt[3], Angelica Reddy[3], Dean Williams[4], Annie Huang[5], Ashton B. DeRossette[1]
[1]United States Army Corps of Engineers - Engineering Research and Development Center, Vicksburg, MS
[2]United States Army Corps of Engineers - Engineering Research and Development Center, Lewisville, TX
[3]USDA ARS Invasive Species and Pollinator Health Research Unit, Albany, CA
[4]Texas Christian University, Fort Worth, TX
[5]Oak Ridge Institute for Science and Education, Vicksburg, MS

03:50 PM **Assessment of Removal Methods for Arrowhead Vine (*Syngonium podopyhllum*) in Forest Wetlands in Florida.**
Stephen F. Enloe, Coral Foster
University of Florida, Gainesville, FL

04:10 PM **Spray Retention of Commonly Managed Invasive Emergent Aquatic Macrophytes.**
Erika J. Haug[1], Andrew W. Howell[1], Christopher R. Mudge[2], Benjamin P. Sperry[3], Robert J. Richardson[1], Kurt D. Getsinger[4]
[1]North Carolina State University, Raleigh, NC
[2]U.S. Army Engineer Research & Development Center, Baton Rouge, LA
[3]US Army Corps of Engineers, Gainesville, FL
[4]United States Army Corps of Engineers - Engineering Research and Development Center, Vicksburg, MS

SCAPMS Duck Race
5:00 pm – 6:00 pm
Hyatt Regency Atrium

APMS Awards Reception/ Banquet
6:00 pm – 9:00 pm
Studio 220 and NOMA A

Thursday, July 21

Thursday's Agenda-at-a-Glance

7am – 12pm	Registration (*Meeting Planning Room*)
7am-8am	Continental Breakfast (*Regency A&B*)
7am – 12pm	Exhibits (*Regency A&B*)
8am-12pm	Session V (*Regency C*)
10am - 1020am	Break
12pm	Annual Conference adjourns
12pm	Lunch on your own

Session V – General Session
8:00 am - 12:00 pm
Regency C
Moderator: Dr. Brett Hartis – APMS President Elect (*Duke Energy Corporation, Charlotte, NC*)

08:00 AM **Whole-genome Sequencing of an Herbicide Selection Experiment Identifies a Chromosomal Region Associated with Fluridone Resistance in Eurasian Watermilfoil.**
Ryan Thum, Gregory M. Chorak
Montana State University, Bozeman, MT

08:20 AM **Field Evaluation of Intermittent Pulse Endothall Treatment for Dioecious Hydrilla Control in Spring Creek, Lake Seminole, GA.**
Benjamin P. Sperry[1], Michael W. Durham[2], Robert J. Richardson[3]
[1]US Army Corps of Engineers, Gainesville, FL
[2]University of Florida Center for Aquatic and Invasive Plants, Gainesville, FL
[3]North Carolina State University, Raleigh, NC

08:40 AM **The Use of Thrips to Control Alligatorweed.**
Brandon Jones
Catawba Riverkeeper Foundation, Charlotte, NC

09:00 AM **Potential Impact of Herbicide Overspray on Phytoplankton Blooms in Arkansas Ponds.**
George L. Selden
University of Arkansas at Pine Bluff, Jonesboro, AR

09:20 AM **Field Evaluations of Cuban Bulrush (*Oxycaryum cubense*) Response to Select Herbicide Treatments.**
Gray Turnage
Mississippi State University, Starkville, MS

09:40 AM **Biological Control Using *Cytobagous salviniae* on the Santee Cooper Lakes to Manage *Salvinia molesta*: Early Steps in Rearing Efforts.**
Judson Riser
Santee Cooper, Moncks Corner, SC

10:00 AM **Break**

10:20 AM **Field Testing the Performance and Selectivity of Discrete In-water Applications of Imazamox on the Invasive Water Hyacinth (*Pontederia crassipes*).**
Kelli Gladding[1], Jonathan Glueckert[2], James Leary[3]
[1]Center for Aquatic and Invasive Plants, University of Florida, New Smyrna Beach, FL
[2]Center for Aquatic and Invasive Plants, University of Florida, Loxahatchee, FL
[3]Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL

10:40 AM **Evaluations of ProcellaCOR for Regional Weeds of Interest and Select International Invasive Aquatic Plants.**
Mark A. Heilman
SePRO Corporation, Carmel, IN

11:00 AM **The State of Aquatic Plant Management Education in the U.S.**
Candice M. Prince, Jason Ferrell
University of Florida, Gainesville, FL

11:20 AM **Connecting County Extension Agents to Aquatic Vegetation Management Challenges: A Texas Update.**
Brittany Chesser[1], Mikayla Killam[2]
[1]Texas A&M AgriLife Extension Service, Bryan, TX
[2]Texas A&M AgriLife Extension Service, College Station, TX

11:40 AM **Holistic and Integrative Approaches to Controlling Waterhyacinth in South Florida.**
Melissa C. Smith, Jeremiah R. Foley, Seth C. Farris
USDA Invasive Plant Research Laboratory, Fort Lauderdale, FL

63rd Annual Meeting
Hyatt Regency Indianapolis
Indianapolis, Indiana
July 24-27, 2023

Notes:

APMS

The Aquatic Plant Management Society

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 online 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.

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Abstracts - General Sessions and Poster Session

Abstracts are listed by alphabetically in the program. Presenting author appears in **bold.**

ORAL

2021 Survey Results for the Most Common and Troublesome Aquatic Weeds (And Washington DC Update). (19) **Lee Van Wychen**
WSSA, Alexandria, VA

The 2021 Weed Survey for the U.S. and Canada surveyed the most common and troublesome weeds in: 1) irrigation and flood control; 2) lakes, reservoirs, and rivers; and 3) ponds. Common weeds refer those most frequently seen while troublesome weeds are the most difficult to control, but not necessarily widespread. There were 135 total survey responses from 31 U.S. states and Quebec. No responses were submitted from Alaska, Arizona, Georgia, Hawaii, Illinois, Kansas, Louisiana, Maine, New Jersey, New Mexico, North Dakota, Oklahoma, South Dakota, Tennessee, Utah, Vermont, Virginia, West Virginia, and Wyoming. Across all surveyed aquatic areas (irrigation, lakes, and ponds) the three most common and troublesome weeds were 1) *Myriophyllum spicatum*; 2) *Hydrilla verticillata*; and 3) *Eichhornia crassipes*. The top three common weeds in irrigation were 1) *Eichhornia crassipes*; 2) *Pistia stratiotes*; and 3) a tie between *Rotala rotundifolia* and *Stuckenia pectinate* while the most troublesome weeds were 1) *Nymphoides cristata*; 2) *Eichhornia crassipes*; and 3) *Vallisneria americana*. The top three most common and troublesome weeds in lakes were *Myriophyllum spicatum*, *Hydrilla verticillata*, and *Potamogeton crispus*. The top three most common weeds in ponds were 1) *Algae* spp.; 2) *Typha* spp.; and 3) *Hydrilla verticillata* whereas the three most troublesome weeds were 1) *Algae* spp.; 2) *Nymphoides* spp.; and 3) *Eleocharis baldwinii.* The 2021 weed survey data is available at: www.wssa.net/wssa/weed/surveys/.

A Role for Legacy Phosphorous in Driving Microseira (Lyngbya) Growth. (6) Tryston Metz, Samuel P. Putnam, Timothy J. Shaw, Geoff I. Scott, **John L. Ferry**
University of South Carolina, Columbia, SC

Total maximum daily loads (TMDLs) are a widely applied regulatory tool for preventing and restricting the growth of algal and cyanobacterial blooms in surface waters. Lake Wateree SC has enjoyed the benefits of a restrictive TMDL on phosphorous for many years. Despite this restriction the lake has suffered from the continuous and growing presence of a harmful cyanobacteria, Microseira wollei. Citizen scientist volunteers have worked with teams of researchers from the University of South Carolina and established that in 2019 Microseira blooms had grown from their first sighting in 2012 to engaging 30-40% of the total lake shore. These teams also determined that the lake currently holds approximately 5,000,000 kg of the mat material. M. wollei dominated microbial mats are filamentous colonies that with biomass that can exceed 10 kg per square meter. Work reported in this presentation details characterization of the mat material, determination of toxins, and assessment of nutrient sources that could support such remarkable growth. A series of known cyanobacterial growth models were applied as diagnostic tools to identify the critical causal or predictive factors supporting this bloom; evaluating the role of temperature, nitrogen, chlorophyll, phosphorous in the water column, phosphorous in the sediment, and compounded effects of these variables (e.g. the interaction between temperature and chlorophyll). Of all the factors sedimentary phosphorous was the only one that predicted the observed M. wollei density to within the 95% confidence interval of the model. Possible mechanism for sedimentary phosphorous extraction are presented and the confounding role of legacy sedimentary phosphorous in TMDL development discussed.

Assessing the Compatibility of Metsulfuron-methyl and *Cyrtobagous salviniae* for the Control of *Salvinia molesta* . (36) **Samantha L. Prinsloo**[1], Christopher R. Mudge[2], Rodrigo Diaz[1]
[1]Louisiana State University, Department of Entomology, Baton Rouge, LA
[2]U.S. Army Engineer Research & Development Center, Baton Rouge, LA

Giant salvinia, *Salvinia molesta* (D.S Mitchell) is free-floating aquatic fern that originates from South America. Through human introduction, giant salvinia has escaped its native range and is now listed an invasive species across multiple continents. Hindrance to irrigation systems and waterway transportation can be attributed to the large mats formed on the water surface during heavy infestations. These mats reduce sunlight in aquatic ecosystems which impacts water quality, aquatic wildlife and habitats. In Louisiana, giant salvinia infestations also have a negative socio-economic impact on both the private and public tourism and recreation industries. Although there are several herbicides available for use on giant salvinia, cost and often inaccessible access to waterbodies limit control of infestations using herbicides. In Louisiana a Special Local Need (SLN) label was granted for metsulfuron-methyl because it was found to be highly efficacious against giant salvinia. In addition to herbicide control, other strategies for combating this invasive plant include biological control using the salvinia weevil, *Cyrtobagous salviniae* (Calder and Sands). However, colder temperatures in the northern parts of Louisiana have been attributed to poor insect survival during the winter. Hence, an integrated pest management (IPM) program needs to be developed to optimize the control of giant salvinia. Assessing the compatibility of both control technologies is key to creating an IPM program. Using laboratory methods outlined in previous herbicide/salvinia weevil compatibility studies, we aimed to investigate whether direct exposure to metsulfuron at the recommended rate will result in weevil mortality. The results from this experiment are forthcoming. Understanding the interactions between control agents is key for developing IPM strategies for managing giant salvinia across Louisiana and other states infested with the invasive species.

Assessment of Removal Methods for Arrowhead Vine (*Syngonium podopyhllum*) in Forest Wetlands in Florida. (50) **Stephen F. Enloe**, Coral Foster
University of Florida, Gainesville, FL

Arrowhead vine (*Syngonium podophyllum*) is an aggressive climbing vine in the Araceae family that is native to Latin America. It has been a popular houseplant for decades. However, it has escaped cultivation and is now problematic in forest wetlands including cypress strands in south and central Florida. Arrowhead vine forms a dense groundcover, outcompeting many other species and climbs into trees up to 10 m. Management has proven extremely difficult as many climbing vines survive after cutting via aerial roots that regrow to the ground. Additionally, many herbicide treatments have not been effective. To address this troublesome plant, a field study was conducted on the Loxahatchee River floodplain near Jupiter, Florida in 2020 and 2021 to assess the effectiveness of manual removal and herbicide foliar and reverse cut stem treatments. Plots were 10 by 10 m and replicated four times per treatment. Foliar treatments were applied to arrowhead vine ground cover and included imazamox, a tank mix of imazamox + carfentrazone, or no herbicide. Reverse cut stem treatments included glyphosate at 50% v/v or no herbicide, applied with a foamer or a two second dip method. Hand removal included the complete removal of all vines covering the ground and trees. Syngonium ground and tree cover were recorded at multiple times from 0 to 270 days after treatment (DAT). At 270 DAT, imazamox alone and the imazamox + carfentrazone tank mix did not effectively reduce Syngonium ground cover, while hand removal reduced ground cover by approximately 82%. Reverse cut stem treatments with glyphosate applied with a foamer applicator or a dip method reduced climbing vine cover by 98 and 99% respectively, while cutting alone reduced climbing cover by 87%. However, surviving climbing vines that had been cut with no herbicide treatment had regrown aerial roots an average of 50 cm from the cut and were approaching ground level. This study indicates that a combination of manual removal and reverse cut stem treatment techniques may be the most effective approach for managing Syngonium in forest wetlands. Future work should address additional herbicides for foliar ground treatments.

Automated Classification of Aquatic Invasive Plants Using Deep Learning AI and Visible Spectrum Imagery. (40) **Ashutosh Shah**, Sathishkumar Samiappan, Gray Turnage, Cary Daniel McCraine
Mississippi State University, Starkville, MS

Aquatic invasive plant species (AIS) affect recreational (i.e., fishing and boating) and ecological uses (i.e., nutrient cycling, floral and faunal biodiversity, etc.); both of which can affect local and regional economics through lost income or increased management expense. Spatio-temporal assessment of water bodies is essential for efficient management of aquatic resources. Identification and classification of AIS are usually performed on-site by subject matter experts and thus require time and resources. Mapping of lakes using aerial remote sensing was explored in the past with some success. However, the time needed to process aerial imagery often makes it impractical to assess small waterbodies. The purpose of this project was to develop an AI model that reduces image processing time in order to make detection and monitoring efforts more efficient by providing instantaneous species identification. We used visible spectrum imagery (a.k.a., conventional point-and-shoot cameras) and deep learning artificial intelligence (AI) to train a model to detect and classify aquatic invasive plants. Species assessed were 1) alligatorweed, 2) Cuban bulrush, 3) giant salvinia, 4) water primrose, 5) torpedograss, 6) water hyacinth, 7) water lettuce, and 8) white water lily. Training data acquisition and model optimization were conducted over a 4 month period. Overall identification accuracy of the optimized model is 82%. The AI model was also validated by uploading the model to an NVIDIA Jetson Nano microcomputer with integrated camera and then randomly passing live plants through the camera field of view and recording the system output (i.e., plant name) for each image collected. The compactness of this system (less than half square feet) will allow for implementation on autonomous systems for more effective management of waterbodies by increasing the speed at which waterbodies are surveyed for invasive species.

Biological Control Using *Cytobagous salviniae* on the Santee Cooper Lakes to Manage *Salvinia molesta*: Early Steps in Rearing Efforts. . (57) **Judson Riser**

Santee Cooper, Moncks Corner, SC

Giant salvinia *Salvinia molesta* was discovered on the Santee Cooper Lakes in 2017. Ongoing efforts to control the plant utilizing herbicide applications begin immediately following its discovery. In 2021 it was decided to implement rearing giant salvinia weevils *Cytobagous salviniae* as a biological control to reach nursery pockets and areas of the lake where herbicide applications were not feasible. Since a local supply of weevils was not present on the East Coast of the U.S. and winter temperatures do not permit winter pond cultivation at Santee Cooper's latitude the decision was made to construct a 30'x84' greenhouse. Greenhouse construction and fabrication was complete by February of 2022 and the cultivation of giant salvinia and the weevils began spring of 2022. The presentation will detail the greenhouse design, construction, fabrication, water quality, and first step rearing efforts by Santee Cooper to cultivate giant salvinia for weevil production.

Chemical Control of Brazilian Peppertree (*Schinus terebenthifolia*) in Areas of Freshwater and Brackish Inundation. (47) **Conrad A. Oberweger**[1], Candice M. Prince[2], Stephen F. Enloe[2], James Leary[3]

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Coastal ecosystems are vulnerable to hurricanes and are predicted to experience such storms more frequently. Although the ecosystem impacts of hurricanes are well established, there is little information about how they affect invasive plant management using herbicides. Here, we evaluated the effects of hurricane-related disturbances (i.e., inundation in fresh and saline water) on herbicide efficacy for Brazilian peppertree (*Schinus terebinthifolia*) in a greenhouse experiment in summer of 2021. Sixty Brazilian peppertrees were first placed into 94-L tubs and subjected to: 1) freshwater inundation to 7-cm above soil (0.2 ppt); 2) saltwater inundation to 7-cm above soil (15 ppt); or 3) freshwater irrigation as needed. After two weeks, we collected preliminary data (height, leaf number, leaf biomass, and specific leaf area) on 4 plants per treatment. Remaining plants were assigned to the following herbicide treatments: 1) cut stump applications (50% v/v triclopyr acid + oil carrier); 2) basal bark applications (10% v/v triclopyr acid + oil carrier); 3) foliar applications (1.44-lb. a.e. acre^{-1} triclopyr acid + non-ionic surfactant (0.25% v/v)); or 4) non-treated control. There were 4 plants per application method, per flooding treatment, and two experimental runs. Plants were evaluated for visual injury 30 and 90 days after treatment (DAT), and live cambium height 180 DAT. All herbicide applications provided control (>80% injury) by 30 DAT. There were few differences between application methods. By 90 DAT, cut stump applications provided less control than foliar applications in the non-flooded treatment. All other treatments resulted in similar injury across flooding treatments. Salinity significantly affected plants, with non-treated controls in saltwater showing 100% injury by 90 DAT and no measurable live cambium by 180 DAT (compared to >125-cm for non-treated controls in freshwater and non-flooded conditions). These results indicate that stress from prolonged saline inundation may enhance tree mortality regardless of herbicide application.

Common Nursery Evaluation of Eight Ecotypes of Illinois Pondweed (*Potamogeton illinoensis*). (17)
Joseph W. Sigmon, Kyle L. Thayer, Jennifer H. Bishop, Lyn A. Gettys
University of Florida Ft Lauderdale Research and Education Center, Davie, FL

Native submersed aquatic vegetation (SAV) is crucial to healthy lake ecosystems as it can improve water quality and create habitat for fish and other wildlife. Illinois pondweed is a native SAV found in lakes throughout Florida. Despite being abundant in most lakes where it is present, there are many Florida lakes where the species is absent altogether. Resource managers would like to include Illinois pondweed in restoration plans for lakes that lack this SAV, so a goal of these experiments was to identify a broadly adapted ecotype of the species. We collected Illinois pondweed from eight Florida lakes and evaluated plant growth under common nursery conditions with five different substrates and four different fertilizer rates. Experimental units consisted of 2L containers filled with substrate and planted with ten Illinois pondweed stems. Each treatment was replicated four times and all replicates for a single ecotype were randomized within one 8' culture tank filled with pond water that was continually circulated using a biofilter. Plants were grown for 16 weeks, then measured for height and subjected to a destructive harvest. Plants were separated into roots and shoots then dried in a forced-air oven until a constant weight was achieved. Dry weights and stem length data were analyzed using the General Linear Model procedure and LSD separation of means. Ecotypes did respond differently to common nursery conditions and these results may be useful when developing SAV restoration projects that include planting Illinois pondweed.

Connecting County Extension Agents to Aquatic Vegetation Management Challenges: A Texas Update. (61) **Brittany Chesser**[1], Mikayla Killam[2]
[1]Texas A&M AgriLife Extension Service, Bryan, TX
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Texas A&M AgriLife Extension Service directly reaches over 5 million Texans regarding agricultural production annually. A major component driving the success of these agricultural lands is water, which is supported by the 789,220 documented ponds in Texas. Through funding provided by Southern Sustainable Research and Education, a professional development program titled Aquatic Habitat Management on Agricultural Lands was developed and implemented 2021-2022. During this talk we will discuss challenges specifically related to aquatic vegetation management, as identified by 73 out of 250 county extension offices in Texas. A current update of the program will be given along with potential solutions identified by participants to increase knowledge transfer of aquatic vegetation management in each county.

Controlling Freshwater Harmful Algal Blooms ? the "Elephant in the Room". (1) **JoAnn M. Burkholder**

North Carolina State University, Raleigh, NC

Freshwater harmful algal blooms in the U.S. have been combatted using various approaches, some dating back nearly a century. Dredging has been conducted where practical to remove legacy nutrients and noxious benthic algae; water-column aeration has minimized stratification; dyes and other types of shading have decreased light for algal photosynthesis; many herbicides have been applied; and potential biocontrol agents have ranged from viruses to carp. Some of these approaches have been locally, usually temporarily successful in minimizing harmful blooms or mitigating their impacts. Long-term control generally has remained beyond reach, and harmful algae in many surface waters nationwide are dramatically increasing in frequency, duration, and extent. These blooms are being fueled by chronic, extreme nutrient (nitrogen, N and phosphorus, P) contamination as watersheds are increasingly characterized by rapid urbanization, poor sewage treatment, and/or industrialized animal production. The U.S. is failing to control N and P even in its sewage. High nutrient contamination has also facilitated takeovers by noxious exotic/ invasive plant and animal species, with major ecosystem changes that impede recovery after nutrient reductions. Nevertheless, major decreases in both external and legacy (internal) N and P have led to long-term success in minimizing noxious algal blooms. Societies such as the APMS can be valuable in stewardship efforts to help the general public and policymakers understand the broad-reaching importance of this issue. As an overall prognosis, the many approaches being used in attempts to control harmful algae will mostly act as "band-aids" until major efforts, backed by major funding, achieve reductions in N and P pollution that are as dramatic as the increasingly massive harmful algal blooms affecting many U.S. surface waters.

Development of Non-Chemical Management Recommendations for Starry Stonewort (*Nitellopsis obtusa*). (42) **Alyssa M. Haram**, Ryan M. Wersal

Minnesota State University, Mankato, Mankato, MN

Starry stonewort is an aquatic macro-alga that is native to Europe and Asia but is currently listed as an invasive species in North America. Colonies of starry stonewort were first discovered in Lake Koronis, Minnesota in 2015 and since has spread to 17 other water ways, most recently to the Mississippi River in 2021. When starry stonewort colonizes a waterway, it outcompetes native vegetation and exhibits a growth pattern that blocks out sunlight, impedes recreation, inhibits fish spawning, and leads to Oxygen depletion events. Management of starry stonewort has been focused on the use of copper algaecides or the combination use of copper algaecides and mechanical pulling, which has been effective at reducing above ground biomass but with no success in reducing underground bulbil density. Since bulbils are the only known form of reproduction of starry stonewort in North America, determining if mechanical treatment alone can reduce bulbil density would be beneficial for future management programs. Under greenhouse conditions three clipping treatments were evaluated (four clippings, two clippings, one clipping, and a no clipping control) to simulate harvester treatments in a controlled environment. At 16 weeks after treatment (WAT) only the 4 clips per season treatment reduced above ground biomass (35.5%) and reduced bulbil density (5%) when to compared to non-treated starry stonewort. However, bulbil densities were still higher than pre-clipping levels. Starry stonewort will be re-evaluated at 52 WAT to determine long-term clipping efficacy.

Environmental Conditions Triggering Germination of Overwintering Cyanobacteria: A Review.
(5) **Alyssa J. Calomeni**[1], Andrew D. McQueen[1], Ciera M. Kinley-Baird[2], Gerard A. Clyde[3]
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Overwintering cyanobacteria (akinetes and vegetative cells) in sediment result in different outcomes that range in severity. Overwintering cells have remained quiescent in sediments for decades while others are consequential seedstock for harmful algal bloom (HAB) resurgences. Because HABs can have devastating outcomes (e.g., toxicity to aquatic organisms, wildlife, domestic animals, and humans), questions arise regarding factors triggering HAB development from sediment seedstocks. The aim of this literature review was to identify environmental conditions (light, temperature, nutrients, and mixing) that trigger overwintering cell germination and growth. Environmental triggers for akinete germination differ from those leading to vegetative cell growth. For akinetes, light (0.5-100 µmol m-2s-1; 100-8,000 LUX) and temperature (5-35?) are critical factors for germination. Maximum germination was discerned at light intensities ranging from 5-100 µmol m-2s-1 and 1,200-3,000 LUX and temperatures ranging from 10-27?. For *Microcystis* overwintering cells, maximum growth rates occurred at light intensities of 100 µmol m-2s-1 and 600-1,800 LUX, temperatures ranging from 15-35?, and nutrient concentrations of 500 µg N/L as nitrate and ammonia, 100-500 µg N/L as NH4Cl, and 130 µg P/L as total phosphorus. Using these environmental conditions, laboratory incubation studies can be designed to assess the potential planktonic transfer and viability of overwintering cells in sediments collected from a water body. Additionally, *in situ* monitoring can be informed as zones within water bodies that meet these environmental conditions for overwintering cell growth may serve as sources for HABs. Ultimately, results from laboratory incubation studies and *in situ* monitoring will inform preventative management of HABs.

Evaluating the Efficacy of Florpyrauxifen-benzyl on North Carolina Noxious Weeds. (39) **Kara J. Foley**, Jens P. Beets, Erika J. Haug, Robert J. Richardson
North Carolina State University, Raleigh, NC

There is limited research available on the efficacy of florpyrauxifen-benzyl, the newest chemical control option in North Carolina, for use on problematic species listed on North Carolina's Noxious Weed List including *Ludwigia hexapetala* (creeping water primrose, CWP), *Alternanthera philoxeroides* (Alligatorweed, AW), and monoecious *Hydrilla verticillata* (hydrilla, HV). The goals of this study were to: 1) determine how plant density and exposure time impact the efficacy of FPB on CWP and HV, and 2) study how herbicide combinations can alter the efficacy of FPB on CWP and AW. For objective 1, CWP and MH were established in mesocosms under greenhouse conditions in low, medium, and high density plantings. MH was treated with 40 ppb FPB and CWP was treated with 1.36 kg ha^{-1} FPB. A surfactant (methylated seed oil) was included in all foliar treatments. Plants were exposed for 24-hour, 72-hour, or static periods. For objective 2, AW and CWP were established in greenhouse conditions and treated with FPB alone (0.68 and 1.36 kg ha^{-1}), triclopyr alone (3 and 6 kg ha^{-1}), 2,4-D alone (3 and 6 kg ha^{-1}), or combinations of each FPB rate with each other product rate. Visual ratings occurred weekly, and were harvested six weeks after treatment (WAT). All collected data were subjected to appropriate statistical analysis. By 6 WAT, FPB effectively controlled CWP in low and medium densities at all exposure times. Additional HV data will be presented. CWP was impacted by all tested herbicide treatment combinations by 6 WAT, except for FPB alone in low concentrations. AW was impacted by all

tested herbicide treatment combinations by 6 WAT, except for FPB alone. Results suggest that resource managers should target CWP populations that are low to medium density and should consider FPB applications in combination with low rates of triclopyr or 2,4-D for improved efficacy.

Evaluating the Response of Invasive Flowering Rush (Butomus Umbellatus) Cytotypes to Chemical Control Measures. (44) **Jacob A. Hockensmith**[1], Gray Turnage[1], Cory Shoemaker[2]
[1]Mississippi State University, Starkville, MS
[2]Slippery Rock University, Slippery Rock, PA

Establishment and spread of invasive species has affected ecosystems across the globe. These intruders compete with native species for resources, which often leads to reduced biodiversity and other environmental issues. Flowering Rush (*Butomus umbellatus*) is one species that has invaded the northern United States and Canada. Flowing Rush is a perennial, aquatic species that can be found growing along shorelines of lakes and other waterbodies. In North America, two distinct cytotype populations occur: diploid and triploid. These cytotypes differ in key anatomical and physiological properties. Despite these differences, current best management practices of chemical control are based solely off research conducted on triploid populations, which account for only 29% of populations across North America. In this study, we assessed the effect of two commonly used chemical control measures for aquatic plants, Diquat and Endothall, on diploid and triploid cytotypes in both Pennsylvania (PA) and Mississippi (MS). After establishment and subsequent herbicide application, plants were followed to eight weeks post-treatment. Plants were then harvested to assess the efficacy of treatments on above- and belowground biomass accumulation, and belowground asexual rhizomatous bud production. We observed that when completed in PA, no significant differences occurred between treatments of either cytotype and the control. In MS, response variables were often seen to be significantly lower compared to the control in diploid plants treated with diquat. This reduction was not observed as often for endothall. Additionally, in triploid plants, some significant differences from the control were observed, but were rarer when compared to differences observed in the diploid plants. Our results suggest that diploid and triploid populations display different reactions to chemical controls and that further research is needed to elucidate these differences.

Evaluation of Granular Endothall Concentration-Exposure Times for Vallisneria Control. (48)
Grace Bell[1], Benjamin P. Sperry[2], Michael W. Durham[3]
[1]University of Florida, Gainesville, FL
[2]US Army Corps of Engineers, Gainesville, FL
[3]University of Florida Center for Aquatic and Invasive Plants, Gainesville, FL

Evaluation of Granular Endothall Concentration-Exposure Times for Vallisneria Control Grace E. Bell[1], Benjamin P. Sperry[2], Mike W. Durham[1] [1]Biologist, University of Florida, Center for Aquatic and Invasive Plants, Gainesville, FL [2]Research Biologist, US Army Engineer Research and Development Center, Gainesville, FL Eelgrass (*Vallisneria americana*) is a submersed aquatic plant native to the US. While it is not exotic, eelgrass is considered a nuisance plant under certain conditions in systems such as private waters and in hydropower reservoirs. Unfortunately to our knowledge, eelgrass control recommendations is limited to anecdotal evidence from operations and university extension guidance from the 1960s. Recent operational success with endothall suggest that eelgrass control can be achieved with granular formulations of the amine salt; however, little is known and documented of the

concentration-exposure time requirements for effective biomass reduction. In effort to clarify these uncertainties and provide guidance for future management, we conducted a mesocosm experiment to evaluate eelgrass control with endothall under various concentrations and exposure times. Granular endothall (amine salt) was tested at 1, 3, or 5 mg L^{-1} and granular potassium salt of endothall was tested at 5 mg L^{-1}, both for 6, 12, 24, or 48 hour exposure times. Aboveground biomass was reduced 30 to 86% initially. However, after initial aboveground biomass harvest all plants began to recover from treatments and belowground biomass was largely not affected. Results indicate that future research on eelgrass control should evaluate alternative application techniques and other herbicide active ingredients to identify strategies for long-term control.

Evaluations of ProcellaCOR for Regional Weeds of Interest and Select International Invasive Aquatic Plants. (59) **Mark A. Heilman**
SePRO Corporation, Carmel, IN

The reduced-risk aquatic herbicide ProcellaCOR® (a.i., florpyrauxifen-benzyl) has been registered and used operationally in the US since 2018 with well-documented selective, systemic activity on hydrilla (*Hydrilla verticillata*), Eurasian watermilfoil (*Myriophyllum spicatum*), floating hearts (*Nymphoides* spp.), and several other major North American aquatic invasive plants. Building upon past development studies on these species and initial operational results, work continues to investigate ProcellaCOR activity on various additional aquatic weed species emerging as new threats to North American aquatic ecosystems or that are currently problematic globally and at risk of possible future introduction. Studies and regulatory efforts are also pursuing registration of ProcellaCOR in Canada and several other international locations. This presentation will summarize results from more recent lines of investigation under controlled settings or in the field to characterize activity of ProcellaCOR on several currently unlabeled potential target species including Cuban bulrush (*Cyperus blepharoleptos*), European frogbit (*Hydrocharis morsus-ranae*), water soldier (*Stratiotes aloides*), lagarosiphon (*Lagarosiphon major*), and yellow flag iris (*Iris pseudacorus*). In addition, available updates on efforts to develop and register ProcellaCOR outside the US, including efforts in Canada, and an overview of studies of new application techniques such as unmanned aerial systems will be provided.

Field Evaluation of Intermittent Pulse Endothall Treatment for Dioecious Hydrilla Control in Spring Creek, Lake Seminole, GA. (53) **Benjamin P. Sperry**[1], Michael W. Durham[2], Robert J. Richardson[3]
[1]US Army Corps of Engineers, Gainesville, FL
[2]University of Florida Center for Aquatic and Invasive Plants, Gainesville, FL
[3]North Carolina State University, Raleigh, NC

A field demonstration was conducted in Spring Creek on Lake Seminole near Bainbridge, GA in 2022 to evaluate an intermittent-pulse application of endothall to control dioecious hydrilla [*Hydrilla verticillata* (L.f.) Royle]. Potassium salt of endothall was dripped into spring creek at 3 mg ai L^{-1} for 8 hours a day for three days (24 hours total treatment). This novel application technique allows for application equipment to be manned during treatment hours and does not require overtime labor for equipment supervision outside of normal work hours. Additionally, current mesocosm research suggests that this intermittent exposure pattern can potentially increase plant control compared to constant exposure at equivalent concentrations and exposure times. Four plots, one upstream and three downstream of the injection site, were established for point intercept surveys while the entire main channel was surveyed for vegetation cover and biovolume using sonar techniques. Spring Creek consisted primarily of hydrilla prior to treatment with some small populations of coontail (*Ceratophyllum demersum*). Pretreatment (January 2022) vegetation cover and biovolume was 37 and 92%, respectively. By May of 2022 (3 months post-treatment), vegetation cover and biovolume was reduced to 22 and 79%, respectively. However, based on point-intercept data, vegetation cover and biovolume data from May mostly consisted of coontail which appears to have replaced areas previously infested with hydrilla. Further details of the demonstration will be given in the presentation as data collection is ongoing. Future work will aim to refine intermittent pulse intervals with endothall and other herbicides for optimized control of submersed aquatic plants.

Field Evaluations of Cuban Bulrush Response to Select Herbicide Treatments. (56) **Gray Turnage**
Mississippi State University, Starkville, MS

Cuban bulrush (*Oxycaryum cubense*) is an invasive aquatic plant species native to South America that is spreading across the Southeastern U.S. Cuban bulrush is a perennial floating species that can completely cover a waterbody and disrupt ecological and biological processes as well as hamper human uses of water resources. In the early stages of invasion, Cuban bulrush survives as an epiphytic plant on other floating objects (other plants, logs, etc.) but in later stages the plant traps sediment in its root system and forms a floating island (tussock) that reduces the need for an underlying substrate for survival. Tussocks can be hundreds of acres in size and portions of them can break away, drift to new locations, and establish new colonies. To date, there is limited literature regarding chemical control of Cuban bulrush. The purpose of this work was to validate meso-scale results on field populations. Preliminary work in 2017 and 2018 along with literature reviews identified diquat, flumioxazin, penoxsulam, glyphosate, 2,4-D, triclopyr, and florpyrauxifen-benzyl (FPB) as suitable candidates. In 2021, two field trials were implemented: one in Mississippi and the other in Florida. The Mississippi trial found that diquat (1.1 kg ai/ha), 2,4-D (4.2 kg ai/ha), and triclopyr (1.67 kg ai/ha) provided better control (>94% biomass reduction) of Cuban bulrush than FPB (0.029 kg ai/ha; 60% reduction) 12 weeks after treatment. In Florida, diquat (1.68 kg ai/ha) or triclopyr (5.04 kg ai/ha) applications resulted in >90% biomass reduction eight weeks after treatment while FPB achieved 80% reduction (0.029 kg ai/ha). Samples will be collected from field plots one year after treatment (summer 2022) to determine if the herbicide rates tested will deliver long term control of Cuban bulrush. Final results of field trials will be used to make recommendations for resource managers engaged in operational control of Cuban bulrush.

Field Testing the Performance and Selectivity of Discrete In-water Applications of Imazamox on the Invasive Water Hyacinth (*Pontederia crassipes*). (58) **Kelli Gladding**[1], Jonathan Glueckert[2], James Leary[3]
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[2]Center for Aquatic and Invasive Plants, University of Florida, Loxahatchee, FL
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Annually, up to 25k acres of public waters are under maintenance control targeting water hyacinth (*Pontederia crassipes*) in Florida. Foliar treatments with 2,4-D and diquat have been the institutional standards for floating plant control for several decades due to its high level of efficacy and low cost. This is a highly discriminate treatment, minimizing non-target injury, when target populations are very small and isolated. However, larger treatments (i.e., beyond maintenance control) in mixed communities of native emergent plants can cause significant collateral damage. These collatoral "brown out" conditions have precipitated several complaints from user groups and stakeholders triggering demands to prohibit herbicides. This inspired the need to explore alternative treatment methods to reduce the negative optics from foliar herbicide treatments. Imazamox is an ALS inhibitor registered for aquatic use since 2008. Its primary use pattern in APM has been foliar treatments at 32 fl oz acre^{-1} on primrose (*Ludwigia* sp.) and cattail (*Typha* sp.), but also lists foliar and in-water use patterns (100—200 ppb) to control water hyacinth. Institutional knowledge of operational submersed imazamox treatments is very limited. Multiple operational-sized (14-30 acres) submersed imazamox treatments were set up between 2020-2022. Target concentrations of 200 µg l^{-1} were administered in dense, mixed communities of hyacinth and spatterdock (*Nuphar advena*). The dissipation half-life was ~ 2 days with detection out to 8 DAT. Photolysis was arrested in dark water under leaf canopy. Monitoring was performed monthly with aerial platforms at high resolution for species identification and injury. At 9 MAT, over 90% reduction of hyacinth has been maintained with no evidence of injury to spatterdock. While the initial cost of imazamox is much higher than the foliar standards, The total economy of a submersed treatment starts to equalize with the standard when interventions are significantly reduced.

Herbicide Efficacy on Floatinghearts in Florida. (45) **Ian J. Markovich**, Kyle L. Thayer, Joseph W. Sigmon, Jennifer H. Bishop, Lyn A. Gettys
University of Florida Ft Lauderdale Research and Education Center, Davie, FL

Florida is the adopted home of a number of species in the genus *Nymphoides*. In addition to the native *N. aquatica* (banana lily), there are reports of *N. peltata* (yellow floatingheart), *N. cristata* (crested floatingheart), *N. grayana* (Gray's floatingheart), *N. humboldtiana* (Humboldt's floatingheart), and hybrid *N. aquatica* x *N. cristata* populations in the state. Because these introduced species interfere with aquatic systems, management of them is a priority. Therefore, the goal of these experiments was to determine the response of these plants to selected aquatic herbicides. Plants were grown in 68L mesocosms in a greenhouse at the University of Florida Fort Lauderdale Research and Education Center in Davie FL with one plant of a single species in each mesocosm. When coverage reached 80%, plants were treated once with Weedar 64 (2,4-D), Ecomazapyr (imazapyr), Clearcast (imazamox), AquaSweep (2,4-D+triclopyr), Depth Charge (2,4-D+flumioxazin), ProcellaCOR (florpyrauxifen benzyl), or plain water as an untreated check. All treatments included a nonionic surfactant and were replicated four times. Plants were grown out for 16 weeks after treatment to allow development of symptoms and recovery from treatments, then all live above-ground plant material was harvested and dried to determine biomass. These experiments revealed that these species respond differently to herbicides, which may be useful for aquatic managers that are responsible for controlling populations of *Nymphoides*.

Herbicide Spray Loss: Influence of Spray Trajectory Angle, Spray Pattern Type and Application Equipment. (41) **Christopher R. Mudge**[1], Benjamin P. Sperry[2], Michael W. Durham[3], Kurt D. Getsinger[4]

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[4]United States Army Corps of Engineers - Engineering Research and Development Center, Vicksburg, MS

Foliar applied aquatic herbicides have been the primary means to control unwanted floating and emergent vegetation in the U.S. for decades. Although efficacy, selectivity, and general use patterns of most of these products is well understood, limited information exists on the aqueous spray deposition levels (i.e., spray loss to the water column) of the herbicides following foliar applications. Therefore, a series of outdoor mesocosm experiments were conducted in 2020 and 2021 in Baton Rouge, LA and Gainesville, FL to evaluate the influence of spray trajectory angle, spray pattern type, and broadcast vs spot spray application methods on spray loss when applied to the foliage of floating aquatic plants. The inert tracer dye rhodamine WT was used as an herbicide surrogate to evaluate these factors as foliar applications to waterhyacinth, water lettuce, and giant salvinia. Results will be provided in the presentation.

Herbicide Trials with Brazilian Egeria (*Egeria densa)* for Management in the Sacramento - San Joaquin River Delta. (32) **John D. Madsen**, John Miskella

USDA-ARS, Davis, CA

Brazilian egeria (*Egeria densa*) is the dominant submersed plant in the Sacramento - San Joaquin River Delta (Delta), displacing native plant species and degrading habitat for endangered fish species. In an effort to identify the best potential herbicides for management of this invasive plant in California, a mesocosm study was conducted at the USDA Aquatic Weed Facility. Fifty mesocosm tanks of 160 L capacity were planted with four 3.8L pots of Brazilian egeria and allowed to establish for four weeks before treatment. Four tanks each were treated with bispyrabic sodium (45 ppb), carfentrazone-ethyl (200 ppb), ethylenediamine complex of copper (1000 ppb), diquat (390 ppb), potassium salt of endothall (5000ppb), dimethylalkylamine salt of endothall (5000 ppb), florpyrauxifen-benzyl (50 ppb), flumioxazin (400 ppb), fluridone (60 ppb), imazamox (500 ppb), penoxsulam (60 ppb), and four tanks were conserved as an untreated reference. All exposures were single treatments, static exposures for twelves. At the end of twelve weeks, all pots were harvested, and the shoots were dried at 70C for 48 hours. All herbicides produced some statistically significant reduction in biomass. Copper, diquat, endothall dimethylalkylamine and fluridone produced 90% or better control. Carfentrazone (69%) and the potassium salt of endothall (62%) provided better than 50% control, with other herbicides producing somewhat less than 50% control. Field demonstration has substantiated some of these findings. A study of three treatment plots in 2016 found an 85% reduction in biomass in fluridone-treated plots, compared to a 26% increase in biomass in untreated plots. Further field demonstrations are anticipated using diquat. Copper-based herbicides and endothall dimethylalkylamine are not permitted for use in the Sacramento / San Joaquin River system, due to endangered fish species concerns. A further study of endothall concentration and exposure time (C/ET) was also performed on Brazilian egeria and Eurasian watermilfoil.

