



**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:** The Aquatic Plant Management Society strives to promote environmental stewardship through operations, research, education and outreach related to integrated management of vegetation in aquatic systems.





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## Board of Directors

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## Committee Chairs

Awards	Don Doggett
Bylaws and Resolutions	Jim Schmidt
Education and Outreach	Susan B. Wilde
Exhibits	Harry Knight
Finance	Richard Hinterman
Legislative	Joe Bondra
Meeting Planning	Bo Burns
Membership	Joshua Cheshier
Nominating	Carlton Layne
Past President’s Advisory Program	Carlton Layne
Publications	Linda Nelson
Regional Chapters	Michael Netherland
Scholastic Endowment	Tyler Koschnick
Strategic Planning	Susan Sweeney
Student Affairs	John H. Rodgers, Jr.
Website	Rebecca Haynie Mike Grodowitz

## Special Representatives

AERF	Carlton Layne
BASS Representative	Gerald Adrian
CAST Representative	John Madsen
ISAC Representative	Earl Chilton
NALMS Representative	Michael Netherland
RISE Representative	Joe Bondra
Science Policy Director	Lee Van Wychen
Webmaster	Dave Petty
WSSA Representative	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 "Lou" 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

## **Past 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" Val Guerra (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)

### **President's Award (year of honor)**

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)

### **Max McCowen Friendship Award (year of honor)**

Judy McCowen (1995)  
John E. Gallagher (1997)  
Paul C. Myers (2000)  
William T. Haller (2002)  
Bill Moore (2006)

### **T. Wayne Miller Distinguished Service Award (year of honor)**

Gerald Adrian (2005)  
Linda Nelson (2007)  
Surrey Jacobs (2009)

## Sustaining Members

The Aquatic Plant Management Society appreciates the valuable support of the following Sustaining Members!



Applied Biochemists, an Arch Chemicals, Inc. company, congratulates the APMS on its 50<sup>th</sup> Anniversary. This longevity is testimony to a professional organization with worthy objectives, strong leadership, dedicated membership and consistent financial support. AB employees are proud to have been members, sponsors and participants in APMS for over 40 of these years. As a manufacturer of algaecides and aquatic herbicides, we place high value on the science and integrity the APMS and its members bring to our industry.



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 the state of Florida that include individuals, developers, homeowners associations, golf courses, mobile home communities, utilities, local, state and federal government agencies and industry. Our experienced professional applicator staff provides unique knowledge along with advanced equipment to manage all types of waterway, right of way, wetland, and upland systems.



Aquarius Systems offers a wide variety of equipment for surface water management applications worldwide. Our product line includes aquatic plant harvesters, marine debris skimmers, heavy duty aquatic vegetation shredders, amphibious excavators and many other custom designed vessels. Please visit our website to learn more! [www.aquarius-systems.com](http://www.aquarius-systems.com)



**Aqua Services, Inc.**

Aqua Services, Inc. is a full-service, aquatic resource management company that specializes in aquatic vegetation management. Established in January 1983 by Terry Goldsby, the company has provided aquatic plant management services for entities in the southeastern U.S. that include the Army Corps of Engineers, the Tennessee Valley Authority, Southern Company partners, and the Pearl River Valley Water Supply District. Aqua Services also provides lake and pond management consulting including electro-fishing assessments, water quality analysis and enhancement, and recreational lake design.



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, BASF, BioSafe Systems, Brewer International, SePRO, Syngenta, United Phosphorus Incorporated, AquaMaster, Kasco, and Otterbine. Aquatic Control, Inc. has three offices that offer aquatic vegetation management plans including vegetation mapping and application services, fountain and aeration system installation, maintenance, and service throughout the Midwest.



Brewer International has been a chemical manufacturer since 1973. Brewer is located in Vero Beach, Florida. 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 New OMRI Listed Organic surfactants: Organic-Kick and Vin-Kick. The company offers aquatic surfactants Cide-Kick, Cygnet Plus, I'Vod, and Poly Control 2. Check out our web site [www.brewerint.com](http://www.brewerint.com).



BioSonics has worked with the aquatic community for more than 30 years, applying the science of hydroacoustics to assess and monitor underwater habitats. Specialized analysis software developed in cooperation with the U.S. Army Corps of Engineers, enables rapid, economical, reliable collection and assessment of submersed aquatic vegetation distribution and abundance. Tested and proven around the world; reliable, repeatable, quantifiable data from the BioSonics DT-X scientific echosounder can also provide information on fish and substrate.





Cygnet Enterprises, Inc. is a national single source distributor of aquatic management products with offices and warehouses in Michigan, Indiana, Pennsylvania, North Carolina, California, Idaho, and Washington. 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. Please visit [www.cygnetenterprises.com](http://www.cygnetenterprises.com)



Clarke 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.



Phoenix Environmental Care, LLC, where proven, popular aquatic and turf care products are made better through enhanced technology. Our name is a good descriptor, because we truly are an organization that cares. We care about delivering real, measurable benefits to our customers by providing products with superior efficacy, innovation, and cost-effectiveness, backed by exceptional services and product support.



ReMetrix, LLC is the national leader in large-scale aquatic habitat mapping. Since 1999 ReMetrix has mapped over one million surface acres of aquatic resources through the combined use of hydroacoustic surveys, remote sensing analyses, species sampling, sediment sampling, GIS, GPS-linked underwater imaging, and complementary technologies.



SePRO Corporation is recognized as an industry leader in providing the highest level of technical services to customers who operate in specialty niche markets of the USA. SePRO's key business segments include the U.S. Aquatics Industry, Horticulture/Greenhouse Markets, and Professional Turf Management. After 17 years, SePRO has established itself as the world's largest manufacturer of aquatic plant protection products and has grown into the largest dedicated sales, research and marketing organization in the aquatics industry. Learn more about SePRO Corporation, its products, services and technologies at the SePRO website: [www.sepro.com](http://www.sepro.com)



Invasive weeds can devastate both natural and commercial habitats. **Syngenta Professional Products** provides high performance products to control these destructive weeds while helping to restore the habitat of aquatic environments. Proven herbicides for the weed control industry from Syngenta include Reward®, Touchdown PRO®, and Refuge™, the latest and most concentrated glyphosate in the aquatics market.



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



**Get the Vertex Advantage!** Vertex Water Features manufactures advanced diffused air aeration systems for all sizes of lakes and ponds. Vertex aeration can help your aquatic management plan meet pending NPDES permitting "Best Management Practices" requirements. Reduce chemical costs by oxidizing suspended organic particulates that and reduce efficacy of diquat, fluridone and other algaecides and herbicides. Aeration can eliminate low-oxygen fish kills and odors, reduce nutrients and digest bottom muck. Contact us at **800-432-4302** ♦ [www.vertexwaterfeatures.com](http://www.vertexwaterfeatures.com).

## Meeting Sponsors

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

### Platinum

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**Florida Aquatic Plant Management Society**  
Orlando, Florida

**United Phosphorus, Inc.**  
King of Prussia, Pennsylvania

**Syngenta Professional Products**  
Greensboro, North Carolina

**Valent USA Corporation**  
Walnut Creek, California

### Silver

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**Aquatic Ecosystem Restoration Foundation**  
Flint, Michigan

**SePRO Corporation**  
Carmel, Indiana

**Phoenix Environmental Care, LLC**  
Valdosta, Georgia

### Bronze

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**Applied Biochemists**  
Germantown, Wisconsin

**Vertex Water Features**  
Pompano Beach, Florida

**Helena Chemical Company**  
Collierville, Tennessee

### Contributor

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**Aqua Services, Inc.**  
Guntersville, Alabama

**Aquatic Systems, Inc.**  
Pompano Beach, Florida

**Crop Production Services**  
Loveland, Colorado

**Aquatic Control, Inc.**  
Seymour, Indiana

**Brewer International**  
Vero Beach, Florida

**Cygnets Enterprises, Inc.**  
Flint, Michigan

## **Scholastic Endowment Sponsors**

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

### **Reverse Raffle Grand Prize**

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*Cygnets Enterprises, Inc.*  
*Flint, Michigan*

*Cygnets Enterprises, Inc. has graciously donated a \$1,500 VISA gift card for the Reverse Raffle*

### **Duck Race**

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*SePro Corporation*  
*Carmel, Indiana*

*SePro Corporation has graciously contributed \$500 for the Duck Race*

## Exhibitors

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

***Applied Biochemists***  
*Germantown, Wisconsin*

***Aquatic Eco-Systems, Inc.***  
*Apopka, Florida*

***Biosorb, Inc.***  
*St. Charles, Missouri*

***Chemical Containers, Inc.***  
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***Commerce Systems Group***  
*Virginia Beach, Virginia*

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***Natural Reflections, LLC***  
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***Remetrix, LLC***  
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***Sonic Solutions, LLC***  
*West Hatfield, Massachusetts*

***United Phosphorus, Inc.***  
*King of Prussia, Pennsylvania*

***Vertex Water Features***  
*Pompano Beach, Florida*

***Aquatic Control, Inc.***  
*Seymour, Indiana*

***BioSafe Systems, LLC***  
*Canoga Park, California*

***Brewer International***  
*Vero Beach, Florida*

***Clean Lakes, Inc.***  
*Couder d'Alene, Idaho*

***Crop Production Services***  
*Loveland, Colorado*

***Helena Chemical Company***  
*Collierville, Tennessee*

***Phoenix Environmental Care, LLC***  
*Valdosta, Georgia*

***Red River Specialties***  
*Davenport, Florida*

***SePRO Corporation***  
*Carmel, Indiana*

***Syngenta Professional Products***  
*Greensboro, North Carolina*

***Valent USA Corporation***  
*Walnut Creek, California*

## **General Information**

### **Program Organization**

The Agenda is organized by day and time. Posters and abstracts are organized in alphabetical order by first author.

### **Name Badges**

For all events and functions at the meeting, your name badge is your ticket. 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 is located in the Calusa Prefunction area located in front of the Calusa Ballrooms. For specific times, please see the Agenda in this Program. Messages will be posted at the meeting registration desk.

### **Exhibits**

Exhibits will be open from 7:30 a.m. Monday to 3:00 p.m. Wednesday in Calusa Ballrooms D-H.

### **Posters**

Posters will be open for viewing from 7:30 a.m. Monday to 3:00 p.m. Wednesday in Calusa Ballrooms D-H. A special Poster Session and Reception will be held on Monday from 6:00 p.m. to 7:30 p.m. in Calusa Ballrooms D-H. Poster presenters are required to attend the special Poster Session to answer questions. In addition, presenters are requested to be in attendance during scheduled refreshment breaks.

### **Refreshment Breaks**

Continental breakfasts, mid-morning, and afternoon refreshment breaks, graciously co-sponsored by the Florida Aquatic Plant Management Society, Helena Chemical Company, Vertex Water Features, Crop Production Services, and Brewer International, will be served each day of the meeting in Calusa Ballrooms D-H. For specific times, please see the Agenda in this Program.

### **APMS Student Affairs Luncheon**

The Student Affairs Luncheon will be held Monday, 12:00 p.m. - 1:30 p.m. in the Captiva Room. All students that register for the meeting are invited to attend. This luncheon will be a great opportunity to meet other students, interact with the APMS leadership, and learn how to become more involved in the Society. Susan Wilde will be the moderator, please contact Susan by 12:00 p.m. Sunday, July 11 and confirm your attendance. This luncheon is graciously sponsored by SePRO Corporation.

### **APMS Annual Business Meeting**

The APMS Annual Business Meeting will be held Tuesday, 4:30 p.m. - 5:00 p.m. in the Calusa Ballrooms A-C. 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. - 8:00 a.m. in the Captiva Room. Representatives from each APMS regional chapter are invited to attend this breakfast. Tyler Koschnick, APMS Vice President and Regional Chapters Committee Chair, will be the moderator for discussions on aquatic plant management activities within each region. Please contact Tyler by 8:00 a.m. Monday, July 12 and confirm your attendance. This breakfast is graciously sponsored by the Florida Aquatic Plant Management Society.

### **APMS Past Presidents' Luncheon**

All APMS Past Presidents are invited to attend the Past Presidents' Luncheon on Tuesday, 12:00 p.m. - 1:30 p.m. in the Captiva Room. Carlton Layne, Past President from 2009, will be the moderator for discussions on affairs of the Society. Please contact Carlton by 12:00 p.m. Monday, July 12 and confirm your attendance. The luncheon is graciously sponsored by Phoenix Environmental Care, LLC.

## **APMS Special Events**

### ***President's Reception, Sunday, July 11, 7:00 p.m. - 9:00 p.m., Waterfall Pool Deck***

The APMS cordially invites all registered delegates, guests, and students to the President's Reception, graciously sponsored by Valent USA Corporation. Enjoy a casual gathering visiting with old friends and meeting new friends, while savoring delicious hors d'oeuvres and your favorite beverage. Non-registered guests may purchase tickets at the meeting registration desk. In case of inclement weather, the President's Reception will be held at the Cypress Courtyard.

### ***Poster Session and Reception, Monday, July 12, 6:00 p.m. - 7:30 p.m., Calusa Ballrooms D-H***

The APMS cordially invites all registered delegates, guests, and students to the Poster Session and Reception, graciously sponsored by Syngenta Professional Products. This reception will provide for the viewing of posters and professional interactions and discussions in a casual setting, while enjoying delicious hors d'oeuvres and your favorite beverage. Non-registered guests may purchase tickets at the meeting registration desk.

### ***Guest Tour, Monday, July 12, 9:00 a.m. - 2:00 p.m., Meet in the Lobby, Hyatt Regency Hotel***

The APMS cordially invites all registered guests of meeting delegates to the Guest Tour, graciously sponsored by Applied Biochemists. Enjoy a 1.5-hr guided tour of the Thomas Edison and Henry Ford Winter Estates. The tour will include historic buildings, tropical gardens, Edison Botanic Lab and Estates Museum. The newly restored Edison buildings include the Main House, Guest House, and Edison Caretaker's House. The 1929 historic landscape is evident throughout the property, including Mina Edison's award winning Moonlight Garden. The Estates Museum houses an impressive collection of inventions, artifacts, special exhibitions, and archives. Guests can also enjoy the Museum Store, Garden Shoppe, Cottage Shoppe, and outdoor Banyan Café. Following the Edison-Ford Winter Estates tour, the group will enjoy fine local cuisine with lunch at *The Veranda*. Non-registered guests may purchase tickets at the meeting registration desk. The tour is limited to approximately 30 participants, so please confirm your attendance by signing up for the tour at the registration desk by noon on Monday, July 12 to ensure an accurate count for seating and lunch arrangements. The Lee County Hyacinth Control District will provide transportation; space is limited so please sign up early for the tour.

### ***Duck Race, Tuesday, July 13, 5:30 p.m. - 7:00 p.m., Belvedere Terrace Fountain***

The Scholastic Endowment Committee will conduct a "duck race" fund-raising event in the outside fountain at Belvedere Terrace. Rubber ducks can be purchased at the Meeting Registration Desk. You won't want to miss this exciting event! All proceeds generated from the duck race are directed to the APMS Scholastic Endowment Fund to support future student events and the APMS Graduate Student Research Grant. Cash prizes for winners of the race are graciously provided by SePRO Corporation.

### ***Awards Banquet, Wednesday, July 14, 6:00 p.m. - 11:00 p.m., Calusa Ballrooms A-C***

The APMS cordially invites all registered delegates, guests, and students to the APMS Awards Banquet, graciously sponsored by United Phosphorus, Inc. This year's banquet will once again prove to be a memorable occasion. After dinner, we will recognize those who have served and contributed to the Society, welcome new officers and directors, and present awards to the student paper and poster participants. Our evening will conclude with the reverse raffle grand prize drawing, graciously sponsored by Cygnet Enterprises, Inc. Non-registered guests may purchase raffle tickets at the meeting registration desk. Entertainment will be provided throughout the evening by "The Wigglers."

A pre-banquet reception co-sponsored by Aquatic Systems, Inc. and Aquatic Control, Inc., will be held at the Calusa Prefunction area from 6:00-7:00 p.m.

**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.

**Post-Conference Student Tour**

Following the annual meeting, students will have an opportunity to participate in a tour to observe and learn about regional aquatic plant management issues in coordination with the South Florida Water Management District, U.S. Army Corps of Engineers, Lee County Mosquito Control District, and Helicopter Applicators, Inc. Students will enjoy an airboat tour of aquatic plant management sites on and around Lake Okeechobee, see a helicopter application demonstration, and visit the Lee County Mosquito Control headquarters. The group will depart the Hyatt Regency Coconut Point at 8:00 a.m. on Thursday, July 15, and return to the Fort Myers airport Friday afternoon, July 16 about 1:00 p.m. The tour is graciously sponsored by the Florida Aquatic Plant Management Society. Accommodations for Thursday night will be provided at the historic Clewiston Inn in Clewiston, Florida, located near Lake Okeechobee. Contact Brett Bultemeier, APMS Student Affairs Committee Tour Coordinator, or Susan Wilde, APMS Director and Student Affairs Committee member, for more details.

## APMS by the Decade

As we celebrate the 50<sup>th</sup> Anniversary of the Aquatic Plant Management Society, it is insightful to look back at the events that have lead us to today. The following trends and events are summarized from the Society’s Journal articles and Newsletters over the previous five decades as well as issues in the headlines related to aquatic plant management.

### 1961 – 1970

The Hyacinth Control Society incorporates on July 17, 1961, primarily for managers to share information on their efforts to control water hyacinth in Florida’s lakes, rivers, and canal systems. Accordingly, the Society is one of the first organizations formed exclusively to manage invasive species in natural areas. The first years of the Society are dedicated to defining the extent of the problem and establishing infrastructure for planning and sustaining funding to control water hyacinth. The scope of the Society quickly expands to include hydrilla (first mistakenly identified as elodea) and by the end of the decade, research begins to focus on specific tools to manage these two plants.

#### Key Events and Issues of the 1960s

- APMS organizational years
  - A Board of Directors is developed and Bylaws are adopted
  - Annual meetings are scheduled to share ideas and research results
- A journal is published to provide information to aquatic plant managers throughout the year
- *Hyacinth Control Journal* articles:
  - Majority of articles on assessing environmental problems, planning, funding, etc.
  - Most management articles focus on herbicide registration and general environmental impacts
  - Plant management articles concentrate equally on water hyacinth and hydrilla
  - Emphasis is on Florida waters and issues
- **Hydrilla is reported in FL – misidentified and called elodea through the mid 1960s**

The following tables and the tables at bottom of the next four pages summarize the focus of APMS Journal articles through the decades. The first table condenses subjects of journal articles into three categories: invasive plants, plants not considered to be invasive (i.e. native or non-problem causing exotic plants) and general articles. General articles do not concentrate on a particular plant or group of plants; rather, their focus is on establishing management programs, control priorities, funding sources, mapping protocols, etc. The second table lists plants that were the primary subject of journal articles at least five times during the decade. Both tables list the source of the article as from the USA or outside the USA (International). These summaries can reveal interesting statistics or trends. For example, from the two tables below, of the 47 invasive plant articles (top table), 37 focused on water hyacinth and hydrilla (bottom table). Nearly two-thirds of all articles during the 1960s addressed general issues related to aquatic plant management rather than control methods for specific plants.

#### Subjects of APMS Journal articles during the 1960s

Subject	# USA	# International	# Total	Percent
Invasive plant	43	4	47	30
Non-invasive plant	3	1	4	3
General	101	4	105	67

#### Plants occurring in more than five APMS Journal articles as primary focus of research during the 1960s

Plant	Status	# USA	# International	# Total
Water hyacinth	Invasive	17	4	21
Hydrilla	Invasive	16	0	16



## APMS by the Decade

### 1971 - 1980

Pesticide issues like DDT and Agent Orange compel the U.S. federal government to revise pesticide regulations. The U.S. Environmental Protection Agency is created and the Federal Water Protection and Clean Water Acts are passed by Congress. The Society further broadens its scope in the 1970s addressing plant management issues across the U.S. and reincorporating as The Aquatic Plant Management Society. Most of the research reported in the re-named *Journal of Aquatic Plant Management* centers on specific control methods for invasive aquatic plants. The species of primary concern are water hyacinth, hydrilla, and Eurasian watermilfoil; a plant that is more problematic in waters outside of Florida. Several regional chapters form to address specific operational needs of field managers. Student participation is emphasized to bring fresh ideas and leadership into the Society.

#### Key Events and Issues of the 1970s

- The U.S. Environmental Protection Agency (EPA) is formed
  - Pesticides are hereafter registered under EPA vs. the U.S. Department of Agriculture
  - The Federal Water Protection Act (1972) and Clean Water Act (1977) are enacted
  - First NPDES (National Pollution Discharge Elimination System) permits are issued
- The Hyacinth Control Society broadens its reach to a national scope
  - In 1976, the Hyacinth Control Society becomes the Aquatic Plant Management Society, Inc.
  - Annual conferences increasingly are held outside of Florida
- APMS expands to cover regional issues
  - Regional Chapters form:
    - Florida (1976), South Carolina (1979), MidSouth (1979), Midwest (1980)
  - *Aquatics* magazine is first published in 1979
- The 1<sup>st</sup> APMS student paper contest is held at the 1974 annual meeting
- *Journal of Aquatic Plant Management* articles:
  - Emphasis increases on specific control methods for targeted plants
  - Most management articles address chemical and biological control methods
  - Plant management articles focus on specific invasive aquatic plants
    - water hyacinth, hydrilla, and Eurasian watermilfoil
- **Hydrilla is first reported in AL, CA, DE, GA, and LA - eradicated from IA (1976)**

#### Subjects of APMS Journal articles during the 1970s

Subject	# USA	# International	# Total	Percent
Invasive plant	104	11	115	56
Non-invasive plant	17	1	18	9
General	61	10	71	35

#### Plants occurring in more than five APMS Journal articles as primary focus of research during the 1970s

Plant	Status	# USA	# International	# Total
Water hyacinth	Invasive	33	6	39
Hydrilla	Invasive	33	0	33
Eurasian watermilfoil	Invasive	25	1	26
Egeria	Invasive	5	2	7
Alligatorweed	Invasive	5	0	5

## APMS by the Decade

### 1981 - 1990

APMS grows both internally and internationally during the 1980s. Steps are taken to improve internal organization and financial sustainability of the Society as well as to reach out to the international community. APMS sponsors an International Symposium on Watermilfoil in conjunction with the Silver Anniversary Annual Meeting in Vancouver, Canada in 1985. Research increases on understanding plant physiology to better exploit weaknesses in plants targeted for control and to conserve non-target, comingled plants. Debate increases regarding utilizing hydrilla as a fishery and water clarity improvement tool in several southeastern states where hydrilla has colonized.

#### Key Events and Issues of the 1980s

- Internal growth of APMS:
  - Initiatives: develop financial plan, membership drives, fund student initiatives, photo contest
  - Projects: purchase computer, develop membership database, produce video tapes and other educational materials
- Increase international contacts and relevance
  - Watermilfoil symposium at 25<sup>th</sup> Anniversary Meeting in Vancouver, Canada
- Hydrilla expansion - especially monoecious hydrilla in the Potomac River and surrounding states
- Hydrilla debates:
  - Clears water in VA and MD
  - Supports fisheries in NC and FL
- Two additional APMS Regional Chapters form:
  - Western APMS forms in 1981, Texas APMS forms in 1989
- *Journal of Aquatic Plant Management* articles:
  - Emphasis on additional plants: algae, water lettuce, duckweed, spikerush, sago pondweed
  - Increasing emphasis on plant physiology, morphology, and genetics
  - Plant management focused primarily on hydrilla, water hyacinth, and Eurasian watermilfoil
- **Hydrilla is first reported in AZ, CT, MD, MS, NC, SC, TX, and VA**

#### Subjects of APMS Journal articles during the 1980s

Subject	# USA	# International	# Total	Percent
Invasive plant	114	15	129	54
Non-invasive plant	56	8	64	27
General	32	12	44	19

#### Plants occurring in more than five APMS Journal articles as primary focus of research during the 1980s

Plant	Status	# USA	# International	# Total
Hydrilla	Invasive	42	1	43
Water hyacinth	Invasive	27	6	33
Eurasian watermilfoil	Invasive	26	1	27
Algae	Native / exotic	10	0	10
Duckweed	Native	8	0	8
Water lettuce	Invasive	6	2	8
Sago pondweed	Native	5	1	6
Spike rush	Native	6	0	6
Alligatorweed	Invasive	5	0	5
Cattail	Native	5	0	5

## APMS by the Decade

### 1991 – 2000

Eurasian watermilfoil continues to gain importance as an invasive weed of national significance in the U.S. as water hyacinth continues to fade as an APMS research priority. Nearly three decades after the formation of the Hyacinth Control Society, a national awareness of problem-causing, non-native or alien plants and animals begins to take shape and the term “invasive” enters the lexicon to describe these species that have profound negative impacts on the environment and the economy. Federal funding through the U.S. Army Corps of Engineers (USACE), the long-time leader in invasive aquatic plant research and control, is significantly reduced during the mid-1990s prompting an increased role in state and non-government entity involvement in aquatic plant management. This transition is facilitated via the years of networking through APMS.

#### Key Events and Issues of the 1990s

- Increasing use of terms like holistic management, biological pollution, and invasive species
- Reduction in federal funding leads to increased APMS management role
  - USACE research and operational cost-share funds are significantly reduced nationwide
  - Aquatic Ecosystem Restoration Foundation is founded
  - More state and APMS regional chapter activity
  - APMS members assist MN and WA in developing aquatic plant management strategies
- Education and Outreach efforts
  - Scholastic Endowment Committee established in 1991 to raise funds for APMS projects
  - First APMS research grant awarded in 1998
  - Considerable outreach efforts with BASS including Memorandum of Understanding
  - Establish APMS website and online Member Directory
- Northeast APMS forms in 1999
- APMS holds international Annual Meetings – Daytona (1992) and San Diego (2000)
- Fluridone resistance confirmed and reported at San Diego Annual Meeting triggering a decade of activity to develop new herbicide management tools and strategies
- *Journal of Aquatic Plant Management* articles:
  - Management articles have increasing focus on impacts to non-target plants
  - Hydrilla and Eurasian watermilfoil peak in numbers of research articles; hyacinth is a distant third
  - Numbers of plant physiology articles draw close to chemical control research projects
- **Hydrilla is first reported in AR, PA, TN, and WA**

#### Subjects of APMS Journal articles during the 1990s

Subject	# USA	# International	# Total	Percent
Invasive plant	120	13	133	55
Non-invasive plant	28	16	44	18
General	52	15	67	27

#### Plants occurring in more than five APMS Journal articles as primary focus of research during the 1990s

Plant	Status	# USA	# International	# Total
Hydrilla	Invasive	50	2	52
Eurasian watermilfoil	Invasive	35	0	35
Water hyacinth	Invasive	10	3	13
Algae	Native / exotic	5	0	5
Torpedograss	Invasive	5	0	5

## APMS by the Decade

### 2001 – 2010

Seeking to re-energize, APMS increases efforts to support student involvement at all grade levels through instructional materials, scholarships, and financial assistance to attend and present information at APMS Annual Meetings. Hydrilla and Eurasian watermilfoil still top the list in terms of numbers of research articles, especially related to developing new compounds and strategies to control fluridone-resistant hydrilla in Florida. However, nearly a dozen invasive and native plants share the limelight with increasing awareness of giant salvinia and harmful algae blooms leading the newcomers. Standardization of regulations and federal oversight of pesticide applications to waters of the U.S. for the control of aquatic plants takes shape during the decade culminating in a 2010 EPA draft Pesticide General Permit under the National Pollution Discharge Elimination System (NPDES) permitting program. This effort will likely shape the direction of the APMS for many years to come.

#### Key Events and Issues of the 2000s

- APMS Education and Outreach
  - Graduate research stipends increase in funding
  - Student Poster and Presentation competitions established; complimentary rooms / registration
  - APMS and sponsors produce 16-page *Understanding Invasive Aquatic Weeds* booklet
    - 800,000 copies distributed nationwide 2001-2010: online interactive version activated in 2009
- NPDES permitting for aquatic plant control evolves from northwestern states to nationwide
  - 9<sup>th</sup> Circuit Court rules in 2001 that NPDES permits are required for aquatic plant control (APC)
  - EPA issues 2006 rule negating NPDES permits for APC conducted according to the EPA label
  - 6<sup>th</sup> Circuit Court vacates EPA 2006 rule, requiring national NPDES permitting for APC
  - EPA publishes draft Pesticide General Permit for APC under the NPDES permitting program
- Invasive species awareness increases
- Researchers at several universities and institutions confirm fluridone resistance in Florida hydrilla
  - APMS works with Industry and EPA to register additional herbicide compounds for hydrilla control
- Harmful algae blooms become an increasing environmental and management issue
- *Journal of Aquatic Plant Management* articles:
  - Number of Eurasian watermilfoil articles surpass hydrilla; Giant salvinia articles match hyacinth
  - 25 different invasive species are focus of published research
- **Hydrilla is first reported in ID, IN, KY, MA, ME, NJ, NY, OK, WI, and WV**

#### Subjects of APMS Journal articles during the 2000s

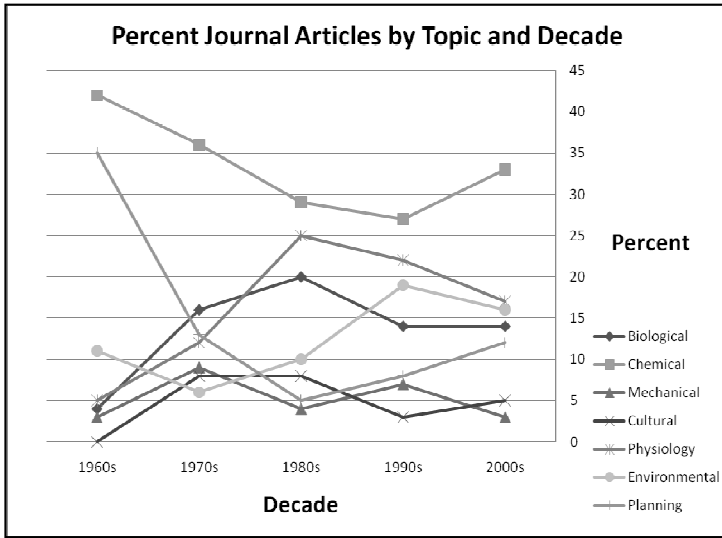
Subject	# USA	# International	# Total	Percent
Invasive plant	137	19	156	60
Non-invasive plant	42	1	43	18
General	46	13	59	23

#### Plants occurring in more than five APMS Journal articles as primary focus of research during the 2000s

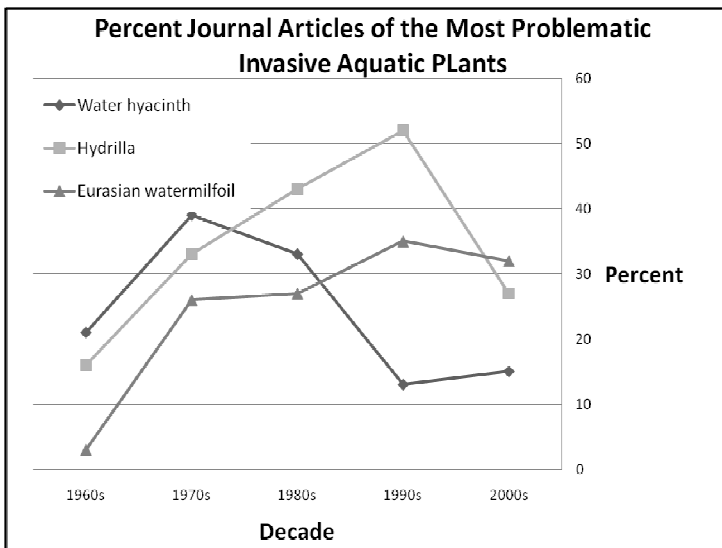
Plant	Status	# USA	# International	# Total
Eurasian watermilfoil	Invasive	30	2	32
Hydrilla	Invasive	26	1	27
Water hyacinth	Invasive	11	4	15
Giant salvinia	Invasive	11	3	14
Algae	Native / exotic	8	0	8
Cordgrass (in US NW)	Invasive	7	0	7
Melaleuca	Invasive	6	1	7
Water celery	Native	6	0	6
Variable leaf milfoil	Native / invasive	6	0	6
Parrott feather	Invasive	5	0	5

# APMS by the Decade

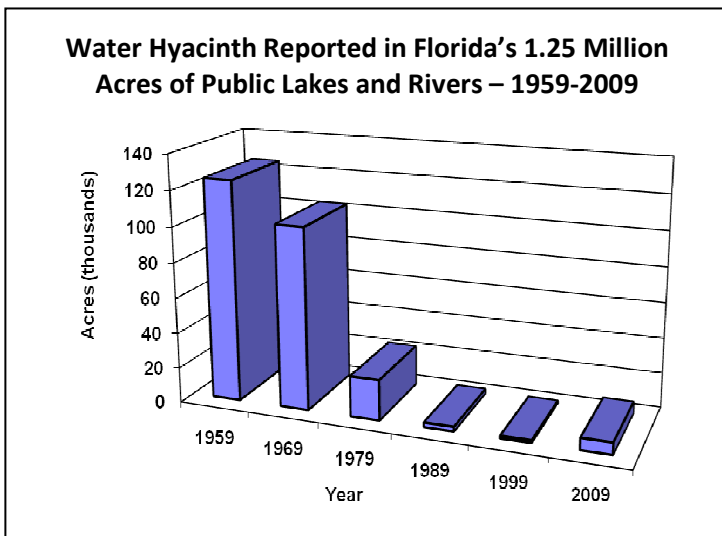
## Summary of *Journal of Aquatic Plant Management* Articles



Through the decades, APMS journal articles focused primarily on chemical control of aquatic plants. Articles range from application tactics, to selectivity, to evaluating modes of action and registering new compounds. Planning articles were abundant in the early 1960s as managers developed regulations and economic strategies to implement them. More recent planning articles evaluate mapping and sampling techniques. Mechanical and cultural control articles have remained consistently low through the years. Attention to biological controls increased early then tapered off. Similarly, articles on plant physiology and environmental parameters that impact plants and management increased steadily during APMS's first 30 years and have converged with biological control and planning articles during the past two decades.



As discussed on previous pages, early objectives of the Hyacinth Control Society included organizing management and funding efforts to control water hyacinth. Shortly thereafter, hydrilla was identified in Florida and became the focus of attention for researchers contributing to the Society's journal. With hydrilla's expansion into other states also came increasing awareness of other invasive plants like Eurasian watermilfoil, ironically a problem in nearly every state except Florida. Although there has been increasing research on other invasive as well as native plants in recent years, these three species have dominated the APMS journal for 50 years, ranking in the top three most studied and reported aquatic plants in each of APMS's five decades.



The graph at the left depicts the daunting task that faced water hyacinth managers when they convened the inaugural Hyacinth Control Society Conference in 1961. While water hyacinth remains a significant management issue among APMS members, research is now directed toward an increasing number of aquatic plants causing more pressing environmental concerns. Developing management strategies for the seemingly insurmountable distribution of water hyacinth in Florida waters brought the Society together. If the success of an organization is measured by its accomplishments, then the results of Florida's water hyacinth management program, developed through research and information sharing of APMS Members, attest to the significant role APMS holds in invasive aquatic plant management.

# Agenda

## Sunday, July 11

### Sunday's Agenda-at-a-Glance

- 7:30 am - 5:00 pm APMS Board of Directors Meeting (*Captiva*)
- 12:00 pm - 5:00 pm Exhibits Setup (*Calusa D-H*)
- 12:00 pm - 5:00 pm Posters Setup (*Calusa D-H*)
- 1:00 pm - 5:00 pm Registration (*Calusa Prefunction*)
- 7:00 pm - 9:00 pm President's Reception (*Waterfall Pool Deck*)  
*Sponsored by Valent USA Corporation*

## Monday, July 12

### Monday's Agenda-at-a-Glance

- 7:30 am - 8:00 am Continental Breakfast (*Calusa D-H*)  
*Sponsored by Florida Aquatic Plant Management Society*
- 7:30 am - 5:00 pm Registration (*Calusa Prefunction*)
- 7:30 am - 5:00 pm Exhibits Open (*Calusa D-H*)
- 7:30 am - 5:00 pm Posters Open (*Calusa D-H*)
- 8:00 am - 12:00 pm Session I (*Calusa A-C*)
- 9:00 am - 2:00 pm Guest Tour  
*Sponsored by Applied Biochemists*
- 9:30 am - 10:00 am Refreshment Break (*Calusa D-H*)  
*Sponsored by Helena Chemical Company*
- 12:00 pm - 1:30 pm Lunch on Your Own
- 12:00 pm - 1:30 pm APMS Student Affairs Luncheon (*Captiva*)  
*Sponsored by SePRO Corporation*
- 12:00 pm - 1:30 pm Aquatic Ecosystem Restoration Foundation Meeting (*Great Egret*)
- 1:30 pm - 5:30 pm Session II (*Calusa A-C*)
- 3:00 pm - 3:30 pm Refreshment Break (*Calusa D-H*)  
*Sponsored by Helena Chemical Company*
- 6:00 pm - 7:30 pm Poster Session and Reception (*Calusa D-H*)  
*Sponsored by Syngenta Professional Products*

### Session I: APMS Past and Present, Special Session on NPDES Draft Rules, Guidance and Plans for Implementation

8:00 am - 12:00 pm

Calusa A-C

**Moderator:** Greg MacDonald, APMS President, Agronomy Department, University of Florida, Gainesville, Florida

- 8:00 am **Welcome, Opening Remarks and Announcements**
- 8:15 am **Keynote Speaker**  
**William T. Haller**  
**Fifty Years of Aquatic Plant Management: A Historical Perspective**  
*Center for Aquatic and Invasive Plants, University of Florida, Gainesville, Florida*
- 8:45 am **Presidential Address**  
**APMS - The Next Fifty Years**  
**Greg MacDonald**  
*Agronomy Department, University of Florida, Gainesville, Florida*
- 9:10 am **Washington Update**  
**Lee Van Wychen**  
*Weed Science Society of America, Washington, D.C.*
- 9:30 am **Refreshment Break** (*Calusa D-H*)
- 10:00 am **EPA's Proposed General NPDES Permit for Applications of Pesticides to U.S. Waters**  
**Allison Wiedeman**  
*Water Permits Division, U.S. Environmental Protection Agency, Washington, D.C.*
- 10:30 am **Steps Toward Implementing NPDES Regulations in Florida**  
**Jeffrey D. Schardt**  
*Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida*

11:00 am **Ten Years of NPDES Permitting and Water Monitoring in California: A Permittee's Perspective**  
**Robert Leavitt**  
*California Department of Food and Agriculture, Sacramento, California*

11:30 am **NPDES Panel Discussion**  
**All NPDES Session Presenters**

12:00 pm **Lunch on Your Own**

## **Session II: How Regional Perspectives Influence the Approach Towards Hydrilla Management**

1:30 pm - 5:30 pm

Calusa A-C

**Moderator: Michael D. Netherland**, *APMS Editor 2005-2010, U.S. Army Engineer Research and Development Center, Gainesville, Florida*

1:30 pm **Session Introduction – Goals and Purpose**  
**Michael D. Netherland**  
*U.S. Army Engineer Research and Development Center, Gainesville, Florida*

1:40 pm **Adapting to Evolving Hydrilla Management Issues in Florida**  
**Jeffrey D. Schardt**  
*Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida*

2:00 pm **Hydrilla Eradication vs. “Management” – Lessons from the Western United States**  
**Lars W. J. Anderson**  
*U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, California*

2:20 pm **Monoecious Hydrilla Biology, Distribution, and Management**  
**Robert J. Richardson**  
*Crop Science Department, North Carolina State University, Raleigh, North Carolina*

2:40 pm **Managing Hydrilla with Triploid Grass Carp in Large Reservoirs: the Carolina's Experience**  
**Steven J. de Kozlowski**  
*South Carolina Department of Natural Resources (retired), Columbia, South Carolina*

3:00 pm **Refreshment Break (Calusa D-H)**

3:30 pm **Managing Hydrilla with Herbicides**  
**William T. Haller**  
*Center for Aquatic and Invasive Plants, University of Florida, Gainesville, Florida*

3:50 pm **Insect Biocontrols for Hydrilla**  
**Ted Center**  
*U.S. Department of Agriculture, Agricultural Research Service, Invasive Plant Research Laboratory, Fort Lauderdale, Florida*

4:10 pm **A Workshop to Discuss Use of Registered Herbicides for Hydrilla Management in Florida Provides a Window into the Mind of Managers**  
**Michael D. Netherland<sup>1</sup>, William T. Haller<sup>2</sup>, and Jeffrey D. Schardt<sup>3</sup>**  
<sup>1</sup>*U.S. Army Engineer Research and Development Center, Gainesville, Florida*  
<sup>2</sup>*Center for Aquatic and Invasive Plants, University of Florida, Gainesville, Florida*  
<sup>3</sup>*Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida*



- 4:30 pm      **Hydrilla Management from a BASS Angler's Perspective**  
**Chris Horton**  
*BASS/ESPN Outdoors, Lake Buena Vista, Florida*
- 4:50 pm      **What Challenges Lie Ahead for Hydrilla Management?**  
**John D. Madsen**  
*Geosystems Research Institute, Mississippi State University, Mississippi State, Mississippi*
- 5:10 pm      **Panel Discussion**  
**All Session Presenters**
- 5:30 pm      **Adjourn**

## Poster Session

6:00 pm - 7:30 pm

Calusa D-H

**The IR-4 Project: Forerunner of the Future – Collaborative Aquatic Herbicide Registrations**  
**Marija Arsenovic**<sup>1</sup>, K. Getsinger<sup>2</sup>, J. Baron<sup>1</sup>, D. Kunkel<sup>1</sup>, J. Parochetti<sup>3</sup>, W. Haller<sup>4</sup>, D. Stubbs<sup>5</sup>, D. Kenny<sup>6</sup>,  
 B. Madden<sup>6</sup>, S. Jackson<sup>6</sup>, J. Walz<sup>7</sup>, G. Adrian<sup>7</sup>, C. Gray<sup>7</sup>, J. Norton<sup>8</sup>, and R. Holm<sup>9</sup>

<sup>1</sup>*IR-4 Project, Rutgers University, Princeton, New Jersey*

<sup>2</sup>*U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi*

<sup>3</sup>*U.S. Department of Agriculture, National Institute of Food and Agriculture, