55th Annual Meeting of the Aquatic Plant Management Society

Program & Abstracts

Hilton Myrtle Beach Oceanfront Resort at Kingston Plantation
Myrtle Beach, South Carolina
July 12-15, 2015

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.

The Objectives of the Society are to assist in promoting the management of nuisance aquatic plants, to provide for the scientific advancement of members of the Society, to encourage scientific research, to promote university scholarships, and to extend and develop public interest in the aquatic plant science discipline.

Our Mission: Promote environmental stewardship through scientific innovation and development of technology related to integrated plant management in aquatic and riparian systems.

The Aquatic Plant Management Society thanks Duke Energy Carolinas for their generous contribution to print and distribute the Program for the 55th Annual Meeting!

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Awards	Mike Netherland
Bylaws and Resolutions	Jim Schmidt
Education and Outreach	Jeffrey Schardt
Exhibits	Craig Aguillard
Finance	John Gardner
Legislative	John Madsen
Meeting Planning	Tommy Bowen
Membership	Joe Vassios
Nominating	Terry Goldsby
Past President's Advisory	Terry Goldsby
Program	Cody Gray
Publications	Jay Ferrell
Regional Chapters	Rob Richardson
Scholastic Endowment	Tom Warmuth
Strategic Planning	John H. Rodgers, Jr.
Student Affairs	Rebecca Haynie
Website	Karen Brown

Special Representatives

AERF	Carlton Layne
BASS	Gerald Adrian
CAST	Ryan Wersal
NALMS	Terry McNabb
RISE	Joe Bondra
Science Policy Director	Lee Van Wychen
WSSA	Cody Gray

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 Nelson	Baltimore, MD
2012	Tyler Koschnick	Salt Lake City, UT
2013	Terry Goldsby	San Antonio, TX
2014	Mike Netherland	Savannah, GA
2015	Cody Gray	Myrtle Beach, SC

APMS Award Recipients

Honorary Members (year of honor)

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	1988
Luciano “Lou” Gallagher	1988
Max C. McCowen	1989
James D. Gorman	1995
T. Wayne Miller, Jr.	1995
A. Leon Bates	1997
Richard Couch	1997
N. Rushing	1997
Alva P. Burkhalter	2002
J. Lewis Decell	2004
Paul C. Myers	2005
David L. Sutton	2006
Dean F. Martin	2007
Robert C. Gunkel, Jr.	2008
Allison M. Fox	2010
Randall K. Stocker	2010
Steven J. de Kozlowski	2010
Carole Lembi	2011
Lars W.J. Anderson	2012
David Tarver	2012
Don Doggett	2013
Richard Hinterman	2013

President’s Award (year of 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

Max McCowen Friendship Award (year of award)

Judy McCowen	1995
John E. Gallagher	1997
Paul C. Myers	2000
William T. Haller	2002
Bill Moore	2006
Vernon V. Vandiver, Jr.	2012
Tommy Bowen	2014

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/smile.

T. Wayne Miller Distinguished Service Award (year of award)

Gerald Adrian	2005
Linda Nelson	2007
Surrey Jacobs	2009
Amy Richard	2010
Michael Netherland	2011
John H. Rodgers, Jr.	2012
John Madsen	2013
Jim Schmidt	2014

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

Outstanding Graduate Student Award (year of award)

Ryan Wersal	Mississippi State University	2010
Joe Vassios	Colorado State University	2011
Sarah True-Meadows	North Carolina State University	2013
Justin Nawrocki	North Carolina State University	2014

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

Outstanding International Contribution Award (year of award)

Deborah Hofstra	National Institute of Water and Atmospheric Research	2013

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

Outstanding Journal of Aquatic Plant Management Article Award

James Johnson, Ray Newman	University of Minnesota	2012
A Comparison of Two Methods for Sampling Biomass of Aquatic Plants		

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

Outstanding Research/Technical Contributor Award (year of award)

Michael D. Netherland, Dean Jones, Jeremy Slade	2010
Kurt Getsinger	2011
Mark Heilman	2013

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

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

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, and 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			

Sustaining Members

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

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

Applied Biochemists®, A Lonza Business., is proud of its active membership and participation with the APMS for over 40 years. As a manufacturer and supplier of algaecides, aquatic herbicides and other water management products, we highly value the science and integrity the APMS brings to our industry. We are part of a leading life sciences company, dedicated to the development, production and application of a wide variety of products to improve the recreational and functional value of water, and quality of life throughout the world.

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

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.

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

Sustaining Members

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

Chem One is a national leader of 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 also offers a wide variety of dry inorganic chemicals. Chem One is certified to ISO 9001, ISO 14001, OHSAS 18001.

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

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

Lake Restoration produces products for lakes & ponds including: Mizzen algaecide, LAKEMAID, Goose D-Fence, Sapphire Bay pond dye, and MuckMaid. Mizzen is a copper based algaecide. The patented LAKEMAID eliminates lake weeds automatically. The Goose D-Fence is a retractable solution for goose problems. Founded in 1977, Lake Restoration is based in Minnesota. For more information visit our website www.lakerestoration.com.

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.

Nufarm Americas offers a portfolio of 10 products labeled for aquatics. This provides a wide variety of products labeled for aquatics use; both systemic and contact, that can be used selectively or broad spectrum depending on their use. It also allows customers to be able to spot treat or treat whole lakes depending on the need. Nufarm continues to look for ways to improve existing formulations while also looking to bring new formulations to the market.

Sustaining Members

Pond Boss PRO, a division of the OASE group, provides a line of professional grade products specifically formulated to effectively and rapidly deal with challenges associated with large bodies of fresh water. Our products and innovation will clean, clear, condition and balance water chemistry allowing lakes to be enjoyed the way nature intended. www.thepondboss.net From container gardens to the backyard Oasis and the management of lakes and watersheds, "Living Water" is OASE's passion. www.oase-livingwater.com

For 21 years, **SePRO Corporation** has developed innovative technologies to advance the science of water management. The SePRO team provides comprehensive assessment, planning and implementation solutions. Our focused disciplines include aquatic plant and algae management, water quality restoration, laboratory analysis, mapping and data management. Whether you are looking to assess a water resource, design a prescription plan or implement a restoration program, SePRO provides expertise and solutions to preserve our most precious natural resource – water. www.sepro.com

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

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

Vertex Water Features, a division of **Aquatic Systems, Inc.** is a science and engineering based aeration system manufacturer that provides custom designed water quality solutions distributed through its dealer network to interested lake owners, lake managers, developers and government agencies throughout North America and internationally. www.vertexwaterfeatures.com 1-800-432-4302 sue@vertexwaterfeatures.com.

Meeting Sponsors

The Aquatic Plant Management Society appreciates the generous support of the following meeting sponsors. Through their support and contributions, we are able to conduct a successful and enjoyable meeting.

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Exton, Pennsylvania

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Carmel, Indiana

Syngenta Professional Products
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Applied Biochemists, Lonza
Germantown, Wisconsin

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Exhibitors

The Aquatic Plant Management Society thanks the following companies for exhibiting their products and services.

Airmax Ecosystens, Inc.
Romeo, Michigan

Alligare, LLC
Davidson, North Carolina

Applied Biochemists, Lonza
Germantown, Wisconsin

Applied Polymer Systems
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Aqua Services, Inc.
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Aquatic Control, Inc.
Seymour, Indiana

BioSafe Systems, LLC
East Hartford, Connecticut

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Brandt Consolidated, Inc.
Springfield, Illinois

Brewer International
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Crop Production Services
Oviedo, Florida

Cygnet Enterprises, Inc.
Flint, Michigan

Helena Chemical Company
Tampa, Florida

Keycolour, Inc.
Phoenix, Arizona

Navico, Inc.
Minneapolis, Minnesota

Nufarm Americas
Raleigh, North Carolina

Otterbine Barebo, Inc.
Lawrenceville, Georgia

Sensient Industrial Colors
King's Lynn, Norfolk, Great Britain

SePRO Corporation
Carmel, Indiana

Sonic Solutions, LLC
West Hatfield, Massachusetts

Syngenta
Royal Palm Beach, Florida

UPI
Exton, Pennsylvania

Vertex Water Features
Pompano Beach, Florida

Winfield
Ville Platte, Louisiana

General Information

Program Organization

The Agenda is organized by day and time. Posters and abstracts are organized alphabetically by presenting author. For more event information, please see the Agenda-at-a-Glance pages for each day in this Program. Messages will be posted at the meeting registration desk.

Name Badges

Your name badge is your ticket for all events and functions 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, Guest Tour, Poster Session Reception, and Awards Banquet at the meeting registration desk.

Meeting Registration Desk

The meeting registration desk will be located in Group Registration South in the Convention Center, near the entrance to the Palisades Ballrooms, for the duration of the meeting.

Exhibits

Exhibits will be open from 7:00 p.m. Sunday to 10:30 a.m. Wednesday in Palisades DEF.

Posters

Posters will be open from 7:00 p.m. Sunday to 10:30 a.m. Wednesday in Palisades DEF. A Poster Session Reception will be held on Monday from 6:00 p.m. to 7:30 p.m. in Palisades DEF. Poster presenters are required to attend the Poster Session to answer questions. In addition, presenters are requested to be in attendance during refreshment breaks. The Poster Reception is provided by APMS Silver Level Sponsors.

Continental Breakfasts / Refreshment Breaks

Continental breakfasts, provided by our Bronze Level Sponsors, and mid-morning and afternoon refreshment breaks, provided by Contributor Level Sponsors, will be served each day in Palisades DEF. Please see the Agenda-at-a-Glance for specific times and locations. Also take time to visit with Exhibitors in Palisades DEF while enjoying your breakfast or break.

APMS Student Affairs Luncheon

The Student Affairs Luncheon will be held Monday, July 13 from 11:30 p.m. to 1:00 p.m. in Palisades I. All students registered for the meeting are invited to attend. This luncheon is a great opportunity to meet other students, interact with the APMS leadership, and learn how to become more involved in the Society. Rebecca Haynie, Student Affairs Committee Chair, will be the moderator. Please contact Rebecca by noon Sunday, July 12 to confirm your attendance. This luncheon is provided by APMS Silver Level Sponsors.

APMS Annual Business Meeting

The APMS Annual Business Meeting will be held Monday, July 13 from 4:30 p.m. to 5:00 p.m. in Palisades ABC. All APMS members are encouraged to attend.

APMS Past Presidents' Luncheon

All APMS Past Presidents are invited to attend the Past Presidents' Luncheon on Tuesday, 11:30 a.m. to 1:00 p.m. in Palisades H. Mike Netherland, Immediate Past President, will be the moderator. Please contact Mike by noon Monday, July 13 to confirm your attendance. The luncheon is provided by Bronze Level Sponsors.

APMS Regional Chapters Presidents' Luncheon

The Regional Chapters Presidents' Luncheon will be held Tuesday, July 14 from 11:30 a.m. to 1:00 p.m. in Palisades I. Two representatives from each APMS regional chapter are invited to attend the Luncheon. John Madsen, APMS Vice President and Regional Chapters Committee Chair, will be the moderator for discussions on aquatic plant management activities in each region. Please contact John by12:00 noon Monday, July 13 to confirm your attendance. This luncheon is provided by our Bronze Level Sponsors.

APMS Special Events

President's Reception: *Sunday, July 12, 7:00 p.m. to 9:00 p.m., Dunes Ballroom, Hilton Hotel 16th Floor*
Join your APMS friends and colleagues at this gathering to "kick-off" our annual meeting while enjoying exceptional food and beverage provided by our Silver Level Sponsors. The President's Reception is open to all registered delegates, guests, and students. Non-registered guests may purchase tickets for this event at the meeting registration desk. We have the great pleasure to host musician Ben Prestage who will be playing for us during the President's Reception. He is an amazing one man band from Florida, playing Juke Joint Country Stomp, Blues, and Blue Grass. We encourage everyone to get to the meeting in time for the President's Reception and plan to stay for a great time!

Guest Tour: *Monday, July 13, 10:00 a.m. - 3:30 p.m., Group photo at 9:45 a.m. in the Hilton main lobby.*
This year, our spouses, children, and guests will be treated to a tour of Brookgreen Gardens, one of Myrtle Beach's most dearly loved attractions. You will be picked up at the Hotel at 10:00 a.m. and will return by 3:30 p.m. The experience begins with a guided tour of the Gardens, named by TripAdvisor as One of the Top Ten Gardens in the U.S. Experience the guided cruise on a 48 foot pontoon boat along historic rice fields, now home to alligators, waterfowl, and osprey. The Dalton and Linda Floyd Domestic Animals of the Plantation Exhibit provides an element of education not only for the Lowcountry Zoo, but it connects the zoo to the Lowcountry Trail and Brookgreen's history. Lunch will be served at the Gardens. Round out your visit by strolling through the Cypress Aviary, the only aviary built over an existing cypress swamp, observing herons, mergansers, and egrets. Non-registered guests may purchase tickets for this event at the meeting registration desk. The Guest Tour is provided by APMS Bronze Level Sponsors.

Poster Session and Reception: *Monday, July 13, 6:00 p.m. to 7:30 p.m., Palisades DEF – Convention Center*
This reception, made possible through donations by our Silver Level Sponsors, provides for the viewing of posters and exhibits along with professional interactions and discussions in a casual setting while enjoying light hors d'oeuvres and beverages. The Poster Session Reception is open to all registered delegates, guests, and students. Non-registered guests may purchase tickets for this event at the meeting registration desk.

On your mark, get set… *Tuesday, July 14, 6:00 p.m. to 7:30 p.m., Embassy Suites Hotel, Splash Lazy River*
The Society is bringing back the popular Scholarship **Duck Race** on Tuesday evening, at the Lazy River, Embassy Suites Hotel, beside the Palmetto Pavilion. The Duck Race will be held during the Awards Reception just prior to the Awards Banquet next door in the Palmetto Pavilion.

Awards Reception and Banquet: *Tuesday, July 14, 6:00 p.m. to 10:00 p.m., Palmetto Pavilion, Embassy Suites*
Registered delegates, guests and students are invited to the Awards Banquet in the Palmetto Pavilion, Embassy Suites Hotel, provided by our APMS Gold Level Sponsor. Join us for a pre-banquet reception during the duck race, from 6:00 -7:30 p.m. After dinner, we will recognize those who have served APMS and SCAPMS, welcome new officers and directors, and this year's student paper and poster award participants. Our evening will conclude with a raffle for several prizes. Raffle tickets may be purchased at the registration desk and during the Awards Banquet. Ticket sales promote APMS and SCAPMS sponsorship of student initiatives. The Embassy Suites Hotel is a 5-10 minute walk from the Hilton along the beach or boardwalk, or take the round trip shuttle, courtesy of our Contributor Level Sponsors. See the registration desk for the shuttle schedule to and from the Embassy Suites Hotel.

Spur of the Moment Meeting Room
We have a room set up conference style for 25 guests. Please check at the Meeting Registration desk to reserve.

Student Tour
All students are invited to participate in a tour of local aquatic plant management activities on Thursday, July 16. Tour funding is provided by APMS sponsors and will be hosted by Santee Cooper Power and the South Carolina Department of Natural Resources. Our airboat tour will cover management of a variety of species, including Crested Floating Heart, on the Santee Cooper Lakes. We thank our tour hosts and are looking forward to a great day in the beautiful South Carolina Low Country!!

Meeting-at-a-Glance

Sunday:

APMS Board of Directors Meeting
Exhibits Setup
Poster Setup
Registration
Golf Tournament
President's Reception – Live Entertainment!

