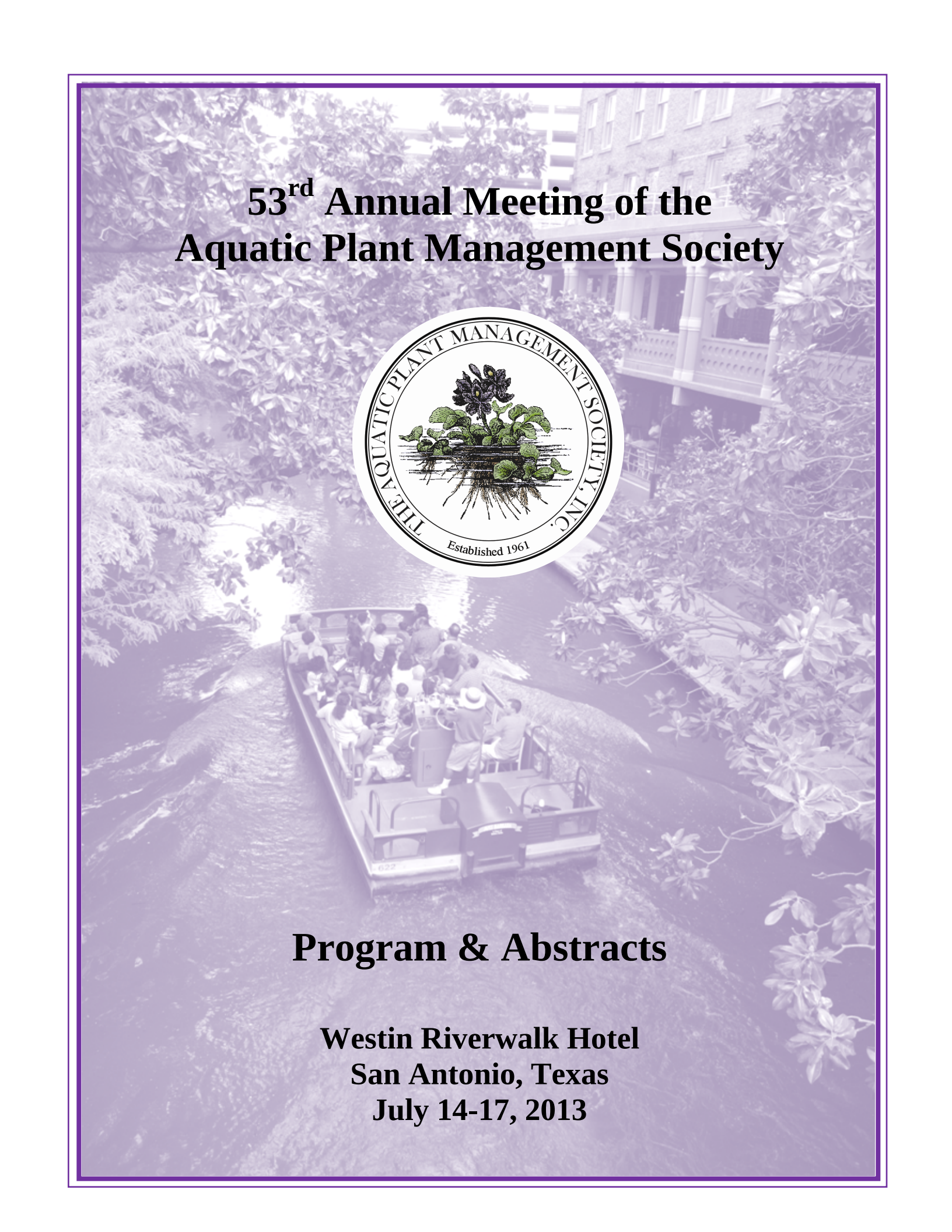
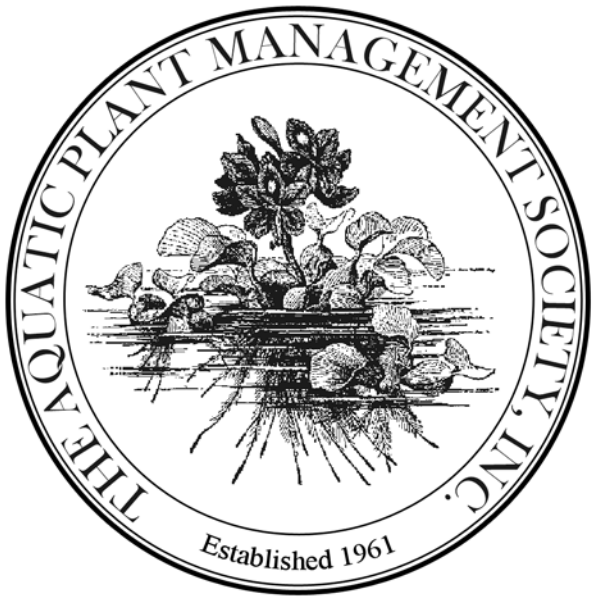
53rd Annual Meeting of the Aquatic Plant Management Society



Program & Abstracts

Westin Riverwalk Hotel
San Antonio, Texas
July 14-17, 2013



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 53rd Annual Meeting!

DUKE ENERGY.

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Guntersville, Alabama

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Regional Chapters	Cody Gray
Scholastic Endowment	John Gardner
Strategic Planning	John H. Rodgers, Jr.
Student Affairs	Rebecca Haynie
Website	Ryan Wersal

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, Florida
1962	T. Wayne Miller, Jr.	Fort Lauderdale, Florida
1963	William Dryden	Tampa, Florida
1964	Herbert J. Friedman	Tallahassee, Florida
1965	John W. Woods	Palm Beach, Florida
1966	Zeb Grant	Lakeland, Florida
1967	James D. Gorman	Fort Myers, Florida
1968	Robert D. Blackburn	Winter Park, Florida
1969	Frank L. Wilson	West Palm Beach, Florida
1970	Paul R. Cohee	Huntsville, Alabama
1971	Stanley C. Abramson	Tampa, Florida
1972	Robert J. Gates	Miami Springs, Florida
1973	Brandt G. Watson	New Orleans, Louisiana
1974	Alva P. Burkhalter	Winter Park, Florida
1975	Luciano Val Guerra	San Antonio, Texas
1976	Ray A. Spirnock	Fort Lauderdale, Florida
1977	Robert W. Geiger	Minneapolis, Minnesota
1978	Donald V. Lee	Jacksonville, Florida
1979	Julian J. Raynes	Chattanooga, Tennessee
1980	William N. Rushing	Sarasota, Florida
1981	Nelson Virden	Jackson, Mississippi
1982	Roy L. Clark	Las Vegas, Nevada
1983	Emory E. McKeithen	Lake Buena Vista, Florida
1984	A. Leon Bates	Richmond, Virginia
1985	Max C. McCowen	Vancouver, British Columbia
1986	Lars W. J. Anderson	Sarasota, Florida
1987	Dean F. Martin	Savannah, Georgia
1988	Richard D. Comes	New Orleans, Louisiana
1989	Richard Couch	Scottsdale, Arizona
1990	David L. Sutton	Mobile, Alabama
1991	Joseph C. Joyce	Dearborn, Michigan
1992	Randall K. Stocker	Daytona Beach, Florida
1993	Clarke Hudson	Charleston, South Carolina
1994	S. Joseph Zolczynski	San Antonio, Texas
1995	Steven J. de Kozlowski	Bellevue, Washington
1996	Terence M. McNabb	Burlington, Vermont
1997	Kurt D. Getsinger	Fort Myers, Florida
1998	Alison M. Fox	Memphis, Tennessee
1999	David F. Spencer	Asheville, North Carolina
2000	J. Lewis Decell	San Diego, California
2001	Jim Schmidt	Minneapolis, Minnesota
2002	David P. Tarver	Keystone, Colorado
2003	Richard M. Hinterman	Portland, Maine
2004	Ken L. Manuel	Tampa, Florida
2005	Eric P. Barkemeyer	San Antonio, Texas
2006	Jeffrey D. Schardt	Portland, Oregon
2007	Donald W. Doggett	Nashville, Tennessee
2008	Jim Petta	Charleston, South Carolina
2009	Carlton Layne	Milwaukee, Wisconsin
2010	Greg MacDonald	Bonita Springs, Florida
2011	Linda Nelson	Baltimore, Maryland
2012	Tyler Koschnick	Salt Lake City, Utah
2013	Terry Goldsby	San Antonio, Texas

APMS Award Recipients

Honorary Members (year of honor)

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
William 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)

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

APMS Award Recipients *(continued)*

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

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

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

Outstanding International Contribution Award (year of award)

Deborah Hofstra	National Institute of Water and Atmospheric Research	2013

Outstanding Journal of Aquatic Plant Management Article Award

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

Outstanding Research/Technical Contributor Award (year of award)

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

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

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, 2013 - $40,000
A Quantitative Genetics Approach to Identifying the Genetic Architecture of Herbicide Susceptibility, Tolerance, and Resistance in Hybrid Watermilfoils (Myriophyllum spicatum x sibiricum)

Sustaining Members

Alligare, LLC is a leading supplier in industrial vegetation management and a subsidiary of Makhteshim-Agan Industries, 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. 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 four offices that offer aquatic vegetation management plans including vegetation mapping and application services, fountain and aeration system installation, maintenance, and service throughout the Midwest.

BioSonics, Inc. of Seattle, WA manufactures scientific echosounder systems. BioSonics offers the MX Echosounder for aquatic habitat assessment and mapping of bathymetry, substrate type, and submerged vegetation. Housed in a rugged Pelican Case with convenient transducer/cable storage and an internal DGPS, the MX comes complete with specialized software. Visual Habitat software is easy to learn, offers unique data visualization tools and instant map making functionality and quickly generates accurate results that are easy to interpret. www.biosonicsinc.com

Brewer International, located in Vero Beach, Florida, has been a chemical manufacturer since 1973. This location is perfect because the company purchases limonene, which is 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 www.brewerint.com.

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

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

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

For over 20 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 Professional Products** provides high performance products to control destructive weeds while helping to restore the habitat of aquatic environments. Proven herbicides for the weed control industry from Syngenta include Reward®, and Refuge™, the latest and most concentrated glyphosate in the aquatics market.

United Phosphorus, Inc. manufactures and markets aquatic herbicides and algaecides for lakes, ponds, and irrigation canals. These products are marketed as Aquathol®, Hydrothol®, Cascade®, Teton®, Symmetry® and Current®. 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.

Valent Professional Products has the solutions applicators have been waiting for. Our products manage tough aquatic plants and provide the selectivity you can count on to maintain desirable vegetation. Clipper™ Aquatic Herbicide provides rapid, contact control of many tough aquatics plants including cabomba and watermeal. It's tough. It's fast. It's gone. Clear the way with Tradewind™ Aquatic Herbicide - systemic and selective control of hydrilla, watermilfoil and other aquatic plants. www.valentpro.com/aquatics.

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.

Platinum

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Silver

Crop Production Services, Inc.
Raleigh, North Carolina

Helena Chemical Company
Tampa, Florida

SePRO Corporation
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Syngenta Professional Products
Greensboro, North Carolina

Winfield
Ville Platte, Louisiana

Bronze

Alligare, LLC
Davidson, North Carolina

Applied Biochemists, A Lonza Business
Germantown, Wisconsin

Brewer International
Vero Beach, Florida

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Ames, Iowa

Cygnet Enterprises, Inc.
Flint, Michigan

Duke Energy Carolinas
Charlotte, North Carolina

Vertex Water Features
Pompano Beach, Florida

Scholastic Endowment Sponsors

The Aquatic Plant Management Society appreciates the generous support of the following scholastic endowment sponsors. Revenues generated through the Raffle at the Awards Banquet and Silent Auction are applied toward the Scholastic Endowment Fund which supports student attendance and functions at the Annual Meeting, the APMS Graduate Student Research Grant, and Student Director participation on the Board of Directors.

Raffle Contributors

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Applied Biochemists, A Lonza Business
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AquaMaster
Kiel, Wisconsin

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Biosorb, Inc.
Saint Charles, Missouri

Brewer International
Vero Beach, Florida

Crop Production Services, Inc.
Loveland, Colorado

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Future Horizons, Inc.
Hastings, Florida

Hurricane Lake and Fountain, Inc.
Pasadena, Texas

Johnson Lake Management Services
Martindale, Texas

Keeton Industries, Inc.
Wellington, Colorado

Pentair Aquatic Eco-systems, Inc.
Apopka, Florida

Pond Boss Magazine
Sadler, Texas

SePRO Corporation
Carmel, Indiana

Syngenta Professional Products
Wilmington, Delaware

Vertex Water Features
Pompano Beach, Florida

Exhibitors

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

Airmax Ecosystens, Inc.
Romeo, Michigan

Alligare, LLC
Opelika, Alabama

Applied Biochemists, A Lonza Business
Germantown, Wisconsin

AquaMaster Fountains and Aerators
Kiel, Wisconsin

Aquatic Control, Inc.
Seymour, Indiana

BioSafe Systems, LLC
Canoga Park, California

Brandt Specialty Formulation
Spring, Texas

Brewer International
Vero Beach, Florida

Clarke Aquatic Services
Roselle, Illinois

Clean Lakes, Inc.
Coeur d'Alene, Idaho

Contour Innovations, LLC
Minneapolis, Minnesota

Crop Production Services, Inc.
Loveland, Colorado

Cygnet Enterprises, Inc.
Flint, Michigan

Helena Chemical Company
Collierville, Tennessee

Keeton Industries, Incorporated
Wellington, Colorado

Pentair Aquatic Eco-Systems, Inc.
Apopka, FL

Red River Specialists
Davenport, Florida

SePRO Corporation
Carmel, Indiana

Sonic Solutions, LLC
West Hatfield, Massachusetts

Sprayco
Houston, Texas

Syngenta Professional Products
Greensboro, North Carolina

Texas Hunter Products
San Antonio, Texas

United Phosphorus, Inc.
Exton, Pennsylvania

Valent USA Corporation
Walnut Creek, California

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.

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 any of the 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 the Pre-function area in front of the Navarro Ballroom for the duration of the meeting. For specific times, please see the Agenda-at-a-Glance pages for each day in this Program. Messages will be posted at the meeting registration desk.

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

Posters
Posters will be open from 7:00 p.m. Sunday to 10:30 a.m. Wednesday in Navarro Ballroom. A Poster Session Reception will be held on Monday from 6:00 p.m. to 7:30 p.m. in Navarro Ballroom. 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 cosponsored by Helena Chemical Company and SePRO Corporation.