Holistic and Integrative Approaches to Controlling Waterhyacinth in South Florida. (62) **Melissa C. Smith**, Jeremiah R. Foley, Seth C. Farris
USDA Invasive Plant Research Laboratory, Fort Lauderdale, FL

Waterhyacinth (*Pontederia crassipes*) remains persistently pesky throughout the freshwater communities in several ecologically critical watersheds including the Greater Everglades Ecosystem. Waterhyacinth invasion impedes navigation, reduces dissolved oxygen, harbors mosquito populations, and contributes to harmful algal blooms. Waterhyacinth, which was brought to Florida in the late 19th century, has been aggressively controlled through by federal, state and local entities for nearly 60 years. Chemical, physical, and most recently, biological control has reduced coverage to a fraction of its historical extent, but without these measures, waterhyacinth rapidly returns. Biological control has been present on the landscape for over 40 years, but research into integrated management of waterhyacinth has never been researched at the landscape scale. As attitudes and costs surrounding chemical control shift, a new paradigm that maximizes the efficiency of each control method needs to be implemented. Herein we present preliminary results from previous research, and current and future research exploring integrative approaches, including active restoration, to restore and maintain freshwater aquatic communities in America's largest wetland.

Human Health Effects of Freshwater HABs: A One Health Issue. (2) **Geoffrey I. Scott**
University of South Carolina, Columbia, SC

One Health" concept developed by the US Centers for Disease Control recognizes that the health of people is connected to the health of nature, animals and the environment. "One Health" is a collaborative, multi-sectoral, and transdisciplinary approach—working at the local to global levels—with the goal of optimizing health outcomes by recognition of the interconnection between people, animals, plants, and their shared environment. Climate change and eutrophication are two major factors causing the recent increases in HABs events world-wide. Backer et al. (2015) reported on US HAB related illnesses as 4,534 events were reported to the Harmful Algal Bloom-related Illness Surveillance System (HABISS). Most HAB events producing toxins (97%) occurred in freshwater (e.g. lakes, rivers, streams, and ponds) and the remaining events occurred in brackish (1.45%) or marine waters (1.46%). Most Toxins Related acute Illnesses occurred in marine waters, while effects from FW HABs may often be more chronic in nature. Mammalian toxicology studies with the freshwater HAB toxin Microcystin have been shown to increase inflammatory responses in the liver and kidney leading to increased severity of Non-Alcoholic Liver Disease (NAFLD), enhanced insulin resistance, an altered gut microbiome resulting in increased inflammation that affects the tight junction proteins in the blood brain barrier. Also, microcystin has been found to be an endocrine disrupting chemical, altering functions in the ovary, including endocrine disruption of important reproductive hormones. Preventing exposure is key in reducing health impacts of HABs to humans

Hydrilla Fragment Tolerance to Desiccation in Simulated Boat Bunk Conditions. (14) **Taylor L. Darnell**[1], Benjamin P. Sperry[2], Candice M. Prince[3]
[1]University of Florida/ Center for Aquatic Invasive Plants, Gainesville, FL
[2]US Army Corps of Engineers, Gainesville, FL
[3]University of Florida, Gainesville, FL

Hydrilla (*Hydrilla verticillata*) is a Federal noxious weed that can establish in a variety of aquatic habitats. Hydrilla has three main mechanisms of spread: stem fragments, axillary turions, and subterranean turions (i.e., tubers). Stem fragments can be spread between waterbodies via boat trailers. However, little is known about how long hydrilla fragments can tolerate this level of desiccation. Here, we evaluated the desiccation tolerance of hydrilla fragments on three common boat bunk materials (plastic, carpet, and bare wood). Hydrilla fragments (6 fragments per group with 5 replicates per desiccation time) were placed on bunks for 2.5, 8, 24, 48, 72, or 96 hours, or 5, 6, 7, 8, 9, 10, 11, 12, 13, or 14 days. After desiccation, fragments were moved to 1L containers filled with 5 cm of sand and 0.6 L of water for 4 weeks. Fragments were evaluated weekly for viability (0=dead, 1=alive) for four weeks, at which point oven-dried biomass was recorded. Fragments on either wood or carpeted bunks desiccated 5 times faster than plastic-covered bunks. Fragments placed on plastic bunks had high survival rates (99% viability) four weeks after desiccation, regardless of desiccation time, compared to fragments on bare wood (89% viable) or carpeted bunks (93% viable). Final biomass was negatively correlated with desiccation time for all three bunk materials. Results indicate that hydrilla fragments that are desiccated between wood, carpet, or plastic boat bunks can survive and establish new populations after 14 days of desiccation. These data indicate that hydrilla-contaminated boat trailers pose high risk for spread of this invasive species to new uninfected waterbodies even after short-term storage.

Influence of Temperature on Waterhyacinth Control with Florpyrauxifen-benzyl. (43) **Michael W. Durham**[1], Benjamin P. Sperry[2], Christopher R. Mudge[3]
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[2]US Army Corps of Engineers, Gainesville, FL
[3]U.S. Army Engineer Research & Development Center, Baton Rouge, LA

Since receiving registration for use in aquatic systems in 2018, the auxin-mimic florpyrauxifen-benzyl has been highly efficacious against invasive aquatic species including waterhyacinth, crested floating heart, hydrilla, as well as other difficult to control floating, emergent, and submersed plants. To date, thousands of acres of waterhyacinth have been treated with florpyrauxifen-benzyl by multiple management agencies in Florida. Despite the expanded use of the systemic herbicide, foliar applications of florpyrauxifen-benzyl targeting waterhyacinth in late 2020 and early 2021 failed to control the floating plant throughout Florida. The lack of control in northern Florida where moderate temperatures exist, as well as limited activity in the central and southern portions of the state during the cooler months, is a cause for concern. Ongoing field monitoring is determining control outcomes; however, more guidance is needed to determine when florpyrauxifen-benzyl is susceptible to failure (i.e., optimal application timing). Based on previous research with other auxin-mimic herbicides, these herbicide failures could be growth-rate driven and florpyrauxifen-benzyl may not perform well when plants are not actively growing. Therefore, outdoor mesocosm research was conducted over a 12-month period to evaluate waterhyacinth response to several rates of florpyrauxifen-benzyl (SC formulation) under various environmental and seasonal conditions at two locations (Gainesville, Florida and Baton Rouge,

Louisiana) to aid in the development of guidelines for use and determine if/when failures occur. In addition, the commonly used herbicides diquat and 2,4-D were included for comparison purposes. Results will be provided in the presentation.

Integration of Preventative Algaecide Treatments into Current Harmful Algal Bloom Management Strategies. (4) **Ciera M. Kinley-Baird**[1], Andrew D. McQueen[2], Alyssa J. Calomeni[2], Gerard A. Clyde[3]
[1]Aquatic Control, Inc., Seymour, IN
[2]US Army Engineer Research and Development Center, Vicksburg, MS
[3]US Army Corps of Engineers, Tulsa District, Tulsa, OK

Overwintering cyanobacteria cells in sediments may play a critical role as seedstock for harmful algal blooms (HABs) in impacted freshwater resources. Given what is known about overwintering cell life cycles of cyanobacteria, there is an opportunity to use algaecides in an innovative and preventative manner, to target overwintering cells prior to germination and growth. As this is a novel approach, questions arise regarding the potential benefits and practical application within the current management paradigm for treating HABs. The purpose of this presentation is to discuss common approaches for using algaecides in HAB management and how preventative algaecide treatments can be integrated into this model. Considerations relevant to treatment design, timing, and scale are discussed based on data from peer-reviewed literature as well as monitoring and analysis from HAB-impacted reservoirs in the midwestern US. Risk scenarios are compared among the current and proposed management approaches to highlight the potential ecological, economic, and social benefits of utilizing preventative algaecide treatments. Conceptualization of the potential risk reduction and practical applications of this approach are critical first steps towards implementing preventative treatments of sediment seedstocks for HABs into management plans for freshwater resources.

Invasive Alligator Weed (*Alternanthera philoxeroides*) in the Southeastern United States: a Future Research Plan. (13) **Samuel A. Schmid**[1], Gary N. Ervin[2], Gray Turnage[3]
[1]Minnesota State University, Mankato, Mankato, MN
[2]Mississippi State University, Mississippi State, MS
[3]Mississippi State University, Starkville, MS

Invasive aquatic plants have the capacity to fundamentally alter the structure and function of the systems they inhabit. *Alternanthera philoxeroides* (alligator weed) is an emergent aquatic amaranth that is native to South America and invasive in many regions globally. Historically, invasion (and management as a result) has been most intense in the southeastern United States; however, there are substantial invasive ranges in Australia, New Zealand, and East Asia. In invaded sites, alligator weed can alter system structure by forming dense mats of shoots at the water's surface. These mats can displace native plants that are important food and habitat for aquatic fauna. In the United States, biocontrol of alligator has primarily focused on the insect vector *Agasicles hygrophila* (alligator weed flea beetle). The success of alligator weed biocontrol in geographic locations with climate conducive to the survival of the flea beetle led to global adoption of this strategy in areas of similar climate. This allowed aquatic plant managers in these areas to shift their focus and resources to other target species. However, alligator weed continues to colonize newer and more environmentally diverse ecosystems with climate not suitable for the survival of the flea beetle. This poses new problems for alligator weed management. This presentation 1) summarizes the historic research and management paradigms for alligator weed, 2) contextualizes the

literature with the current status of alligator weed, 3) discusses the future of alligator weed biocontrol in the southeastern United States, and 4) exhibits preliminary research efforts at Mississippi State University including alligator weed phenology and integrated management utilizing herbicides and a second insect vector, *Amynothrips andersoni* (alligator weed thrips).

Life History of Diploid Flowering Rush (*Butomus umbellatus*) from Field Populations in New York and Ohio. (12) **Maxwell G. Gebhart**[1], Ryan M. Wersal[1], Bradley T. Sartain[2], Nathan E. Harms[3]
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[2]US Army Corps of Engineers Engineer Research and Development Center, Vicksburg, MS
[3]United States Army Corps of Engineers - Engineering Research and Development Center, Lewisville, TX

Flowering rush (*Butomus umbellatus*) is an invasive perennial monocot from western Asia that is known to block canals and reduce water recreation throughout the U.S. and Canadian border. Currently there are two karyotypes (diploid and triploid), however there is a lack of information regarding the life history for the diploid type. To gain an understanding of life history strategies in diploid flowering rush, field populations in New York and Ohio were sampled from April to November 2021. The plant tissues were divided into four groups, dried, then weighed to assess seasonal biomass allocation. Peak above ground biomass occurred in August and was 989.11, 1013.46, 1300.87 g DW/m^2 for Mentor Marsh, Unity Island, and Tonawanda sites, respectively. Peak below ground biomass occurred in September and was 578.52, 617.18, and 2009.08 g DW/m^2 for Mentor Marsh, Unity Island, and Tonawanda sites, respectively. The above and below ground biomass was seen to be almost twice that of the triploid karyotype. Bulbil density reached 13,300 per m^2 almost twenty times more numerous, than what has been reported for the triploid type. A second year of life history data is being collected in 2022. Future work will assess the relationships between biomass allocation and environmental factors as well as quantify resource allocation through starch analysis.

Measuring the Expansion of an Incipient Floating Plant Invasion on a Small Tropical Wetland in Chetumal, Mexico. (18) **Christian Huix**[1], Sergio Cohuo Durán[2], James Leary[3]
[1]Technological Institute of Chetumal, Chetumal, QR, Mexico
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La Sabana is a small (i.e., 109 ha), perennial freshwater wetland located on the urban interface of Chetumal, Mexico (18.5141° N 88.3038° W). It serves as habitat to Mojarra (*Mojarra* sp.) and Pinta (*Chiclasoma* sp.) fish species harvested for local consumption along with many other indigenous birds and reptiles. In the last decade it has succumbed to anthropogenic pollution causing severe reductions in water quality. Coincidentally, an incipient invasion of water lettuce (*Pistia stratoites* L.) was reported in 2017, which quickly expanded across this shallow, hypereutrophic lake. Subsequently another incipient invasion of water hyacinth (*Pontederia crassipes* L.) was recently discovered in 2021. Floating aquatic plant (FAP) infestations can incite a wide range of hydrological, ecological and socioeconomic impacts. Here we demonstrate a unique opportunity to capture this early onset of an incipient plant invasion through retroactive satellite remote sensing. We collected imagery from the Sentinel-2 constellation from 2017-2022 (n= 47). We used a Normalized Difference Vegetation Index (NDVI) and supervised

classification methods to discriminate FAP cover within the water boundary. In 2021, *P. stratoites* reached a maximum coverage of 24.7 ha, while *P. crassipes* had quickly reached 9.6 ha. Coverage fluctuated during this time period but showed a positive growth trend (Mann Kendall test z = 4.1). Forecasts using an ARIMA (2,2,1) model have predicted future outcomes of FAP expansion within this hypereutrophic wetland. Managing this invasion has proven to be difficult and could potentially be counterproductive. This study of the FAP population dynamics will contribute to a more comprehensive restoration plan.

Mitigating HAB Blooms in the Western United States. (8) **Terence M. McNabb**
Aquatechnex, LLC, Bellingham, WA

Harmful Algae Blooms (HAB)are an increasing problem in the United States as more and more lakes and reservoirs receive phosphorus pollution. There are programs nationwide at the state and local level that monitor for these conditions, but the end result of these programs is often just the placement of warning signs.The technologies do exist to mitigate these blooms and remove the threat. The first part of this talk will focus on using monitoring tools to track cyanobacteria blooms and respond with US EPA registered algaecides in two case studies. The first case will focus on a bloom that threatened to impact an Ironman event a few days prior. The second will focus on a potable water reservoir that supplies to over 4 million homes and was shut down for an HAB bloom.The second part of the talk will focus on inlake strategies to mitigate phosphorus pollution. Aluminum Sulfate has been the primary tool for sequestering in lake phosphorus for decades. A case study will be presented documenting the use of this technology to mitigate HAB blooms and meet TMDL numeric targets for P in Southern California. A second newer technology, Lanthanum Modified Clay, was developed by the Australian National Science Academy to address in lake phosphorus sequestration. Like all inventions, the scientists there were looking for ways to improve upon current technology. Lanthanum Modified Clay is a combination of two earth elements. Bentonite clay is the primary carrier. Lanthanum is the phosphorus binding agent and replaces the sodium in the clay matrix. The material is applied to the lake surface and as it settles through the water column attracts and adsorbs free reactive phosphorus. The light layer created on the lake bottom captures additional free reactive phosphorus releasing from lake sediments and that released from decaying algae cells that fall to the lake bottom. The last case study will focus on Kitsap Lake and the mitigation of HAB blooms over the past few years using adaptive management and lanthanum based phosphorus sequestering technologies. Treatments in 2020 and 2021 have resolved long standing HAB lake closures and the results of this study will be presented.

Monitoring Overwintering Cyanobacteria in Sediments from Three HAB Impacted Waterbodies.
(7) **Andrew D. McQueen**[1], Alyssa J. Calomeni[1], Ciera M. Kinley-Baird[2], Gerard (Tony) A. Clyde[3]
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[2]Aquatic Control, Inc., Seymour, IN
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Freshwater cyanobacteria causing harmful algal blooms (HABs) can overwinter in sediments as quiescent cells (akinetes or vegetative colonies) and contribute to bloom resurgences in subsequent growing seasons. Algaecide applications targeting overwintering cells in HAB impacted waterbodies may provide a viable approach to increase the duration between bloom events while decreasing the intensity and severity of blooms. However, this is a novel strategy and there are limited data and resources to inform preventative management. Therefore, the overall objective of this study was to illustrate relevant data needs to support identification and prioritization of sites that contain overwintering cells (and have HAB growth potential) with the goal to inform actionable decisions for mitigation. To achieve this, sediment samples were collected, and overwintering cells were identified and enumerated from three HAB-impacted waterbodies in the central US as pertinent examples. To inform overwintering cell viability and growth potential, laboratory incubation studies were developed based on peer-reviewed literature of environmental conditions (e.g., temperature, light, and nutrients) suitable for overwintering cyanobacterial growth. Overwintering cells were present in sediments at all three of the HAB-impacted waterbodies sampled, with 85% of sites (n=13) containing akinetes or overwintering colonies in sediments, and 54% of sites (n=13) with a growth potential to produce problematic cell densities (>100,000 cells/mL) in the planktonic phase. Identification and prioritization of sites for preventative management should consider multiple lines of evidence: 1) presence and density of overwintering cyanobacteria, 2) growth potential as informed by laboratory incubation studies, and 3) environmental conditions at the sediment water interface (e.g., light intensity and attenuation, temperature, nutrient concentrations). Ongoing research is being conducted to identify effective algaecide treatments for overwintering cells and in-lake demonstration scale experiments are planned.

Multi-metric Cold Tolerance Evaluation of Established Agent Populations to Improve Biological Control of Weeds. (49) **Ian A. Knight**[1], Nathan E. Harms[2], Paul Pratt[3], Angelica Reddy[3], Dean Williams[4], Annie Huang[5], Ashton B. DeRossette[6]
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[6]US Army Corps of Engineers Engineer Research and Development Center, Vicksburg, MS

Climate mismatches between target weeds and biocontrol agents (BCAs) can lead to large variation in control across invaded regions. In the Southeastern USA, several aquatic weeds have wider distributions than their introduced (BCAs) due to differences in winter mortality between them. Alligatorweed, *Alternanthera philoxeroides*, is a globally invasive aquatic weed and is present in 16 states in the southeastern US and California. Early efforts at biological control with the alligatorweed flea beetle (AWFB), *Agasicles hygrophila*, were successful in warm coastal areas. However, as the weed expanded into more temperate climates, control at these new latitudes has been limited due to poor cold tolerance of the agents, originally sourced from subtropical climates in South America. Foreign exploration to target temperate regions of an invader's native range is the historical solution of sourcing climatically suited BCAs; however, this process can be costly and time consuming, clearing additional regulatory hurdles before introduction. An emerging solution is to leverage local adaptation in introduced populations by surveying established BCAs and assaying them for desired traits (eg. cold tolerance) before rearing and redistribution. We surveyed AWFB and alligatorweed thrips (AWT), *Amynothrips andersoni*, from 10 and 8 populations, respectively across the southeastern US and South America. We compared cold tolerance between populations using a range of metrics including supercooling point, Ct_{max}, lower lethal temperature and exposure times, and temperature dependent development. We explore the relationships between these measures, identify putatively more cold tolerant populations, and discuss other ongoing projects that could benefit from improve biological control at sites where releases have previously been unsuccessful.

Non-target Impacts of Florpyrauxifen-benzyl Treatments Using Split Applications and Herbicide Combinations. (46) **Jens P. Beets**[1], Erika J. Haug[1], Benjamin P. Sperry[2], Robert J. Richardson[1]
[1]North Carolina State University, Raleigh, NC
[2]US Army Corps of Engineers, Gainesville, FL

Invasive plant management is pivotal to ensuring ecosystem function and maintenance of water bodies. Aquatic invasive plant species, such as hydrilla (Hydrilla verticillata [L.f. Royle]) and Eurasian watermilfoil (Myriophyllum spicatum L.; EWM) can severely impact ecosystems and economies of the areas they invade, including displacing native species. Native species often provide desirable ecosystem services, such as providing habitat and food, improving water quality, and soil stabilization. Herbicide combinations and sequential/split applications are often used to provide selective, long-lasting control of invasive species. However, little research has been performed on these approaches with florpyrauxifen-benzyl. An experimental trial was set up at NSCU investigating the effects of split applications on dioecious hydrilla, white waterlily, spatterdock, and coontail. A second series of trials was set up at NCSU investigating effects of herbicide combinations on white waterlily, EWM, spatterdock, and cattail. These methods were repeated at UF investigating dioecious hydrilla, bulrush, and Kissimmee grass. Split applications resulted in 80-94% biomass reduction of dioecious hydrilla. Moderate damage to coontail, and near total control of white waterlily were also observed. Reductions in biomass to spatterdock were variable, depending on exposure and treatment pattern. Herbicide combinations resulted in 100% reduction of EWM biomass and 67-100% biomass reduction for dioecious hydrilla. Effects on desirable species were more variable, with limited impacts on bulrush, cattails, and Kissimmee grass and moderate to severe impacts on spatterdock and white waterlily. Considerations such as exposure time and combinations with specific herbicides should be taken into account depending on the presence of desirable native species within the treatment area.

Observations of Submersed Aquatic Vegetation Community Shifts with Selective Hydrilla Management in Lake Sampson Florida. (16) Jacob Thayer[1], **James Leary**[2], Kelli Gladding[3], Jonathan Glueckert[4], Amber Riner[1]
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Submersed aquatic vegetation (SAV) communities are major ecological components of Florida's shallow lake systems. Hydrilla (*Hydrilla verticillata*) is a non-native SAV dominating many of these lakes and is often observed to be growing in large monospecific cultures exclusive to other native community members. This invasive species is the top priority for aquatic plant management in Florida with objectives to conserve native SAV through selective suppression. Lake Sampson is approximately 770 hectares and located in rural Bradford County, Florida. It is mesotrophic with high color; half of the lake is littoral and has a long history of hydrilla management. A 2020 survey recorded over 400 ha of hydrilla infestation and strong representations of native eelgrass (*Vallisneria americana*) and Illinois pondweed (*Potamogeton illinoensis*). An in-water treatment of florpyrauxifen-benzyl was administered in early spring to 360 ha of the littoral area in the 1.2-2.4 m depth range. The target concentration was 29 µg l^{-1} covering 47% of the total surface area and 32% of the whole lake volume. The treatment equilibrated throughout the lake by 8 DAT and had measurable levels of the acid degradate at 32 DAT. Species and abundances were recorded with point intercept, hydroacoustic, and airborne imagery surveys to assess changes in community structure with high spatial and temporal resolution. Hydrilla was suppressed in 87% of the occupied area at 20 WAT. Coincident to that, eelgrass expanded 1 ha to 141 ha total, while pondweed expanded 70 ha to 175 ha total. These migrations were observed in spaces that were co-occupied with hydrilla and further showed a slight shift into deeper water. Here, we present on some of the basic attributes in community ecology consisting of native and nonnative patch networks influenced by environmental filtering and competitive exclusion. Selective hydrilla management is enhancing local composition of native SAV communities.

Potential Impact of Herbicide Overspray on Phytoplankton Blooms in Arkansas Ponds. (55)
George L. Selden
University of Arkansas at Pine Bluff, Jonesboro, AR

A common inquiry from aquaculture producers and pond owners is what impact a mistaken aerial herbicide application will have on their fish. These calls frequently follow a fish kill which has occurred after a suspected overspray. With few exceptions, the most used row-crop herbicides will be harmless to fish. What is often then asked is could the herbicides have negatively impacted the phytoplankton bloom, causing it to crash, leading to a fish kill due to low dissolved oxygen. To investigate the potential for an herbicide overspray to negatively impact an algal bloom, extension crop scientists were consulted for a list of the most common aerially applied herbicide active ingredients (AI). A representative label was selected for each AI to determine the maximum amount of chemical that would potentially be applied to the pond, to the depth of one foot (AI ppm/acre*ft). This value was then compared to the EC50 for a representative green algae *Raphidocelis subcapitata*. These results were then compared with known algicides. The results of this investigation indicate that some of the most common aerially applied herbicides have the potential to negatively impact planktonic algal blooms. Due to the nature of algae and ponds, while an herbicide overspray might negatively impact algae, this may not necessarily cause a low dissolved oxygen fish kill, but it can't be categorically dismissed.

Recent Chemical Management of *Lyngbya* on Lake Gaston, NC/VA. (9) **Jessica R. Baumann**[1], Robert J. Richardson[2]
[1]North Carolina State University / Dept. Crop and Soil Sciences, Raleigh, NC
[2]North Carolina State University, Raleigh, NC

Lake Gaston is an 8,200-ha hydroelectric reservoir, located in the Roanoke River system on the border between Virginia and North Carolina. Aquatic plant management on the lake has been active since the late 1980's, but has historically focused on chemical and biological control of *Egeria densa* and monoecious *Hydrilla verticillata*. In more recent years, a native filamentous cyanobacterium, lyngbya (*Microseira wollei*), has become increasingly problematic on the lake. Lyngbya forms thick black mats along the benthos that display variable temporal and geographical spatial patterns. During winter months lyngbya mats are located solely within the benthic zone, however as water temperatures increase mats begin to proliferate and become stratified throughout the water column. The formation of surface mats has negative impacts on the recreational and esthetic values of the lake. Additionally, proliferation of this

species raises concerns for potential ecological and human health impacts, as some strains of lyngbya are capable of producing cyanotoxins. An effective management protocol for lyngbya in a large, dynamic system has yet to be identified. Chemical treatments are hindered by the physical makeup of dense lyngbya mats and the presence of a robust, protective sheath surrounding strands of individual living cells. Assessment of treatment protocols has also proven difficult due to variable growth patterns of lyngbya mats both spatially across the benthic floor and throughout the water column. From 2019 through 2021, management protocols for lyngbya in Lake Gaston were evaluated using a series of in-lake chemical trials utilizing multiple algaecide formulations and application techniques. Efficacy of these treatments was determined using both traditional and novel sampling techniques. Results of this research indicate advancements in identifying effective treatment protocols for lyngbya and appropriate methods for determining efficacy of these protocols.

SCDHEC And Harmful Algal Blooms. (10) **Emily Bores**
South Carolina Department of Health and Environmental Control, Columbia, SC

In 2018, the South Carolina Department of Health and Environmental Control initiated the HABs Monitoring Program to investigate the effects that cyanotoxins have on human health and the environment within the state. The current program has expanded today to include establishing baseline data for cyanotoxin distribution in state reservoirs and estuaries, monitoring drinking water intakes with a history of HABs and/or taste and odor issues, issuing recreational advisories for waterbodies that exceed SC state standards, and identifying potential correlative relationships between cyanotoxin concentrations and other physiochemical water quality parameters. From 2018 to 2021, monthly-monitoring cyanotoxin results were generally lower than the SCDHEC state recreational standards, which were adopted in 2020. This suggests that recreational activities in South Carolina are not an immediate concern. Estuaries were included for the first time in the 2020 cyanotoxin monitoring season and showed low initial microcystin concentrations. Continuing to monitor the estuarine environment in the future will improve and expand SCDHEC's understanding of harmful cyanobacteria presense along the coast. Two recreational advisories were issued for lakes in 2020 and three recreational advisories were issued for lakes in 2021. Advisories are removed once two consecutive samples come back as less than the state recreational standards. The HAB monitoring program continues to work on educating South Carolina residents and entities on HABs and has developed informational and education resources such as a webpage, rack cards, signs, and an app for the public to use.

Small Plot Evaluations of Aquatic Pesticides for Control of Starry Stonewort (*Nitellopsis obtusa*) in Lake Koronis, MN. (35) **Patrick Carver**[1], Ryan M. Wersal[1], Bradley T. Sartain[2]
[1]Minnesota State University, Mankato, Mankato, MN
[2]US Army Corps of Engineers Engineer Research and Development Center, Vicksburg, MS

Nitellopsis obtusa (starry stonewort) is a green macroalga native to Eurasia in the family Characeae. It has become an invasive species in much of the Midwestern United States. Starry stonewort is difficult to control due to its rapid and dense growth, and ability to produce underground structures called bulbils. These bulbils act as a method of asexual reproduction which can serve to recolonize previously managed locations. There has been a lack of research on the efficacy of chemical treatments and combinations of chemical treatments on starry stonewort. Therefore, treatments of copper, diquat, and copper + diquat combinations were evaluated in small plots in Lake Koronis, MN during the summers of 2020 and 2021.

In 2020, applications of copper reduced aboveground biomass at eight weeks after treatment by > 90%. Diquat was not effective at reducing starry stonewort biomass or bulbil density at four and eight weeks after treatment. Bulbil densities in diquat plots ranged from 33.3 ± 33.3 to 4266.7 ± 3963.3 bulbils m^2 depending upon sample time and site. The estimated diquat half-life in Lake Koronis was < 2 h among all treated plots which was a factor in the lack of diquat efficacy. In 2021, copper treatments resulted in a 78% and 27% reduction in aboveground biomass at four and eight weeks after treatment respectfully. Copper treatments also reduced bulbil density by four weeks after treatment. Plots treated with the copper + diquat had aboveground biomass reductions of 76% and 65% at four and eight weeks after treatment respectfully. Bulbil densities did not show a reduction in the combination plots. Regrowth was evident in all plots regardless of treatment by eight weeks. Additional strategies are needed to target bulbil production, induce bulbil mortality, or gain longer-term control of aboveground biomass.

Spray Retention of Commonly Managed Invasive Emergent Aquatic Macrophytes. (51) **Erika J. Haug**[1], Andrew W. Howell[1], Christopher R. Mudge[2], Benjamin P. Sperry[3], Robert J. Richardson[1], Kurt D. Getsinger[4]
[1]North Carolina State University, Raleigh, NC
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Invasive emergent macrophytes can have detrimental impacts on aquatic ecosystems. Management of these aquatic weeds frequently relies upon foliar application techniques with aquatic herbicides. However, there is inherent variability of overspray (herbicide loss) for foliar applications among commonly managed emergent macrophytes. This study aims to elucidate some of the biotic factors contributing to foliar spray retention (herbicide captured) among commonly managed emergent aquatic weeds. We evaluated the spray retention of four commonly managed invasive broadleaf emergent species: water hyacinth (*Eichhornia crassipes*), alligatorweed (*Alternanthera philoxeroides*), creeping water primrose (*Ludwigia grandiflora*), parrotfeather (*Myriophyllum aquaticum*), and two emergent grass weed: cattail (*Typha latifolia*) and torpedo grass (*Panicum repens*). For all species, spray retention was simulated using foliar applications of rhodamine dye (RWT) as an herbicide surrogate under controlled mesocosm conditions. Applications were made via a CO_2 pressurized backpack sprayer calibrated to deliver 935 Lha^{-1} of a 0.1% v/v RWT + 0.25% v/v NIS spray solution overtop mesocosms containing dense vegetation growth and no plants (positive control). Spray retention of the broadleaf species was further evaluated using similar methods in a CO_2 pressurized spray chamber. Evaluation metrics included species-wise canopy cover and height influence on in-water RWT concentration using image analysis and modeling techniques. Results indicated spray retention (BK: backpack, SC: spray chamber) was greatest for water hyacinth (BK: 76.1±3.8, SC: 64.7±7.4). Spray retention values were similar among the three sprawling marginal species alligatorweed (BK: 42±5.7, SC: 37.5±4.5), creeping water primrose (BK: 52.7±5.7, SC: 54.9±7.2), and parrotfeather (BK: 47.2±3.5, SC: 48.2±2.3) for both application methods. Canopy cover and height were strongly correlated with spray retention for water hyacinth and sprawling marginal species. However, neither canopy cover nor plant height were effective predictors for grass species spray retention. Torpedo grass and cattail, while similar in percent foliar coverage, differed in percent spray retention (8.5±2.3 and 28.9±4.1, respectively). The upright leaf architecture of the grass species likely influenced the lower spray retention values in comparison to the broadleaf species. Further studies are needed to evaluate the biotic factors beyond foliar coverage and canopy height that could be responsible for these differences in spray retention.

The Rest of the Story: More Selectivity and Efficacy Trials to Evaluate "Natural" Products for Aquatic Weed Control. (38) **Lyn A. Gettys**, Kyle L. Thayer, Joseph W Sigmon
University of Florida Ft Lauderdale Research and Education Center, Davie, FL

Florida researchers have been charged with evaluating the efficacy and selectivity of non-synthetic products for invasive species management in aquatic systems. In this project we investigated the activity of a range of concentrations of acetic acid and d-limonene after foliar applications to selected invasive floating and native emergent plants. Efficacy was evaluated on target invasive species including waterhyacinth, waterlettuce, common salvinia and feathered mosquitofern. Selectivity was evaluated on non-target native species including pickerelweed, broadleaf sagittaria, spikerush and cattail. Plants were co-cultured in pairs (one invasive and one native) in 68L mesocosms until floating plant coverage was > 80%, then treated once with a single product or combination (plus surfactant). Four replicates were prepared for each treatment and all plants were maintained for 8 weeks after treatment. Plants were then evaluated for visual quality, destructively harvested and placed in a forced-air drying oven for 2 weeks to determine reduction in biomass compared to untreated control (UTC) plants. We were able to identify treatments that were efficacious on target species and selective on native species, but deployment of these treatments at scale would result in significant increases in costs. These data reveal that alternative products may be useful for aquatic weed management but more research – including field trials – is necessary to confirm these results.

The State of Aquatic Plant Management Education in the U.S. (60) **Candice M. Prince**, Jason Ferrell
University of Florida, Gainesville, FL

Management of aquatic weeds and invasive plants is necessary to safeguard food production, protect native biodiversity, and maintain human health and safety. Nuisance plants must be managed in a way that is both effective and environmentally safe; to achieve this, managers must have in depth knowledge of weed biology, herbicides, and more. It is critical that universities in the United States provide appropriate coursework related to weed and invasive plant management. To determine if we are meeting this need, we analyzed the availability of weed science courses within 154 universities across the U.S. Our analysis included land grant institutions, universities represented in the Weed Science Society of America (WSSA) and Aquatic Plant Management Society (APMS) membership lists, and universities that are members of the Global Council for Science and the Environment (GCSE). Using university course catalogs, we recorded the number of courses in the following categories for each university: wetlands, weed science, invasive plant management, aquatic plants, ecological restoration, and limnology. We classified wetlands, invasive plant, and aquatic plant courses as either primarily theoretical (i.e., ecology focused) or applied (i.e., management focused) based on course descriptions. With this talk, we will discuss the availability of plant management coursework within different regions of the U.S., differences between land grant and non-land grant institutions, and identify gaps in invasive and aquatic plant education.

The Use of Thrips to Control Alligatorweed. (54) **Brandon Jones**
Catawba Riverkeeper Foundation, Charlotte, NC

Alligatorweed is an aquatic invasive plant native to South America that began threatening the Catawba-Wateree ecosystem in the 1980s. This rooted perennial herb can create navigational hazards, increase

sedimentation, reduce sunlight penetration, impact recreational uses, and reduce species diversity. The most utilized biological control, alligatorweed flea beetles (Agasicles hygrophila), will only overwinter where the average January temperature is 11°C (51.8°F) or warmer putting areas in North Carolina and upper South Carolina out of the species tolerance range. With few options for eradication or management, it has spread throughout the system with population estimates over 100 acres on Lake Wylie alone. Another biological control, alligatorweed thrips, have been identified and successfully established in eastern NC by the Oslow Cooperative Extension. They appear to be cold tolerant but have not traditionally been used due to their lack of self-dispersal. Our organization collaborated with Duke Energy's Aquatic Plant Management staff, NCWRC, and other partners to design a volunteer driven propagation and dispersal plan. This pilot program is now in its second year with evidence that the initial stocked colony successfully overwintered and additional stocking scheduled for the summer.

Transforming Our Approach to Harmful Algal Bloom Management. (3) **West Bishop**[1], Mark A. Heilman[2]
[1]SePRO, Whitakers, NC
[2]SePRO Corporation, Carmel, IN

Complementary to longer-term and watershed practices, *in situ* approaches for HAB's should be incorporated in management programs to ensure the safety and usability of the water resource. Leveraging an understanding of the biology and ecology of these organisms, and in coordination with monitoring strategies, allows strategic implementation of proactive and reactive solutions for HAB's. Expertise and knowledge regarding control of nuisance organisms in water resources has been ongoing operationally and can be applied to HAB management at multiple scales and in sensitive sites. Numerous perceived concerns over direct management have limited adoption of large-scale implementation, though times are changing. Some of the concerns that are often used to impede operational management include: · Leaky cell/toxin release · Fear of copper (cure worse than disease) · Nutrient correlation perception · Assumed safety with closing water bodies However, when these are technically evaluated in a risk-based framework, the need for managing these HAB's becomes abundantly clear. This information is now rapidly changing the direction of how decisions are made. The risks of the toxins/ exposure routes/ new ecological and human health concerns and the chronic and worsening exposure without management are now becoming more widely considered factors in the decision to manage. Humans are now at an inflection point where we will rise and take back our precious water resources.

Trending Legislative and Regulatory Issues Impacting the Aquatics Industry. (34) **Megan Provost**
RISE (Responsible Industry for a Sound Environment), Arlington, VA

Join RISE (Responsible Industry for a Sound Environment), the national trade association representing manufacturers, formulators, distributors and other industry leaders in the specialty pesticide and fertilizer industry to learn about legislative, regulatory, and judicial opportunities and challenges in the specialty pesticide space, especially impacting the aquatics segment. RISE advocates for the specialty pesticide and fertilizer industry at the local, state and federal level. Advocacy actions can take many different forms, from interfacing with key decision and policymakers at all levels to engaging in grassroots activities in local communities. Learn how individuals can be engaging policymakers and regulators about the aquatic plant management industry!

Unmanned Aerial Systems Support Giant Salvinia Research and Eradication Activities in North Carolina. (37) **Andrew W. Howell**, Erika J. Haug, Robert J. Richardson
North Carolina State University, Raleigh, NC

The non-native floating plant, giant salvinia (*Salvinia molesta*), often disrupts native aquatic biomes and hinders local activities within invaded waterways. Once established, giant salvinia rapidly forms thick vegetation mats, which alters water chemistry and reduces light availability to submersed flora and fauna. The recent discovery of giant salvinia in a North Carolina cypress swamp system (Columbus Co.) has prompted various water resource agencies to conduct early detection, rapid response (EDRR) measures to eradicate the invasive plant prior to further spread. While foliar herbicide combinations and techniques are established to control giant salvinia, few field studies have occurred in North Carolina. In 2021, a series of in-field trials were conducted using floating quadrats to evaluate foliar application strategies to support on-going eradication efforts. In total, fourteen foliar herbicide treatments were evaluated over the eight-week study period. Unmanned aerial systems (UAS) were utilized to monitor treatment effects over time and to deliver select herbicide treatments. Results suggest collected biomass was not a good indicator of treatment success and that aerial imagery provided more accurate representation and separation of herbicide treatments. Findings also indicate true-color UAS imagery and GIS modeling provides a suitable option for assessing foliar herbicide treatments in hard-to-access sites. Similar monitoring techniques could be applied to other floating plant treatment programs and to support spatiotemporal visual monitoring of research applications. Further evaluations are underway to identify suitable herbicide tank mixes and carrier volumes that may provide improved efficacy and efficiency from UAS spray systems. Discussion will provide insight on future strategies for UAS imaging and the opportunity to deploy UAS sprayers to support continued giant salvinia eradication efforts among invaded waterways.

Using Long-Term Datasets to Understand Impacts of Aquatic Plant Management. (11) **Candice M. Prince**[1], Amy E. Kendig[1], S. Luke Flory[1], Mark Hoyer[1], James Leary[2]
[1]University of Florida, Gainesville, FL
[2]Center Aquatic and Invasive Plants, UF/IFAS, Gainesville, FL

Over the past several years, Florida stakeholders have expressed concerns about the impacts of aquatic herbicide use on native biodiversity, water quality, and fish populations. While the direct, short-term effects of aquatic herbicide use have been well-studied, there is limited information about the effects of long-term herbicide use on public waterbodies. The Florida Fish and Wildlife Conservation Commission (FWC), Florida LAKEWATCH, and US Army Corps of Engineers (USACE) have maintained several long-term datasets on aquatic herbicide use, water quality, fish populations, and plant communities in Florida. With this project, we collated these datasets to address the following questions: 1) how effective is herbicide management of *Hydrilla verticillata* (hydrilla), *Eichhornia crassipes* (water hyacinth), and *Pistia stratiotes* (water lettuce); 2) how are these invasive species impacting native plant communities;

and 3) how is management of these species impacting native plant communities? To answer these questions, we identified common lakes among datasets and fit panel data models and generalized linear mixed-effect models, where appropriate. Results showed that management is effective at reducing populations of *H. verticillata*, and that maintenance control is effective at maintaining populations of *E. crassipes* and *P. stratiotes*. Results also demonstrated an overall net-positive impact of herbicide use on native species, although the impact was dependent on native species habitat (emersed, floating, or submersed).