Monday:

General Meeting Opens
Guest Tour
Student Luncheon
APMS Annual Business Meeting
Poster Session & Reception

Tuesday:

General Session – Student Presentations
APMS Past Presidents' Luncheon
State Chapter Presidents' Luncheon
SCAPMS Annual Business Meeting & Board Meeting
Duck Races – Awards Reception
Awards Banquet – APMS and SCAPMS Awards Presentations

Wednesday:

General Session – Updates
Aquatic Plant ID Session
General Meeting Adjourns – Noon
APMS Board of Directors Meeting

Agenda

Sunday, July 12

Sunday's Agenda-at-a-Glance

7:30 am	-	5:00 pm	APMS Board of Directors Meeting *(Palisades H – Convention Center)*
12:00 pm	-	5:00 pm	Exhibits Setup *(Palisades DEF – Convention Center)*
12:00 pm	-	5:00 pm	Poster Setup *(Palisades DEF – Convention Center)*
1:00 pm	-	6:00 pm	APMS / SCAPMS Scholarship Golf Tournament *(Arcadian Shores Golf Club)*
1:00 pm	-	5:00 pm	Registration *(Group Registration South – Convention Center)*
7:00 pm	-	9:00 pm	President's Reception *(Dunes Ballroom – Hotel, 16th Floor)*
			Provided by Silver Level Sponsors

Monday, July 13

Monday's Agenda-at-a-Glance

7:00 am	-	8:00 am	Continental Breakfast *(Palisades DEF – Convention Center)* *Provided by Bronze Level Sponsors*
7:00 am	-	5:00 pm	Exhibits Open (*Palisades DEF – Convention Center)*
7:00 am	-	5:00 pm	Posters Open *(Palisades DEF – Convention Center)*
7:30 am	-	5:00 pm	Registration *(Group Registration South – Convention Center)*
8:00 am	-	11:30 pm	Session I – General Session *(Palisades ABC – Convention Center)*
10:00 am	-	3:30 pm	Guest Tour – Pre-registered Guests meet at the Hilton Main Lobby at 9:45 am *Provided by Bronze Level Sponsors*
9:50 am	-	10:10 am	Refreshment Break *(Palisades DEF – Convention Center)* *Provided by Contributor Level Sponsors*
11:30 am	-	1:00 pm	Lunch on your own
11:30 am	-	1:00 pm	APMS Student Affairs Luncheon *(Palisades I – Convention Center)* *Sponsored by Silver Level Sponsors*
1:00 pm	-	4:30 pm	Session II – General Session and Student Presentations *(Palisades ABC – Convention Center)*
2:40 pm	-	3:10 pm	Refreshment Break *(Palisades DEF – Convention Center)* *Provided by Contributor Level Sponsors*
4:30 pm	-	5:00 pm	APMS Annual Business Meeting *(Palisades ABC – Convention Center)*
6:00 pm	-	7:30 pm	Poster Session and Reception *(Palisades DEF – Convention Center)* *Provided by Silver Level Sponsors*

Session I – General Session

8:00 am - 11:30 pm
Palisades ABC – Convention Center

Moderator: Dr. Rob Richardson - APMS President Elect, Program Committee Chair
North Carolina State University, Crop Science Department, Raleigh, NC

8:00 am **Presidential Address**
Cody Gray
UPI, Peyton, CO

8:10 am **EPA and Aquatic Pesticide Registration – Managing Risks in Aquatic Areas**
Dan Kenny
U.S. Environmental Protection Agency, Office of Pesticide Programs, Alexandria VA

8:30 am **Movement Towards an Adaptive Systems Approach to Freshwater Management and Initial Treatment Results from Jordan Lake, a 14,000-Acre Reservoir**
H. Kenneth Hudnell
Medora Corporation, New Bern, NC

8:50 am **North Carolina Wildlife Resources Commission's Role with Aquatic Plant Management in the North Carolina Piedmont**
Mark Fowlkes
North Carolina Wildlife Resources Commission, Elkin, NC

9:10 am **Past, Present, and Future of Aquatic Plant Management in Florida Public Waters**
Jeffrey D. Schardt
APMS Secretary, Thomasville, GA

9:30 am **The Tennessee Valley Authority Aquatic Plant Management Program – A Look at the Past, Present, and Future**
Brett M. Hartis
Tennessee Valley Authority, Aquatic Plant Management Program, Guntersville, AL

9:50 am **Refreshment Break** *(Palisades DEF – Convention Center)*

10:10 am **Prospects for (Meaningfully) Integrating Molecular Biology into Aquatic Plant Management**
Ryan A. Thum
Montana State University, Plant Sciences Department, Bozeman, MT

10:30 am **Scientifically-based Technology or Stupid Lake Trick? A Suggestion for Improving Aquatic Plant Management**
John D. Madsen
U.S. Department of Agriculture, Agriculture Research Service, Exotic and Invasive Weeds Research, Davis, CA

10:50 am **The Underappreciated Economic and Ecological Return from Eradication Programs for Invasive Aquatic Plant Infestations**
Mark Heilman
SePRO Corporation., Carmel, IN

11:10 am **Linking Plant Biology with Management Strategies for Control of Monoecious Hydrilla**
Michael D. Netherland[1], Robert J. Richardson[2], and Justin J. Nawrocki[2]
[1]U.S. Army Corps of Engineers, Engineer Research Development Center, Gainesville, FL
[2]North Carolina State University, Crop Science Department, Raleigh, NC

11:30 am **Lunch on your own**

Session II – Hydrilla Management Perspectives and Student Presentations

1:00 pm - 4:30 pm
Palisades ABC – Convention Center

Moderator: Dr. Vernon V. Vandiver, Jr. - APMS Board of Directors
Professor Emeritus, University of Florida, Gainesville, FL

1:00 pm **Cayuga Lake Watershed Hydrilla Project: Early Detection and Rapid Response to Hydrilla in Central NY**
James Balyszak
Hydrilla Task Force of the Cayuga Lake Watershed, Program Manager, Ithaca, NY

1:20 pm **Response of Sprouting Monoecious Hydrilla Turions to Varying Temperature and Salinity Levels (*Student Presentation*)**
Shannon M. Auell and Robert J. Richardson
North Carolina State University, Crop Science Department, Raleigh, NC

1:40 pm **Monoecious Hydrilla in the Chowan River, North Carolina**
Rob Emens[1] and Robert J. Richardson[2]
[1]North Carolina Department of Environment and Natural Resources, Raleigh, NC
[2]North Carolina State University, Crop Science Department, Raleigh, NC

2:00 pm **Hydrilla Management at Claytor Lake, Virginia: A Cautionary Tale**
John R. Copeland[1], William B. Kittrell, Jr.[2], Matt Weberg[3], Brian Murphy[4], and Andrew Rypel[5]
[1]Virginia Department of Game and Inland Fisheries, Blacksburg, VA
[2]Virginia Department of Game and Inland Fisheries, Marion, VA
[3]Minnesota Department of Natural Resources, Grand Marais, MN
[4]Virginia Tech University, College of Natural Resources and the Environment, Blacksburg, VA
[5]Wisconsin Department of Natural Resources, Madison, WI

2:20 pm **Submersed Plant Population Dynamics over Time in Roanoke Rapids Lake (*Student Presentation*)**
Andrew Howell, Justin J. Nawrocki, Steve T. Hoyle, and Robert J. Richardson
North Carolina State University, Crop Science Department, Raleigh, NC

2:40 pm **Refreshment Break** *(Palisades DEF – Convention Center)*

3:10 pm **Aquatic Invaders - Plant Camp Carolinas**
Anne Ellis
Horizons Unlimited, Salisbury, NC

3:30 pm **Effects of Copper Ethylenediamine on Hydrilla in Pickwick Lake, AL**
Lee G. Turnage[1], Ryan M. Wersal[2], and Harry Knight[3]
[1]Mississippi State University, Geosystems Research Institute, Starkville, MS
[2]Applied Biochemists, Alpharetta, GA
[3]Applied Biochemists, Cullman, AL

3:50 pm **Field Evaluation of Tradewind Herbicide for Control of Suspected Fluridone Resistant Hydrilla**
Leif Willey[1] and Bo Burns[2]
[1]Aquatic Systems, Inc., Lutz, FL
[2]Nufarm Americas, Inc., Raleigh, NC

4:10 pm **Impacts of Herbicide Management on Watermilfoil Species Dynamics in a Field Setting**
Syndell Parks[1] and Ryan Thum[2] (*Student Presentation*)
[1]Grand Valley State University, Biology Department, Muskegon, MI
[2]Montana State University, Plant Sciences Department, Bozeman, MT

4:30 pm **APMS Annual Business Meeting** *(Palisades ABC – Convention Center)*

5:00 pm **Adjourn General Session**

6:00 pm **Poster Session and Reception** *(Palisades DEF – Convention Center)*

Poster Session

6:00 pm - 7:30 pm
Palisades DEF – Convention Center

Developing an Integrated, Adaptive Approach to Hydrilla Management to Reduce Risk of Avian Vacuolar Myelinopathy at J. Strom Thurmond Reservoir (GA/SC) (*Student Presentation*)
Garon Brandon[1], Michael D. Netherland[2], and Susan Wilde[1]
[1]University of Georgia, Warnell School of Forestry and Natural Resources, Athens, GA
[2]U.S. Army Corps of Engineers, Engineer Research Development Center, Gainesville, FL

Utilizing Phylogenetic Analysis and Population Genetics to Track the Movement of the Cyanobacterium *Cylindrospermopsis raciborskii*
Clay Britton
Methodist University, Department of Biology, Fayetteville, NC

Variable-leaf Milfoil Response to Herbicides: A Five Year Summary (*Student Presentation*)
Evan Calloway[1], Justin J. Nawrocki[1], Trevor Israel[2], and Robert J. Richardson[1]
[1]North Carolina State University, Crop Science Department, Raleigh, NC
[2]University of Tennessee, Department of Plant Science, Knoxville, TN

Sediment Copper Concentrations, in situ Benthic Abundance, and Sediment Toxicity: Comparison of Coves Treated with Copper-Based Algaecides and Untreated Coves in a Southern Reservoir *(Student Presentation)*
Tyler D. Geer[1], Kyla J. Iwinski[2], Alyssa J. Calomeni[1], and John H. Rodgers[1], Jr.
[1]Clemson University, Department of Forestry and Environmental Conservation, Clemson, SC
[2]Clemson University, Department of Fisheries and Wildlife Biology, Clemson, SC

Stocking Grass Carp - Is the Reward Worth the Risk? An Examination of Virginia's Grass Carp Program
Johnathan Harris and Bonnie Brown
Virginia Department of Game and Inland Fisheries, Richmond, VA
Virginia Commonwealth University, Department of Biology, Richmond, VA

Establishment of a New Cool Climate Mesocosm Facility
Tyler J. Harris[1], Robert J. Richardson[1], Tracy Taylor[2], Steve T. Hoyle[1], Justin J. Nawrocki[1], Andrew Howell[1], and Alexander M. Stewart[3]
[1]North Carolina State University, Crop Science Department, Raleigh, NC
[2]North Carolina Department of Agriculture and Consumer Services, Upper Mountain Research Station, Laurel Springs, NC
[3]North Carolina Department of Agriculture and Consumer Services Research Station Division, Raleigh, NC

Maximizing Water Quality using Passive Polymer Enhanced Treatment Systems
Seva I. Iwinski
Applied Polymer Systems, Inc., Woodstock, GA

***Ficaria verna* (Fig buttercup) – An emerging weed in the Southeastern U.S.**
Bridget R. Lassiter[1] and Anthony L. Koop[2]
[1]North Carolina Department of Agriculture and Consumer Services, Plant Industry Division, Raleigh, NC
[2]U.S. Department of Agriculture, Plant Epidemiology and Risk Analysis laboratory, Plant Protection and Quarantine, Raleigh, NC

Cyber-Cyano: A Cloud Infrastructure for Early Detection of Cyanobacteria Harmful Algal Blooms
Benjamin Page and Deepak Mishra
University of Georgia, Geography Department, Athens, GA

Aquatic Plants: A Free Android and Apple App from North Carolina State University
Robert J. Richardson[1], Steve T. Hoyle[1], Tyler J. Harris[1], and Bridget Lassiter[2]
[1]North Carolina State University, Crop Science Department, Raleigh, NC
[2]North Carolina Department of Agriculture and Consumer Services, Plant Industry Division, Raleigh, NC

A Novel Invasive Species of Water Chestnut Found in the Potomac River near Washington, D.C.
Nancy B. Rybicki[1], Elizabeth Striano[2], and Ryan A. Thum[3]
[1]*U.S. Geological Survey, National Research Program, Reston, VA*
[2]*Rails to Trails Conservancy, Washington, DC*
[3]*Montana State University, Plant Sciences Department, Bozeman, MT*

How Ultrasonic Technology Kills and Controls Algae for Better Pond Management
Kirk Whatley
Sonic Solutions, LLC, West Hatfield, MA

Tuesday, July 14

Tuesday's Agenda-at-a-Glance

7:00 am	-	8:00 am	Continental Breakfast *(Palisades DEF – Convention Center)* *Provided by Bronze Level Sponsors*
7:00 am	-	5:00 pm	Exhibits Open *(Palisades DEF – Convention Center)*
7:00 am	-	5:00 pm	Posters Open *(Palisades DEF – Convention Center)*
7:30 am	-	5:00 pm	Registration *(Group Registration South – Convention Center)*
8:00 am	-	11:30 pm	Session III – General Session and Student Presentations *(Palisades ABC – Convention Center)*
9:40 am	-	10:10 am	Refreshment Break *(Palisades DEF – Convention Center)* *Provided by Contributor Level Sponsors*
11:30 am	-	1:00 pm	Lunch on your own
11:30 am	-	1:00 pm	APMS Past Presidents' Luncheon *(Palisades H – Convention Center)* *Provided by Bronze Level Sponsors*
11:30 am	-	1:00 pm	APMS Regional Chapters Presidents' Luncheon (*Palisades I – Convention Center*) *Provided by Bronze Level Sponsors*
1:00 pm	-	5:00 pm	Session IV – General Session and Student Presentations *(Palisades ABC – Convention Center)*
3:00 pm	-	3:20 pm	Refreshment Break *(Palisades DEF – Convention Center)* *Provided by Contributor Level Sponsors*
5:00 pm	-	6:30 pm	SCAPMS Annual Business Meeting & Board Meeting (*Palisades ABC – Convention Center)*
6:00 pm	-	7:30 pm	Duck Races *(Splash Lazy River, Embassy Suites Hotel)*
6:00 pm	-	7:30 pm	Awards Reception *(Splash Lazy River, Embassy Suites Hotel)* *Provided by Gold Level Sponsor*
7:30 pm	-	10:00 pm	Awards Banquet *(Palmetto Pavilion, Embassy Suites Hotel)* *Provided by Gold Level Sponsor*
8:30 pm	-	10:00 pm	APMS and SCAPMS Awards Presentations *(Palmetto Pavilion, Embassy Suites Hotel)*

Session III – General Session and Student Presentations

8:00 am - 11:30 pm
Palisades ABC – Convention Center

Moderator: Christopher R. Mudge
U.S. Army Corps of Engineers, Engineer Research and Development Center, Baton Rouge, LA

8:00 am **Evaluating the Potential for Herbicide Resistance Evolution in Hybrid Watermilfoil using a Temporal Genetic Analysis Pre- Versus Post-treatment with Auxinic Herbicides (*Student Presentation*)**
Jeff Pashnick[1], Ryan A. Thum[2], Syndell Parks[3], and Gregory Chorak[4]
[1]*Montana State University, Plant Sciences Department - Plant Genetics, Bozeman, MT*
[2]*Montana State University, Plant Sciences Department, Bozeman, MT*
[3]*Grand Valley State University, Biology Department, Muskegon, MI*
[4]*Grand Valley State University, Annis Waters Resources Institute, Muskegon, MI*

8:20 am **Status of *Arundo donax* as a Biofuel Crop in North Carolina and Potential Containment Strategies**
Steve T. Hoyle[1], Robert J. Richardson[1], Sam Brake2, and Jacob Barney[3]
[1]*North Carolina State University, Crop Science Department, Raleigh, NC*
[2]*North Carolina Department of Agriculture and Consumer Services, Bioenergy Research Initiative, Oxford, NC*
[3]*Virginia Tech, Department of Plant Pathology, Physiology, and Weed Science, Blacksburg, VA*

8:40 am **Laboratory Crosses Demonstrate that Interspecific and Intraspecific Hybridization Can Lead to Rapid Increases in Invasive Growth (*Student Presentation*)**
Danielle E. Grimm and Ryan A. Thum
Montana State University, Plant Sciences Department, Bozeman, MT

9:00 am **The Effect of Glyphosate and PPO Herbicide Combinations on Difficult to Control Aquatic Plants**
Christopher R. Mudge[1] and Michael D. Netherland[2]
[1]U.S. Army Corps of Engineers, Engineer Research and Development Center, Baton Rouge, LA
[2]U.S. Army Corps of Engineers, Engineer Research and Development Center, Gainesville, FL

9:20 am **2,4-D Absorption and Translocation in Eurasian Watermilfoil (*Myriophyllum spicatum*) and a 2,4-D Tolerant Milfoil Hybrid (*M. spicatum* X *M. sibiricum*) (*Student Presentation*)**
Kallie C. Kessler and Scott J. Nissen
Colorado State University, Bioagricultural Sciences and Pest Management, Fort Collins, CO