Continental Breakfasts / Refreshment Breaks
Continental breakfasts and mid-morning and afternoon refreshment breaks sponsored by Aqua Services, Inc., Brewer International, Becker Underwood, Inc., Crop Production Services, and Vertex Water Features, will be served each day in Navarro Ballroom. Please see the Agenda-at-a-Glance for specific times, locations, and sponsors.

APMS Student Affairs Luncheon
The Student Affairs Luncheon will be held Monday, 12:00 p.m. to 1:30 p.m. in El Rincon de Maria - Lobby Level. 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 14 to confirm your attendance. This luncheon is sponsored by SePRO Corporation.

APMS Annual Business Meeting
The APMS Annual Business Meeting will be held Monday, 4:20 p.m. to 5:00 p.m. in Hidalgo. All APMS members are encouraged to attend.

APMS Regional Chapters Presidents' Breakfast
The Regional Chapters Presidents' Breakfast will be held Tuesday, 6:30 a.m. to 8:00 a.m. in El Rincon de Maria - Lobby Level. Representatives from each APMS regional chapter are invited to attend this breakfast. Cody Gray, APMS Vice President and Regional Chapters Committee Chair, will be the moderator for discussions on aquatic plant management activities in each region. Please contact Cody by 8:00 a.m. Monday, July 15 to confirm your attendance. This breakfast is sponsored by Brewer International.

APMS Past Presidents' Luncheon
All APMS Past Presidents are invited to attend the Past Presidents' Luncheon on Tuesday, 12:10 p.m. to 1:40 p.m. in El Rincon de Maria - Lobby Level. Tyler Koschnick, Immediate Past President, will be the moderator. Please contact Tyler by noon Monday, July 15 to confirm your attendance. The luncheon is sponsored by Alligare, LLC.

APMS Special Events

President's Reception*, Sunday, July 14, 7:00 p.m. to 9:00 p.m., Navarro Pre-function*
Join your APMS friends and colleagues at this gathering to "kick-off" our annual meeting, cosponsored by Syngenta Professional Products and Winfield. This is an excellent time to visit and to meet new friends while enjoying exceptional food and your favorite beverage. The President's Reception is open to all registered delegates, guests, and students. Non-registered guests may purchase tickets for this event by submitting the Meeting Registration Form or at the meeting registration desk.

Poster Session and Reception*, Monday, July 15, 6:00 p.m. to 7:30 p.m., Navarro Ballroom*
This reception, cosponsored by Helena Chemical Company and SePRO Corporation will provide for the viewing of posters and professional interactions/discussions in a casual setting while enjoying 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 by submitting the Meeting Registration Form or at the meeting registration desk.

Guest Tour: **Alamo City**, *Monday, July 15, 10:00 a.m. to 3:00 p.m. Meet in the Lobby of the Westin*
This year, guests will be treated to a tour of Alamo City. Your tour, sponsored by Applied Biochemists, will begin with a narrative city driving tour in route to the "Shrine of Texas Liberty" - The Alamo. The next stop will be a cool ride along the historic and famous San Antonio River. Sit back and enjoy listening to fun and historical information from your tour captain. Your final designation will be Market Square, known as El Mercado by the locals. Two blocks of shopping filled with everything from piñatas and poetry to colorful clothing and metal work, all the while being serenaded by a local Mariachi group. Lunch will be served at one the local favorite restaurants, the Mi Tierra Café. The Guest Tour is open to all registered guests (spouse, partner, or child over 12 years of age). Non-registered guests may purchase tickets for this event by submitting the Meeting Registration Form or at the meeting registration desk.

Awards Reception and Banquet*, Tuesday, July 16, 6:00 p.m. to 10:00 p.m., Hidalgo*
All registered delegates, guests and students are invited to the APMS Awards Banquet, sponsored by United Phosphorus, Inc. Join us for a pre-banquet reception from 6:00 -7:00 p.m. sponsored by Valent USA Corporation. After dinner, we will recognize those who have served the Society, welcome new officers and directors, and this year's student paper and poster participants. Our evening will conclude with a raffle for several prizes including a rifle custom-made for this event. Raffle tickets may be purchased at the registration desk throughout the week and during the Awards Banquet. Raffle ticket sales promote APMS sponsorship of student initiatives.

Spur-of-the-Moment Meeting Room
Do you have a spur-of-the-moment meeting and need a room? We have a room set up conference style for 25 guests. For available times and location, please check at the meeting registration desk.

Student Tour
Many thanks to Casey Williams, APMS Student Director, for planning this year's tour. The 2013 Student Tour will commence at 8:00 a.m. on Wednesday, July 17. Students will depart the Westin for a short drive to New Brunfels and quick stop to view Comal Springs. Comal Springs, the largest in Texas, feeds clear spring runs that are home to several endangered species. Afterwards, students will tour the San Marcos National Fish Hatchery. The hatchery is a designated refugia where endangered species from San Marcos and Comal Springs are held in captivity for breeding purposes. It is also a site for aquatic plant research and propagation for restoration activities along the San Marcos and Comal Rivers. Lunch will be provided at Salt Grass Steakhouse of the San Marcos River. Then on to Aquarena Center for a 30-minute glass bottom boat tour at San Marcos Springs. Aquarena Center is the beginning of the San Marcos River and is home to eight endangered or threatened species. Students will have from about 3:00 -7:00 p.m. to tube, snorkel, kayak, and explore the San Marcos River before returning to San Antonio and the Westin. For more information on the student tour please contact Dr. Rebecca Haynie at hayniers@gmail.com.

Agenda

Sunday, July 14

Sunday's Agenda-at-a-Glance

7:30 am	-	5:00 pm	APMS Board of Directors Meeting *(Camino Real)*
12:00 pm	-	5:00 pm	Exhibits Setup *(Navarro Ballroom)*
12:00 pm	-	5:00 pm	Poster Setup *(Navarro Ballroom)*
1:00 pm	-	5:00 pm	Registration *(Navarro Pre-function)*
7:00 pm	-	9:00 pm	President's Reception *(Navarro Pre-function)*
			Cosponsored by Syngenta Professional Products and Winfield

Monday, July 15

Monday's Agenda-at-a-Glance

7:00 am	-	8:00 am	Continental Breakfast *(Navarro Ballroom)* *Sponsored by Crop Production Services*
7:00 am	-	5:00 pm	Exhibits Open *(Navarro Ballroom)*
7:00 am	-	5:00 pm	Posters Open *(Navarro Ballroom)*
7:30 am	-	5:00 pm	Registration *(Navarro Pre-function)*
8:00 am	-	12:00 pm	Session I *(Hidalgo)*
10:00 am	-	3:00 pm	Guest Tour *Sponsored by Applied Biochemists*
10:10 am	-	10:40 am	Refreshment Break *(Navarro Ballroom)* *Sponsored by Crop Production Services*
12:00 pm	-	1:30 pm	Lunch on your own
12:00 pm	-	1:30 pm	APMS Student Affairs Luncheon *(El Rincon de Maria - Lobby Level)* *Sponsored by SePRO Corporation*
12:00 pm	-	1:30 pm	Aquatic Ecosystem Restoration Foundation Meeting *(Lantana - Lobby Level)*
1:30 pm	-	4:20 pm	Session II *(Hidalgo)*
2:50 pm	-	3:20 pm	Refreshment Break *(Navarro Ballroom)* *Sponsored by Crop Production Services*
4:20 pm	-	5:00 pm	APMS Annual Business Meeting *(Hidalgo)*
6:00 pm	-	7:30 pm	Poster Session and Reception *(Navarro Ballroom)* *Cosponsored by Helena Chemical Company and SePRO Corporation*

Session I – Special Opening Session and General Presentations

8:00 am - 12:00 pm
Hidalgo

Moderator: Dr. Michael D. Netherland - APMS President Elect, Program Committee Chair
U.S. Army Corps of Engineers, Engineer Research and Development Center, Gainesville, FL

8:00 am **Welcome, Opening Remarks and Announcements**

8:05 am **Presidential Address**
Terry Goldsby
Aqua Services, Incorporated, Guntersville, AL

Opening Session I: Perspectives on Research and Management Progress in Three Disciplines Closely Related to Aquatic Plant Management: Toxic Algae Mitigation, Terrestrial Weed Science, and Mosquito Control

8:15 am **Research and Management Progress in Mitigating and Controlling Toxic Algae Blooms**
Dan Roelke
Texas A&M University, College Station, TX

8:40 am **Successes and Challenges in Terrestrial Weed Research and Control over the Past Five Years**
Scott Senseman
University of Tennessee, Knoxville, TN

9:05 am **The Science of Mosquito Control: Successes and Challenges in Management and Research over the Past Five Years**
Clark Wood
Clarke Mosquito Control, Batavia, IL

General Session I

9:30 am **Eradicating Hydrilla from New Zealand**
Deborah E. Hofstra and John S. Clayton
National Institute of Water and Atmospheric Research, Hamilton, New Zealand

9:50 am **Monoecious Hydrilla - The Aquatic Weed for the New Century?**
John D. Madsen
Mississippi State University, Mississippi State, MS

10:10 am **Refreshment Break** *(Navarro Ballroom)*

10:40 am **Citizen Science: A New Role for APMS Chapters?**
Lars W. Anderson
Waterweed Solutions, Davis, CA

11:00 am **Innovations in Citizen-Based Aquatic Plant Monitoring and Collaborations**
Matthew B. Johnson and Ray D. Valley
Contour Innovations, LLC, Minneapolis, MN

11:20 am **Private / Public Partnership in Aquatic Plant Management: The Complex and Dynamic Process of Industry, Government, and Citizen Participation in Collaboration for Improved Management and Stewardship of Our Aquatic Resources**
Mark A. Heilman
SePRO Corporation, Carmel, IN

11:40 am **NPDES and Operational Reporting Requirements and Results for Aquatic Plant Management in FL Public Waters**
Jeffrey D. Schardt
Florida Fish and Wildlife Conservation Commission, Tallahassee, FL

12:00 am **Lunch on your own**

Session II – General Session and Student Presentations

1:30 pm - 4:20 pm
Hidalgo

Moderator: Dr. Rob Richardson - APMS Editor
North Carolina State University, Raleigh, NC

1:30 pm **A Novel Method for SAV Restoration**
Lyn A. Gettys
University of Florida, Institute of Food and Agricultural Sciences, Ft. Lauderdale Research and Education Center, Davie, FL

1:50 pm **Efficacy of Three Algaecides on the Epiphytic Cyanobacterium (Order Stigonematales) Associated with Avian Vacuolar Myelinopathy (*Student Presentation*)**
Jamie Morgan[1], Rebecca S. Haynie[1], West M. Bishop[2], Susan Wilde[1]
[1]*University of Georgia, Athens, GA*
[2]*SePRO Corporation, Whitakers, NC*

2:10 pm **Refining Chemical Control of Floating Heart (*Student Presentation*)**
Justin J. Nawrocki, Steve T. Hoyle, and Rob J. Richardson
North Carolina State University, Raleigh, NC

2:30 pm **Flumioxazin Alone and in Combination with Endothall, Glyphosate, Imazamox and Bispyribac-sodium for the Control of Giant Salvinia**
Dearl E. Sanders
Louisiana State University AgCenter, Clinton, LA

2:50 pm **Refreshment Break** *(Navarro Ballroom)*

3:20 pm **An Initial Test into the Selectivity of Eight Herbicides for Management of Hydrilla in the Presence of Eight Co-occurring Native Plant Species (*Student Presentation*)**
Bradley T. Sartain and John D. Madsen
Mississippi State University, Mississippi State, MS

3:40 pm **Metabolic Profiles of Monoecious Hydrilla Treated with Penoxsulam and Endothall (*Student Presentation*)**
Sarah T. Meadows, Rob J. Richardson, and Jim Burton
North Carolina State University, Raleigh, NC

4:00 pm **Response of Non-target Emergent Plants to Low Doses of Imazamox and Penoxsulam Plus Contact Herbicides**
Christopher R. Mudge[1] and Michael D. Netherland[2]
[1]*U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, MS*
[2]*U.S. Army Corps of Engineers, Engineer Research and Development Center, Gainesville, FL*

4:20 pm **APMS Annual Business Meeting** *(Hidalgo)*

5:00 pm **Adjourn**

Poster Session

6:00 pm - 7:30 pm
Navarro Ballroom

Grass Carp Feeding Preference and Control of *Egeria densa*
Claudinei Cruz[1], Adilson F. Silva[2], Silvio C. Santos[3], and Robinson A. Pitelli[4]
[1]*FEB Barretos, Barretos, Brazil*
[2]*Unesp Jaboticabal, Jaboticabal, Brazil*
[3]*AES Tiete, Promissao, Brazil*
[4]*Ecosafe Ltda, Jaboticabal, Brazil*

Imazamox Toxicity to Non-target Organisms and Its Efficacy on the Control of Submerged Aquatic Weeds
Claudinei Cruz[1], Adilson F. Silva[2], and Robinson A. Pitelli[3]
[1]*FEB Barretos, Barretos, Brazil*
[2]*Unesp Jaboticabal, Jaboticabal, Brazil*
[3]*Ecosafe Ltda, Jaboticabal, Brazil*

Developing a Risk Assessment Tool for Identifying Potential Aquatic Invasive Plants in Texas (*Student Presentation*)
Elizabeth A. Edgerton[1], Michael Masser[1], Lucas Gregory[2], William Grant[1], and Allen Knutson[3]
[1]*Texas A&M University, College Station, TX*
[2]*Texas Water Resources Institute, College Station, TX*
[3]*Texas A&M AgriLife Extension Service, College Station, TX*

Characterization, and Evaluation of Biotechnological Potential of Waterhyacinth (*Eichhornia crassipes*) (*Student Presentation*)
Hector A. Fileto-Perez[1], Mark D. Sytsma[2], Jose G. Rutiaga-Quiñones[3], Jesus B. Paez-Lerma[1], Javier Lopez-Miranda[1], and Olga M. Rutiaga-Quiñones[1]
[1]*Durango Institute of Technology, Durango, Mexico*
[2]*Portland State University, Portland, OR*
[3]*Universidad Michoacana de San Nicolas de Hidalgo, Morelia, Mexico*

Modeling the Potential Geographic Distribution of *Hydrilla verticillata* in North America and Beyond (*Student Presentation*)
Brett M. Hartis and Rob J. Richardson
North Carolina State University, Raleigh, NC