Utilizing the Propagule Pressure Hypothesis to Optimize the Impact of *Cyrtobagous salviniae* on *Salvinia molesta* in Louisiana. (33) **Korey D. Pham**[1], Rodrigo Diaz[2], Christopher R. Mudge[3]
[1]Louisiana State University, Department of Entomology, Pride, LA
[2]Louisiana State University, Department of Entomology, Baton Rouge, LA
[3]U.S. Army Engineer Research & Development Center, Baton Rouge, LA

Salvinia molesta is a free-floating aquatic fern native to Brazil and is considered one of the worst aquatic weeds in the southeastern United States. *Cyrtobagous salviniae* is a biological control agent native to Brazil that has been successful at reducing *S. molesta* coverage, especially in Louisiana. Currently, most land managers receive *C. salviniae* infested *S. molesta* from the LSU AgCenter and release them in one site of the infestation. Using the ecological theory of propagule pressure, we hypothesized that if the number of release points per area increases, then population growth of *C. salviniae* will increase, thus resulting in faster insect spread and control of *S. molesta*. Replicated outdoor mesocosms were used to examine the impact that the number of releases have on *C. salviniae* population growth in 2021. Summer and fall trials were conducted for five weeks in Louisiana with six treatment levels (Control/0, 1, 2, 3, 4, and 5 release points). Each treatment received 200 grams of *C. salviniae* infested *S. molesta*, and the average *C. salviniae* per kilogram was 41 and 150 for summer and fall trials, respectively. *Cyrtobagous salviniae* density and *S. molesta* performance [mat thickness, biomass, percent coverage, plant damage] were measured over time for each release treatment. In the summer trial, *C. salviniae* density was not significantly different among release points, and *S. molesta* performance was significantly different among release points, but there was a low impact on mat thickness, biomass, percent coverage, and plant damage overall. In the fall trial, larval density increased and *S. molesta* performance decreased as propagule pressure increased ($p<0.05$). Thus, the mesocosm study supported that increasing propagule pressure increases the establishment of *C. salviniae*. The study will be repeated in outdoor ponds to evaluate the population growth trends under field conditions, which will be more applicable to land managers.

Whole-genome Sequencing of an Herbicide Selection Experiment Identifies a Chromosomal Region Associated with Fluridone Resistance in Eurasian Watermilfoil. (52) **Ryan Thum**[1], Gregory M. Chorak[2]
[1]Montana State University, Bozeman, MT
[2]Montana State University Department of Plant Science, Bozeman, MT

A long-term goal of Eurasian watermilfoil management is to identify genes for herbicide resistance, so that genetic assays can distinguish susceptible versus resistant populations. Although current molecular fingerprinting methods can distinguish two strains of fluridone resistant Eurasian watermilfoil from other strains, we do not know the specific gene(s) involved in fluridone resistance. This is important, because

resistance genes can be passed on through sexual reproduction, and transmission of resistance genes to new strains is not detectable with the currently available molecular markers. We developed a genetic mapping population for fluridone resistance by crossing a known resistant strain to a known susceptible strain. We conducted a fluridone selection experiment by exposing the progeny to 6 ppb fluridone, and we then performed whole-genome sequencing on the most resistant ('resistant bulk') and most susceptible ('susceptible bulk') progeny to compare DNA sequence variant frequencies across the genome between the two bulks. We identified a large-effect quantitative trait locus (QTL) on one chromosome of the Eurasian watermilfoil genome. We are currently using bioinformatics approaches to identify the genes that lie in the region of this QTL. Interestingly, the phytoene desaturase gene (PDS), the target for fluridone, is not located in this chromosomal region, and is therefore not the mechanism of resistance for this strain. We have constructed a second fluridone resistance mapping population with a second fluridone resistant strain. This mapping population will allow us to determine whether the same or different chromosomal region is associated with fluridone resistance in our second strain. These data will enable the development of molecular markers specifically associated with resistance, which in turn will allow large-scale genetic screening for fluridone resistance without the need for time-consuming and cumbersome herbicide screens. More generally, our results illustrate that genomics and forward genetics approaches for non-model, aquatic weeds, is increasingly feasible.

POSTER

***Lyngbya wollei* In Lake Wateree, South Carolina: Management Implications During Lake Drawdown.** (30) **Margaret A. Carson**, Tryston Metz, Geoff I. Scott, John L. Ferry
University of South Carolina, Columbia, SC

Harmful algal blooms (HABs) are naturally occurring, excessive growths of algae that have the potential to produce toxins harmful to water and air quality, aquatic species, and humans. Key forcing factors for the development of HABs include climate change, nutrient enrichment, urbanization, and other anthropogenic activities. Many HAB species are invasive and/or opportunistic and take advantage of altered habitat conditions and Lake Wateree, SC is no exception. Researchers have observed extensive blooms of cyanobacterial algal mats, *Lyngbya wollei* (*Microseira wollei*) in Lake Wateree, SC since 2012. This study aimed to address the potential hazards posed by *Lyngbya wollei* toxins to aquatic species. Algae samples were collected from one site across 3 months on Lake Wateree and used in laboratory toxicity testing. Levels of *Lyngbya wollei* toxins were quantified, using high resolution mass spectrometry. Toxicity tests using fathead minnows (*Pimephales promelas*) were conducted using nominal concentrations of freeze-dried, live, and air-dried algae. A total of 3 replicates/treatment/site were used and the mortality over time for the test endpoint of each bioassay. Laboratory toxicity tests indicated that live algae were not toxic but both air dried algae and freeze-dried algae were acutely toxic to the fathead minnow. The mortality results varied based off concentration and month of algae collection. Results of field toxicity tests will be discussed. Laboratory toxicity tests indicated that mortality was lower in air dried algae tests than freeze dried tests. These findings are important as there are two drinking water intakes on Lake Wateree and people continually participating in contact recreation on Lake Wateree. Residents are concerned about the presence of HAB species and the potential for human exposure to the toxin when using the lake. Development of effective management strategies for *Lyngbya wollei* is important to mitigate potential health impacts, including management strategies during lake drawdowns.

***Microseira wollei* And *Phormidium* Algae More Than Doubles DBP Concentrations and Calculated Toxicity in Drinking Water.** (27) **Md. Tareq Aziz**
University of South Carolina, Department of Chemistry and Biochemistry, Columbia, SC

Warm weather and excess nutrients from agricultural runoff trigger harmful algal blooms, which can affect drinking water safety due to the presence of algal toxins and the formation of disinfection by-products (DBPs) during drinking water treatment. In this study, 66 priority, unregulated and regulated DBPs were quantified in chlorinated controlled laboratory reactions of harmful algae *Microseira wollei* (formerly known as *Lyngbya wollei*) and *Phormidium* using gas chromatography (GC)-mass spectrometry (MS). Live algae samples collected from algae-impacted lakes in South Carolina were chlorinated in ultrapure water and real source waters containing NOM. DBPs were also measured in finished water from a drinking water plant impacted by a *Microseira* bloom. Results show that the presence of *Microseira* and *Phormidium* more than doubles total concentrations of DBPs formed by chlorination, with levels up to 587 μg/L formed in natural lake waters. Toxic N-DBPs also more than

doubled in concentration, with levels up to 36.1, 3.6, and 37.9 μg/L for haloacetamides, halonitromethanes, and haloacetonitriles, respectively. In ultrapure water, DBPs also formed up to 314 μg/L, demonstrating the ability of algae to serve as direct precursors for these DBPs. When environmentally relevant levels of bromide and iodide were added to chlorination reactions, total DBPs increased 144, 51, and 24% for drinking water reservoir, Lake Marion and Lake Wateree *Microseira* respectively and 29% for *Phormidium*. Iodo-DBPs, bromochloroiodomethane, chloroiodoacetic acid, bromoiodoacetic acid, and diiodoacetic acid were observed in finished water from a drinking water plant impacted by *Microseira*, and bromochloroiodomethane and dibromoiodomethane were observed in chlorinated ultrapure water containing algae, bromide, and iodide. Notably, total calculated cytotoxicity tripled in *Microseira*– impacted waters and doubled for *Phormidium*-impacted waters. Calculated genotoxicity doubled for *Microseira*-impacted waters and more than doubled in *Phormidium*-impacted waters.

Evaluation of the Utility and Performance of an Autonomous Surface Vehicle for Mobile Monitoring of Waterborne Biochemical Agents. (21) **Jessica S. Wolfe**[1], Gary D. Chesser[1], John W. Lowe[2], Jane Moorhead[2], Gray Turnage[3], Dash Padmanava[2], Robert Moorhead[2]
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There is an increasing need for real-time monitoring and management of water quality in inland and coastal marine environments due to increases in land utilization which negatively impact aquatic ecosystems via surface water runoff. Contemporary monitoring techniques are laborious and expensive, requiring in-situ monitoring stations and/or specialized manned vessel sampling missions at fixed locations for water sample analysis. These techniques limit the ability to gather high resolution spatio-temporal data. Solar powered autonomous surface vehicles (ASV) may provide a long endurance solution to overcome spatio-temporal drawbacks of conventional sampling and data collection by providing a mobile powered platform for sensors/instrumentation. However, commercially available solar powered ASVs are limited, and ASV autopilot navigational accuracy may be affected by environmental conditions (wind, current, and waves) that can alter trajectories and negatively affect spatio-temporal resolution of water quality sampling efforts. The goal of this research was to evaluate the utility and navigational performance of a commercially available solar powered ASV (SeaTrac SP-48) equipped with a multi-sensor payload to operate autonomously under varying conditions of environmental forces. The specific objectives were to *evaluate the ASV's ability to*: 1) accurately and repeatedly maintain route heading (measur*ed as cross-track-error [XTE]*) and 2*)* hold *a fixed* position *(measured as time and distance off station) under varying* environmental conditions. *XTE increased as intensity of environmental forces increased. Time and distance off station were not affected by environmental forces but were affected by internal mission parameters (i.e., station size) as larger stations increased time and distance off station.* This work serves to provide a conceptual framework for development of spatial and temporal resolution limitations of ASVs for real-time monitoring campaigns and future development of obstacle avoidance and adaptive sampling technologies. *Future work will focus on integration of water quality sensors for in-situ data collection and monitoring.*

Giant KelpeR: A Webapp for Exploratory Analysis of *Macrocystis pyrifera* Population Change in Southern-Central California. (22) **Nathan Tennies**, Filipe Alberto

University of Wisconsin-Milwaukee Biological Sciences, Milwaukee, WI

On the North American West Coast, giant kelp (*Macrocystis pyrifera*) population declines have been prevalent with increasing extreme heat waves in sea surface temperature (SST). Individuals typically persist below 22° C and past this quickly die off. Giant kelp is the foundational species of the California coast kelp forest ecosystem. The value of this ecosystem's services has led to several kelp cover monitoring programs, most using remote imagery. Input data and output products are mostly formatted for academic use despite stakeholder value. To tackle this, we are developing an RShiny webapp to visualize time series of kelp biomass in Southern-Central California with SST changes and derived statistics (number of consecutive days with SST above 22° C and SST anomalies). Rshiny is a package for webapp development in the R language. RShiny users can program a webapp in R ran with HTML and CSS. In our webapp, users click a location on a map of kelp biomass and choose a radius around the selection. In this radius, the previous statistics are calculated from average kelp biomass and SST. Our webapp will help stakeholders and non-specialists explore kelp and SST time series data. Eventually we plan to add spatially explicit kelp genetic monitoring records from projects by our team censusing genetic diversity changes in California kelp beds. Currently we are deploying our webapp online and after will incorporate OpenStreetMap software to improve our map interface and interactivity.

Herbivory and Characteristics of Crested Floating Heart Infestations in the Southern United States. (28) **Nathan E. Harms**[1], Megann Harlow[2], Ian A. Knight[3]

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The invasive floating-leaved plant, *Nymphoides cristata* (crested floating heart; CFH) is increasingly problematic in the southeastern US and requires effective management to prevent negative ecological and economic impacts to aquatic systems. Although biological control is under investigation, preliminary surveys in the invaded range serve to assess existing herbivory and identify any potential agents already present in the US. In 2019, we surveyed 15 CFH populations in Florida, Texas, Louisiana, and South Carolina, and quantified plant-level characteristics (leaf toughness, leaf chemistry, dry mass content (DMC), specific leaf area (SLA)), herbivory (percent leaf area consumed, leaf-feeding insect taxa present) and, in a subset of populations, population-level characteristics (11 sites; flowering, dominance index). Dominance of CFH ranged from 0.87 – 1.0 at surveyed sites and flower production was high (up to 618 / m^2). The amount of leaf area consumed by herbivores ranged from 0% to 42% and we detected six herbivorous insect taxa, all generalist species such as the aquatic moths *Parapoynx* sp. and *Elophila* (=*Synclita*) *obliteralis*, and the leaf beetle *Donacia* sp. We did not find strong correlations between mean leaf characteristics and percent leaf damage. However, leaf toughness was strongly correlated with %N (r= -0.66), C:N ratio (r= 0.75), and DMC (r= 0.85), and weakly correlated with SLA (r= -0.54). This is the first report of baseline herbivory and infestation characteristics for CFH in its invaded range, and this information can be used in the future to assess potential benefits and possible interactions from biological control, should it be pursued. Additionally, a hybrid *N. cristata* x *N. aquatica* population was recently identified in South Carolina, so the ways in which herbivore taxa vary among populations of *N. cristata*

and its hybrid may be important for determining the role of biological control in the future management of the species in the US.

How Many Clips to Kill a Hydrilla Tuber? (29) **Taylor L. Darnell**[1], Benjamin P. Sperry[2], Candice M. Prince[3]
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[2]US Army Corps of Engineers, Gainesville, FL
[3]University of Florida, Gainesville, FL

Hydrilla (*Hydrilla verticillata*) is one of the most problematic aquatic weeds, and one of the most expensive to manage. Hydrilla produces subterranean turions (i.e., tubers) that facilitate regrowth of the population following herbicide application. However, little is known about tuber physiology, sprouting mechanisms, longevity of the tuber bank, or tuber response to adverse environmental conditions. Here, we evaluated the effect of repeated shoot biomass removal on dioecious hydrilla tubers. Shoot biomass was clipped five times over the study period (Dec. 2021 - May 2022), following one of four clipping schemes (900 tubers per experimental run): 1) no clipping (control), 2) removal of all sprouted biomass, 3) removal of the apical tip(s) and 3 or 4 whorls of leaves, and 4) removal of biomass above the third whorl of leaves. This experiment was replicated in space. We recorded the initial tuber weight, as well as length and weight of removed biomass for each clipping time (every 35 days for clipping #1-3, and every 45 days for clipping #4 and #5). For control tubers, we recorded shoot and tuber biomass. Data were regressed over initial tuber starting weights to evaluate the depletion of carbohydrate reserves. The number of clipping events significantly reduced tuber and shoot biomass. The removal of the apical meristem and several whorls of leaves had stimulated biomass production (1.03 g [shoot and tuber weight], compared to 0.83 g for non-clipped tubers), while removal of all sprouted biomass as well as biomass above the third whorl of leaves decreased biomass production over time. Results suggest that total removal of sprouted biomass may be more effective at exhausting a tuber's starch reserves than other biomass removal techniques. The removal of all biomass led to secondary node sprouting in several replicates, suggesting that secondary or tertiary node spouting is possible.

Intact Endothall Translocates to the Roots of Aquatic Plants: Providing Evidence of Systemic Activity. Mirella F. Ortiz[1], Scott J. Nissen[2], Franck E. Dayan[1]
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Endothall and 2,4-D have been used to control aquatic weeds for more than 60 years, and still there is very little information available about the *in planta* behavior of these herbicides in aquatic weed species. 2,4-D is purportedly a systemic in aquatic plants based almost entirely on its behavior in terrestrial plants. Several recent studies, using radiolabeled 2,4-D and endothall, demonstrated that plants can translocate the radioactivity from shoots to root systems; however, these values were generated by biological sample oxidation and therefore there was no way to determine if the radioactivity in the roots was parent herbicide or a metabolite(s), and the question of the true systemic behavior for 2,4-D or endothall has not been definitively answered. Therefore, the objective of this research was to use multiple analytical methods to answer the question if 2,4-D and endothall are truly systemic in aquatic plants. By using radiolabeled herbicides, it was possible to determine that 68% and 57% of 2,4-D was extractable from shoots and roots, respectively, while 61.7% and 86.0% endothall was extractable from shoots and roots, respectively. About 17% of extracted ^{14}C-2,4-D from the shoots metabolized into one single unidentified metabolite, while 41% of extracted ^{14}C-endothall from the shoots was metabolized also into one single unidentified metabolite. The quantities of intact 2,4-D and endothall present in the roots were about 10 times less than the amount of herbicide in the shoots. The intact 2,4-D detected in the shoots was 1.31 µg g^{-1} dry weight (DW) and 0.11 µg g^{-1} DW was detected in the roots. For endothall, 1.08 and 0.12 µg g^{-1} DW was detected in the shoots and roots, respectively. In conclusion, using a combination of ^{14}C-labeled studies and analysis of unlabeled herbicides by LC-MS/MS, we can conclude that both 2,4-D and endothall have similar *in planta* behavior, with about 8-10% of absorbed intact active ingredient translocating to the roots of these aquatic plants.

Integrating Invasive Plant Management Research and Practice: Aquatic Ecosystem Restoration in the Texas Western Gulf Coast Plain/Lower Rio Grande Alluvial Floodplain. (31) **Aaron N. Schad**
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As part of the U.S. Army Corps of Engineers (USACE) environmental mission, aquatic ecosystem restoration (AER) projects focus on restoring aquatic habitats for the benefit of fish and other wildlife. Since 2017, USACE Engineer Research and Development Center researchers in the Aquatic Ecology and Invasive Species Branch have collaborated with USACE Galveston District, The Nature Conservancy, U.S. Fish and Wildlife Service, National Park Service, and local non-Federal sponsors to study restoration methods on former, naturally cut-off, channels of the Lower Rio Grande River, TX, USA. Locally termed "resacas", these aquatic ecosystems which are home to endemic species, have been degraded by disconnection, urbanization, and invasive species—primarily Brazilian peppertree (*Schinus terebinthifolia*). This presentation will document the research, planning, design, construction, monitoring, and adaptive management activities throughout the multiagency restoration and research projects. In particular, new research, funded by the USACE Aquatic Plant Control Research Program (APCRP), focusing on a new biological control agent for Brazilian peppertree—the Brazilian peppertree thrips (*Pseudophilothrips ichini*)—and the benefits of integrating invasive weed biological control into USACE AER projects are highlighted. Methods and results for invasive species management and aquatic and riparian vegetation establishment in endemic Texas ebony resaca forest, subtropical Texas palmetto woodland, and Texas ebony/snake-eyes shrubland habitats are also discussed.

Invasive Aquatic and Native Marine Vegetation on the Mississippi Barrier Islands. (20) **Gray Turnage**, Andrew Sample
Mississippi State University, Starkville, MS

Seagrass beds serve as feeding and spawning habitat for many species of marine fauna. Barrier island lagoons may act as refugia for seagrass species that are vital components of marine ecosystems in the Gulf of Mexico and the Mississippi Sound. Lagoons may also be invaded by aquatic invasive plant species (AIS) capable of surviving brackish environments. Loss of ecosystem function due to AIS has been documented in many brackish and saline habitats, suggesting that AIS invasion could further reduce seagrass abundance in island lagoons such that these sites no longer function as nursery populations that replenish seagrass beds in the Mississippi Sound. The goal of this project was to survey the aquatic and marine vegetation in select lagoons on the four major barrier islands (Petit Bois, Horn, Ship, and Cat) of Mississippi to 1) determine the aquatic/marine plant community of each lagoon and 2) determine if AIS were present in these systems. Twelve lagoons and six reference sites in the MS Sound were identified and surveyed in 2020 using the point intercept method to generate baseline density of seagrasses. All lagoons had vegetation present with Shoal grass (native) and torpedograss (AIS) being the most prevalent species. Seagrass was recorded in 58% of lagoons with 70% of those populations potentially serving as nursery populations for offshore sites adjacent to each island and approximately 40% serving as nursery sites across the Mississippi Sound. However, AIS were present in 66% of lagoons and co-occurred with seagrass populations in 25% of lagoons. To our knowledge, this is the first work to document AIS co-occurring with seagrasses on the Mississippi Barrier islands. Future reduction of AIS in lagoons may allow for subsequent colonization by seagrasses which could further increase the abundance of nursery seagrass populations in the Mississippi Sound.

Meet the New Arrival: Ribbonweed (*Vallisneria australis*) in the Sacramento-San Joaquin River Delta. (23) **John D. Madsen**[1], John Miskella[1], Patricia Gilbert[2]
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Ribbonweed (*Vallisneria australis* S.W.L. Jacobs and Les). Ribbonweed is native to eastern Australia. Common names used for this species also include Australian watercelery and Australian eelgrass. Although native to Australia, it is a common nuisance weed to Australian irrigation canals and rivers. It is an introduced weed to western Australia, New Zealand, Japan, Europe, and now norther California. In northern California, it has been found in the northern portion of the Delta. It was found in parcel shipments to California for sale in the aquarium trade. In the aquarium trade, it is often referred to (erroneously) as *V. gigantea*. In Europe, New Zealand, and now California, it has been rated as a noxious weed, with the regulatory consequences that suggests. Ribbonweed is a submersed plant that forms numerous strap-like leaves from a rosette, up to 3 m long and up to 35 mm wide. The leaves have 5-6 longitudinal veins. The plant is dioecious, forming pistillate and staminate flowers from separate plants; not unlike other species of *Vallisneria*. When introduced to a new range, it is easily confused with other species of *Vallisneria*, but the leaves are much larger. The plants spread new rosettes from stolons. In Australia and New Zealand, the plant is controlled using diquat and both formulations of endothall. Further studies on the distribution and management of *V. australis* in the Delta are anticipated.

Release and Chemical Fate of *Lyngbya wollei* Toxins from *Microseira wollei*-Dominated Microbial Mats. (26) **Tryston Metz**, Samuel P. Putnam, Geoffrey I. Scott, John L. Ferry
University of South Carolina, Columbia, SC

Microseira wollei is a benthic cyanobacteria that is widespread in hydroelectric reservoirs in the Southeastern US. This cyanobacteria forms dense, filamentous mats with biomass that can exceed 10 kg per square meter. Additionally, *M. wollei* is known to produce analogues of the paralytic shellfish toxin saxitoxin. These analogues, LWTs, are not as toxic as saxitoxin but can occur in high concentrations in the organism. The role of these mats as reservoirs of neurotoxins is therefore concerning for environmental and human health. *M. wollei* mats typically grow along the shoreline and in hydroelectric reservoirs, where water levels can fluctuate quickly, are often subjected to sudden exposure and re-wetting cycles. This work explores the stability of the LWTs in drying biomass, their role of drying and re-wetting as factors in the release of the LWT reservoir, and the chemical fate of LWTs in the water column once released. Work presented here explores the environmental fate of the LWTs in natural lake waters over the wide range of temperatures and pHs observed in the field adjacent to *M. wollei*-

dominated microbial mats in Lake Wateree, SC. *M. wollei* samples were collected from multiple points in the reservoir and processed in the laboratory to quantify and qualify the LWTs present in each sample. Leaching studies were performed to determine the possibility that toxins could be released from live or dessicated algal samples into surrounding waters. Leaching from dessicated algae was observed to be a facile process, but the LWTs were not persistent in the water column. The role of pH (6-10) and temperature (10^{o}C-40^{o}C) in their degradation was assayed through a quantitative multifactorial experiment, and a numerical model predicting hydrolysis rate and by-product formation is presented. A model of net hazard in the water (expressed as saxitoxin equivalents) is presented.

Results of International Natural Enemy Surveys for Biological Control of Yellow Floating Heart in the US. (24) **Nathan E. Harms**[1], Matthew Purcell[2], Megann Harlow[3], Patrick Häfliger[4], Hong Sun-hee[5], Jialiang Zhang[6], Sonja Stutz[4], Ian A. Knight[7], Chenxi Liu[8]
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Yellow floating heart (YFH; *Nymphoides peltata*) is a widespread floating-leaved aquatic invasive plant in the US. To provide a long-lasting sustainable method of control, biological control of YFH is under development. The first step in biological control development is native range surveys to locate host-specific and damaging agents (natural enemies). From 2018-2021, we conducted YFH surveys in Europe (16 locations) and Asia (80 locations) to create a list of candidate agents and collect baseline infestation data for comparison between introduced and native ranges. Previous genetic work found that YFH in the US was most-closely related to populations in Europe but we found no promising agents in Europe except for two fungal pathogens previously reported in the literature. In Asia, 11 arthropod species were identified as potential biocontrol agents based on observed damage *in situ* and literature reports about host-specificity. Of particular interest are three species of *Bagous* weevils, one of which may be *Bagous charbenensi*, and a leaf-mining *Hydrellia* fly species, yet to be identified. During domestic surveys in the US, generalist leaf-cutting caterpillars were common. A major discovery was the damaging fungal pathogen, *Septoria villarsiae* isolated from plants in a private pond in Maine- a first record in the Western hemisphere. Pathogen host-specificity testing is underway now. Next steps for this program should include initial host-specificity and impact assessments of the fruit-feeding *Bagous* spp. in China, and the leaf-mining *Hydrellia* sp. fly from South Korea.

Sprouting Characteristics of Flowering Rush (*Butomus umbellatus*) Propagules. (25) **Bradley T. Sartain**[1], Nathan E. Harms[2], Ashton B. DeRossette[1], Sandor G. Dibble[3]
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Flowering rush (*Butomus umbellatus*) is an invasive Eurasian aquatic weed in the US, with several diploid and at least one triploid genotypes in the US and Canada. Spread of flowering rush is primary clonal in the US, but the factors that promote sprouting of propagules, and whether those factors vary by genotype are unknown. We conducted a series of growth chamber experiments using four flowering rush genotypes (one triploid, three diploid) to investigate the role of shade or temperature for rhizome (triploid) or bulbil (diploid) sprouting. For the first shade study, bulbils and rhizome segments with a single bud were harvested from parent plants in October 2021 and placed into petri dishes under five shade treatments. Bulbil and rhizome segments were monitored for sprouting over a four-week period. In the second shade study, the experiment was repeated except diploid bulbils were cold-stratified at 4°C for 5 weeks beforehand. In both experiments, shade had a minimal effect on sprouting. The proportion of sprouted triploid rhizome segments ranged from 0.90 to 0.99 whereas diploid bulbils ranged from 0.00 to 0.18 without cold-stratification. After holding at 4?, the proportion of sprouted bulbils increased to =0.93 across diploid genotypes. To assess the role of temperature in propagule sprouting, we harvested rhizomes and bulbils in November 2021, then held them at 4°C until April 2022, at which point we placed them in growth chambers at 5, 10, 20, 25, 30, and 35°C and monitored sprouting for six weeks. After six weeks we confirmed viability of low temperature treatments by moving those propagules to 25°C for an additional two weeks. Maximum sprouting occurred at 20°C and 25°C for triploid populations and 25C° and 30°C for diploid populations, although bulbil sprouting was significantly lower than rhizomes, which often had more than one sprout per segment.