9:40 am **Refreshment Break** *(Palisades DEF – Convention Center)*

10:10 am **Growth and Control of *Miscanthus* spp. in Wetland Environments**
Lee G. Turnage[1], Nicole Barksdale[2], John D. Byrd[2], and John D. Madsen[3]
[1]Mississippi State University, Geosystems Research Institute, Mississippi State, MS
[2]Mississippi State University, Plant and Soil Sciences, Starkville, MS
[3]U.S. Department of Agriculture, Agriculture Research Service, Exotic and Invasive Weeds Research, Davis, CA

10:30 am **Responses of a Cyanobacterium (*Planktothrix agardhii*) and a Green Alga (*Pseudokirchneriella subcapitata*) to a Chelated and Non-chelated Copper Algaecide (*Student Presentation*)**
Alyssa J. Calomeni and John H. Rodgers, Jr.
[1]Clemson University, School of Agricultural, Forest and Environmental Sciences, Clemson, SC

10:50 am **Field Response of Crested Floating Heart to Herbicide Treatments Over Two Years**
Justin J. Nawrocki and Robert J. Richardson
North Carolina State University, Crop Science Department, Raleigh, NC

11:10 am **Establishment of Native Aquatic Vegetation in Conjunction with an Integrated Invasive Aquatic Vegetation Management Program (*Student Presentation*)**
Haley N. Kokel[1], Michael P. Masser[1], and Mark A. Webb[2]
[1]Texas A&M University, Department of Wildlife and Fisheries Sciences, College Station, TX
[2]Texas Parks and Wildlife Department, Inland Fisheries Division, Snook, TX

11:30 am **Lunch on your own**

Session IV – General Session and Student Presentations

1:00 pm - 5:00 pm
Palisades ABC – Convention Center

Moderator: Michael D. Netherland - APMS Immediate Past President, Awards Committee Chair
U.S. Army Corps of Engineers, Engineer Research Development Center, Gainesville, FL

1:00 pm **Incorporating Geospatial Ecological Modeling in Aquatic Invasive Risk Assessments; An Overview of Methods and Applications (*Student Presentation*)**
Amanda M. West[1], Paul Evangelista[1,2], Catherine S. Jarnevich[3], Nicholas Young[1], Matthew W. Luizza[1], Stephen Chignell[2], Tewodros Wakie[1], and Melissa Haeffner[4]
[1]Colorado State University, Natural Resource Ecology Laboratory, Fort Collins, CO
[2]Colorado State University, Department of Ecosystem Science and Sustainability, Fort Collins, CO
[3]U.S. Geological Survey, Fort Collins Science Center, Fort Collins, CO
[4]Colorado State University, Department of Anthropology, Fort Collins, CO

1:20 pm **Restoration and Management of Submersed Aquatic Macrophytes after Carp Removal in Minnesota Lakes**
Raymond M. Newman[1], Jonathan D. JaKa[2], and Joshua Knopik[2]
[1]University of Minnesota, Department of Fisheries, Wildlife, and Conservation Biology, Minneapolis, MN
[2]University of Minnesota, Department of Fisheries, Wildlife, and Conservation Biology, St. Paul, MN

1:40 pm **Modes of Reproduction in Crested Floating Heart (*Nymphoides cristata*) (*Student Presentation*)**
Erika J. Haug and Robert J. Richardson
North Carolina State University, Crop Science Department, Raleigh, NC

2:00 pm **Movement of Triploid Grass Carp in the Regulated Pee Dee River, North Carolina**
Troy Thompson
North Carolina Wildlife Resources Commission, Wadesboro, NC

2:20 pm **Movement Patterns of Stocked Grass Carp in a Lentic and Lotic System of North Carolina**
Kelsey J. Lincoln[1], Jessica R. Baumann[2], and Corey N. Oakley[1]
[1]North Carolina Wildlife Resources Commission, Division of Inland Fisheries, Mebane, NC
[2]North Carolina Wildlife Resources Commission, Division of Inland Fisheries, Swepsonville, NC

2:40 pm **Efficacy and Movement Patterns of Triploid Grass Carp in the Presence of a Reduced Hydrilla Tuber Bank in Tar River Reservoir, NC**
Kirk Rundle
North Carolina Wildlife Resources Commission, Division of Inland Fisheries, Whitakers, NC

3:00 pm **Refreshment Break** *(Palisades DEF – Convention Center)*

3:20 pm **Cellular and Aqueous Microcystin-LR Following Laboratory Exposures of *Microcystis aeruginosa* to Copper Algaecides (*Student Presentation*)**
Kyla J. Iwinski[1], Alyssa J. Calomeni[2], Tyler D. Geer[2], and John H. Rodgers, Jr.[2]
[1]Clemson University, Department of Fisheries and Wildlife Biology, Clemson, SC
[2]Clemson University, School of Agricultural, Forest and Environmental Sciences, Clemson, SC

3:40 pm **Azoxystrobin Bioremoval Capacity of Aquatic Plants**
Travis W. Gannon and Matthew D. Jeffries
North Carolina State University, Crop Science Department, Raleigh, NC

4:00 pm **Creeping Water-Primrose (*Ludwigia grandiflora/ hexapetala*) Management with Combination Treatments utilizing Clearcast® (Imazamox) and Stingray® (Carfentrazone)**
Kelli L. Gladding[1], Ben E. Willis[2], and Todd C. Horton[3]
[1]SePRO Corporation, New Smyrna Beach, FL
[2]SePRO Corporation, SePRO Research & Technology Campus, Whitakers, NC
[3]SePRO Corporation, Anderson, SC

4:20 pm **Grass = Bass: Getting B.A.S.S. Members Involved in the Equation**
Gene Gilliland
Bass Anglers Sportsman Society, Norman, OK

4:40 pm **Hyperspectral Imaging: Species Delineation**
John Merrill
Galileo Group, Research Triangle Park, NC

5:00 pm **Adjourn General Session**

5:00 pm **SCAPMS Annual Business Meeting & Board Meeting *(Palisades ABC - Convention Center*)**

6:00 pm **Duck Races and Awards Banquet Reception *(Splash Lazy River, Embassy Suites Hotel)***
Take the Shuttle or a 5-10 minute walk south on the boardwalk or beach to the Embassy Suites Hotel
Shuttle picks up and returns from in front of the Hilton
Every 15 minutes from the Hilton to the Embassy Suites Hotel from 6:00 p.m. to 7:30 p.m.
Every 15 minutes return to the Hilton Hotel from 9:45 p.m. to 11:00 p.m.

7:30 pm **Awards Banquet *(Palmetto Pavilion, Embassy Suites Hotel)***

Wednesday, July 15

Wednesday's Agenda-at-a-Glance

7:00 am	-	8:00 am	Continental Breakfast *(Palisades DEF – Convention Center))* *Provided by Bronze Level Sponsors*
7:00 am	-	10:20 am	Exhibits Open *(Palisades DEF – Convention Center)*
7:00 am	-	10:20 am	Posters Open *(Palisades DEF – Convention Center)*
7:30 am	-	12:00 pm	Registration *(Group Registration South – Convention Center)*
8:00 am	-	12:30 pm	Session V – General Presentations and Updates *(Palisades ABC – Convention Center)*
10:00 am	-	10:20 am	Refreshment Break *(Palisades DEF – Convention Center)* *Provided by Contributor Level Sponsors*
10:20 am	-	12:00 pm	Poster and Exhibit Breakdown *(Palisades DEF – Convention Center)*
1:00 pm	-	5:00 pm	APMS Board of Directors Meeting *(Palisades H – Convention Center)*

Session V – General Presentations and Updates

8:00 am - 12:30 pm
Palisades ABC – Convention Center

Moderator: Dr. John Madsen - APMS Vice President
U.S. Department of Agriculture, Agriculture Research Service, Exotic and Invasive Weeds Research, Davis, CA

8:00 am **RISE: Industry and Issues Update**
Aaron Hobbs
Responsible Industry for a Sound Environment, Washington, D.C.

8:30 am **The Most Common and Troublesome Aquatic Weeds – What the Experts Say**
Lee VanWychen
Weed Science Society of America, Science Policy Director, Alexandria, VA

8:45 am **Horned Pondweed (*Zannichellia palustris*) Control with Endothall Formulations in Greenhouse Mesocosms**
Scott J. Nissen and Kallie Kessler
Colorado State University, Bioagricultural Sciences and Pest Management, Fort Collins, CO

9:05 am **Water Willow Habitat Projects on Georgia Reservoirs**
Tony Beck
Georgia BASS Nation, Lake Oconee Bassmasters, Eatonton, GA

9:20 am **Mapping Invasive Species using EDDMapS and Apps**
Rebekah D. Wallace, Charles T. Bargeron, and Karan A. Rawlins
University of Georgia, Center for Invasive Species and Ecosystem Health, Tifton, GA

9:40 am **It's not just "For the Birds" Anymore: Expanding Locations and Species at Risk from Avian Vacuolar Myelinopathy (AVM)**
Susan Wilde, Bridgette Haram, Sonia Hernandez, Vanessa Kinney, and John Maerz
University of Georgia, Warnell School of Forestry and Natural Resources, Athens, GA

10:00 am **Refreshment Break** *(Palisades DEF – Convention Center)*

10:20 am **Control of Algae Producing Taste and Odor in the Drinking Water Supply for the Anderson Regional Joint Water System**
John H. Rodgers, Jr.
Clemson University, Department of Forestry and Environmental Conservation, Clemson, SC

10:40 am **The Evolution and Future of Lyngbya Management**
Ben E. Willis[1], West M. Bishop[1], and Todd C. Horton[2]
[1]*SePRO Corporation, SePRO Research & Technology Campus, Whitakers, NC*
[2]*SePRO Corporation, Anderson, SC*

11:00 am **Aeration's Effect on Algae: A Review of Success and Failures**
Patrick Goodwin
Vertex Water Features, Pompano Beach, FL

11:20 am **Planning Integrated Aquatic Plant Management in the Tahoe Keys: A Process in Stakeholder Collaboration**
Lars W. J. Anderson[1] and Kris Kiehne[2]
[1]*Waterweed Solutions, Point Reyes, CA*
[2]*Sierra Ecosystem Associates, Placerville, CA*

11:40 am **Aquatic Weeds in Botswana: Historical Perspective and Management**
C. N. Kurugundla[1]**,** B. Mathangwane[2], and S. Sakuringwa[2]
[1]*Department of Water Affairs, Maun, Botswana*
[2]*Department of Water Affairs, Gaborone, Botswana*

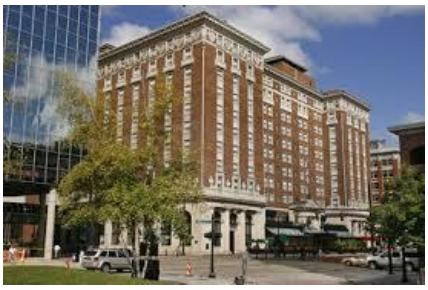
12:00 pm **APMS Regional Chapters: An Update on Key Initiatives within Each Region**
John Madsen, Moderator
U.S. Department of Agriculture, Agriculture Research Service, Davis, CA

Western	South Carolina	Midwest	Florida
Texas	Northeast	MidSouth	

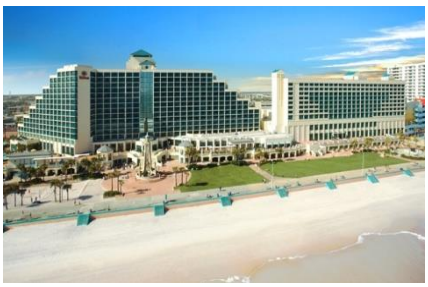
12:30 pm **Adjourn 55th Annual Meeting**

1:00 pm **APMS Board of Directors Meeting** *(Palisades H – Convention Center)*

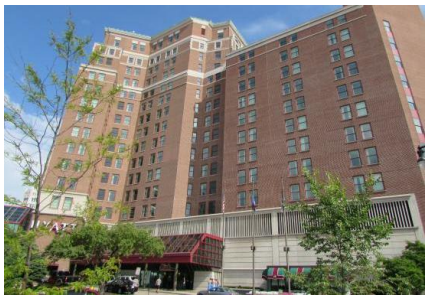
56th Annual Meeting
Amway Grand Plaza Hotel
Grand Rapids, Michigan
July 17-20, 2016



57th Annual Meeting
Hilton Daytona Beach Resort
Ocean Walk Village
Daytona Beach, Florida
July 16-19, 2017



58th Annual Meeting
Hyatt Regency Buffalo
Buffalo, New York
July 15-18, 2018



Abstracts

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

General Sessions and Poster Session

Planning Integrated Aquatic Plant Management in the Tahoe Keys: A Process in Stakeholder Collaboration
Lars W. J. Anderson[1] and Kris Kiehne[2]
[1]*Waterweed Solutions, Point Reyes, CA*
[2]*Sierra Ecosystem Associates, Placerville, CA*

Invasive and nuisance aquatic plants have degraded ecosystems services in Lake Tahoe for over 30 years. Priorities for ecosystem management has been focused on improving Tahoe water clarity, and only since 2007 have significant efforts been made to reduce impacts from aquatic invasive species and to prevent new AIS introductions. Eurasian watermilfoil, curlyleaf pondweed and coontail) are most abundant and problematic in the Tahoe Keys lagoons in South Lake Tahoe. The infestation is relatively small (ca. 150-170 acres); however, regulatory constraints have confined management to mechanical harvesting and very small-scale use (<5 acres) of bottom barriers. Current harvesting and removal costs $400,000 per year. To improve management efficiency and reduce spread of propagules to the lake proper, the Tahoe Keys Property Owners Association (TKPOA) is developing an Integrated Weed Management Plan (IWMP) that identifies, considers and prescribes all feasible tools-including aquatic herbicides-tailored to specific sites in the Keys. Anticipated changes in the Lahontan Regional Water Quality Board regulations provide a process for requesting an exemption to current prohibitions on use of aquatic herbicides. As an integral part of the IWMP, TKPOA has engaged a wide range of stakeholders, including environmental and conservation groups, primary bi-state agency (Tahoe Regional Planning Agency), state and federal regulatory agencies, marina owners, potable water purveyors, and homeowners. Oversight is achieved through an external Science Panel with expertise in AIS and specifically invasive aquatic plants. The final plan is scheduled for submittal to regulatory agencies in fall, 2015. Due to the unique conditions surrounding Lake Tahoe, a CEQA/NEPA document will be generated as well. Full implementation of the IWMP with all feasible tools is anticipated for 2017. Implementation of the IWMP will not only improve aquatic weed management in the Tahoe Keys, it will also help reduce AIS impacts in Lake Tahoe and discourage introductions of new invasive species.

Response of Sprouting Monoecious Hydrilla Turions to Varying Temperature and Salinity Levels (*Student Presentation)*
Shannon M. Auell and Robert J. Richardson
North Carolina State University, Crop Science Department, Raleigh, NC

Hydrilla (*Hydrilla verticillata*) is a submersed macrophyte and is one of the most expensive and difficult to control aquatic weeds in the U.S. Monoecious hydrilla, the prominent biotype of North Carolina, is an herbaceous perennial. Regrowth is dependent upon sprouting of subterranean and axillary turions (Harlan et al., 1985). This study aims to determine differences in sprouting rate and frequency of monoecious hydrilla turions at six different temperatures. Biomass production and survivability of sprouted turions were also examined across a salinity gradient. Temperature studies were conducted on a temperature gradient table at NCSU. Turions were floated in jars held at six different temperatures (T1 = 41.0°C, T2 = 34.9°C, T3 = 29.3°C, T4 = 24.0°C, T5 = 17.6°C, and T6 = 12.3°C). Sprouting frequency and shoot length were measured every other day for twelve days. Turions did not sprout at the most extreme temperatures, and sprouting differed by temperature with optimum sprouting at 29.3 and 34.9°C. Sprouted turions were then floated in seven different salinities from ranging from 35ppt to 0ppt. Initial and final shoot lengths and time to senescence were recorded. Results from this study will be useful when considering management programs across latitudes or elevations and for predicting hydrilla's invasive potential in brackish waters.

Cayuga Lake Watershed Hydrilla Project: Early Detection and Rapid Response to Hydrilla in Central NY
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Program Manager, Hydrilla Task Force of the Cayuga Lake Watershed, Ithaca, NY

Following the discovery of hydrilla in the Cayuga Inlet (Ithaca, NY) in August 2011, the Hydrilla Task Force of the Cayuga Lake Watershed (HTF) was quickly formed to spearhead response efforts. This multidisciplinary task force collaborates with stakeholders and experts to develop and implement comprehensive management strategies to eradicate hydrilla within the Cayuga Lake Watershed. A primary goal for the ongoing Cayuga Lake Watershed Hydrilla Project (Project) is to prevent the spread of hydrilla further into Cayuga Lake, neighboring Finger Lakes, and beyond. The Project has provided a case study for the implementation of Early Detection/Rapid Response strategies in New York State. Management strategies have involved the application of herbicide treatments, benthic barriers, and small-scale physical removal efforts. These strategies and decisions are outlined in the comprehensive Cayuga Lake Watershed Hydrilla Management Plan, which is updated on an annual basis and provided to the public via the Project website (www.Stophydrilla.org). In addition to in-field management, Project activities also include extensive plant community monitoring and sampling, and extensive public education and outreach. The HTF will continue its efforts to manage and eradicate hydrilla in the Cayuga Lake Watershed in 2015 and beyond.