Increasing the Selectivity of Contact Herbicides on Hydrilla: Sensitivity Tests with American Lotus
John D. Madsen[1], Gray Turnage[1], and Ryan M. Wersal[2]
[1]*Mississippi State University, Mississippi State, MS*
[2]*Applied Biochemists, Alpharetta, GA*

Grass Carp Feeding Preferences for Two Novel Invasive Aquatic Plants
Michael Masser[1], Dan Roelke[1], Michael T. Neisch[2]
[1]*Texas A&M University, College Station, TX*
[2]*Texas A&M AgriLife Extension Service, College Station, TX*

Effects of *Eichhornia azurea* and *Pistia stratiotes* Biomass Soil Incorporation on Chemical Proprieties of a Degraded Soil
Antonio Nader Neto[1], Monicke O. Vieira[2], Alfredo F. Yamauchi[1], Robinson A. Pitelli[3], and Robinson L. Pitelli[3]
[1]*Unesp Jaboticabal, Jaboticabal, Brazil*
[2]*Light Energia SA, Pira, RJ, Brazil*
[3]*Ecosafe Ltda, Jaboticabal, Brazil*

Herbicide Exposure from the Perspective of Submersed Aquatic Plants
Michael D. Netherland[1] and Leif Willey[2]
[1]*U.S. Army Corps of Engineers, Engineer Research and Development Center, Gainesville, FL*
[2]*University of Florida, Center for Aquatic and Invasive Plants, Gainesville, FL*

Evaluation of Aquatic Macrophyte Community with Emphasis on *Hydrilla verticillata* in Porto Primavera Reservoir, Brazil
Robinson L. Pitelli[1], Robinson A. Pitelli[1], Carlos J. Rodrigues[2], and Joao H. Dias[2]
[1]*Ecosafe Ltda, Jaboticabal, Brazil*
[2]*Sao Paulo Energy Company, Ilha Solteira, Brazil*

Response of *Urochloa subquadripara* and *U. mutica* Accesses to Herbicide Doses, under Greenhouse Conditions
Robinson L. Pitelli[1] and Dagoberto Martins[2]
[1]*Ecosafe Ltda, Jaboticabal, Brazil*
[2]*Unesp Botucatu, Botucatu, Brazil*

The Use of Algaecides in Adaptive Water Resource Management
John H. Rodgers, Jr. and Alyssa Calomeni
Clemson University, Clemson, SC

Floating Aquatic Weed Control Using Imazapyr
Adilson F. Silva[1], Claudinei Cruz[2], Natalia S. Shiogiri[1], Robinson A. Pitelli[3], and Robinson L. Pitelli[3]
[1]*Unesp Jaboticabal, Jaboticabal, Brazil*
[2]*FEB Barretos, Barretos, Brazil*
[3]*Ecosafe Ltda, Jaboticabal, Brazil*

Phenology of Curlyleaf Pondweed (*Potamogeton crispus*) in the Southeastern U.S.
Gray Turnage and John D. Madsen
Mississippi State University, Mississippi State, MS

Evaluation of Nutrients Leaching during Decomposition of Aquatic Weeds: Lysimeters Studies
Monicke O. Vieira[1], Robinson L. Pitelli[2], Alfredo F. Yamauchi[3], Antonio Nader Neto[3], and Robinson A. Pitelli[2]
[1]*Light Energia SA, Pira, RJ, Brazil*
[2]*Ecosafe Ltda, Jaboticabal, Brazil*
[3]*Unesp Jaboticabal, Jaboticabal, Brazil*

Comparative Phyto-uptake Across Distribution Coefficients of Pharmaceutical Compounds and Aquatic Macrophytes: Carbamazepine and Amiodarone Uptake in *Lemna* spp. (*Student Presentation)*
Kristy Woodard
University of North Texas, Denton, TX

Tuesday, July 16

Tuesday's Agenda-at-a-Glance

6:30 am	-	8:00 am	APMS Regional Chapters Presidents' Breakfast *(El Rincon de Maria - Lobby Level)* *Sponsored by Brewer International*
7:00 am	-	8:00 am	Continental Breakfast *(Navarro Ballroom)* *Sponsored by Crop Production Services*
7:00 am	-	5:00 pm	Exhibits Open *(Navarro Ballroom)*
7:00 am	-	5:00 pm	Posters Open *(Navarro Ballroom)*
7:30 am	-	5:00 pm	Registration *(Navarro Pre-function)*
8:00 am	-	12:10 pm	Session III *(Hidalgo)*
10:00 am	-	10:30 am	Refreshment Break *(Navarro Ballroom)* *Sponsored by Becker Underwood, Inc.*
10:15 am	-	11:00 am	TAPMS Annual Business Meeting *(La Babia)*
12:10 pm	-	1:40 pm	Lunch on your own
12:10 pm	-	1:40 pm	APMS Past Presidents' Luncheon *(El Rincon de Maria - Lobby Level)* *Sponsored by Alligare, LLC*
1:40 pm	-	5:10 pm	Session IV *(Hidalgo)*
2:50 pm	-	3:20 pm	Refreshment Break *(Navarro Ballroom)* *Sponsored by Aqua Services, Inc.*
6:00 pm	-	7:00 pm	Awards Reception *(Navarro Pre-function)* *Sponsored by Valent USA Corporation*
7:00 pm	-	10:00 pm	Awards Banquet *(Hidalgo)* *Sponsored by United Phosphorus, Inc.*

Session III – General Session and Student Presentations

8:00 am - 12:10 pm
Hidalgo

Moderator: Dr. John Madsen - APMS Board of Directors
Mississippi State University, Mississippi State, MS

8:00 am **Investigation of Darwin's Naturalization Hypothesis in Invaded Macrophyte Communities**
Jonathan P. Fleming[1], Eric D. Dibble[2], John D. Madsen[2], and Ryan M. Wersal[3]
[1]*University of North Alabama, Florence, AL*
[2]*Mississippi State University, Mississippi State, MS*
[3]*Applied Biochemists, Alpharetta, GA*

8:20 am **Detection and Assessment of Harmful Algae in Georgia Waterbodies Using GIS and Proximal Remote Sensing Techniques *(Student Presentation)***
Bradley Bartelme, Susan Wilde, Deepak Mishra, Rebecca S. Haynie, and Jamie Morgan
University of Georgia, Athens, GA

8:40 am **The Full Monty: How Simultaneously Assessing Both Plant Species Occurrence and Abundance using Standard Methodology is Critical for Good Lake Ecosystem Management**
Ray D. Valley
Contour Innovations, LLC, Minneapolis, MN

9:00 am **Incorporating Hydroacoustic Data Collection with Traditional Assessment Technologies to Evaluate Long-term Response of Submersed Vegetation to Management**
Dean Jones[1], Ray D. Valley[2], and Michael D. Netherland[3]
[1]*University of Florida, Lake Alfred, FL*
[2]*Contour Innovations, LLC, Minneapolis, MN*
[3]*U.S. Army Corps of Engineers, Engineer Research and Development Center, Gainesville, FL*

9:20 am **Using Research Driven Criteria for Development of a Long Term Aquatic Plant Management Plan: Revitalization after 15 Years of Management on Lake Gaston (*Student Presentation)***
Brett M. Hartis, Rob J. Richardson, Steve T. Hoyle, and Justin J. Nawrocki
North Carolina State University, Raleigh, NC

9:40 am **A Novel Flow-through Exposure System for Testing the Efficacy of Aquatic Herbicides in Irrigation Canals and Laterals**
Lauren Courter[1] and **Craig Gyselinck[2]**
[1]*Mount Hood Environmental, Portland, OR*
[2]*Quincy-Columbia Irrigation District, Quincy, WA*

10:00 am **Refreshment Break** *(Navarro Ballroom)*

10:15 am **TAPMS Annual Business Meeting – Concurrent with General Session III** *(La Babia)*

10:30 am **Pre-emergent Control of *Equisetum hyemale* (Scouringrush) in De-watered Irrigation Canals with Galleon™ (a.i. penoxsulam)**
Andrew Z. Skibo[1], Jill Schroeder[2], and Mark A. Heilman[3]
[1]*SePRO Corporation, Fort Collins, CO*
[2]*New Mexico State University, Las Cruces, NM*
[3]*SePRO Corporation, Carmel, IN*

10:50 am **Selectivity and Efficacy of Tradewind Aquatic Herbicide**
Joe Chamberlin
Valent USA Corporation, Snellville, GA

11:10 am **Management Options for *Prymnesium parvum***
John H. Rodgers, Jr.
Clemson University, Clemson, SC

11:30 am **Rolling Down the River: Public Perceptions and Attitudes towards Invasive Species and Invasive Species Management in the San Marcos River**
Florence M. Oxley
Texas State University, San Marcos, TX

11:50 am **Confessions of an Applicator: How Our Industry Was Helped by NPDES and How We Continue to Grow**
Brett W. Bultemeier
Clarke Aquatic Services, Alachua, FL

12:10 pm **Lunch on your own**

Session IV – Texas Aquatic Plant Management Society Session

1:40 pm - 5:10 pm
Hidalgo

Moderator: Mr. Matt Ward – TAPMS President Elect
Total Lake Management, Bryan, TX

1:40 pm **Snake Recognition, Preservation, and Safety for the Aquatic Specialist**
Clint Pustejovsky
Texas Snakes, Houston, TX

2:30 pm **Interplay between Ambient Surface Water Mixing and Manipulated Hydraulic Flushing: Implications for Harmful Algal Bloom Mitigation**
Veronica M. Lundgren[1], **Daniel L. Roelke[1]**, James P. Grover[2], Bryan W. Brooks[3], Krista N. Prosser[3], W. Casan Scott[3], Coridon A. Laws[2], George D. Umphres[1]
[1]Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX
[2]Department of Biology and Program in Earth and Environmental Sciences, University of Texas at Arlington, Arlington, TX
[3]Department of Environmental Science, Center for Reservoir and Aquatic Systems Research, Baylor University, Waco, TX

2:50 pm **Refreshment Break** *(Navarro Ballroom)*

3:20 pm **Aquatic Vegetation Management in Texas: An Update**
Earl W. Chilton
Texas Parks and Wildlife Department, Austin, TX

3:40 pm **Assessment of *Arundo donax* control on Lady Bird Lake in Austin, TX**
Aaron Richter and Mary P. Gilroy
City of Austin, Austin, TX

4:00 pm **Aquatic Plant Identification and Management: Importance and Perceptions of Educational Outreach through the Texas A&M Agrilife Extension Service**
Todd D. Sink
Texas A&M Agrilife Extension Service, College Station, TX

4:20 pm **AERF Update – "You are going to like this one."**
Carlton Layne
Aquatic Ecosystem Restoration Foundation, Marietta, GA

4:45 pm **Laws and Regulations "I am so happy I could…"**
Carlton Layne
Aquatic Ecosystem Restoration Foundation, Marietta, GA

5:10 pm **Adjourn**

Wednesday, July 17

Wednesday's Agenda-at-a-Glance

7:00 am	-	8:00 am	Continental Breakfast *(Navarro Ballroom)* *Sponsored by Brewer International*
7:00 am	-	10:30 am	Exhibits Open *(Navarro Ballroom)*
7:00 am	-	10:30 am	Posters Open *(Navarro Ballroom)*
7:30 am	-	12:00 pm	Registration *(Navarro Pre-function)*
8:00 am	-	12:00 pm	Session V *(Hidalgo)*
10:05 am	-	10:35 am	Refreshment Break *(Navarro Ballroom)* *Sponsored by Vertex Water Features*
10:30 am	-	12:00 pm	Poster and Exhibit Breakdown *(Navarro Ballroom)*
12:30 pm	-	5:00 pm	APMS Board of Directors Meeting *(Camino Real)*

Session V – General Presentations and Special Session on Herbicide Resistance Management in Aquatics

8:00 am - 12:00 pm
Hidalgo

Moderator: Dr. Cody Gray, APMS Vice President
United Phosphorous, Incorporated, Colorado Springs, CO

8:00 am **Lake Restoration Using Aeration and Alum: A Florida Case Study**
Josette M. La Hee
Vertex Water Features, Pompano Beach, FL

8:20 am **Interactivity of Phosphorus and Copper in Algae Management**
West M. Bishop and Ben E. Willis
SePRO Corporation, Whitakers, NC

8:40 am **Herbicide Applications to Dried Ponds: Will it Prevent the Growth of Submersed Vegetation in Arkansas Baitfish Culture Ponds?**
George Selden
University of Arkansas at Pine Bluff, Jonesboro, AR

Special Session on Herbicide Resistance Management in Aquatics

9:00 am **Session Introduction**
Michael D. Netherland
U.S. Army Corps of Engineers, Engineer Research and Development Center, Gainesville, FL

9:05 am **Perspectives from Industry and the Working Relationship with WSSA**
Cody J. Gray
United Phosphorous, Incorporated, Colorado Springs, CO

9:15 am **Perspectives from a Public Management Agency**
Jeffrey D. Schardt
FL Fish and Wildlife Conservation Commission, Tallahassee, FL

9:25 am **Perspectives from Academia**
Rob J. Richardson
North Carolina State University, Raleigh, NC

9:35 am **Perspectives from a Private Applicator**
David Isaacs
Aquatic Control, Seymour, IN

9:45 am **Open Discussion on Herbicide Resistance Management**

10:05 am **Refreshment Break** *(Navarro Ballroom)*

10:35 am **Fate of Copper from Herbicide and Algaecide Applications: Myths and Data**
John H. Rodgers, Jr.
Clemson University, Clemson, SC

10:55 am **Optimizing the Use of Clipper Aquatic Herbicide**
Bo J. Burns[1], Joe Chamberlin[2], and Jason Fausey[3]
[1]Valent USA Corporation, Raleigh, NC
[2]Valent USA Corporation, Snellville, GA
[3]Valent USA Corporation, Freemont, OH

11:15 am **APMS Regional Chapters: An Update on Key Initiatives within Each Region**
Dr. Cody Gray, Moderator
United Phosphorous, Incorporated, Colorado Springs, CO

Western
Texas
South Carolina
Northeast
Midwest
MidSouth
Florida

11:45 am **Highlights from the 53rd Annual Meeting and Thoughts on the Direct and Indirect Impacts of a Wave of Imminent Retirements**
Michael D. Netherland
U.S. Army Corps of Engineers, Engineer Research and Development Center, Gainesville, FL

12:00 pm **Adjourn 53rd Annual Meeting**

NEXT YEAR

54th Annual Meeting
Hilton Savannah DeSoto
Savannah, Georgia
July 13-16, 2014

Abstracts

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

Monday Opening Session on Perspectives on Research and Management Progress in Three Disciplines Closely Related to Aquatic Plant Management

Session Abstract

The Annual Meeting of the Aquatic Plant Management Society (APMS) brings together a diverse group of resource managers, researchers, industry representatives, and private applicators. As we meet each year, the ability to gauge progress in technology or changes in management philosophy over time is somewhat difficult to assess. For example, the issues we face from new species of concern to regulatory changes to herbicide resistance can evolve rapidly, and areas of minor focus can suddenly become a major focus and vice versa. As we consider the future direction of aquatic plant management, it can be instructive to see how other related disciplines are progressing. To give APMS members of sense of the link between research, technology and management changes, we have invited experts in the fields of toxic algae, terrestrial weed science, and mosquito control to provide an overview of these disciplines with a focus on the major technological advances or challenges over the past several years, and how research, regulatory, or business issues have evolved in these disciplines. This opening session is meant to inform APMS members on the science related to these other fields of management, but we also view this as an opportunity for members to potentially incorporate some of the successful strategies from other disciplines into the field of aquatic plant management.

Research and Management Progress in Mitigating and Controlling Toxic Algae Blooms
Dan Roelke
Texas A&M University, College Station, TX

Successes and Challenges in Terrestrial Weed Research and Control over the Past Five Years
Scott Senseman
University of Tennessee, Knoxville, TN

The Science of Mosquito Control: Successes and Challenges in Management and Research over the Past Five Years
Clark Wood
Clarke Mosquito Control, Batavia, IL

Wednesday Special Session on Herbicide Resistance Management

Session Abstract

The topic of herbicide resistance has been addressed in various presentations at numerous APMS and Regional Chapter meetings. While individual presentations have been informative, the larger issue of resistance management in aquatics has received limited attention at professional meetings. In response to significant issues with herbicide resistance in terrestrial systems, the Weed Science Society of America (WSSA) has been developing policies for herbicide use that reduce the potential for resistance development. The WSSA has tasked the APMS with developing a module for herbicide resistance management in aquatics. As a prelude to developing this module, a special session on herbicide resistance and resistance management has been organized. This session will include a series of short presentations from industry, academia, public managers, and private applicators. A discussion period will follow to allow members to provide perspective and ask questions of the panel. Herbicide resistance management in aquatic settings is a complex issue and it is likely that some of the policies that make good sense in terrestrial systems may not be feasible in aquatic systems. Recognition of this complexity and the unique nature of aquatic plant management will be highlighted during this session.

APMS and Herbicide Resistance: Perspectives from Industry and the Working Relationship with WSSA
Cody J. Gray
United Phosphorous, Inc., Colorado Springs, CO

APMS and Herbicide Resistance: Perspectives from a Private Applicator
David Isaacs
Aquatic Control, Seymour Indiana

APMS and Herbicide Resistance: Perspectives from Academia
Rob J. Richardson
North Carolina State University, Raleigh, NC

APMS and Herbicide Resistance: Perspectives from a Public Management Agency
Jeffrey D. Schardt
FL Fish and Wildlife Conservation Commission, Tallahassee, FL

General Sessions and Poster Session

Citizen Science: A New Role for APMS Chapters?
Lars W. Anderson
Waterweed Solutions, Davis, CA

The lay public has been recording and noting "environmental data" for 100's of years (e.g. rainfall and temperature). With the widespread use of the Internet, there has been an increasing effort to engage the public in gathering useful synoptic environmental data of various types. The U.S. National Phenology Network (USNPN) is probably the most widely used node to which data on flowering time, bird presence and other phenological events are being reported. Perhaps the most well known and relevant to APMS members is the "Great Secchi Dipin", now in its 18th year this summer. However, these efforts don't focus specifically aquatic plants or aquatic weeds, nor do they aim at improving early detection of newly invading aquatic species. The increased availability of accurate, low-cost instrumentation, included GPS referencing, and ease of digital image recording suggests that very useful data sets can be generated by enlisting the public's help over wider geographical regions. This type of information would be extremely helpful in understanding impacts from climate change on aquatic plant growth (emergence, flowering, etc.), geographic spread, competition (e.g. percent relative surface cover) of non-native plants with native plants, fish/plant interactions, alerts of new invaders and economic impacts as well. APMS chapters include most of the U.S. and some international areas as well. This suggests that a chapter-driven public outreach effort, coupled with standard "reporting" protocols from APMS and USNPN, could be developed into an effective "Citizen Science Aquatic Plant Management " project (CSAPM). APMS could encourage other related societies (e.g. NALMS and its chapters) to participate. A CSAPM would not only help in understanding aquatic weed population trends, it would undoubtedly increase public (and political!) awareness in general.

Detection and Assessment of Harmful Algae in Georgia Waterbodies Using GIS and Proximal Remote Sensing Techniques *(Student Presentation)*
Bradley Bartelme, Susan Wilde, Deepak Mishra, Rebecca S. Haynie, and Jamie Morgan
University of Georgia, Athens, GA

With anthropogenic climate change and a global population reaching over seven billion, freshwater resources are under intense pressure. Excess nutrients, especially phosphorus, potentially lead to harmful algal blooms, decreasing overall water quality with negative effects on the health of livestock, wildlife, and even humans utilizing the resource. With an increase in temperatures and drought frequency, the effects of eutrophication are intensified in Georgia's watersheds. In May 2012, we began receiving reports of livestock deaths associated with algal blooms. Based on clinical signs and algal screening, we were able to document four cattle deaths at one central Georgia pond with a dense *Microcystis aeruginosa* bloom (4.4 x106 cells/mL) and very high levels of the hepatotoxin, microcystin. Since this incident, we have received and screened numerous water samples from livestock drinking water ponds throughout the state. Harmful algal blooms (HABs) are monitored worldwide using

various techniques, however the ability to not only monitor, but predict bloom formation in freshwater systems, is relatively novel. Studies by Mishra et al. (2009) have shown that specific signature wavelengths between cyanobacteria and green algae can be detected via hyperspectral remote sensing. We used remote sensing technologies and GIS to create ways to detect and assess harmful algal blooms across Georgia. Past and present pond water nutrient data were acquired from the University of Georgia's Agricultural and Environmental Service Laboratory. Landcover, hydrography, and monthly climate data: including precipitation, temperature, and drought state, were obtained and combined in ArcMap 10.0. The bloom risk potential maps incorporated specific landcover, nutrient, temperature, precipitation, and drought thresholds. Over 92 counties in Georgia were found to be within an elevated HAB risk area based upon high pond phosphorus values and abiotic measures. In order to further develop the hyperspectral remote sensing of HABs, monoculture algal species were scanned to create a spectral profile library, creating the ability to identify and measure densities of blooms in the field. Preliminary data has shown that different species produce a unique signature based upon the approximate 620 nm absorption indicative of Phycocyanin (a cyanobacterial pigment). Ultimately this tool may provide an efficient way to screen for algal blooms versus archetypical methods (i.e. cell counts and microscopy). Rapid assessment will allow for more extensive monitoring, early management intervention and decreasing exposure time to any potential toxin.

Interactivity of Phosphorus and Copper in Algae Management

West M. Bishop and Ben E. Willis
SePRO Corporation, Whitakers, NC

Algae possess disparate innate sensitivities to reactive algaecides based upon numerous factors including the specific species and strain. Despite these inherent differences, environmental factors can also alter susceptibility to algaecide exposures. Phosphorus is a pollutant of particular concern due to its introduction in freshwater systems, conserved nature, and implications for algae management. The role of phosphorus in algae management, focused on its ability to shift the sensitivity of algae to copper, will be reviewed in terms of published literature, field observations, and future research. Preliminary laboratory and field research supports limiting phosphorus content or bioavailability as critical avenues for altering the susceptibility of some algae to copper algaecides. Increasing the efficiency of algaecides by addressing phosphorus is an integrated approach that can assist water resource managers in today's regulatory and economic environment.

Confessions of an Applicator: How Our Industry Was Helped by NPDES and How We Continue to Grow

Brett W. Bultemeier
Clarke Aquatic Services, Alachua, FL

With the changes in legislation and implementation of NPDES, our jobs as managers have become increasingly difficult. With enhanced public awareness, it is important for those of us in the field to protect our industry. This does not mean a change in everything we do, but highlighting what we already do well. While our job is to control invasive plants, we must also manage public perception as well. We should think creatively on how we spread our message to those outside our group. Through a continued sense of professionalism and a few helpful tips we can use NPDES to show how good we are at what we do and why it is important to allow us to do it.

Optimizing the Use of Clipper Aquatic Herbicide

Bo J. Burns[1], Joe Chamberlin[2], and Jason Fausey[3]
[1]*Valent USA Corporation, Raleigh, NC*
[2]*Valent USA Corporation, Snellville, GA*
[3]*Valent USA Corporation, Freemont, OH*

Following registration in 2011, Clipper Aquatic Herbicide (flumioxazin) has been used throughout the U.S. to manage a wide variety of nuisance aquatic vegetation under different environmental conditions. Surface and submersed applications of Clipper have been closely monitored for activity against specific plant species, movement from the treatment area, and persistence in the water column. Clipper is a contact herbicide for controlling difficult to manage plants such as Fanwort (*Cabomba caroliniana*), Watermeal (*Wolffia* spp.), water lettuce (*Pistia stratiotes*), hygrophila (*Hygrophila polysperma*), and certain filamentous algae, It has also been effective against *Hydrilla verticillata* when tank mixed with diquat. Unlike most contact herbicides, Clipper has

the ability to manage both floating and submersed weeds and can be used to treat small ponds or sections of larger water bodies. Data will be shared confirming that Clipper is relatively selective herbicide, has a short-life in the water column and can be used as a rotation partner to help manage resistance of other contact herbicides. Factors that influence product performance including concentration, time of year, and plant density will be discussed.

Selectivity and Efficacy of Tradewind Aquatic Herbicide
Joe Chamberlin
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During 2012 and 2013, Tradewind Aquatic Herbicide (Bispyribac-sodium) was applied operationally to control *Hydrilla verticillata* in multiple Florida lakes. Single subsurface applications of Tradewind were effective at 20-45 ppb, and had little or no impact on most desirable aquatic plant species. Whole and partial lake treatments of Tradewind + Endothal were effective against hydrilla. Tradewind is also being evaluated in combination with other contact herbicides. ELISA demonstrated that bispyribac concentrations remained relatively stable in water for 2-3 months in lakes treated during the spring and summer and only one application per year has been required in most cases. Mesocosm evaluation demonstrated that when applied at labeled rates, Tradewind did not impact biomass of 6 of 8 plant desirable floating and submersed plant species. Surface sprays of Tradewind + Clipper are being evaluated for selective removal of water lettuce and water hyacinth in desirable native plants.

Aquatic Vegetation Management in Texas: An Update
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Aquatic vegetation management in Texas has evolved significantly during the past decade. Controlling authorities, lakeside homeowners, and angler groups have proven critical allies with Texas Parks & Wildlife Department (TPWD) in the management of nuisance aquatic species. Long term commitments from stakeholders have made extended control efforts possible in problematic areas. Texas' most problematic aquatic plant species continue to be giant salvinia, water hyacinth, and hydrilla now found in 23, 35, and 110 public water bodies, respectively. In addition to aquatic plant species, TPWD has been increasing efforts to control riparian species as part of river and stream restoration. Riparian species of concern include giant reed, elephant ear, chinaberry, Chinese tallow, and saltcedar. Allocating adequate resources to address aquatic and riparian invasive plant infestations continues to be a major concern. Non-traditional funding sources have allowed TPWD to manage infestations in a number of hotspots such as Toledo Bend (largest water body in TX) and Caddo Lake (only natural lake in TX) where giant salvinia is a major problem, hydrilla in Lake Austin and Lake Conroe where trophy largemouth bass fisheries are managed, and water hyacinth infestations in Lake Fork (premiere bass fishery in TX) and the Guadalupe River.

A Novel Flow-through Exposure System for Testing the Efficacy of Aquatic Herbicides in Irrigation Canals and Laterals
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Standard herbicide efficacy studies conducted in static exposure systems establish application concentrations for the control of nuisance aquatic plants in various aquatic environments. It is unclear whether such results are applicable to the management of plants growing in riverine environments or irrigation canals. We have designed and constructed a novel flow-through exposure system with consistent laminar flow ($\leq$ 1 ft/sec) throughout the water column. Developed methodology includes rearing seedlings in flowing water to mimic plant structure, leaf morphology and herbicide contact time observed in irrigation waterways. Water quality parameters within the exposure system are adjusted to region-specific water temperature and chemistry in order to customize herbicide treatment in distinct climatic and geochemical regions. Results from a recent flow-through efficacy study involving *Zannichellia* sp. indicate that concentrations necessary for effective control in static systems differs from levels needed for control in a flowing environment. This study provides irrigation canal maintenance professionals with applicable efficacy data necessary to make informed decisions on effective water delivery management.

Grass Carp Feeding Preference and Control of *Egeria densa, Egeria najas* and *Ceratophyllum demersum*
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The triploid grass carp is being evaluated as a potential biological control agent of submerged aquatic plants in Brazil. The main targets are *Egeria densa, Egeria najas* and *Ceratophyllum demersum* which cause problems across a broad geographic distribution. A study was conducted under mesocosms conditions (2000 L capacity and 2.8 days of water renewal time) to evaluate biomass consumption by grass carp (average of 6.2 cm of length and 67 g of weight) of these three aquatic weeds offered separately or in pairs. The feeding time was 72 hours and a total of 60 grams of biomass was offered per mesocosm. The total period of assessment was 81 days. The biomass consumption by grass carp was similar on *C. demersum* and *E. najas*, providing a control level between 70% and 80%, during the experimental period. The grass carp showed low preference for *E. densa* providing between 40% and 60% control. The highest weight gain of grass carp was observed when the individuals fed on *E. densa* and *E. najas* at the same time.

Imazamox Toxicity to Non-target Organisms and Its Efficacy on the Control of Submerged Aquatic Weeds
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Over the last two decades, submerged aquatic weeds have become a serious problem in Brazil, especially in hydropower reservoirs. With the potential for new pesticide registration for use in aquatic environments, a series of studies is being carried out with submerged weeds as the main focus. Lab and greenhouse trials were carried out to evaluate the acute toxicity (LC50;48h e EC50;48h) of imazamox (Sweeper®) to the floating plants *Lemna minor* and *Azolla caroliniana*, the fish *Hypessobrycon eques*, the snail *Pomacea canaliculata* and the submersed plants *Ceratophyllum demersum* and *Hydrilla verticillata*. Imazamox was considered of low toxicity to non-target organisms, ranging from 787 mg.L-1 for *P. canaliculata* to over 600 mg.L-1 for *L. minor*. This herbicide shows good promise for controlling these two submerged aquatic weeds.