Water Willow Habitat Projects on Georgia Reservoirs
Tony Beck
Georgia BASS Nation, Lake Oconee Bassmasters, Eatonton, GA

The Lake Oconee Bassmasters Club from Eatonton, Georgia wanted to do a unique and long-lasting conservation project. The Club decided to grow an aquatic plant called water willow. Water willow is an aquatic plant that can grow from the shoreline out to about 5 feet deep. Water willow is a native, non-invasive plant that provides shoreline cover for young and adult fish, and can help prevent shoreline erosion. It is fairly easy to grow because it can generate roots from the stem. The Club takes cuttings from established plants and pots them in small pots. The pots are placed in small pools filled with water so the plants will have constant moisture. Other than keeping the pools filled with water, there is very little maintenance that needs to be done to the plants. After about 3 months, the plants are rooted and ready to be transplanted to the lake. One of the advantages of this plant is that once it is established, it will move around on its own by breaking loose, and rooting elsewhere. This is a great long-lasting project that can have a positive impact on the fish population and the aquatic environment. The Club has been participating in this project for about 10 years. We are currently working on a 3-year project on Lake West Point in Lagrange, Georgia.

Developing an Integrated, Adaptive Approach to Hydrilla Management to Reduce Risk of Avian Vacuolar Myelinopathy at J. Strom Thurmond Reservoir (GA/SC) (*Student Presentation*)
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Avian Vacuolar Myelinopathy (AVM) is a neurological disease that commonly causes fatalities in birds of prey and waterfowl including bald eagles (*Haliaeetus leucocephalus*) and American coots (*Fulica americana*). The novel cyanobacteria, *Aetokthonos hydrillicola*, found on hydrilla leaves, produces a neurotoxin that attacks the optic tectum of the bird's brain. Toxin is transferred through ingestion; coots consume the toxic hydrilla directly and raptors are exposed when they consume the sick/dead waterbirds. One of the worst disease locations is J. Strom Thurmond Reservoir, on the Savannah River (GA/SC), where over 80 bald eagles and 100's of American coots have died from AVM since 1998. Hydrilla management is ecologically and socially complex in a multi-purpose reservoir (~70,000 acres) designed for flood control, hydropower, fish and wildlife, water supply, navigation, and recreation. Environmental assessment of the aquatic plant control is underway to develop and optimize a management plan for environmentally sound, economically feasible, and effective hydrilla control to reduce risk of Vacuolar Myelinopathy in and around Thurmond Reservoir. Field studies at Thurmond Reservoir will initiate in summer 2015 by mapping vegetation in the study area to accurately assess hydrilla biomass and document native vegetation. Replicate treatment coves will be stocked with sterile triploid grass carp (60/cove), or a combination of a grass carp (30/cove) and herbicide (Komeen/Diquat; label rate) to test the efficacy of biological

and chemical control in this reservoir. A subset of the triploid grass carp (20) will be implanted with sonic telemetry tags to facilitate tracking their movement from the stocking location with a boat mounted Yagi receiver. Sonar mapping will be used to quantify seasonal changes in aquatic plant biomass and effectiveness of treatment alternatives in all experimental/control coves. This multi-year study will include seasonal monitoring of AVM disease and mapping of aquatic vegetation in experimental coves to facilitate development of adaptive management strategies for hydrilla control in Thurmond Reservoir.

Utilizing Phylogenetic Analysis and Population Genetics to Track the Movement of the Cyanobacterium *Cylindrospermopsis raciborskii*

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The use of population genetics is an underutilized technique for tracking the movement of cyanobacteria between lakes and reservoirs. The majority of population genetic studies for cyanobacteria have focused on toxin producers (e.g., *Anabaena, Microcystis, Aphanizomenon*, and *Nodularia* spp.) with few studies examining the genetic variation of the invasive and toxin-producing *Cylindrospermopsis raciborskii*. This study examines the population genetics of *C. raciborskii* from three North American states (i.e., Florida, Indiana and North Carolina) and 11 countries. To analyze the relationships of populations at the local level, gene sequences from six loci were analyzed from single filaments of *C. raciborskii* isolated from cultured and natural populations. Additionally, novel gene sequences from the North American isolates were added to previously published phylogeographic gene trees from numerous European isolates. The phylogenetic and population genetic analyses show that although there are regionally distinct clades there are also genetic similarities between some of these geographically separated populations. These results are potentially useful for tracking the movement of *C. raciborskii* into new regions. The continued collection of this information would allow the origin of introduced populations of *C. raciborskii* to be identified so that management practices could be established to minimize movement of *C. raciborskii* from regions in which the cyanobacterium is already well-established.

Variable-leaf Milfoil Response to Herbicides: A Five Year Summary (*Student Presentation*)

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Variable-leaf milfoil is a native submersed aquatic plant that can become invasive in certain parts of the U.S. It impedes recreation and agricultural irrigation, disrupts diverse ecosystems, and reduces waterfront property value. Traditionally, synthetic auxin herbicides have been the most effective control strategy for variable-leaf milfoil. As newer herbicides become available for aquatic use, research is needed to determine the efficacy of these options in field situations. We evaluated the response of variable-leaf milfoil infestations in North Carolina to several aquatic herbicides including newly available products as well as industry standards. Visual coverage estimates and rake toss samples were obtained to determine percent reduction in coverage. At one month after treatment, over 80% reduction in coverage was observed for ponds treated with 200 µg ai L^{-1} carfentrazone-ethyl, 200 µg ai L^{-1} diquat, 200 µg ai L^{-1} flumioxazin, and 0.5, 1, and 2 mg ai L^{-1} triclopyr. At four months after treatment, 200 µg ai L^{-1} diquat, 200 µg ai L^{-1} flumioxazin, 2 mg ai L^{-1} triclopyr and 2 mg ai L^{-1} 2,4-D reduced coverage nearly 100%. Ponds treated with diquat at 200 µg ai L^{-1}, carfentrazone plus diquat at 100 + 100 µg ai L^{-1}, triclopyr at 2 mg ai L^{-1}, and 2,4-D at 2 mg ai L^{-1} exhibited the greatest decrease in coverage at twelve months after treatment. Ponds treated with 100 or 200 µg ai L^{-1} carfentrazone, 2 mg ai L^{-1} endothall, and 15 µg ai L^{-1} penoxsulam displayed little change in coverage from pretreatment ratings at twelve months after treatment.

Responses of a Cyanobacterium (*Planktothrix agardhii*) and a Green Alga (*Pseudokirchneriella subcapitata*) to a Chelated and Non-chelated Copper Algaecide *(Student Presentation)*

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Reliable relative sensitivity data for algae are needed to predict responses in the field to algaecide exposures. Laboratory cultures dominated by *Planktothrix agardhii* and *Pseudokirchneriella subcapitata* were exposed to a

series of concentrations of a chelated copper algaecide (Cutrine®-Ultra) and a copper salt (CuSO4 $5H_2O$) in 7-day toxicity experiments. Measures of algal responses included cell density, uptake of stain (erythrosin b), chlorophyll a concentration, pheophytin a concentration and respiration (measured as 2-(p-iodophenyl)-3-(p-nitrophenyl)-5-phenyl tetrazolium formazan absorbance (INT)). Algal responses to exposures were measured every 24 h for the duration of the experiment. Potency slopes and 96h EC_{50}s were calculated for each alga and algaecide exposure. Cell densities and erythrosin b stained cells had sufficient accuracy and precision to differentiate responses of *P. agardhii* and *P. subcapitata* from resident algae while chlorophyll a concentrations and INT formazan absorbances did not discriminate. In this study, pheophytin a concentrations lacked precision and accuracy. *P. agardhii* was an order of magnitude more sensitive than *P. subcapitata* and Cutrine®-Ultra was more than twice as potent as $CuSO_4$ $5H_2O$. This laboratory study demonstrates differences in relative sensitivities of *P. agardhii* and *P. subcapitata* to $CuSO_4$ $5H_2O$ and Cutrine®-Ultra exposures.

Hydrilla Management at Claytor Lake, Virginia: A Cautionary Tale

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In September 2013, Virginia Department of Game and Inland Fisheries (VDGIF) fisheries biologists documented 16 ha (40 ac) of hydrilla (*Hydrilla verticillata*) in Claytor Lake, a 1,766-ha (4,363-ac) impoundment of the New River in Pulaski County, Virginia. By September 2010, hydrilla reached an estimated 162 ha (400 ac) lakewide. As a result, Pulaski County officials requested a coordinated control program. Under the auspices of the Claytor Lake Technical Advisory Committee (CLTAC), a VDGIF fisheries biologist wrote the Claytor Lake Hydrilla Management Plan. In April 2011, Pulaski County received a permit from VDGIF to stock 6,000 triploid grass carp at a rate of 37 per ha (15 per ac). The VDGIF funded a research project through the Virginia Tech Department of Fish and Wildlife Conservation (VTFWC) to determine movements, mortality rates, and control effectiveness of these fish. No hydrilla control was observed by September 2011, so 3,200 triploid grass carp were stocked in May 2012 with a goal of maintaining a population density of 49 per ha (20 per ac) based on an estimated 25% mortality rate. By September 2012, hydrilla coverage was reduced to 93 ha (230 ac). In April 2013, 1,500 triploid grass carp were stocked based on estimated mortality rates from the VTFWC research. By September 2013, the hydrilla infestation was completely controlled due to a combination of triploid grass carp predation and high inflows reducing hydrilla growth rates. To respond to concerns of angler and waterfowl hunters about reduced aquatic vegetation, the CLTAC implemented a native aquatic vegetation restoration project in July 2014, establishing founder colonies of wild celery (*Vallisneria americana*) and water willow (*Justicia americana*). Native aquatic plant restoration efforts involve multiple partners from the boating and angling communities, resulting in the award of multiple grants to support this restorative work.

Aquatic Invaders - Plant Camp Carolinas

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Horizons Unlimited, Salisbury, NC

Aquatic Invaders brings the world of aquatic and invasive plant species to students and teachers in the Piedmont of North Carolina. The University of Florida's Plant Camp 2014 served as the model for this pilot student summer academy. Twenty-four middle school students were selected to attend a week-long summer camp where they were immersed into researching, identifying, and engineering design solutions for management of aquatic plants. Students were assigned a specific invader to "manage". They had to design a tool specific to their plant after learning about the characteristics of each plant. This was put to the test when they rode around local "invaded" waters on airboats and tried to capture the plant. The culmination was the creation of Public Service Announcements via the iMovie app which was shared with all campers and educators. They held a Town Hall meeting for their parents at the end of camp to showcase their experience. This gave the students the chance to see many different viewpoints about a controversial issue while being exposed to sustainability and ecological stewardship. This unique opportunity will be offered to district teachers as professional development with hands-

on kits available on a check out basis. The target educator audience is grades 4, 7, 8 and Earth/Environmental Science.

Monoecious Hydrilla in the Chowan River, North Carolina

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North Carolina's 35-year run with monoecious hydrilla has been dominated primarily by infestations in Piedmont reservoirs. In recent years, hydrilla has expanded its range by moving into the Coastal Plain where it is infesting both reservoirs and natural systems. The Chowan River is a blackwater river draining 4,800 square miles of land in North Carolina and Virginia. Hydrilla was first documented in the Chowan River in 2009 and has been found in about 15 miles along the river. Infestation sites are isolated pockets but include side canals with little flow, main portions of the river run, and areas near the mouth. This river exceeds one mile wide where it opens up into the Albemarle Sound; waters here experience wind tides and fluctuating low levels of salinity. Some of the infested sites in the river are currently being managed, but not all. As environmental managers and the local community become increasingly aware of the problem, more and more people are asking what can be done in this vast area. NC Sea Grant and Chowan Soil & Water Conservation District partnered and coordinated a broad survey effort by recruiting volunteers in 2014. Additional survey and management efforts are needed to reduce impacts from spreading hydrilla.

North Carolina Wildlife Resources Commission's Role with Aquatic Plant Management in the North Carolina Piedmont

Mark Fowlkes
North Carolina Wildlife Resources Commission, Elkin, NC

Aquatic plants provide valuable nursery and refuge habitat for juvenile sport fish, serve as a food source for waterfowl and other aquatic wildlife, improve water quality, and help reduce shoreline erosion. However, excessive plant growth can form dense underwater stands that restrict waterways for recreational activities like boating, fishing, and swimming and can negatively alter aquatic habitat. Although the North Carolina Wildlife Resources Commission (Commission) does not regulate aquatic plants, it does provide technical guidance on reservoir shoreline management plans through the Federal Energy Regulatory Commission relicensing process, permits triploid grass carp stocking for controlling hydrilla and other invasive species, and conducts research on and establishes aquatic plants for fish habitat. Over the past two years, the Commission facilitated the development of a triploid grass carp stocking analysis for large piedmont reservoirs that relates stocking rates to area of standing hydrilla and area of the total tuber bank. This effort was undertaken because of the understanding that long-term management of the tuber bank is crucial for controlling hydrilla. Along with controlling hydrilla, the Commission realizes the importance of establishing native vegetation in reservoirs. Therefore, a five year study was developed to evaluate the establishment and expansion of four native plant species, softstem bulrush (*Schoenoplectus tabernaemontani*), pickerelweed (*Pontederia cordata*), arrowhead (*Sagittaria latifolia*), and eelgrass (*Vallisneria americana)*. Preliminary results suggest that softstem bulrush and pickerelweed are fairly easy to establish; however, eelgrass is extremely vulnerable to herbaceous predators and difficult to expand beyond protective cages. We expect that the triploid grass carp analysis and native vegetation establishment research will help guide future management of valuable public resources.

Azoxystrobin Bioremoval Capacity of Aquatic Plants

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Greenhouse experiments (Raleigh, NC, USA) were conducted to assess the capacity of aquatic species to remove 2,4-D and azoxystrobin, two commonly applied pesticides in turf systems, from water bodies. Evaluated species included arrow arum (*Peltandra virginica*), pickerelweed (*Pontederia cordata*), and Virginia iris (*Iris virginica*). At experiment initiation plant containers filled with pond water (2 L) were adjusted to a 5 mg L-1 pesticide concentration. Water samples were collected 0, 1.75, 3.5, 7, 14, and 28 days after treatment (DAT) for HPLC

analysis. Container water volume was also recorded at each sampling event to calculate the total parent material remaining within the container. At 14 and 28 DAT plants were destructively harvested and sectioned into above- and below-soil surface portions for pesticide residue analysis. When comparing pesticides, azoxystrobin was more readily removed by plants from water than 2,4-D at 14 and 28 DAT. Overall, water-pesticide residue reduction was greatest at 28 DAT for Virginia iris compared to arrow arum or pickerelweed. Finally, pesticide residues in plant biomass revealed differential absorption and/or translocation and metabolism of each compound between species. Information from this research may help select plant species that are best suited to mitigate adverse effects from upslope pesticide-treated turf areas.

Sediment Copper Concentrations, in situ Benthic Abundance, and Sediment Toxicity: Comparison of Coves Treated with Copper-Based Algaecides and Untreated Coves in a Southern Reservoir *(Student Presentation)*
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Copper-based algaecides are frequently used to control noxious algae blooms that compromise uses of lakes and reservoirs. However, there are concerns regarding potential adverse effects to benthic aquatic biota following long-term applications. Multiple lines of evidence are useful for evaluating potential ecological risks. These lines of evidence are encompassed in the sediment quality triad (SQT) and include measured sediment copper concentrations, in situ benthic invertebrate data, and sediment toxicity testing. The overall objective of this study was to measure potential ecological risks associated with long-term (i.e. years to decades) applications of copper algaecides in coves in Lay Lake, Alabama. Sediment samples from three coves that had been treated for approximately 7, 10 and 20 years were compared to samples from three untreated coves within Lay Lake in terms of sediment copper concentrations, in situ benthic macroinvertebrate total abundance, and results from laboratory sediment toxicity assays using naïve cultured *Hyalella azteca* and *Chironomus dilutus*. In general, sediment copper concentrations were not significantly different between treated and untreated covers, with the exception of one treated cove (PC-1S) that contained elevated sediment copper concentrations compared to all other coves, likely due to a copper algaecide application on the sampling day (prior to sediment sampling). However, the copper was not bioavailable to organisms based on in situ macroinvertebrate abundance and laboratory toxicity analyses. In situ benthic invertebrate abundance was not different between treated and untreated coves. In all sediments tested, there were no measurable adverse effects (survival greater than 80%) to *H. azteca* and there were no significant differences in the survival of *C. dilutus* between treated and untreated coves. Based on this weight-of-evidence approach, there were no adverse effects to benthic invertebrates in copper treated coves in Lay Lake as compared to untreated coves.

Grass = Bass: Getting B.A.S.S. Members Involved in the Equation
Gene Gilliland
Bass Anglers Sportsman Society, Norman, OK

Gene Gilliland retired in 2013 from the Oklahoma Department of Wildlife Conservation after 32 years as a fishery biologist, supervisor and administrator. Now as the B.A.S.S. National Conservation Director, he represents America's bass anglers on national councils involved in fishery policy, oversees the efforts of 47 B.A.S.S. Nation volunteer conservation directors, works to build positive relationships with state fishery management agencies, and is responsible for fish care practices at Bassmaster tournaments.

Creeping Water-Primrose (*Ludwigia grandiflora/ hexapetala*) Management with Combination Treatments utilizing Clearcast® (Imazamox) and Stingray® (Carfentrazone)
Kelli L. Gladding[1], Ben E. Willis[2], and Todd C. Horton[3]
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Creeping water primrose, *Ludwigia grandiflora/ hexapetala*, has expanded significantly throughout the southeast. This macrophyte is still being distinguished by researchers but for operational management, the plant is considered

a Category I invasive exotic species by the Florida Exotic Pest Plant Council (FLEPPC). Creeping water primrose was first observed on Lake Harney, a tributary of the St. Johns River, in the spring of 2012, at which time field trials began to determine an effective method for controlling the invasive plant to slow its spread in the river. Pond scale herbicide evaluations (0.1 acres) demonstrated Stingray (a.i., carfentrazone, PPO-inhibitor; 4 fl oz/acre) in combination with Clearcast (a.i., imazamox, ALS-inhibitor; 1 qt/acre) as an effective tool for rapid (days) and long-term control of creeping water primrose. Operational use of Clearcast tank mixed with Stingray began in 2013 for its selectivity around beneficial native species on the St. Johns River and other areas throughout Florida (Kissimmee and Clermont Chain of Lakes) in 2014. Preliminary field results indicate a submersed application of Clearcast along with a foliar treatment with Clearcast and Stingray provide for longer control and knockdown of creeping water primrose, targeting the submersed, floating and emergent morphologies of the plant at the same time.

Aeration's Effect on Algae: A Review of Success and Failures
Patrick Goodwin
Vertex Water Features, Pompano Beach, FL

Bottom aeration is a restoration tool commonly used for improving multiple aspects of lake health, including the occurrence of algal blooms and the quality of algal assemblages. The intense mixing brought about by artificially aerating a lake can affect an algal community by: (i) increasing dissolved oxygen concentrations and changing the lake's water chemistry (pH, carbon dioxide and alkalinity), which can lead to a more desirable shift in an algal community; (ii) reducing levels of internal nutrient cycling within a lake, which reduces the large amount of nutrients used to sustain algal blooms; (iii) decreasing the amount of solar energy available for photosynthesis; (iv) favoring algal species that tend to sink quickly and need mixing currents to remain suspended in the upper water column (e.g. diatoms); and (v) mixing algae-eating zooplankton into deeper, darker waters, thereby reducing their predation by sight-feeding fish, and increasing their ability to graze on algae cells. This presentation discusses the current literature regarding aeration's effect on lake algal communities and outlines successes and failures associated with this lake management approach, along with the major factors that tend to influence the outcome of any aeration based management strategy.

Laboratory Crosses Demonstrate that Interspecific and Intraspecific Hybridization Can Lead to Rapid Increases in Invasive Growth (*Student Presentation*)
Danielle E. Grimm and Ryan A. Thum
Montana State University, Plant Science Department, Bozeman, MT

Hybrid Eurasian x northern watermilfoil (*Myriophyllum spicatum* x *M. sibiricum*) in natural populations frequently display increased vegetative growth rate and branching compared to pure Eurasian watermilfoil. But, it is unclear whether hybrid genotypes from natural populations represent predictable phenomena that would arise from crosses between most or all possible parental Eurasian and northern genotypes, or whether they represent a unique and small subset of all possible hybrid genotypes that could be created by hybridization between any Eurasian and northern genotypes. Moreover, it is unclear how long it takes for a hybrid population to develop invasive traits. Can they evolve instantaneously in the first-generation due to hybrid vigor, or do they evolve by natural selection over several generations? To address these questions, we performed controlled laboratory crosses to compare vegetative growth, branching, germination, and survival of first generation Eurasian x northern interspecific hybrids to purebred parental Eurasian and northern watermilfoil. Our lab-derived hybrids showed higher vegetative growth, branching, germination, and survival compared to purebred parental genotypes. These results were consistent across two different experiments using different parental genotypes, suggesting that hybrid vigor is a common phenomenon among crosses with different parental genotypes. In addition, we performed controlled laboratory crosses among two distinct biotypes of Eurasian watermilfoil that were previously identified with molecular analyses. These two biotypes are rarely distinguished in the field, and nothing is currently known about their potential for intraspecific hybridization. Indeed, intraspecific hybrids between the two biotypes exhibited higher vegetative growth, branching, germination, and survival compared to inbred crosses within each biotype. These results suggest that even "pure" populations of EWM may vary in growth depending on opportunities for sexual reproduction with other EWM biotypes. Our study demonstrates the potential for both interspecific hybridization (Eurasian x northern) and intraspecific hybridization among distinct Eurasian biotypes to rapidly

generate vigorous populations of watermilfoil. Vigorous hybrid genotypes are expected to arise from crosses between most or all possible parental genotypes, as opposed to being restricted to a unique or small subset of parental genotypes. Thus, all populations where parental Eurasian and northern co-occur, or where distinct biotypes of Eurasian watermilfoil co-occur, should be considered high risk for generating vigorous hybrid genotypes. Furthermore, we have shown that evolutionary changes in growth characteristics can occur in a single generation through hybrid vigor, and do not require multiple generations of selection for vigorous genotypes. This in turn implies that dramatic changes in watermilfoil growth in natural populations could occur over very short timescales via hybridization.

Stocking Grass Carp - Is the Reward Worth the Risk? An Examination of Virginia's Grass Carp Program
Johnathan Harris and Bonnie Brown
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Grass carp are illegal to possess in Virginia except under a permit administered by the Virginia Department of Game and Inland Fisheries. Triploid (sterile) grass carp are permitted as a vegetation management tool in Virginia only in closed systems and can only be obtained from suppliers certified by the U.S. Fish and Wildlife Service National Triploid Grass Carp Inspection and Certification Program that agree to random ploidy blood test of carp on their shipments (ploidy determined by flow cytometry). The use of triploid grass carp is extensive in Virginia with over 300 permits issued on an average year and managers have had great success with the control of certain aquatic vegetation. In the 1,766-hectare Claytor Lake, Virginia, managers observed greater than an 80% reduction in hydrilla after two years of grass carp stocking. The successes with triploid grass carp have not come without risk. Since the grass carp program started in 1985, Virginia's independent blood testing has identified numerous diploid carp on certified triploid deliveries. The instances of diploid carp reached a high between 2008 and 2012 with multiple shipments containing up to 30% diploid fish. Additionally, the collection of feral carp in rivers like the James has increased considerably since 2012. In 2024, 28% of feral carp collected from the James tested diploid. The potential of a spawning population in Virginia's river systems is a big concern and increased vendor testing and greater enforcement is warranted to reduce the risks associated with grass carp stockings.

Establishment of a New Cool Climate Mesocosm Facility
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North Carolina State University in cooperation with North Carolina Department of Agriculture and Consumer Services is constructing a new mesocosm facility at the Upper Mountain Research Station near Laurel Springs, NC. At an elevation of approximately 2,800 ft, the climate of Laurel Springs is closely comparable to Albany, NY. The facility will have recirculating tanks of various sizes and will allow for research to be conducted simultaneously in Raleigh and Laurel Springs to evaluate the impact of climate on plant growth. Phase I of construction is nearing completion and active research was initiated in June.

The Tennessee Valley Authority Aquatic Plant Management Program – A Look at the Past, Present, and Future
Brett M. Hartis
Tennessee Valley Authority, Aquatic Plant Management Program, Guntersville, AL

The Tennessee Valley Authority (TVA) has a long history of aquatic plant management. TVA currently holds management responsibility in over 40 impoundments spanning across seven states at Public (non-profit) facilities. Since 1980, aquatic plant management has mostly centered on main stem reservoirs where water depth and flow regimes are most conducive for aquatic plant growth. In recent decades, several TVA reservoirs have become well known for producing trophy fisheries, particularly targeting largemouth bass, which have subsequently become a large contributor to local and state economies. This industry is often perceived as a direct result of the amount of

aquatic vegetation present in the system. Reservoirs within the TVA system have also become popular destinations for other recreation and real estate development. Differing and often strong opinions of various stakeholder groups regarding management have led the government owned corporation to implement a stakeholder driven approach by which local residents, anglers, boaters, industry, tourism councils, local governments, and other reservoir interests must come to agreement on a science driven plan for management. Lake Guntersville, arguably TVA's largest management project, is currently the only reservoir in which such a stakeholder's group exists and where reservoir-wide management is implemented. In recent years; however, the introduction and further spread of invasive plant species throughout the rest of the TVA system has forced TVA to consider the potential for management beyond Guntersville through a stakeholder process. Limited budgets and personnel for large scale programs like the Guntersville project have raised questions about future aquatic plant management programs provided by TVA.

Modes of Reproduction in Crested Floating Heart (*Nymphoides cristata*) (*Student Presentation*)
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Crested floating heart (*Nymphoides cristata*) has been rapidly spreading northward since it was first observed in Naples, Florida in 1996. Despite the apparent threat to our waterways, little published data on the growth characteristics of this highly invasive plant are currently available. It is widely recognized that crested floating heart can reproduce vegetatively via the production of daughter plants, much like water lettuce and water hyacinth. In 2014 research was initiated at North Carolina State University to document reproductive potential. In particular, our studies focused on the production of seed and seed viability as well as vegetative reproduction via leaf and stem fragmentation. Crested floating heart has 10 ovules produced per fruit. Of mature fruit harvested, an average of 1 or 2 seeds appeared to be mature and the remaining ovules appeared to be aborted. In cut stem fragmentation studies, 100% of the plants cut at the stem approximately one inch below the leaf produced new roots and 83% produced new daughter leaves. In leaf fragment studies in which leaves were cut from the stem and then segmented in half, 87% of the leaf fragments produced mature roots and daughter leaves and only one of the leaves died prior to the production of mature roots. These preliminary findings and their potential impacts to management strategies and concerns will be discussed.

The Underappreciated Economic and Ecological Return from Eradication Programs for Invasive Aquatic Plant Infestations
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Eradication is a well-recognized, critical phase of early detection and rapid response to new invasive species. Removing a new population of an invasive species at an early stage of establishment in a particular site is one of the first considerations of resource managers upon detecting a new infestation. The value of eradication at small scale has clear benefits when protecting much larger areas of habitat—either within the infested local area or to prevent wider regional spread to other habitat. As a response to management of a new invasive aquatic plant species, eradication is also a first consideration. At very small-scales and in low diversity habitat, the economic and ecological criteria supporting eradication decisions are more clear. As scale of infestation increases, the cost of eradication multiplies and the potential risk to non-target aquatic vegetation increases. Different invasive aquatic plants species ranging from submersed weeds such as hydrilla and Eurasian watermilfoil to emergent and floating weeds such as giant salvinia or crested floating heart pose different challenges when considering an eradication path. Different herbicide and other management strategies are required for a species such as hydrilla that doesn't respond to some selective management tools. Also the life history and phenology of different species are critical. Despite technical and economic hurdles, there have been a number of very successful eradication programs in the last two decades in the U.S. Several of these recent successes will be highlighted in the presentation ranging from monoecious hydrilla control in CA and the Midwest, select Eurasian watermilfoil eradication efforts in northern lakes, and giant salvinia eradication in the Carolinas. These successes are worth closer analysis and merit comparison to alternative paths without an eradication philosophy in place. It is proposed that better emphasis on eradication effort should be a greater focus, aligning past success with current/future technology and use patterns with an eye towards better long-term, higher-value management.

Submersed Plant Population Dynamics over Time in Roanoke Rapids Lake (*Student Presentation*)
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Built in 1955 for hydroelectric power, Roanoke Rapids Lake is the smallest of three consecutive reservoirs formed on the Roanoke River. Owned by Dominion Resources, this developed lake not only provides power to surrounding areas but also recreational opportunities for both water sport enthusiast and outdoorsmen alike. Water levels frequently change due to hydroelectric power production and the corresponding water releases from both Roanoke Rapids and Lake Gaston dams. Roanoke Rapids Lake has been infested with monoecious hydrilla (*Hydrilla verticillata*), *Egeria densa*, Eurasian watermilfoil (*Myriophyllum spicatum*), and other submersed vegetation for many years with minor management input. Whole-lake point intercept surveys were conducted to determine temporal changes in submersed aquatic vegetation (SAV) abundance, distribution and dominance. With the use of a double-sided throw rake, points were sampled at ~ 90m intervals transecting perpendicular to the shoreline throughout the littoral zone. Hydroacoustics were also utilized to determine the depth at each sampled point. Using a binary system and GIS software, SAV species were mapped to visually appraise species coverage, distribution, and dominance. During the surveyed years, 1999, 2012, and 2014 respectively, SAV species and population distributions ominously shifted. In all surveyed years, SAV was most abundant in depths less than 3m with no aquatic weeds found in depths greater than 6m at any location. During the 1999 spring survey, 812 points were collected and plant species included hydrilla, Eurasian water milfoil, coontail (*Ceratophyllum demersum*), brittle naiad (*Najas minor*), and muskgrass (*Chara* sp.). Hydrilla dominated more than half of the species present, followed by milfoil and coontail. In 2012, 236 sites were sampled. Neither brittle naiad nor muskgrass was found; however, cabomba (*Cabomba caroliniana*) was observed as the third most abundant aquatic weed behind Eurasian watermilfoil and hydrilla. In the fall 2014 survey, 123 points were sampled. Hydrilla was the leading SAV species followed by cabomba and Eurasian watermilfoil as third most prevalent.

Status of *Arundo donax* as a Biofuel Crop in North Carolina and Potential Containment Strategies
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North Carolina legislated that 10% of petroleum imports should be replaced with locally sourced bioenergy. In an effort to meet that target, the bioenergy industry in North Carolina has recently been focused on two species, *Arundo donax* and *Miscanthus* x *giganteus*. These species would likely be established on hog waste spray fields where high biomass, non-consumption crops are required. One of the first steps toward judicious establishment of these species was the creation of a Voluntary Best Management Practices Guide. A second step is the evaluation of herbicide control measures for when these species may no longer be wanted, or if they escape from cultivation. In Fall 2014, multiple rates of glyphosate and imazapyr, as well as combinations of glyphosate plus imazapyr, were evaluated for control of established *Arundo donax*. At nine months after treatment, all treatments evaluated provided 90% or greater control.

Movement Towards an Adaptive Systems Approach to Freshwater Management, and Initial Treatment Results from Jordan Lake, a 14,000-Acre Reservoir
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Despite almost three decades and $billions applied to EPA's Nonpoint-Source Management Program (NSMP), nutrient and other pollutant inputs to freshwater are increasing, as are eutrophication, cyanobacterial harmful algal bloom, cyanotoxin, and noxious compound incidences. Although the Point-Source Management Program is successful, accounting for only 5-10% of inputs, the NSMP is limited by high cost, large-scale implementation difficulty, and marginal effectiveness of some best-management practices. EPA's policy shift eliminating the Waterbody Management (Clean Lakes) Program in the early 1990s compounded the problem. Sustainable physical, chemical, and biological waterbody treatments can quickly and cost-effectively suppress cyanobacteria, remove accessible and concentrated nutrients, and strengthen beneficial trophic cascades. NALMS recently

enacted policy that calls for full Clean Water Act implementation using an Adaptive Systems Approach (ASA). An ASA uses rigorous scientific and cost-benefit analyses in selecting options from all three programs based on merit alone, and periodically evaluates outcomes and options for cost-effective improvements. Recent EPA actions may signal movement towards an ASA, including: 1) a long-term vision document allowing approaches alternative to Total Maximum Daily Loads (TMDLs); 2) hosting a webinar on waterbody treatments and; 3) posting a webpage describing waterbody treatments. North Carolina was the first state to suspend TMDL-based nutrient management rules to assess waterbody treatments and an ASA. NC is testing cyanobacterial suppression by solar-powered circulation in 14,000-acre Jordan Lake reservoir, and evaluating ASA options for other impaired reservoirs. This presentation reviews initial Jordan Lake results, EPA and state movements toward an ASA, and NALMS promotion of ASA policy.

Cellular and Aqueous Microcystin-LR Following Laboratory Exposures of *Microcystis aeruginosa* to Copper Algaecides (*Student Presentation*)

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Data regarding relationships between copper algaecide exposures and responses of microcystin producing algae are needed. We measured responses of a microcystin-LR producing strain of *Microcystis aeruginosa* (CPCC 300) in the laboratory in terms of cell bound microcystin-LR, aqueous microcystin-LR, and chlorophyll a following exposure to a range of concentrations (0.02-1.0 mg Cu/L) of a copper salt ($CuSO_4$) and a chelated copper compound (Cutrine Plus®). The objective of this study was to determine relationships between copper exposure concentrations and changes in cell bound and aqueous microcystin-LR concentrations. EC_{50}s and slopes for *M. aeruginosa* responses to copper exposures were calculated for chlorophyll a, cellular microcystin-LR, and aqueous microcystin-LR. Differences between the two algaecide formulations were also measured. Results of this study showed that algal responses followed a sigmoidal exposure-response relationship, and cellular microcystin-LR and chlorophyll a were negatively related to copper exposure concentrations. Aqueous microcystin-LR increased with copper concentrations, although the increase in aqueous microcystin-LR was not directly proportional to decreases in cellular microcystin-LR and chlorophyll a. The rate of change of cellular microcystin-LR and chlorophyll a with copper concentrations was approximately 5 times greater than aqueous microcystin-LR. Therefore, aqueous microcystin-LR increased more gradually with copper concentrations as compared to cellular microcystin-LR and chlorophyll a which decreased more precipitously. No significant differences in *M. aeruginosa* responses were measured between $CuSO_4$ and Cutrine Plus® in terms of rate of change of aqueous and cellular microcystin-LR with copper concentration; however, there was a significant difference between the total and aqueous microcystin-LR concentrations at 0.5 and 1.0 mg Cu/L where aqueous microcystin-LR was approximately 10-20% less (depending on day after exposure) following exposure to Cutrine® Ultra in comparison to $CuSO_4$. This laboratory study provides relationships between copper algaecide exposures and *M. aeruginosa* responses in terms of cellular and aqueous microcystin-LR.

Maximizing Water Quality using Passive Polymer Enhanced Treatment Systems

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Construction site managers, municipalities, lake managers and home owners all have the same goal when it comes to ponds, lakes, rivers and streams, and that is to find a way to achieve the highest water quality possible while maximizing the resources that are available. Contaminants such as metals, suspended solids and excess inanimate nutrient loading all contribute to decreases in water quality. Using passive polymer enhanced technologies is a safe and effective way to remove these contaminants. Anionic polyacrylamide has been used in agricultural and erosion control applications for years and has proven highly effective in water treatment applications, while being safe for the environment and aquatic organisms. These types of passive systems have the ability to reduce contaminants by as much as 95% without needing continual monitoring to ensure proper dosing is being released into the system. A city municipality was prompted by their environmental oversight department to implement a passive polymer enhanced treatment system in the largest river system in their region in 2007. Over the next four years, while the polymer enhanced treatment system was maintained, data was collected detailing the system's capability of

reducing suspended contaminants in the river. Consistently the system was able to reduce a wide variety of contaminants to include biological oxygen demand (BOD), chemical oxygen demand (COD), nitrogen/ammonia levels, total phosphorous, a wide variety of metals and total suspended solids (TSS). Conversely when the system was in need of replenishment, moderate increases to spikes in these contaminant measurements were seen proving that the passive polymer treatment system was efficiently working to increase the overall water quality of the river. Further examples of the effectiveness and feasibility in sensitive water bodies will also be presented, specifically Outstanding Florida Waterbody Leitner Creek and Anna River in Michigan's Upper Peninsula.

EPA and Aquatic Pesticide Registration – Managing Risks in Aquatic Areas
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All pesticides are required to be registered by the U.S. Environmental Protection Agency (EPA) before they may be used in the United States. In its assessments, EPA reviews data relevant to toxicity to humans and effects on the environment to determine the safety of a pesticide. Based on the review of these data, the Agency requires language on the pesticide product labeling that serves to mitigate against potential risks. For registration to be granted, the pesticide must meet the Agency's standard that the use will not result in unreasonable risks to humans or the environment. All registrations are to be periodically reevaluated by the Agency to ensure that they continue to meet current safety standards. EPA's correct understanding of current aquatic pest management needs and application strategies are crucial to the proper risk assessment and risk management decisions that are developed in the Agency's pesticide registration and reevaluation processes.

2,4-D Absorption and Translocation in Eurasian Watermilfoil (*Myriophyllum spicatum*) and a 2,4-D Tolerant Milfoil Hybrid (*M. spicatum* X *M. sibiricum*) (*Student Presentation*)
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Herbicides are valuable tools when targeting invasive macrophytes due to the logistical and financial challenges associated with the management of aquatic systems. Currently, 2,4-D is the most cost-effective herbicide labeled for Eurasian watermilfoil (EWM; *Myriophyllum spicatum*) control; however, the discovery of 2,4-D tolerant milfoil hybrids (*M. spicatum* X *M. sibiricum*) may make successful management more difficult and expensive. The objective of this research was to understand the physiological basis of 2,4-D tolerance in hybrid populations. Apical meristems of EWM and hybrid populations (10 cm) were planted into glass jars (9.5 cm height x 5 cm diameter) filled with sand, amended with fertilizer, and allowed to grow for 14 days. Jars were then topped with 10 mL of eicosane wax and placed in 4 L mesocosms filled with 3 L of tap water. Each mesocosm was treated with 1 mg L-1 2,4-D amine (Clean Amine, Loveland Products, Inc.) supplemented with 23 KBq 14C 2,4-D. Three plants from each population were harvested and separated into shoot and root portions at the following time points: 6, 12, 24, 48, 96, and 192 hours after treatment (HAT). Fresh and dry biomass were obtained and samples were oxidized to quantify 2,4-D foliar absorption and root translocation. Foliar absorption and root translocation were similar for both EWM and the hybrid when comparing fresh weight 192 HAT Plant Concentration Factor values defined as PCF (mL g-1) = (Concentration in plant (µg g-1)/Concentration in water (µg mL-1)) (16.3 ± 1.6 SE and 22.1 ± 2.5 SE, respectively). Translocation to roots was less than 1% of absorbed 2,4-D for both populations. Further investigation is needed to determine the mechanism of tolerance in hybrids. Tolerance may be influenced by differences in 2,4-D metabolism between populations.

Establishment of Native Aquatic Vegetation in Conjunction with an Integrated Invasive Aquatic Vegetation Management Program (*Student Presentation*)
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Planting native vegetation in the empty niches of a disturbed ecosystems without a propagule bank can deter establishment of invasive plants. Native vegetation establishment can be delayed by herbivory resulting in the need for protection of plants. Although there are herbivores suspected of feeding on the native plants, specific herbivore

damage has never been documented. Lake Raven was chosen as the study site because it contains multiple invasive aquatic plant species. An integrated pest management approach using chemical (fluridone), biological (grass carp) and mechanical (physical removal) means has been implemented to control the invasive aquatic plants. Native plant restoration was conducted in niches opened from fluridone application and mechanical removal of exotic species. Twelve species of native aquatic plants were planted in 120 protective exclosures along the shoreline with each exclosure containing five plants of a single species. Plants were allowed to establish for one month before the treatment cages were opened. Control and treatment exclosures were monitored weekly for vegetation damage. Submersed game camera took photos every two hours from dawn until dusk to determine herbivore species associated with predation damage. Herbivory pressure was determined through comparison between control and treatment cages using plants survival. Additionally, effect of fluridone on plant species was evaluated using percent chlorosis of plants in each exclosure. Preliminary results indicate influence of fluridone on establishing submerged and floating aquatic plants, low herbivory pressure and successful establishment of emergent plant species.

Aquatic Weeds in Botswana: Historical Perspective and Management

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Three alien invasive plant species, namely salvinia (*Salvinia molesta* Mitchell), water lettuce (*Pistia stratiotes L.*), and water hyacinth (*Eichhornia crassipes* (Mart.) Solms-Laub.), are part of the aquatic ecosystem in Botswana. Controlling salvinia was initially tried by the use of herbicides between 1972 and 1976. With the discovery of the host specific biological control weevil *Cyrtobagous salviniae* (Calder and Sands), it was introduced in Kwando\\Linyanti/Chobe and Okavango Delta systems in 1983 and 1986 respectively. With continuous and sustained liberation of the weevil in these systems again between 1999 and 2000, control of salvinia was achieved by 2003. The first occurrence of water lettuce was recorded on the Kwando and Chobe River in 1986. Its biocontrol weevil *Neohydronomous affinis* (Hustache) was released in the year 1987. However, no post-release evaluation has been carried out after its introduction. Having covered the Selinda Canal and the Zibadianja Lake on Kwando in high flood and rainfall in 2000, research was undertaken to contain water lettuce, which led to its eradication by 2005. Water hyacinth infested the transboundary Limpopo River in 2010, sourced from South Africa. Botswana and South Africa have been jointly implementing an integrated control program for the weed in the River. Political support is vital to the success of any control program especially in trans-boundary Rivers. Maps and data are presented to corroborate the successful control of the weeds. The government of Botswana regulates the movement and importation of boats and aquatic apparatus to prevent the importation and spread of aquatic weeds both within and from the neighboring countries. In conclusion, the Government of Botswana is committed and supportive through the Department of Water Affairs in protecting the wetlands of the country efficiently and prudently.

***Ficaria verna* (Fig buttercup) – An emerging weed in the southeastern U.S.**

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We recently completed a weed risk assessment (WRA) for Fig buttercup (*Ficaria verna*), a perennial spring ephemeral colonizing riparian areas. This species has a wide native distribution ranging from northern Africa to northern and eastern Europe, and has been present in the U.S. since at least 1867 when it was likely introduced as an ornamental plant. There are seven horticultural cultivars available commercially in the U.S. *Ficaria verna* is naturalized in 26 states in the U.S., including Oregon, Washington, North and South Carolina. It is well naturalized in the northeastern U.S., but recent reports from South Carolina indicate that it is spreading in the southern United States. *Ficaria verna* is a banned, prohibited or state noxious weed in Connecticut, Massachusetts, Oregon and Washington. It has demonstrated a strong ability to establish and spread beyond its native range because it is shade tolerant, has sexual and vegetative reproduction, is allelopathic, and emerges earlier than other native species. *Ficaria verna* has already proven to be a significant invader in the U.S., preferring to spread in riparian areas

where it smothers out desirable plants and forms extensive monocultures. Additionally, this species competes with native plants for pollinators and has indirectly reduced seed set of native species. It spreads along major waterways because tubers, bulbils, seeds and small plants can be transported downstream. Based upon our WRA evaluation, F. verna presents a high risk of invasion and has the ability to become established in 79% of the United States. Resource managers should be aware of the threat of this plant as an invasive species.

Movement Patterns of Stocked Grass Carp in a Lentic and Lotic System of North Carolina

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Hydrilla (*Hydrilla verticillata*) is a growing threat to North Carolina's waterways. Triploid grass carp (*Ctenopharyngodon idella*) are commonly used to control hydrilla in typical pond or reservoir systems. The North Carolina Wildlife Resources Commission (Commission) permits the stocking of triploid grass carp. However, the permitting of triploid grass carp in non-traditional settings has been limited because of questions regarding their movement patterns in relation to the location of the hydrilla infestation and regarding how they respond to river flows. To better understand movements of stocked triploid grass carp, Commission staff, in collaboration with the North Carolina Division of Water Resources, stocked these fish in both a lotic and lentic environment. In June 2014, 178 triploid grass carp were implanted with pit tags and stocked into a 5.3-ha sub-impoundment of B. Everett Jordan Reservoir, a 5,270-ha reservoir located west of Raleigh, NC. Approximately 12 acres of hydrilla were detected in the sub-impoundment in 2013; however, hydrilla has not been found in the main reservoir. A pit tag detection array was deployed around a nine foot culvert that acts as the single access point between the sub-impoundment and the main reservoir. Preliminary results show that as of January 2015, no fish have migrated from the sub-impoundment to the main reservoir. Commission staff also stocked 24 triploid grass carp implanted with internal sonic telemetry tags into the Eno River, located in the upper Neuse River watershed. Hydrilla is fairly uniformly distributed throughout 26 km of the Eno River. As of March 2015, 14 fish have been detected both upstream and downstream of the stocking location. Of the 14 fish, five are presumed dead and five have only a single detection so their status is unknown. Of the four fish that are presumed alive due to multiple detections on separate receivers, two are still located within the Eno River and two have traveled approximately 13.2 km and emigrated into Falls of the Neuse Reservoir located north of Raleigh, NC. These two emigration events occurred during a high flow event in late December 2014. Understanding movement patterns of triploid grass carp will assist managers that are trying to control hydrilla and aid the Commission when reviewing triploid grass carp stocking applications.

Scientifically-based Technology or Stupid Lake Trick? A Suggestion for Improving Aquatic Plant Management

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For a pharmaceutical drug to be approved for market by the Food and Drug Administration, it must go through a rigorous process of testing that typically spans 15 years. A potential drug must first be tested in animals to evaluate toxicity. If the drug falls within acceptable parameters, three phases of human testing are required: 1) drug safety, 2) drug effectiveness, and 3) general utility. As an industry, aquatic plant management has no generally-accepted guidelines on how to determine whether a particular treatment or process is technically acceptable desirable. To be deemed scientifically-acceptable, a process or treatment should: 1) have a known and understood mechanism of control, 2) be documented as low risk to the ecosystem, 3) be of widespread value in the management of aquatic weeds, 4) be predictable and repeatable in efficacy and outcome, 5) be compatible with other water uses, and 6) be of general benefit to the lake. All techniques should be backed by peer-reviewed published studies documenting mechanisms, efficacy, and acceptable risk. For instance, biological control agents imported from overseas must be documented to be specific to the target plant species and not impact other plants, but do not have to demonstrate efficacy and predictability before widespread use. Herbicides must go through rigorous testing on toxicity, environmental safety, and ecosystem effects, but likewise only a few states require proof of efficacy for approval. For mechanical and physical control techniques, the principal of Caveat Emptor ("Buyer Beware") predominates. Little scrutiny of the claims, predictability, and safety of mechanical and physical techniques is required, and they

are not regulated in most states. As a society of professionals, we need to substantiate our claims with published scientific evidence that we are in fact doing good, and not harm, to the waters that we manage.

The Effect of Glyphosate and PPO Herbicide Combinations on Difficult to Control Aquatic Plants

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The aquatic herbicide glyphosate has been a mainstay for managing difficult to control floating and emergent vegetation for many years throughout the U.S. In recent years, the protoporphyrinogen oxidase (PPO) inhibiting aquatic herbicides carfentrazone and flumioxazin were registered to control floating, submersed, and emergent invasive plants. Originally, these rapid-acting contact herbicides were utilized as stand-alone treatments. However, recent field use has shown reduced-rates of foliar applied combinations of the PPO inhibitors plus slow-acting systemic herbicides produce rapid injury and are highly efficacious. The practice of applying flumioxazin or carfentrazone in combination with other herbicides to enhance the spectrum or activity of the treatment has expanded into other herbicide combinations. Recent operational use in Florida and throughout the southeastern U.S. has led aquatic applicators and resource managers to suggest mixing the PPO herbicides with glyphosate to improve efficacy in areas where selectivity is not of great concern. Applicators and managers claim combinations of these products are more efficacious, faster, and result in less regrowth compared to either product used alone when applied to floating and emergent problematic species. Moreover, given the largely anecdotal reports, the plant control spectrum and optimum use rates/combinations against the aforementioned aquatic plants have not been defined. Therefore, mesocosm and greenhouse trials were conducted to evaluate low and high foliar rates of glyphosate plus low rates of carfentrazone or flumioxazin against torpedograss (*Panicum repens*), alligatorweed (*Alternanthera philoxeroides*), parrotfeather (*Myriophyllum aquaticum*), and other weedy species. Although all glyphosate alone and combination treatments resulted in significant torpedograss shoot and root reductions compared to the non-treated control plants, there were no differences between treatments regardless of herbicide rate or combination. The addition of either PPO, especially the higher rates, to glyphosate resulted in alligatorweed and parrotfeather injury <6 hrs after treatment (HAT); however, parrotfeather recovery was noted 3 days after treatment (DAT). Overall, these results suggest the combination of glyphosate plus the PPO herbicides are faster in activity than glyphosate alone, but results are not consistent. Visual injury symptoms indicate that the addition of either PPO herbicide failed to enhance glyphosate activity for some species, especially torpedograss at the higher application rates. The results of these initial trials will be used to better manage difficult to control plant species that require non-selective control with glyphosate plus the contact herbicides carfentrazone and flumioxazin.

Field Response of Crested Floating Heart to Herbicide Treatments Over Two Years

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Currently five species of Nymphoides are found in the United States, three are invasive while two are native. *Nymphoides cristata* (Roxb.) Kuntze or crested floating heart is one such invasive species. It is a perennial, emergent macrophyte with alternately arranged leaves that float on the water's surface. The distinct white flower has a ruffled crest running down the center of each petal. The plant exhibits a tremendous growth rate which results in large homogenous stands. Once established in a water-body it can quickly spread through fragmentation. Crested floating heart was first discovered in Florida but quickly spread north and is now found in large expanses of the Santee Cooper lakes in SC as well as several ponds in NC. In order to better understand how to control this new invasive threat NC State University undertook an expansive herbicide trial on Lake Marion, SC. Numerous herbicides were tested with varying formulations, herbicide combinations, application techniques and season of treatment. Treatment sites ranged from 1.6A to 7A in size and repetitious treatments were performed in spring, summer and fall. Depending on time of treatment visual percent control ratings were taken at 2 weeks after treatment, 1, 1.5, 2, 3, 10 and 15 months after treatment (MAT). The summer treatments faired the best with 3 of the treatments having 95% or better control at 15 months. Whereas all spring treatments had 0% control after 1 month. Timing the treatment when all the reserves of the plant are expended in the floating leaves appears to provide the greatest level of control. A foliar application of 0.3 ppm Hydrothol 191 attained the best and longest control with zero regrowth seen at 15 MAT. Secondly 3 ppm Aquathol K + 0.18 ppm Hydrothol 191 showed 99%

control at 15 MAT. Being a relatively new invader, there is still much to learn about controlling crested floating heart.

Linking Plant Biology with Management Strategies for Control of Monoecious Hydrilla
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Monoecious hydrilla (*Hydrilla verticillata*) continues to expand into northern tier waters and many questions remain regarding environmental factors that influence the invasive growth of this plant. Moreover, managers continue to seek improved plant biology data to refine and enhance control strategies in northern waters. Through a series of small-scale studies we have evaluated the role of cold temperatures on in situ tuber sprouting, the role of temperature and photoperiod on short-term hydrilla growth from sprouted tubers, and the impact of tuber density on short-term biomass accumulation. We have also focused on the response of recently sprouted monoecious hydrilla tubers to low rates of fluridone, and response of hydrilla to intermittent exposures of fluridone. Field trials near Buffalo, NY have focused on tuber sprouting dynamics following a large-scale endothall application. Our small-scale trials suggest that short-term continuous exposures of 2 to 4 weeks to cold temperatures (4^{o} C) can result in over 85% in situ tuber sprouting in early June. In contrast, both monoecious and dioecious plants that remained under ambient conditions in Florida, resulted in less than 10% of the tubers sprouting by mid-August. Tuber density (2, 4, 8, or 16 per 0.1 m^2) was not significant in determining hydrilla biomass by 40 days after initiation of the study. Monoecious hydrilla shows a rapid growth response to warming waters and the results of the temperature and day length studies challenge the observation that monoecious hydrilla grows well in colder waters. Fluridone at rates as low 1.5 ppb had a strong negative impact on the ability of sprouting tubers to become established. Intermittent exposure trials challenge our assumptions regarding the need to maintain continuous exposures to fluridone. Tuber sprouting dynamics in the Erie Canal suggest that over 90% of tubers sprout during a short period in June and additional sprouting was not observed over the next 4 months. The relevance of tuber sprouting dynamics to management strategies will be discussed.

Restoration and Management of Submersed Aquatic Macrophytes after Carp Removal in Minnesota Lakes
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Because invasive common carp can suppress aquatic macrophytes and reduce water clarity, there is interest in reducing carp populations to enhance habitat and water quality. We assessed the response of submersed macrophytes to carp removal in a small eutrophic lake and the success of transplanting macrophytes to the lake. The abundance and diversity of native and invasive macrophytes increased after carp removal in winter 2009. The frequency of occurrence of many taxa increased during the first years after removal but declined in 2012 and 2013 due to poor water clarity; plants rebounded somewhat in 2014. Biomass of native plants showed a similar pattern, increasing from 50g/m^2 in 2009 to over 180 g/m^2 in 2011 but only reaching 70 g/m^2 in 2012 and 2013 before rebounding to 125 g/m^2 in 2014. Invasive curlyleaf pondweed also increased each year (from 7.4 g/m^2 in spring 2009 to 50 g/m^2 in 2012) until herbicide treatments were needed in 2013. After a spring endothall treatment in 2013 and 2014, curlyleaf biomass was reduced to <2 g/m^2 and fall turion densities declined from a peak of 90/m^2 to <10/m^2 in 2014, eliminating the need to treat in spring 2015. Transplants in shallow water (≤0.75m) were generally successful. Chara, wild celery, water stargrass, northern watermilfoil and bushy pondweed established and expanded over the 4 years, although wild celery and water stargrass showed the greatest and most persistent expansion. Deeper transplants (1.5 m depth) were not successful due to poor summer clarity. Native plants found in lakewide surveys have increased from 9 taxa in 2009 to 15 taxa in 2014; two additional taxa persist in transplant plots but have not yet expanded to survey sites. The native plant community is slowly expanding but improvements in water clarity will be needed to return rooted vegetation to areas deeper than 1.5m.

Horned Pondweed (*Zannichellia palustris*) Control with Endothall Formulations in Greenhouse Mesocosms
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Horned pondweed (*Zannichellia palustris*) is an important aquatic restoration species; however, when this species persists within water conveyance systems it can become problematic. Horned pondweed control with two endothall formulations (dipotassium salt, Cascade® and dimethylamine salt, Teton®) was evaluated in greenhouse mesocosms. Horned pondweed plants were grown in pots by topping field soil with approximately 18 g of soil containing horned pondweed seed. The soil was collected from an irrigation canal in Washington with a dense horned pondweed infestation. Plants were allowed to grow in a flowing water system until there were approximately 15 to 20 cm of top growth. The dipotassium salt of endothall was applied at 4 mg/L for 6, 8, or 9 hours to control horned pondweed. Dimethylamine salt of endothall was applied 1.5, 2 or 3 mg/L with exposure times ranging from 2-6 hours. The various treatments were achieved by dosing 20 L of water with the desired herbicide concentration. After the desired exposure times, each canal was rinsed with 60 L of clean water. Plants were allowed to grow after treatment in the same canals by circulating water from a common 750 L tank. To evaluate treatment differences, visual evaluations were made on a weekly basis and aboveground biomass was collected 21 days after treatment (DAT). Based on visual evaluations 7 and 14 DAT, the dimethylamine formulation (Teton®) had the greatest impact on horned pondweed; however, there was not a strong rate effect. From these early evaluations, 1.5 ppm for 6 hour appeared to have the greatest impact. There appeared to be a significant amount of new horned pondweed emergence between 14 and 21 DAT so that based on 21 DAT biomass data, there were no significant differences between treatments. Both formulations significantly reduced horned pondweed biomass when compared to the control.

Impacts of Herbicide Management on Watermilfoil Species Dynamics in a Field Setting (*Student Presentation*)
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Not all populations of a non-native watermilfoil exhibit the same population dynamics, impacts, and response to control measures. Understanding the variation and the sources contributing to variation among introduced populations is therefore important for predicting when and where introduced species will successfully have impacts and how best to control them. Eurasian watermilfoil (*Myriophyllum spicatum*) is a high-profile, widespread, and heavily managed invasive aquatic plant species that has hybridized with the native northern watermilfoil (*Myriophyllum sibiricum*). Differences in physiological characteristics and herbicide sensitivity have created challenges in predictive control of hybrid watermilfoil. The ability to accurately characterize distribution and abundance as well as understanding population dynamics of watermilfoil over the course management actions become important factors in designing effect adaptive management plans. Using genetic methods coupled with field mapping, I will look at changes in population dynamics for co-occurring Eurasian, northern, and hybrid watermilfoil in a lake in central Michigan following management. The data presented will look at changes in species distribution and abundance as well as broad changes in genetic structure in response to herbicides in a field setting. This research focuses on bringing concepts formed through laboratory testing into the field and providing data necessary to begin adapting management strategies to provide more effective and predictable long term control.

Evaluating the Potential for Herbicide Resistance Evolution in Hybrid Watermilfoil using a Temporal Genetic Analysis Pre- Versus Post-treatment with Auxinic Herbicides (*Student Presentation*)
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Hybrid watermilfoils (*Myriophyllum spicatum* x *Myriophyllum sibiricum*) are an important concern for aquatic

plant managers. Field and laboratory data have documented decreased response to some herbicides compared to pure Eurasian watermilfoil, and there is growing concern that hybrid watermilfoils exhibit high potential to evolve herbicide resistance. Indeed, hybrid watermilfoil exhibit a large amount of genetic variation across populations collected from a large geographic range. In addition, a recent laboratory study demonstrated heritable variation for 2,4-D response. However, no studies have examined genetic variation in natural populations before versus after herbicide treatment to test for genetic changes that might be associated with local evolution of herbicide resistance. In this study, we conducted a detailed genetic analysis of 176 individuals of hybrid watermilfoil sampled both before and after auxinic herbicide treatment in Houghton Lake, Michigan. We used genomic data from 113 amplified fragment length polymorphism markers (AFLPs) to explore how much genetic diversity was present in the lake, and whether that diversity changed over one growing season following herbicide treatment. Specifically, we asked the following questions: 1) Is there evidence for multiple, genetically distinct biotypes in the lake? 2) If so, is there evidence that distinct biotypes exhibited different seasonal responses to auxinic herbicide treatment? 3) Is there evidence for herbicide selection on genomic regions, inferred by large changes in specific genetic marker frequency pre- versus post-treatment? These changes could indicate potential genome level changes associated with the evolution of herbicide resistance. We found a surprising amount of genetic variation, with evidence for multiple genetically distinct biotypes co-occurring in the lake. We did not detect significant changes in the relative abundance of the different biotypes pre- versus post-treatment, suggesting that the different biotypes exhibited similar seasonal responses to management. However, similar seasonal responses to management by the different biotypes do not necessarily mean that there is no genetic variation for herbicide response. The genes that distinguish biotypes do not need to be the same genes influencing herbicide response. Indeed, we identified five AFLP markers that exhibited large changes in marker frequencies when comparing plants collected pre- versus post-treatment. These changes provide evidence that selection occurred on some regions of the genome, and may indicate regions of the genome associated with herbicide response. While more research is needed to relate genetic variation to management response, this exploratory case study provides a working model for how genetic analyses may ultimately come to bear on our understanding of, and ability to detect, evolutionary responses to management in watermilfoil populations.

Aquatic Plants: A Free Android and Apple App from North Carolina State University

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Aquatic Plants is a free app from North Carolina State University. This app is available for both Android and Apple devices. It contains organized and detailed information, as well as clear and highly detailed pictures for over 50 species. Individual species may be found by searching either categories or alphabetically. This handheld app is invaluable to making an accurate identification in a field situation. It is a valuable tool for any aquatics professional, botanist, or fresh water preservationist. An update scheduled for fall 2015 will add at least 15 additional species.

Control of Algae Producing Taste and Odor in the Drinking Water Supply for the Anderson Regional Joint Water System

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For the past two years, the Anderson Regional Joint Water System (ARJWS) experienced intermittent taste and odor (T&O) problems in raw and finished water from the treatment plant on the Six and Twenty Creek arm of Hartwell Lake, Anderson, South Carolina, making it difficult or impossible to provide the quality of drinking water (odor-free) that approximately 200,000 customers expected. A strategy to intervene began with identifying the putative source of T&O problems as terpene alcohols [2-methylisoboneol (MIB) and geosmin] produced by benthic algae (i.e. blue-green algae and diatoms). With MIB concentrations exceeding 2,000 parts per trillion in Hartwell Lake in the summer of 2014, an algaecide treatment plan was developed based on results from a laboratory study (ACT) of responses of T&O producing algae to exposures of candidate algaecides. A peroxide algaecide and a chelated copper algaecide (both registered for application to drinking water supplies by the U.S. EPA) were applied to the bottom two feet of the water column in the littoral zone of the lake. Approximately 160

acres of the Hartwell Lake littoral zone (from the water line to the 25' depth contour) and 4 acres around the ARJWS water intake structure were treated. Concentrations of copper measured in water near the intake and in the areas of application pre- and post-treatment indicated that targeted exposures were achieved. Pre-treatment total copper concentrations, or "background", in Hartwell Lake ranged from 2.4 to 20.6 µg/L. Three days after treatment, total aqueous copper ranged from 16.5 to 101 µg/L, and returned to background concentrations seven days after treatment. The peroxide-based algaecide, was applied to 4 acres around the water intake structure and hydrogen peroxide was measured in water before and after application. Prior to treatment, hydrogen peroxide was not detected in the treatment area. Fourteen hours after application, hydrogen peroxide concentrations ranged from 2.7 to 3.7 mg/L and by three days after treatment, hydrogen peroxide was not detected. MIB and geosmin concentrations declined significantly in the source water after algaecide applications. Pre-treatment MIB concentrations ranged from 102 to 106 ng/L and post-treatment MIB concentrations declined steadily to 14 ng/L twelve days after treatment. The geosmin concentration was 14 ng/L prior to treatment and declined to as low as 5 ng/L twelve days after treatment. The initial treatment was successful for controlling benthic algae (T&O producers) as well as MIB and geosmin for approximately 8 weeks post-treatment and intensive post-treatment monitoring provided valuable information for future management in this source water.

Efficacy and Movement Patterns of Triploid Grass Carp in the Presence of a Reduced Hydrilla Tuber Bank in Tar River Reservoir, NC

Kirk Rundle

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Grass carp (*Ctenopharyngodon idella*) is a large Cyprinidae native to river systems of eastern Asia, from the Amur River on the China-Russia border and southward. Grass carp are strictly herbivorous and are very effective in controlling many species of submerged aquatic vegetation. Concerns over their impact to native aquatic vegetation have prompted most states in the southeast to allow stocking of only infertile, triploid grass carp. Additionally, because grass carp are natural inhabitants of rivers, they readily escape ponds and lakes that overflow. Therefore, many states recommend or require that barriers be placed across emergency spillways before triploid grass carp can be stocked. Tar River Reservoir is a 752 ha reservoir located in Nash County, North Carolina, owned and operated for water supply by the City of Rocky Mount. The reservoir has a large (approximately 120 m) run of the river concrete dam. Hydrilla (*Hydrilla verticillata*) was first found in one major tributary, Sapony Creek, in the early 2000's. It was successfully treated with fluridone herbicide annually from 2007–2012 and suppressed to just tubers, with a coverage of approximately 134 ha within Sapony Creek only. The North Carolina Wildlife Resources Commission (Commission), in collaboration with the North Carolina Division of Water Resources and the City of Rocky Mount, sought to determine an effective triploid grass carp stocking rate to prevent regrowth of hydrilla, with minimal impacts on native vegetation, and to monitor the movement patterns of triploid grass carp, including escapement. A total of 194 triploid grass carp (approximately 1.5 fish per tuber bank ha) were stocked into the reservoir on June 6, 2013. All of the stocked fish were PIT tagged, while 34 of them had acoustic tags (with a one-year battery life) surgically implanted several days prior to stocking. Eight receivers were placed throughout the reservoir and two receivers were placed downstream of the reservoir to monitor movements of the acoustically tagged triploid grass carp. Movement within the reservoir varied from very inactive to very active, while no fish were detected as escaping the reservoir on the downstream receivers. Further, no hydrilla was detected suggesting that this low stocking rate was successful at preventing hydrilla from reestablishing in Sapony Creek. These results will assist Commission staff when reviewing triploid grass carp stocking applications.

A Novel Invasive Species of Water Chestnut Found in the Potomac River near Washington, D.C.

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Invasive floating aquatic vegetation may obstruct navigation and threaten the integrity of ecosystems services. Early detection and accurate species identification is critical to development of effective control methods for invasive species. *Trapa* sp. (water chestnut) is native to Europe, Asia and tropical Africa and was first introduced to North America in the 1880s. Because of morphological variations, there has been little agreement about the

number of species in the *Trapa* genus. Only one species has been recognized in North America, *T. natans*, a persistent invader in east coast waterbodies of the U.S. In the summer of 2014, a 0.3 acre dense mat of water chestnut (*Trapa* sp.) was found growing in the tidal Potomac River in Virginia for the first time since the costly eradication of *T. natans* from this river in the 1940s. Here we document the occurrence of this recent invader to the Potomac River and in several other nearby locations in Virginia, describe its fruit morphology and genetic characteristics and compare it with the familiar lineage, *T. natans*. This *Trapa* sp. has a medium size, 2-horned fruit that differs significantly from the previously reported large, 4-horned fruit of *T. natans*. Virginia *Trapa* sp. is morphologically not different from *Trapa* spp. found in Japan, specifically, *T. japonica*. Based on a total of 280 fruits collected from three sites in Virginia during 2014 field investigations, the mean width is 37 mm, the mean wet weight is 1.69 g, and the number of horns is 2. A preliminary DNA sequence comparison indicates the recently found *Trapa* sp. in Virginia may be different from *T. natans* samples from Maryland waterways. Additional genetic and morphological review is needed. Resource managers in North America may need to become familiar with this previously unreported species to optimize early detection and control efforts.

Past, Present, and Future of Aquatic Plant Management in Florida Public Waters
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APMS Secretary, Thomasville, GA

Organized aquatic plant management in Florida has evolved over 115 years since the U.S. Army Corps of Engineers (USACE) began removing water hyacinth obstructions from the state's navigable waters in 1899. While the USACE continues to manage water hyacinth, the Florida Fish and Wildlife Conservation Commission is the state's lead agency for coordinating control, research, assessment, and monitoring plant management activities for more than 450 public lakes and rivers accounting for over 1.25 million acres of fresh water. This presentation addresses the evolution of Florida's program from one agency controlling water hyacinth for navigational purposes to nearly 50 government agencies and private companies managing more than 14 invasive species and numerous native plants to conserve and enhance the diverse uses and functions of Florida public waters. The critical relationship between management and research is discussed as well as the importance of technical exchange among managers and outreach to stakeholder groups. Examples of cooperative efforts to secure sustained and dedicated funding, develop and integrate multiple management tools and strategies, and cope with new control and reporting regulations will be discussed. Funds expended and management successes will be presented along with new challenges posed by the latest invasive plant introductions, herbicide resistance stewardship, and changing stakeholder, regulatory agency, and legislative personnel and levels of understanding.

Movement of Triploid Grass Carp in the Regulated Pee Dee River, North Carolina
Troy Thompson
North Carolina Wildlife Resources Commission, Wadesboro, NC

Hydrilla (*Hydrilla verticillata*) was discovered in the Pee Dee River, North Carolina just below the Lake Tillery Dam in 2010. Triploid grass carp (*Ctenopharyngodon idella*) were selected as the most effective treatment method for this system. However, the North Carolina Wildlife Resources Commission (Commission) has not previously permitted triploid grass carp stockings in riverine environments. The Pee Dee River between Lake Tillery Dam and Blewett Falls Dam is regulated by releases from the Lake Tillery Dam but also receives flow from several tributaries including the Rocky River and the Little River. In order to determine the movements of triploid grass carp in a partially regulated river, Commission staff deployed ten VR-2 acoustic receivers in the section between the two dams, and two receivers below Blewett Falls Dam to monitor for escapement. Triploid grass carp (n =24) were implanted with sonic tags and released in June of 2014 at the Red Hill Boating Access Area approximately 20 km downstream of the Lake Tillery Dam. Preliminary analyses indicate that no fish have passed over the Blewett Falls Dam; however, a few have been recorded passing the upstream receivers. This movement upstream indicates that the fish are moving towards the area most infested with hydrilla. This study will provide important information regarding the movements of triploid grass carp in a lotic environment and it will assist Commission staff when reviewing applications to stock triploid grass carp.

Prospects for (Meaningfully) Integrating Molecular Biology into Aquatic Plant Management
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Examples will be presented of how current and developing molecular approaches have, or may, impact the science and practice of aquatic plant management. Potential applications of molecular biology include enhancing basic information about aquatic plant communities, such as discovery, identification, and detection of species. In addition, genetic monitoring approaches may help identify population trends of interest, such as changes in the population sizes of rare or invasive species, sources and routes of invasive species spread, and shifts in the relative abundance of important genetic variants, such as herbicide resistant genotypes. The above approaches may be best suited to assisting the development and evaluation of adaptive aquatic plant management plans. Molecular approaches may also be developed as control methods, through the use of techniques such as RNA interference. However, there are several important practical questions regarding the extent to which molecular biology may impact the practice of aquatic plant management. Will a given technology add measurable value to management planning, regulation, implementation, or evaluation? How will research and development of technology be funded, and who will conduct it (e.g., public versus private)? Who will deliver molecular products and services? And, how will they be regulated?

Effects of Copper Ethylenediamine on Hydrilla in Pickwick Lake, AL
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Hydrilla (*Hydrilla verticillata*) is an invasive plant to lakes and rivers in North America. It has been nicknamed 'the perfect aquatic weed' due to its ability to grow in almost any type of aquatic habitat while out competing neighboring plants for resources. Hydrilla can reproduce through production of turions, rhizomes, and stem fragments as well as sexual reproduction. Control of hydrilla is extremely difficult as it is resistant to some herbicides. Past mesocosm studies have shown that copper ethylenediamine is effective at controlling hydrilla while maintaining selectivity on some co-occurring native species. Study sites were located on Pickwick Lake, AL. The study consisted of five 5-acre treatment plots: granular copper ethylenediamine 0.5 mg/L and 1.0 mg/L, liquid copper ethylenediamine 0.5 mg/L and 1.0 mg/L, and one reference plot that received no herbicide treatments. All sites were located at least a quarter mile apart to reduce the risk of cross contamination from herbicide treatments. The reference site was located upstream from the treatment sites to further prevent contamination from herbicide treatments. Hydrilla biomass was not statistically different from the reference plot in either the granular or liquid 0.5 mg/L plots. However, both the granular and liquid 1.0 mg/L plots showed significant hydrilla biomass reduction from the untreated reference (70 and 74% reduction respectively). The results seen in this study correlate with results seen in previous mesocosm studies using similar herbicide concentrations with the exception of the granular copper ethylenediamine 0.5 mg/L plot. Small scale results suggest that 70-90% biomass reduction could be achieved with copper ethylenediamine depending upon rate and formulation.

Growth and Control of *Miscanthus* spp. in Wetland Environments
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In the last few decades, increased grower interest and federal, state, and county investment has been placed on farm-raised renewable resources for the production of bioenergy. Initially, these efforts were directed to exploiting common row crops already in production, such as corn and soybean. Perennial grasses that could also grow on marginal or fallow land, do not require seeding each year, and have low fertility requirements have been the focus of much interest. One of the potentially invasive taxa under development as a biofuel feedstock is Miscanthus species (*Miscanthus* spp.). Miscanthus is a known facultative wetland plant. In such environments only herbicides

with an aquatic label should be used for vegetation control. Our purpose was to examine the ability of Miscanthus to 1) establish and grow in a simulated wetland environment, 2) to control newly established Miscanthus in wetland habitats with available registered aquatic herbicides, and 3) to assess mowing of Miscanthus as a mechanical control option. Wetland trials simulating an upland and three wetland environments were performed in 2014. By 12 weeks after treatment (WAT), biomass and plant height in all wetland environments were statistically greater than that of plants grown in an upland environment. Herbicide trials in 2014 were performed in one simulated upland and one simulated wetland environment, with plants in both environments divided into either an untreated reference or subjected to one of four aquatic herbicide treatments: glyphosate, imazamox, imazapyr, and penoxsulam. By 12 WAT, all herbicides showed significant reduction of above ground biomass when compared to the reference plants. All herbicide treatments except penoxsulam (upland) showed significant reduction of below ground biomass compared to references. Complete eradication was only attained in a few instances by glyphosate and imazapyr. Miscanthus preferred wetland environments over upland, suggesting this species will readily invade wetland ecosystems. Better control of Miscanthus was achieved in upland environments than in wetlands suggesting higher sediment moisture may reduce herbicide efficacy in the weeks following exposure to the herbicide. Mowing Miscanthus resulted in a 65% reduction in rhizome production but a 45% increase in aboveground biomass and an 11% increase in plant height. Mowing Miscanthus will slow rhizome development, but will stimulate lateral shoot development which increases aboveground biomass and results in a thicker and denser Miscanthus stand which may be more difficult to eradicate.

Mapping Invasive Species using EDDMapS and Apps

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Due to the high economic and ecologic cost, invasive species are increasingly becoming a priority in environmental monitoring programs. In 2005, the University of Georgia's Center for Invasive Species and Ecosystem Health (Bugwood) began the development of a web-based Early Detection and Distribution Mapping System (EDDMapS) to accurately map distribution of invasive plants across the southeast United States. As the program has grown, EDDMapS now maps all taxa across the United States and has projects with several provinces in Canada. EDDMapS' primary goal is to discover the existing range and leading edge of invasive species while documenting vital information about the species and habitat using standardized data collection protocols. EDDMapS serves as an aggregate database for data from many organizations and groups to be combined into one database to show a more complete map of the range of an invasive species. To make mapping as convenient as possible, several regionally and topically focused smartphone applications have been developed with local organizations to encourage reporting invasive species. Current goals of EDDMapS include: identification and integration of existing state and regional data sets, increase search and filtering options on EDDMapS website, inform mapping programs about the updated NAISMA Invasive Species Mapping Standards to promote the use of standardized data collection and documentation, and coordinate with state and regional programs to develop early detection networks.

Incorporating Geospatial Ecological Modeling in Aquatic Invasive Risk Assessments; An Overview of Methods and Applications

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Geospatial ecological models are widely used for evaluating the distribution of invasive species on the landscape and their suitable habitat. The growing popularity of these models has led to their continued methodological scrutiny, refinement, and improvement. The beginning of this presentation will outline the importance of method, resolution, and covariate selection in model development. I will then discuss recent research projects using these models that incorporate land manager and community concerns. Although the last decade has seen a rise in the use of geospatial ecological models in peer-reviewed literature, few of these studies include the perspective of

practitioners and decision makers on their utility. This research aims to fill the gap in ecological modeling for invasive aquatic species and the application of these methods.

How Ultrasonic Technology Kills and Controls Algae for Better Pond Management
Kirk Whatley
Sonic Solutions, LLC, West Hatfield, MA

More and more towns, cities, communities and states are making it tougher and tougher to use chemicals for algae control. A growing number of end users want to get away from chemical algae control also. Ultrasonic algae control is chemical-free and offers an effective and long term solution for algae control. By impacting key aspects of the algae, ultrasonics effectively makes it so that the algae cannot feed itself and starves to death. This presentation will describe how ultrasonic technology works as well as the considerations to keep in mind when sizing solutions.

It's not just "For the Birds" Anymore; Expanding Locations and Species at Risk from Avian Vacuolar Myelinopathy (AVM)
Susan Wilde, Bridgette Haram, Sonia Hernandez, Vanessa Kinney, and John Maerz
University of Georgia, Warnell School of Forestry and Natural Resources, Athens, GA

Investigations on impaired aquatic systems are interdisciplinary and include challenges with invasive plants/animals, nutrient pollution, harmful algal blooms, emerging contaminants and their implications for fish, wildlife, and even humans depending on these valuable water resources. Our field and laboratory research confirmed the food chain transfer of a novel cyanotoxin from invasive plants, primarily hydrilla (*Hydrilla verticillata*) colonized by a novel cyanobacterial species *Aetokthonos hydrillicola*. This disease has resulted in the deaths of bald eagles and waterfowl in reservoirs throughout the piedmont region of the southeastern U.S. Recent research confirms that the same toxin can cause neuropathy in fish, reptiles and amphibians, and is also occurring in coastal plain systems. The breadth of AVM-affected taxa suggests broad sensitivity and potential vulnerability among vertebrates; however, sensitivity varies among taxa. Additionally, we verified AVM risk in six new lakes in central Florida during November 2014 to March 2015. We found extremely high percent coverage of *A. hydrillicola* in Lake Toho, and detected *A. hydrillicola* in downstream Lake Hatchineha for the first time. During December 2014, we also documented *A. hydrillicola* for the first time in Lake Istokpoga and Lake Kissimmee; including a site with >80% coverage and active Snail Kite (*Rostrhamus sociabilis*) nesting. During surveys in January-February 2015, we confirmed *A. hydrillicola* in two additional new lakes; Lake Cypress (3/3 sites) and East Lake Tohopekaliga (3/3 sites). We tested the hydrilla/*A. hydrillicola* methanol extracts from all the Florida sites for nuerotoxicity using an established rat glioma cell line. Extracts developed from Hatchineha and Toho all showed obvious toxicity consistent with cell cycle arrest. The relative toxicity of the Lake Toho site (14 November 2014) was even higher than a 20 November 2014 sample collected from J. Strom Thurmond Reservoir where over 60 eagles have now died from AVM. Extracts from the high density *A. hydrillicola* Kissimmee and Istokpoga sites collected during December-January had even higher relative toxicity. Overall, in terms of the relative cell line toxicity; Kissimmee > Istokpoga > Tohopekaliga > Hatchineha > Cypress. In order to evaluate the prevalence of AVM in these AVM-suspect Florida lakes, we will conduct field collections of symptomatic birds encountered while sampling hydrilla in Toho, Kissimmee, and Istokpoga during fall 2015.

Field Evaluation of Tradewind Herbicide for Control of Suspected Fluridone Resistant Hydrilla
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Fluridone-resistant hydrilla (*Hydrilla verticillata*) has been a concern of many private applicators in Florida in recent years due to the increasing presence of these biotypes and the high cost of alternative herbicides and treatments that can be used for long-term, selective control of this plant. In 2011, a new active ingredient received EPA registration for use in aquatics. Tradewind herbicide (bispyribac-sodium) is an ALS-inhibiting herbicide that offers an alternative to fluridone for hydrilla control and a lower application rate compared to contact type herbicides. However, due to cost, it is not feasible for many private companies to use this product at the higher end

of the recommended label concentrations. Recently, we encountered suspected fluridone resistant hydrilla at a site near Orlando, FL where a fluridone treatment in 2013 had no effect on the hydrilla. In March 2014, bathymetric mapping of the site was conducted to measure water volume as well as plant volume and area coverage. A treatment and monitoring strategy was developed to assess the efficacy of lower label recommended concentrations (25ppb) of Tradewind herbicide. Water samples confirmed that our target concentration of the active ingredient was achieved after the initial treatment and samples were taken monthly to track herbicide degradation. Monthly biomass sampling and quarterly mapping were used to track the effects of the herbicide on submersed vegetation. Six months post treatment, 85% reductions in hydrilla biomass were observed, while an increase in presence of nitella (*Nitella* sp.) and vallisneria (*Vallisneria americana*) have also been documented. As a secondary study in the treatment, laboratory analysis of chlorophyll in hydrilla shoots exposed to a range of fluridone concentrations confirmed the plants were a highly fluridone resistant biotype. Results of this study suggest that Tradewind herbicide can be used as an effective alternative to fluridone in systems where resistant hydrilla is present. Furthermore, the effectiveness of this product at rates below the maximum allowed label rate offers improved economics to private applicators.

The Evolution and Future of Lyngbya Management

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Many algae species have been successfully managed for decades. Site conditions (e.g. dilution, water quality) and algae physiology are factors that can negatively impact traditional algaecide efficacy. Lyngbya's mucilaginous sheath and dense mats often create a difficult scenario for effective algaecide treatment. Thus, traditional approaches of algal management, such as copper sulfate, are commonly ineffective for Lyngbya control. There are several modern ways to manage algae, such as improved formulations (e.g. granular algaecides, algaecides with water quality enhancer or formulations with adjuvants) and treatment programs using combinations of algaecides. With the multitude of potential management options, there is a need to rapidly identify effective treatment programs. This research demonstrates a method to measure the efficacy of algaecide treatment programs for a specific waterbody and targeted algae species using laboratory experiments. Further, data presented are from a case study that compares targeted alga effects (Lyngbya), exposure (mass algaecide/ algae), and dose (infused or absorbed algaecide) in the laboratory and field. The similarity achieved for the effects, exposure, and dose in the laboratory and field demonstrated the validity of this method to assist water resource managers in developing effective treatment strategies for Lyngbya.