Developing a Risk Assessment Tool for Identifying Potential Aquatic Invasive Plants in Texas (*Student Presentation*)
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Determining which non-native aquatic plants have the greatest potential to invade a new area, and prohibiting those species prior to their introduction, is the key to preventing future serious infestations. The vast majority of non-native plants, either aquatic or terrestrial, are intentionally introduced to an area for purposes such as food crops, ornamental gardening, or as novelties. Once established in captivity, many plants are accidentally or intentionally released into the environment. The majority do not pose a serious threat of infestation; however, a select number can quickly become well established and cause severe damage to both the ecosystem and the economy. Each year, millions of dollars are spent in an attempt to control these invaders in the United States. Weed Risk Assessments, tools for determining the invasive potential of a plant species, have been developed and are currently being used around the world to screen non-native plant species and identify those which are likely to be invasive and should be excluded. Most notably, a risk assessment was developed for Australia in 1999 as a biosecurity tool, which is referred to as the Weed Risk Assessment or WRA. The Australian system is regarded as a highly accurate tool for screening non-native terrestrial plants prior to their introduction. This model has been widely adapted to screen for both terrestrial and aquatic plants in a number of other countries including New Zealand, Chile, and the United States, as well as individual states in the U.S. such as California and Hawaii. A tool

specifically tailored to the unique ecosystems of Texas has not yet been developed, however. Texas is a major hub in the aquatic plants trade and has conditions, like a temperate climate, which are favorable for plant invasions, so developing and implementing an effective risk assessment tool is imperative to reducing future invasions. This study will review the models that are currently available, the New Zealand and United States models in particular, and adapt them to develop a tool that will accurately identify those aquatic species which should be prohibited from entering the state of Texas, while recognizing those which should be safe to import. The new tool will be referred to as the Texas Aquatic Plant Risk Assessment, or TX APRA, and will be comprised of two models: a questionnaire-style risk assessment which will give each plant an invasiveness score, and a stochastic model which will show potential plant growth and spread of over time.

Characterization, and Evaluation of Biotechnological Potential of Waterhyacinth (*Eichhornia crassipes*) (*Student Presentation*)

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Eichhornia crassipes could be an excellent raw material for commercial compounds such as reducing sugars and a rich source of natural bioactive compounds such as phytosterols. In the present work, conditions for the saccharification process with microbial enzymes and GC-MS chemical characterization were evaluated. Pretreatments at several temperatures (100, 110, and 120° C) with different sulfuric acid concentrations (0.5, 1.0, 1.5, 2.0, 2.5, and 3%) and residence times (0, 15, 30, 45, 60, 90, and 120 min) were analyzed. *E. crassipes* extracts were derivatized and analyzed by GC-MS. The optimum conditions that maximized yield of reducing sugars included a pretreatment with 2% sulfuric acid at 110° C for 90 min. The optimum conditions for enzymatic saccharification used the commercial cellulase, Celluclast® at 50° C for 24 h of hydrolysis. The maximum yield was 0.54 g of fermentable sugars per g of biomass. Squalene and three steroids: stegmasterol, spirostene, and colestene were found. Data demonstrated *E. crassipes* is suitable as raw material for different products such as bioethanol; however, further fermentations studies are required.

Investigation of Darwin's Naturalization Hypothesis in Invaded Macrophyte Communities

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Although native macrophytes are beneficial in aquatic ecosystems, invasive macrophytes can cause significant ecological and economic harm. Numerous studies have attributed invasiveness to species' characteristics, whereas others attribute invasion to biotic and abiotic characteristics of the invaded community. It has been suggested that studying the link between invader and invaded community is key to understanding invasiveness, and that invasions can be understood through the framework of community ecology theory. Charles Darwin hypothesized that introduced species would be less likely to naturalize in areas containing closely related species (Darwin's Naturalization Hypothesis; DNH), suggesting competition between closely related species could limit naturalization potential (phylogenetic repulsion). The goal of this research was to test DNH using two species of highly invasive aquatic plants, *Myriophyllum spicatum* and *Potamogeton crispus*, and assess whether results were consistent at small and large scales. Twenty-nine lakes containing invasive macrophytes were surveyed between 1997-2011. Invasive *P. crispus* occurred in 15 lakes and *M. spicatum* occurred in 19 lakes. There were 15 native *Potamogeton* and four *Myriophyllum* species. We used generalized linear mixed models with congeneric species richness data to estimate probability of invasive *P. crispus* or *M. spicatum* occupying a given sampling location. Contrary to predictions of DNH, the relationship between congeneric richness and presence of *P. crispus* at point and lake scales was positive. Unlike models for *P. crispus*, native *Myriophyllum* species richness was not a significant model parameter. These results do not support DNH (the expectation of a negative relationship), and models had relatively low determination coefficients indicating very little explained variation. Although this study found no evidence for DNH, there is still a need to investigate how community assembly processes influence

species invasions to allow better invasion risk assessment.

A Novel Method for SAV Restoration
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Lake restoration projects can be challenging due to the limited availability of submersed native plant material, the difficulty of installing plants in an underwater environment, and the instability of many submersed sediments. Significant resources are expended to execute these types of projects, but success is often hindered because newly planted vegetation fails to anchor, establish and expand from the transplant site. These roadblocks can be addressed by producing "sod" of submersed vegetation in the greenhouse. This technique starts with a small number of plants that are plugged into a biodegradable matrix and cultured in tanks for several months, and culminates with well-rooted, densely vegetated mats that can be rolled up and transported to the restoration site. "Sod" produced in this manner is easily installed in the field and results in an instant population of submersed native vegetation that quickly establishes and expands from the transplant site.

Modeling the Potential Geographic Distribution of *Hydrilla verticillata* in North America and Beyond (*Student Presentation*)
Brett M. Hartis and Rob J. Richardson
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Hydrilla verticillata is the top problem aquatic weed in the United States with millions spent annually on control, management, and spread prevention. Despite hydrilla's environmental and economic impacts, little has been done to model the potential geographic spread of this nuisance plant beyond currently infested waters. Recent establishment of hydrilla in the northerly climates of New York, Maine and Washington have only increased the need for establishing a potential infestation range in North America. In this study, the potential infestation of hydrilla is modeled using WORLDCLIM climate data and known international infestation locations to determine the potential extent of infestation in North America and worldwide. The model predicts potentially suitable habitat based on monthly average minimum temperature from 1950-2000. Models were also developed to visualize infestation potential at 1, 2 and 3 degrees Celsius temperature increase as a possible result of climate change. The model indicated that in North America, *Hydrilla verticillata* could potentially establish far to the north throughout Canada and Alaska except for water bodies in the highest mountain ranges. The likelihood of establishment quickly diminishes above 80 degrees North Latitude. Worldwide, the model indicated that hydrilla establishment was expected to be highly to moderately possible as far North as the Arctic circle with only water bodies of the high mountain ranges (the Himalayas and Andes) as exceptions. The additional modeling of a 1, 2 and 3 degree Celsius increase in temperature only showed further advancement of hydrilla northward. The results from this model can be extremely useful in estimating the potential northerly spread of hydrilla from currently infested water bodies while also aiding in the formation of strategies to prevent introduction of the invasive plant into regions with uninvaded water bodies.

Using Research Driven Criteria for Development of a Long Term Aquatic Plant Management Plan: Revitalization after 15 Years of Management on Lake Gaston (*Student Presentation)*
Brett M. Hartis, Rob J. Richardson, Steve T. Hoyle, and Justin J. Nawrocki
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Management of monoecious hydrilla on Lake Gaston has been ongoing for nearly three decades. In 2005, the entities charged with developing a plan for the lake set an overall goal to develop and maintain a healthy lake ecosystem based on a diverse plant community dominated by native species. This included the goal of reducing the overall hydrilla acreage to less than 300 by 2012. Despite intense management through herbicides and grass carp stockings, as well as investigative research and revegetation efforts, hydrilla levels have remained around 1500 acres for a number of years. Funding limitations and inconsistencies have led to "hop-scotch" treatment of areas further complicating the dynamic issue of lake-wide hydrilla management. Furthermore, a lack of communication between funding sources and the lake management group as well as state funding limitations have led to a gradual decrease in annual funding for the past few years. In spring of 2013, revision of a long term management plan for

the lake was undertaken to address these issues while also introducing a research driven model for treatment site selection. The plan was designed primarily to address not only hydrilla biomass, but to take into account tuber bank regeneration in a lake with a long history of hydrilla infestation. Treatment site selection was based on a combination of decision tree modeling and expert opinion. The plan addresses long term lake management through selection of Long Term Treatment Areas (LTTAs) while also taking into account short term need for treatment at Priority Treatment Areas (APTAs) on an annual basis. Selection of LTTAs was highly reliant upon recent previous treatments, county distribution, size, and recreation and tourism value. The overall goal of the plan is to reduce existing hydrilla acreage to maintenance levels which would reduce treatment expenses and realize the initial goals of the lake management group set in 2005. This plan should provide a road map for hydrilla reduction within the lake over the long term while also providing measureable results for funding agencies year to year.

Private / Public Partnership in Aquatic Plant Management: The Complex and Dynamic Process of Industry, Government, and Citizen Participation in Collaboration for Improved Management and Stewardship of Our Aquatic Resources

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The United States approach for the use and regulation of pest management products has led to a complex and dynamic process for development and long-term stewardship of pest control chemicals such as aquatic herbicides and algaecides. In its current form for the most part established in 1972, the Federal Insecticide Fungicide and Rodenticide Act (FIFRA) 'strengthened the registration process by shifting the burden of proof to the chemical manufacturer.' In practice, approved labeling supported by registrant-funded toxicological and related studies establishes the general framework for how FIFRA-registered products can be used 'without unreasonable harm to the environment'. However, the ultimate use patterns adopted and used regularly within a narrower window of label specifications for control of aquatic weeds and algae are typically developed thorough successful private-public partnership that establishes common practices and works to constantly innovate and improve upon them. Sometimes, practices become so fixed in habit that modifying or improving upon them through new methods or new technology requires great energy by the technical community—industry, government, consultants, and professional applicators—energy that is sometimes missing in the relatively niche field of aquatic plant management. When private/public partnership is fully aligned and when distracting factors in our relatively small environmental field are avoided or at least mitigated, success generally follows. From a unique private industry perspective, examples of past success will be highlighted to foster dialogue about the most effective current and future ways that private and public entities in our field can collaborate for the long-term success of our scientific and business endeavors.

Eradicating Hydrilla from New Zealand

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Hydrilla has been in New Zealand since the 1960's and formed major infestations in four lakes within the Hawkes Bay region. Challenges to controlling hydrilla in NZ, have included a lack of tools and the changing responsibilities of local management agencies. As recently as 2004, diquat was the only herbicide registered for aquatic use and the dioecious male strain of hydrilla was not susceptible to diquat. Herbicide screening studies, and the subsequent success of endothall to reduce hydrilla biomass in the field, led to its registration in 2004. A grass carp field trial was initiated in 1988 in the smallest of the hydrilla infested lakes to assess the feasibility of eradicating the hydrilla. After the main hydrilla beds were consumed, regrowth from tubers still occurred for a further twelve years, and the lake has only recently been declared hydrilla free. And now, several decades later a New Zealand central government led eradication response for hydrilla has been implemented using grass carp and endothall. In 2008 endothall was used to reduce the hydrilla biomass in high public use areas, and grass carp were released into the remaining three hydrilla infested lakes. This paper will describe changes in the lake flora and fauna to date.

Innovations in Citizen-Based Aquatic Plant Monitoring and Collaborations

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Natural resource managers and climatologists have long recognized the critical importance of observer networks and volunteer citizen monitoring. With citizen monitoring networks, managers and scientists acquire useful data for making more informed predictions and management decisions, while involved citizens gain an ownership stake in building the knowledgebase about the condition of ecosystems and the climate. Citizen protocols for water quality (e.g., Secchi clarity) and meteorology (e.g., rainfall) data collection are largely objective and are becoming increasingly standardized throughout the nation. As a result, comprehensive datasets are being merged at large geographic scales to assess the current status and trajectory of water resource and climate conditions. Despite well-intentioned citizen programs to map and monitor aquatic plants in several U.S. states, most are subjective and non-standardized. Consequently, results will differ across surveyors, systems, and geographic regions. This strongly limits the power and usefulness of data collected from these programs. This is unfortunate because of the importance of aquatic plants for fish habitat and water clarity, and the vulnerability of lakes to invasive aquatic plants. Homeowner groups and government agencies recognize the urgency of proactively protecting lakes from harm but have lacked tools to evaluate the effectiveness of their aquatic plant management efforts or collaborate in this effort. We present how an automated cloud-based aquatic vegetation mapping system has opened the door to cooperative and objective citizen-based monitoring of aquatic plants with two case studies where public and private lake management entities are working in collaboration with lake homeowner associations

Incorporating Hydroacoustic Data Collection with Traditional Assessment Technologies to Evaluate Long-term Response of Submersed Vegetation to Management

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For over a decade, point-intercept survey methodology for assessment of submersed aquatic vegetation has become a standard tool for lake resource managers and researchers. The methodology entails sampling a uniform grid of points on a lake and noting presence/absence of species collected. It is a relatively rapid way of objectively sampling aquatic plant species communities in a repeatable fashion. In response to various stakeholder criticisms, the point intercept methodology has been modified to include simple subjective density ratings of sparse, moderate and dense in order to account for its insensitivity to abundance of plants (i.e., 1 sampled sprig gets the same weight as a large bed at any one point). Combining the density adaptation with passive collection of aquatic plant abundance using hydroacoustics provides additional spatial data for analysis and interpretation. Utilizing simple GIS overlay methodology, species presence/absence layers can be combined with complementary biovolume (% of water column occupied by vegetation) data to form a more complete survey and picture of both species distribution and abundance prior to and following various management efforts. Further, creation of a dominance index for each species sampled can be used as an aquatic plant management and/or lake habitat monitoring tool. Examples of pre and post treatment surveys of lakes with Eurasian watermilfoil on Lake Minnetonka and hydrilla on Lakes Tohopekaliga and Kissimmee will be used to demonstrate these various technologies are being combined to provide more detailed data. Lake resource managers and researchers utilizing these technologies for monitoring and managing submersed aquatic vegetation communities have the ability to provide data on species frequency, abundance, and distribution with limited additional effort.

Lake Restoration Using Aeration and Alum: A Florida Case Study

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Bahia del Mar is a 14 acre, 50 foot deep, man-made community lake located in St. Petersburg, Florida. The lake has a history of nutrient and organic matter loading that has resulted in an extreme case of hyper-eutrophication, the symptoms of which included algal blooms, extensive fish kills and persistent pungent odors. In January, 2012 a management strategy was devised to restore the lake to a healthy and stable state. The strategy incorporated the use

of aeration for an extended period to improve lake water quality, followed by two alum treatments to reduce the extremely high levels of nutrients in the water column and increase the phosphorus binding capacity of the sediment. One day after aeration installation, stratification in the deepest part of the lake was completely eliminated. Over the next several weeks, oxygen levels increased while turbidity, BOD and nutrient levels decreased markedly. Once conditions in the lake stabilized, two alum treatments were applied, resulting in further drastic reductions in phosphorus levels and increases in water clarity. The results of this study will be presented along with a discussion of the importance of considering multifaceted treatment options for lake restoration and management.

Interplay between Ambient Surface Water Mixing and Manipulated Hydraulic Flushing: Implications for Harmful Algal Bloom Mitigation

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Creation of refugia from fish-killing algal blooms in coves of lakes represents a promising approach to bloom mitigation, especially in regards to *Prymnesium parvum* blooms. A way to create refugia might involve flushing of coves with deeper waters from open lake areas that are free of *P. parvum.* The efficacy of this mitigation approach, however, is likely influenced by the natural rate of water exchange between coves and surface waters of the open lake that often contain *P. parvum.* Conceptually, higher rates of water exchange would dilute mitigation efforts. We explored this potential limitation by conducting several dye-tracer studies in Lake Granbury (USA) that enabled direct measurement of water exchange rates between the open lake and target coves. Our measured rates of water exchange, which were typically in the range of 0.25-0.30 d^{-1} during periods of bloom initiation, development and decline, were then used to inform a numerical model that predicted *P. parvum* bloom dynamics. Our simulations showed that *P. parvum* populations located in coves quickly returned to bloom levels when deep water flushing ceased. Nevertheless, significant benefits were predicted. For example, continuously pumping deeper waters from the open lake at rates of 16.3×10^4 m^3 d^{-1} resulted in hydraulic residence times in the range of 0.88-1.41 days and a 65-80% reduction of bloom in coves. The next steps of this research should involve a valuation study where the costs of deep-water flushing are contrasted against the economic benefits.

Increasing the Selectivity of Contact Herbicides on Hydrilla: Sensitivity Tests with American Lotus

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Reservoirs in the southeastern United States have been particularly susceptible to invasion by both monoecious and dioecious hydrilla (*Hydrilla verticillata*) in the past three decades. Reservoirs often have areas of high water exchange or rapidly changing water flows that prevent the effective use of systemic herbicides for control of hydrilla. With the advent of some populations of hydrilla that have become resistant to fluridone, the switch to contact herbicides has accelerated. While contact herbicides are effective in rapid control of hydrilla biomass under conditions of high water exchange, the downside of many usage patterns is reduced selectivity. In many southeastern reservoirs, American lotus (*Nelumbo lutea*) is a common native plant that provides needed habitat and refuge for both fish and waterfowl. Our recent experience with using a tank mix of diquat with chelated copper in the Ross Barnett Reservoir, MS was that, while it was effective in controlling hydrilla, it damaged adjacent American lotus populations. Therefore, we designed a study to examine the effectiveness of diquat and four chelated copper formulations to control hydrilla while minimizing damage on American lotus. This study was conducted at the R. R. Foil Plant Science Research Center at Mississippi State University, in 132, 100-gallon mesocosm tanks. Hydrilla was planted in five pots per tank, (66 tanks); while American lotus was planted in three pots per tank, in the remaining 66 tanks. Plants were allowed to grow for four weeks. Tanks were treated with diquat or one of four formulations of chelated copper, as well as combinations of diquat with each copper formulation; and an untreated reference for a total of 21 treatments. Each treatment was replicated three times. While several of these combinations provided better than 70% control of hydrilla, most also caused significant

damage to American lotus. Copper ethylendiamine liquid alone at both 0.5ppm and 1.0 ppm provided 80% control of hydrilla, while American lotus actually increased biomass. Further research to demonstrate chelated copper formulations in the field are planned.

Monoecious Hydrilla – The Aquatic Weed for the New Century?
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Research has identified at least twenty-six biotypes of hydrilla, ranging from tropical to cool temperate in origin. At present, only two of these biotypes are known for the United States: a warm subtropical biotype that is dioecious and produces pistillate flowers, and a temperate monoecious biotype. While the 1980's to 1990's were dominated by news of the frontal advance of dioecious hydrilla as the major submersed problem plant, the new century has seen the introduction of widely-dispersed populations of monoecious hydrilla. Monoecious hydrilla is very successful in establishing and dominating cool temperate lakes of the Great Lakes region, and is currently displacing dioecious hydrilla in mid-continental reservoirs from Virginia to Tennesee and even north Alabama. Phenologically, monoecious hydrilla is much more like native temperate plants than dioecious hydrilla; with propagules that both sprout and go dormant at approximately the same time as native species. Unlike dioecious hydrilla, it will go completely dormant to subterranean propagules. In many ways, it is better adapted to temperate North American lakes than dioecious hydrilla. Despite common wisdom, it is also extremely competitive with native species, and forms a dense surface canopy like the dioecious biotype. In appearance, it is very easily mistaken for the native elodea (*Elodea canadensis*). While some research has been done on monoecious hydrilla, much more is needed for natural resource managers to be as well informed on monoecious hydrilla as they are on dioecious hydrilla.

Grass Carp Feeding Preferences for Two Novel Invasive Aquatic Plants
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Aquatic vegetation is an important component of most freshwater systems and provides numerous valuable ecosystem services, providing food, habitat and refuge for a variety of organisms. A significant threat to beneficial aquatic vegetation abundant in many U.S. waterways is the introduction and spread of invasive macrophytes. Invasive aquatic plants degrade water quality, reduce species diversity, alter animal communities and suppress desirable native plants. This research evaluated the potential use of triploid grass carp (*Ctenopharyngodon idella* Valenciennes) as a biological control agent for giant salvinia (*Salvinia molesta* Mitchell) and hygrophila (*Hygrophila polysperma* Anderson), two novel invasive species recently established in Texas waters. Using a controlled mesocosm experiment, maximum consumption rates and feeding preferences were measured. Grass carp were found to be potentially useful in controlling giant salvinia in the preliminary stages of an infestation but seemed an overall poor control option for hygrophila.

Metabolic Profiles of Monoecious Hydrilla Treated with Penoxsulam and Endothall (*Student Presentation*)
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Hydrilla is a federally listed noxious weed that has become one of the most expensive and difficult to manage aquatic weeds in the United States. Of the 14 aquatic herbicides registered by the U.S. Environmental Protection Agency (EPA), only a portion is active on hydrilla. With these limited chemical control tools, and the ongoing threat of herbicide resistance, combinations of herbicides are continuing to be examined for aquatic weed control. Laboratory and field evaluations have shown that penoxsulam and endothall, when applied in combination, decreased exposure requirements for penoxsulam, reduced endothall use rates, and increased duration of control compared to endothall alone. To further examine the penoxsulam-endothall combination, and to assess the effects of herbicide exposure on hydrilla, metabolic profiling was employed. Metabolite profiling is a relatively new, but fast-growing and useful diagnostic technique in herbicidal mode of action research, the goal of which is the identification of links between genotypes and phenotypes. Two mass spectrometry analytical platforms were

utilized to provide comprehensive metabolite coverage. This study generated several statistically valid multivariate models describing the similarities and differences in the metabolic profiles produced from monoecious hydrilla treated with endothall, penoxsulam, and a combination of both herbicides. We found unique variations in the metabolome seen when hydrilla was treated with both penoxsulam and endothall together, which were not seen with the treatments of either herbicide alone.

Efficacy of Three Algaecides on the Epiphytic Cyanobacterium (Order Stigonematales) Associated with Avian Vacuolar Myelinopathy (*Student Presentation*)

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Avian vacuolar myelinopathy (AVM) is an often lethal disease affecting waterbirds and raptors linked to an epiphytic cyanobacterium (Order Stigonematales; stig) which grows primarily on nonindigenous submerged aquatic vegetation (SAV). The putative toxin remains uncharacterized and human health risks have not been fully evaluated. One means of reducing toxin exposure is the control of the SAV that provides vital substrate for stig. However, depending on SAV species composition and/or management priorities, removal of SAV may not be desirable and directly targeting stig may be more appropriate. Through field and laboratory trials, we investigated algae management strategies for systems affected or potentially affected by AVM. Replicated plots of hydrilla (*Hydrilla verticillata*) with stig in a Piedmont GA reservoir were treated with one of three common algaecides (Captain XTR, SeClear, and Pak27) at the maximum rate for planktonic algae. Hydrilla leaflets from untreated areas of this reservoir were collected and treated individually with the same algaecides under controlled laboratory settings. In the field, a repeated measures analysis of variance (ANOVA) and Tukey's HSD revealed no significant difference in the occurrence of stig between treatments at any time point after application. In the laboratory, the same analysis failed to show a significant treatment effect ($p=0.1711$) on the percent area leaf coverage of stig. We did not find the application of Captain XTR, SeClear, and Pak27 at maximum rate for planktonic algae to effectively reduce the presence of stig on hydrilla. These studies indicate that stig is resistant to typical algaecide treatment. We hypothesize that proper algaecide contact was not achieved in the field or laboratory applications. The epiphytic location of stig within the complex architecture of dense hydrilla and the presence of a thick gelatinous sheath around the filaments may provide protection for individual cells. Additional research is needed to better assess contact of algaecides with colonies of stig.

Response of Non-target Emergent Plants to Low Doses of Imazamox and Penoxsulam Plus Contact Herbicides

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The aquatic herbicides 2,4-D and diquat are highly efficacious against water hyacinth (*Eichhornia crassipes* (Mart.) Solms) and water lettuce (*Pistia stratiotes* L.). Both herbicides provide rapid control and offer rapid visual markers (hours to 1 day) which help distinguish treated vs. un-treated sites. Although these visual cues have been important to the floating plant maintenance control program in Florida, visual injury symptoms to non-target vegetation is becoming increasingly scrutinized by stakeholder groups. The desire to reduce non-target injury in mixed plant communities has led to the evaluation of alternative herbicides, particularly the recently registered acetolactate synthase (ALS) inhibiting herbicides imazamox and penoxsulam and the protoporphyrinogen contact herbicides carfentrazone and flumioxazin. Mesocosm research demonstrated that low dose foliar applications of the ALS herbicides alone and in combination with the contact herbicides have potential for use in maintenance control programs. The selectivity of these treatments against non-target emergent plants is unknown; therefore, two studies were conducted to evaluate low dose combinations against duck potato (*Sagittaria lancifolia* L.), jointed spikerush (*Eleocharis interstincta* (Vahl) Roem & J.A. Schult), club-rush (*Eleocharis cellulosa* Torr.), giant bulrush (hard-stem bulrush, *Schoenoplectus californicus* (C.A. Mey) Palla), and soft-stem bulrush (*Schoenoplectus tabernaemontani* (C.C. Gmel.) Palla). In addition, 2,4-D and 2,4-D plus diquat were included for comparison purposes. All herbicide treatments containing imazamox or penoxsulam alone or in combination with contact herbicides resulted in minor visual injury symptoms (<25% injury) to most non-target emergent plants 7 to 14 days

after treatment. Treatments containing the ALS herbicides (alone or combination) did not reduce the biomass of club-rush, giant bulrush, or soft-stem bulrush, whereas these treatments were injurious at varying degrees to duck potato and jointed spikerush by 6 WAT. Duck potato biomass was reduced 46 to 100% by imazamox plus flumioxazin, all penoxsulam treatments, and 2,4-D. With the exception of club rush, 2,4-D alone reduced the dry weight of all emergent non-target plants by 72 to 94% of the non-treated control at 6 WAT. Jointed spikerush, giant bulrush, and soft-stem bulrush dry weight were reduced 50, 74, and 59%, respectively, by the 2,4-D plus diquat treatment. Based on these data, the ALS herbicides imazamox and penoxsulam in combination with the contact herbicides carfentrazone and flumioxazin can be utilized in areas where floating target and emergent non-target plant populations co-exist.

Effects of *Eichhornia azurea* and *Pistia stratiotes* Biomass Soil Incorporation on Chemical Proprieties of a Degraded Soil

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The use of aquatic weed biomass in an environmentally compatible manner is a condition for licensing the activity of mechanical harvesting in water bodies in Brazil. The harvest and the use of biomass must be monitored and reports should be issued periodically. Depending on the water body features, the time of year and location of the reservoir, the aquatic weed species composition of the biomass can vary and this should be considered in the risk analysis of using biomass as an organic fertilizer. The present study evaluated the effects of *Eichhornia azurea* and *Pistia stratiotes* biomass incorporation on the fertility features of a degraded Ultisol. The plants were incorporated alone or in mixtures. The experiment was conducted under conditions of climate-controlled room at 25 ° C and 12 hours photoperiod. Treatments were established in a 2x3x3 factorial design. The variables were: (i) the addition or not of sphagnum moss, (ii) three doses of *P. stratiotes* and (iii) three doses of *E. azurea* (0, 5, 10 t.ha-1). The incorporation of macrophytes alone or in mixtures promoted improvements in all soil characteristics. The incorporation of *P. stratiotes* promoted the most significant increase in soil pH due to the high Ca and Mg contents. *Eichhornia azurea* had a greater influence on phosphorus concentration in the soil. The incorporation of macrophytes did not cause significant increase in the soils concentrations of heavy metals.

Refining Chemical Control of Floating Heart (*Student Presentation*)

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In the last few years, several members of the genus *Nymphoides* have aggressively spread across aquatic sites in the Southeastern United States. The species of most concern are *Nymphoides peltata, cristata* and *indica*. The rapid proliferation of these species has caught managers off guard with little published research available on the management of these plants. Therefore, research was conducted to evaluate herbicide controls for *Nymphoides aquatica, cristata*, and *peltata*. Two trials were performed in the greenhouse and five ponds were repeatedly treated over two years. *Nymphoides peltata* and *cristata* were treated in the greenhouse while *peltata* and *aquatica* were treated in the field. The herbicides in the greenhouse trials were applied as in water treatments and all biomass was collected at 30 DAT. The herbicides included diquat, endothall (both formulations Aquathol and Hydrothol) and flumioxazin, either applied alone or in combination. The herbicides previously mentioned along with fluridone, imazamox, and imazapyr were also applied in the field alone or in combination. Field treatments were applied either as an in water treatment (iwt) or as a foliar spray (fs). Greenhouse results demonstrated differentiation by species with the treatments for *peltata* averaging 89% control while the same treatments on cristata averaged just 71% control after four weeks. Combinations of endothall and diquat consistently controlled ≥80% of both species. Field treatments that achieved greater than 90% control by one month after treatment were 1.5 ppm Aquathol + 0.18 ppm Hydrothol (iwt), 3.0 ppm Aquathol + 0.18 ppm Hydrothol (iwt), 3.0 ppm Aquathol + 2 gal/acre diquat (fs), and 0.6 gal/acre Aquathol + 2 gal/acre diquat (fs). However, these plants did exhibit rapid recovery which required multiple treatments in a single season for adequate control. Future research will focus on refining treatments for greater long term control.

Herbicide Exposure from the Perspective of Submersed Aquatic Plants

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The use of herbicides to control submersed aquatic vegetation is a well-established practice and various strategies from use of granular formulations, deep injection of liquids, use of surfactants, and use of drip applications all demonstrate how managers are seeking to maximize herbicide exposure in the target area. These novel application techniques in conjunction with post-treatment monitoring can provide useful information on herbicide behavior in the field. We have initiated various trials at the laboratory and mesocosm scale to evaluate how submersed plants experience different exposure patterns to aquatic herbicides. This work is an extension of early concentration and exposure time research, and it seeks to mimic unique patterns of herbicide exposure observed under field conditions. We discuss how hydrilla (*Hydrilla verticillata*) responds to intermittent exposures to fluridone or endothall versus continuous exposures. While this work may seem esoteric at first glance, there are numerous practical applications for this data including drip applications and successive treatment strategies in high water-exchange areas. We also describe the response of Eurasian watermilfoil *(Myriophyllum spicatum*) when herbicide exposures are confined to the sediments, the lower third of the plant, or the upper 2/3rd of the plant. Lastly, we discuss the influence of algal versus sediment derived turbidity following treatment of water soldier (*Stratiotes aloides*) with diquat. While development of these protocols is still in an early stage, we feel this type of approach can assist managers in expanding the capabilities of registered herbicides in challenging aquatic environments.

Highlights from the 53rd Annual Meeting and Thoughts on the Direct and Indirect Impacts of a Wave of Imminent Retirements

Michael D. Netherland
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The field of aquatic plant management continues to experience a significant wave of retirements. In the coming two to three years, this pace will accelerate and many of those who have been fixtures in this field for 30+ years will no longer be regular contributors. While the pace of these retirements is disconcerting, of even greater concern, is the fact that many of these positions will either not be filled or replacements will have limited experience in the discipline of aquatic plant management. While the loss of these professionals to retirement is a loss for the APMS, the ability for this organization and the regional chapters to be the lead Societies in providing useful networking and technical information on aquatic plant management for new personnel represents a clear opportunity. While the transition will be difficult, APMS members need to recognize that these changes are inevitable and continue to build a Society that meets the needs of changing membership demographic.

Rolling Down the River: Public Perceptions and Attitudes Towards Invasive Species and Invasive Species Management in the San Marcos River, San Marcos, Texas (*Student Presentation*)

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Invasive nonnative species are one of the main threats to local, regional, and global biodiversity. As a result, there is increasing pressure to control or eradicate invasive species in order to mitigate their impacts. Management programs can be controversial and, in some cases, have been delayed or stopped because of public opposition. Public support can be vital to the success of these projects, and understanding the underlying perceptions and attitudes of the public can help advise outreach and public education activities. To assess the San Marcos River stakeholders' awareness and knowledge of invasive species and their attitudes towards them, a survey of randomly selected users of the San Marcos River from Hays and Travis County was conducted and a total of 351surveys were completed. In general, the public's overall knowledge of invasive species was moderate as was their knowledge of invasive species in the San Marcos River. There was a high level of support for control and eradication programs mainly among men, and people who were familiar with control and eradication projects. Proposed management methods influenced levels of support, and projects involving the use of chemical controls or the deaths of animals were least supported. Survey participants who had prior knowledge of control and eradication programs and who were members of conservation organizations, in general, showed higher levels of

support, indicating the importance public education programs have in terms of increasing public awareness and support for invasive nonnative species management projects.

Evaluation of Aquatic Macrophyte Community with Emphasis on *Hydrilla verticillata* in Porto Primavera Reservoir, Brazil

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Porto Primavera reservoir, located on Parana River, covers 204,000 hectares and is administrated by CESP (Sao Paulo Energy Company). The reservoir was fulfilled in two steps: In the first one, the water level was raised to 253 m (sea level) and, in the second, completed for 257 meters. This reservoir has a very deep central channel (old way of Paraná River), but the major part of the flooded area is relatively shallow, has clear water, and is colonized by a much diversified aquatic plant community. In 2007, hydrilla (*Hydrilla verticillata)* was reported in this reservoir (first time also in Brazil). In 2007, a project was initiated aiming to identify the aquatic weed populations present in this water body and evaluate the hydrilla population development. The project was carried out in two periods: 2007/2008 and 2009/2010. The aquatic macrophyte community was composed by 27 species distributed in 20 botanical families. The main population infesting the water body was *Hydrilla verticillata*, with high frequency values, especially at the shallowest areas (until 2.0 meters), but the colonization was detected until 8 meters of depth in lentic areas. The population size reached 30,000 hectares in 2008. In 2010/2011 an expressive decay of *H. verticillata* population was observed with reduction on plant vigor. Field observations showed several symptoms of natural enemies' actions and a lot of plants sinking due to golden mussel growth in their steams. A new project is being initiated to evaluate the biotic pressure on hydrilla in this reservoir.

Response of *Urochloa subquadripara* and *U. mutica* Accesses to Herbicide Doses, under Greenhouse Conditions

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Urochloa subquadripara and *Urochloa mutica* are the most important exotic species colonizing water bodies in Brazil. These plants have a great power of population expansion in water bodies and very low natural enemies pressure, growing quickly in lake, river and water reservoir margins, displacing native vegetation and reducing local biodiversity. It is very common the epiphytic growth of these weeds on floating plants banks raising its importance in the water body. Twenty-nine accesses of *U. subquadripara* and eight of *U. mutica* were collected from different parts of South-Eastern region of Brazil, including the states of Sao Paulo, Minas Gerais and Paraná. The herbicides glyphosate at 0.5, 1, 2 e 4 L.ha-1, haloxyfop-methyl-ester at 0.25, 0.5 and 1.0 L.ha-1; and imazapyr at 0.5, 1.0 e 2.0 L.ha-1 of the commercial formulations were evaluated in these weed's control. The herbicides were sprayed at 200 L.ha-1 of herbicide solution. All data, based on percentage of tissue damage, were submitted to arc.sen($\sqrt{(x)}$) transformation and the average values were compared by Tukey's analyses. Imazapyr was not efficient controlling both *Urochloa* species. *Urochloa subquadripara* and *U. mutica* accesses showed different response to glyphosate and haloxyfop-methyl-ester, showing tolerance variability, especially in lower doses (0.5 and 1.0 L/ha). Glyphosate at 0.5 L/ha promoted an excess of gem sprouting in *U. subquadripara* plants.

Snake Recognition, Preservation, and Safety for the Aquatic Specialist

Clint Pustejovsky
Texas Snakes, Houston, TX

See http://www.texassnakes.net/ for more information.

Assessment of *Arundo donax* control on Lady Bird Lake in Austin, TX
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City of Austin, Austin, TX

Arundo donax (giant cane) is a tall, perennial reed-like invasive grass species common in central Texas riparian areas. In 2011, *A. donax* covered 3.4 acres around Lady Bird Lake in Austin, TX, growing in 50 discrete patches and prompting City of Austin control efforts. Because of proximity to the public trails, some of the patches were cut starting in August 2011, and allowed to re-grow prior to herbicide treatment in October 2011. Four treatment groups were delineated by cut/not cut treatment and herbicide type. Many patches had adjacent non-target vegetation (mixed patches), so two herbicide solutions were used: glyphosate/imazamox on monoculture patches and, since glyphosate can impact desirable non-target plants, imazamox alone on mixed patches. Patches were grouped according to canopy cover, slope steepness, and distance from water, and then evaluated in 2012 for number of live and dead stalks. The fraction of dead stalks was compared between treatment types and environmental conditions. Results showed that environmental conditions did not significantly affect the fraction of dead *A. donax*, while the herbicide treatments did have a significant effect. The uncut *A. donax* patches sprayed with imazamox and the cut patches sprayed with the glyphosate/imazamox mix had significantly higher fractions of dead stalks. This suggests that the most effective herbicide treatments would be to spray mixed patches with imazamox when *A. donax* is at its full height, or to spray monoculture patches with the glyphosate/imazamox mix.

Fate of Copper from Herbicide and Algaecide Applications: Myths and Data
John H. Rodgers, Jr.
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Copper formulations of herbicides and algaecides have been and continue to be important for management of invasive aquatic weeds and problematic algal blooms. Understanding the consequences of those treatments is crucial for informed management of impaired water resources. The purpose of this research was to compare some general views of the fate and effects of copper applications in aquatic systems with peer reviewed literature and current data. This presentation contrasts views of copper as “a toxic heavy metal” and “speciation and bioavailablity of copper in aqueous and solid phases of aquatic systems.” The ontogeny of the myths is explored as well as factors contributing to their perpetuation. Careful studies of copper applications using modern analytical techniques (such as ICP-OES) as well as laboratory and filed data have served to provide accurate information to evaluate the actual risks associated with applications of copper-based herbicides and algaecides. These studies demonstrate that laboratory experiments and modeling can be used to predict algal responses to algaecide treatments, post-treatment sediment copper concentrations, and responses of benthic invertebrates following algaecide treatments. Further, data from these studies also show that although copper accumulations in sediments from algaecide treatments can be measured, they are likely insufficient to elicit adverse effects on benthic invertebrates or other sensitive species.

Management Options for *Prymnesium parvum*
John H. Rodgers, Jr.
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Recently *Prymnesium parvum* N. Carter has become more widespread and prevalent in the southern United States posing unique problems for water resource managers. Since the potential impacts of *P. parvum* are relatively well known as well as its capabilities to severely affect fish in important fresh and brackish water resources, managers have sought efficacious, environmentally sound and socially acceptable strategies for managing this noxious species. For critical, multiple use water resources, adaptive water resource management is needed and all potentially viable approaches for intervening are considered as these haptophytes colonize an aquatic system. As fish mortalities accumulate and the causative agent is accurately identified, applications of algaecides are capable of controlling *P. parvum* if intervention occurs early in the invasion process. We used laboratory testing to identify an efficacious algaecide for control of *P. parvum*. Samples of *P. parvum* from Texas, Arizona, Florida, North Carolina and South Carolina were evaluated for their responses to U.S. EPA registered algaecides. *P. parvum* from all of these locations uniformly responded to single pulse exposures of Cutrine®-Plus at 200 µg Cu/L. *P. parvum* from West Virginia and Florida has been controlled using Phycomycin. This information has been integrated into

field strategies and has been successful for controlling *P. parvum* at several sites. Given the spread of this haptophyte, site-specific strategies will be needed. As these strategies are implemented, strategic monitoring can provide data to improve decisions made through adaptive water resource management.

The Use of Algaecides in Adaptive Water Resource Management
John H. Rodgers, Jr. and Alyssa Calomeni
Clemson University, Clemson, SC

Noxious and invasive algae have continued to plague important water resources throughout the U.S. These crucial water resources are currently used intensively for multiple purposes and often require an adaptive management strategy to restore these usages. When needs for unimpaired water are imminent, algaecides are often the preferred approach for interdiction. Important in mitigation of risks posed by noxious algae is that the "cure is not worse than the disease". We have developed and implemented Algal Challenge Testing to efficiently and effectively target the specific algal species or strain that is prohibiting or interfering with the use of the water resource. Information derived from the laboratory and thorough field monitoring before and after treatments has illustrated the practicality of this approach. Further, the information can be used to put risks of action vs. no action into perspective. This presentation includes two case studies illustrating an adaptive management approach for water resources.

Flumioxazin Alone and in Combination with Endothall, Glyphosate, Imazamox and Bispyribac-sodium for the Control of Giant Salvinia
Dearl E. Sanders
Louisiana State University AgCenter, Clinton, LA

Giant salvinia (*Salvinia molesta*) has been a major economic invasive aquatic pest in Louisiana since 1999. Current infestation estimates indicate over 50,000 acres of water is infested. Control with herbicides has been problematic over the past 10 years due primarily to the ability of the plant mats to regenerate quickly from remnant plants. Previous work in 2009 and 2010 indicated that the herbicide flumioxazin was very active on giant salvinia but did not provide 100% control from a single application. Three trials were conducted in 2012 and 2013 to determine if foliar applications of flumioxazin used in combination with other aquatic herbicides would increase efficacy. Trial 1 consisted of flumioxazin applied at rates from 0.191 to 0.383 lb/a ai alone or in combination with glyphosate at 3.0 lb/a ai. Glyphosate alone was applied at 3.0 lb/a ai. Giant salvinia control from flumioxazin ranged from 93.3% at the low rate to 98.3 respectively at the high rate 24 DAT. Control with glyphosate alone was 80%. Control with the flumioxazin in combination with glyphosate was 100% at all rates tested. Trial 2 consisted of foliar applications of flumioxazin at 0.191 lb/a ai in combination with glyphosate at 3.0 lb/a ai, endothall at 0.52 lb/a ai, imazamox at 0.25 lb/a ai and bispyriac-sodium at 0.05 lb/a ai. At 28 DAT both the flumioxazin+glyphosate and flumioxazin+endothall combinations provided 100% control. The flumioxazin+imazamox provided 99.3% control and the flumioxazin+bipyribac-sodium provided 97.7% control. Trial 3 consisted of the treatments in Trial 2 applied over-the-top of dormant bald cypress (Taxodium distichum). Applications were made 2/1/2013 to dormant 5-7 ft trees. At 80 days after application the cypress were evaluated for injury. No injury was noted in any of the treatments. Based on these data flumioxazin applied at relatively low rates in combination with relatively low rates of glyphosate or endothall is effective in controlling giant salvinia. Based on the limited data from the cypress trial these treatments may be effective as a dormant season spray by air.

An Initial Test into the Selectivity of Eight Herbicides for Management of Hydrilla in the Presence of Eight Co-occurring Native Plant Species (*Student Presentation*)
Bradley T. Sartain and John D. Madsen
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The effects of four systemic and four contact herbicides on hydrilla and eight native aquatic plant species was observed over a 12 week period at the mesocosm facility located on the R.R. Foil Plant Science Research Center, Mississippi State University, Starkville, Mississippi. A series of treatments was applied to a set of emergent and floating plant species as well as a treatment for submersed plant species. Emergent and floating species consisted of American Lotus (*Nelumbo lutea* Willd.), white water lily (*Nymphaea odorata* Aiton), water primrose (*Ludwigia*

peploides (Kunth) P.H. Raven) and American pondweed (*Potamogeton nodosus* Poir.). Submersed species consisted of coontail (*Ceratophyllum demersum* L.), elodea (*Elodea canadensis* Michx), bladderwort (Utricularia sp.L.), sago pondweed (*Stuckenia pectinata* (L.) Börner), and hydrilla (*Hydrilla verticillata* L.f Royle). Each plant species was planted in 10 x 12 centimeter (cm) pots or 25 x 30 cm submersible cages and was grown for 4 weeks prior to treatment. Plants were treated with four contact herbicides (diquat, endothall, flumioxazin, and copper) and four systemic herbicides (fluridone, imazamox, penoxsulam and bispyribac sodium). All herbicides were applied to the water at typical recommended treatment rates for hydrilla. Contact herbicides were allowed a 12 hour contact time, after which the tanks were drained and replaced with pond water. Harvests for both systemic and contact herbicide treatments were conducted at 4, 8, and 12 weeks post treatment to assess plant biomass and re-growth. Treatments were compared using a two-way analysis of variance with a Fisher's protected LSD test, using time as a variable and species as a variable.The systemic herbicide bispyribac sodium and the contact herbicide copper significantly reduced hydrilla biomass when compared to all other treatments after the 12 week period. Copper also significantly reduced the biomass of all submersed plants used in the study. In contrast, bispyribac sodium selectively controlled for hydrilla, and all other submersed and emergent/floating species treated with bispyribac sodium were not significantly reduced when compared to the reference over the 12 week study period. Research into herbicide selectivity allows for the development of herbicide use patterns that maximize the control of hydrilla and minimize the effects on native aquatic plant species.

NPDES and Operational Reporting Requirements and Results for Aquatic Plant Management in FL Public Waters

Jeffrey D. Schardt
Florida Fish and Wildlife Conservation Commission, Tallahassee, FL

The Florida Legislature designated the Fish and Wildlife Conservation Commission (FWC) as the state's lead agency …"to direct the control, eradication, and regulation related to noxious aquatic weeds"…in Florida waters (369.20, Florida Statutes). FWC contracts with government and private sector entities to control aquatic plants in 1.25 million acres of public lakes and rivers (sovereignty lands accessible via public boat ramps). Since the early 1980s, annual legislative appropriations for aquatic plant management have been made on a needs- and performance-oriented basis. FWC biologists inventory aquatic plants and identify related problems in all 460 public waterbodies, and monitor cost-effectiveness and impacts from management operations. An annual report has been filed each January 1 since 1981 with the Florida Legislature, documenting invasive plant presence, acres controlled, and funds expended managing aquatic plants during the previous year. On October 20, 2011, the Florida Department of Environmental Protection (DEP) issued a generic permit to FWC pursuant to the National Pollution Discharge Elimination System (NPDES) as a large operator discharging herbicides to waters of the U.S. within Florida for the purpose of managing aquatic plants. This permit requires an annual report, due to the DEP on or before February 15 each year, documenting the pounds of each herbicide active component applied under FWC-funded aquatic plant management programs to waters of the U.S. during the previous year. Information will be presented on the collection and reporting of data along with statewide results from both reports.

Herbicide Applications to Dried Ponds: Will it Prevent the Growth of Submersed Vegetation in Arkansas Baitfish Culture Ponds?

George Selden
University of Arkansas at Pine Bluff, Jonesboro, AR

The growth of submersed aquatic vegetation continues to be a significant, economic hindrance for the Arkansas Baitfish industry. In the past, low rates of fluridone, added at the time of pond filling, were successfully used in an attempt to delay plant growth. Last year, six rice herbicides were applied to dried pond bottoms, prior to filling, to act as a pre-emergent. The results were promising for five of the herbicides, but inconclusive. For this growing season the work was repeated, using five of the herbicides selected for last year. Also, instead of 10' spray boom and 13 gallon mixing tank mounted on a 4-wheeler, herbicide application will be conducted using a 20' spray boom mounted to a tractor with a 100 gallon mixing tank. It is hoped that this will make application easier and more consistent. If the use of these pre-emergent herbicides delays the growth of submersed weeds long enough for a phytoplankton bloom to become established, there is a potential to reduce production costs for baitfish growers.

Floating Aquatic Weed Control Using Imazapyr

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Although native to South America, the macrophytes *Eichhornia crassipes*, *Pistia stratiotes* and *Salvinia molesta* cause major problems in Brazil, especially in reservoirs for public water supply and power generation. While control is important, we seek to avoid oxygen depletion.. Imazapyr at 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, and 4.0 L.ha-1 were evaluated.. Doses of 2.5 - 4.0 L.ha-1, provided long lasting control of *E. crassipes*. At lower doses, the control was efficient, but did not avoid profuse plant regrowth. *Pistia* control was achieved at doses above 2.0 L.ha-1. At lower doses regrowth also was observed. The control of *Salvinia molesta* was achieved only at the highest dose (4.0 L.ha-1). The onset of symptoms was slow, but plant growth immediately ceased.

Aquatic Plant Identification and Management: Importance and Perceptions of Educational Outreach through the Texas A&M Agrilife Extension Service

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The need to educate the general public about aquatic plant identification and management is apparent based on the voluminous amount of aquatic plant questions received by County and Regional Extension Agents and Extension Specialist within the state of Texas. Aquatic plant identification and management Extension programming is well attended and is requested more frequently than fish/pond management Extension programs. Texas A&M Agrilife Extension promotes and improves educational outreach for aquatic plant management through County Agent contact, Extension Specialist contact , Extension programming, publications, and web-resources including Aquaplant.tamu.edu. This presentation will cover the various aspects of current aquatic plant management Extension services at Texas A&M, and will detail some of the possible ways in which Extension programming and resource availability are likely to change as Extension resources evolve in the future.

Pre-emergent Control of *Equisetum hyemale* (Scouringrush) in De-watered Irrigation Canals with Galleon™ (a.i. penoxsulam), Sonar Genesis™ (a.i. fluridone), and Clearcast™ (a.i. iImazamox), Alone and in Combination Programs

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Commonly found in terrestrial and riparian sites, alongside sandy banks of irrigation canals, railway embankments, and other frequently disturbed habitats in the Western U.S., *Equisetum hyemale* (Scouring rush: EQUHY) has been documented to result in significant reductions in both canal flow via ponding and subsequent siltation, and through evapotranspiration. *E. hyemale*, while classified as a perennial, can become deciduous in seasonally dry sites such as irrigation canals that would receive little moisture otherwise, especially so in semi-arid regions of the Western U.S. Prior research has documented this species is less responsive than other weed species to common irrigation canal management strategies e.g., mowing, ditch scraping or reshaping, or herbicide chemistries such as glyphosate, diuron, and 2,4-D. Previous research examining the efficacy of the Sonar Genesis™ formulation of fluridone (60 g ai/L), Clearcast™ (imazamox; 120 g ae/L), and their combination on *E. hyemale* demonstrated excellent control throughout season of application and in reducing population densities in subsequent seasons. Following a successful two-year EUP program, Galleon™ (ai: penoxsulam) was registered by USEPA for application to dewatered Western U.S. irrigation canals for pre-emergent weed control following refill. To expand successful pre-emergent use, Galleon was evaluated alone and in combination with Sonar Genesis™ and Clearcast™ for pre-emergent activity and control of *E. hyemale*. Sonar Genesis (2.24 – 0.56 kg fluridone/ha), Clearcast (0.56 – 0.125 kg ae imazamox/ha), Galleon (0.1 – 0.05 kg ae imazamox/ha), Sonar Genesis (2.24 –1.95) plus Clearcast (0.14-0.56 kg ae imazamox/ha), Sonar Genesis (2.24 – 1.95) plus Galleon (0.1 – 0.05 kg ae imazamox/ha), and Clearcast (0.14-0.56 kg ae imazamox/ha) plus Galleon (0.1 – 0.05 kg ae imazamox/ha)

treatments applied to dormant *E. hyemale* that had been previously established in 35.5 cm tall by 11.5 cm diameter pots in the greenhouse and on field sites with no prior herbicide treatment history. *E. hyemale* will be rated for visual symptoms, stems count, and fresh weights of above ground biomass harvested approximately one month after the post-emergent treatment. 2012-13greenhouse and field results will be presented to highlight performance advantages of this new aquatically-labeled active ingredient as combinational program partner for managing *E. hyemale* and other common species encountered in the Western irrigation markets.

Phenology of Curlyleaf Pondweed (*Potamogeton crispus*) in the Southeastern U.S.
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Curlyleaf pondweed (*Potamogeton crispus*) is a submersed aquatic plant that is native to Europe, Asia, Africa, and Australia. It first appeared in the United States in the 1840's and has since been distributed throughout the lower 48 states. Curlyleaf pondweed spread across the southeastern parts of the U.S. in the 1940's and 50's. Long distance dispersal is thought to occur mainly through fish hatchery activities and in many states, the first observance of curly leaf pondweed was in hatchery ponds. Curlyleaf pondweed is capable of outcompeting native species and forming large monospecific beds. Curlyleaf pondweed primarily reproduces vegetatively via turion production or rhizome elongation. Turions, vegetative structures capable of surviving extreme conditions (i.e. drought, freezing, herbicide treatments) and producing a viable plant capable of reproduction, are typically produced in the weeks before the plant senesces. In northern populations, curlyleaf pondweed has an atypical growth cycle in that it senesces in early summer, is dormant through the summer, and turions sprout in mid to late fall, and produces turions in the spring. Our study was conducted to better understand the phenology of curlyleaf pondweed in the southern U.S. because so little is known about these populations. In our study, plant height peaked in July at 68 cm. This coincided with maximum annual water temperatures of 30ºC (86°F). Total biomass peaked in August 2012 and January 2013. However, plant growth occurred in all months. Turion, aboveground (minus turions), and belowground plant structures made up 19 %, 44 %, and 37 % of total plant biomass respectively. On average, plants yielded 39 turions per individual or 2,140 turions per square meter of substrate. It appears that plant growth and turion production occur year round suggesting that southern populations of curlyleaf pondweed have altered their phenology to climatic conditions present in the southeastern U.S.

The Full Monty: How Simultaneously Assessing Both Plant Species Occurrence and Abundance using Standard Methodology is Critical for Good Lake Ecosystem Management
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New acoustic and computing technologies are empowering the aquatic resource manager to acquire more and better data quickly; thus leading to better aquatic resource management decisions. Aquatic managers have long recognized the importance of species frequency surveys for assessing aquatic plant species composition patterns and response to management. However, prior to automated acoustic technologies, fundamental aspects of plant abundance patterns were not generally measured or done so qualitatively. We discuss how complementing both species and abundance surveys is critical for understanding not only status of aquatic plant growth but also water quality conditions, fish habitat quality, and overall ecosystem resilience. Further we stress the importance of standardized quantitative methodology such that managers and researchers across multiple programs can work together, share information, and learn from each other.

Evaluation of Nutrients Leaching during Decomposition of Aquatic Weeds: Lysimeters Studies
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A study was carried out aiming to evaluate the nutrients leaching during aquatic weed decomposition, providing information for risk analysis of the disposal area. The experiment was conducted in 18 lysimeters (2,5 m of height and 1,0 m of diameter) fulfilled with a sandy soil until 1.8 m. Six doses of chopped macrophytes were tested

(disposal layers of 0, 10, 20, 30, 40 and 50 cm) with three replications. The nutrient concentrations were evaluated in soil solutions collected at 0.5, 1,0 and 1,5 m of depth, at 60 days after plant disposition. Comparing the average of all doses for each depth, increases were observed in N, Na, Ca, Mg, Mn concentrations, and reductions in K, S, Cu and Fe, from depths 0.5 to 1.0. There were no differences between depths 1.0 and 1.5 meter. No trends were observed for B and Zn concentrations. The concentration of N and B were not enhanced by the disposition of macrophytes in three depths evaluated. This same behavior was observed for concentrations of Cu and Zn at 1.0 and 1.5 meters. For all depths, the concentrations of K, Na, Ca, Mg and Mn were increased as the amount of biomass increased and there was a tendency of relationship between macrophyte amount and nutrient concentration value. This same behavior was observed for Fe at depths of 1.0 and 1.5 meters. Effectively there is a risk that plant aquatic biomass disposal can contaminate the ground water.

Comparative Phyto-uptake Across Distribution Coefficients of Pharmaceutical Compounds and Aquatic Macrophytes: Carbamazepine and Amiodarone Uptake in *Lemna* spp. *(Student Presentation)*

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Few studies have been conducted on the effectiveness of phytoremediation for pharmaceutical compounds, although the persistent and non-acutely toxic nature of many of these compounds in today's water bodies may yield an ideal application for this practice. To quantify the potentially effectiveness of plant uptake, kinetic and proportional bioconcentration factors (BCF_k, and BCF_p, respectively) in nanograms (ng) Carbamazepine and Amiodarone per gram (g) wet weight plant tissue for *Lemna* spp. were determined utilizing a 14-day continuous flow-through study. Samples were analyzed using isotope dilution liquid chromatography-tandem mass spectrometry (ID-LC-MS/MS) running in positive ion mode. Mean Carbamazepine water exposure concentration for the accumulation portion of the study was 100.3 ± 5.605 µg/L. Kinetic BCF was estimated at 0.5377, while proportional BCF was estimated at 0.485. Mean Amiodarone water exposure concentrations for the accumulation portion were 87.05 ± 54.257 µg/L. Kinetic BCF for the Amiodarone study was estimated at 23.0334, whereas proportional BCF was estimated at 41.340. Steady state was not achieved during the Amiodarone study, so proportional estimates may be overestimated. Average uptake in nanograms of compound per gram of wet weight was found to be greater in Amiodarone-exposed *Lemna* test organisms than during the Carbamazepine exposure. Sources of error, such as possible contamination of the C_{18} column and peristaltic pump failure, may have impacted uptake results. Variability caused by sources of error may have inhibited the accuracy of these data, and given the current lack of research in the field, this work should be considered exploratory, rather than conclusive.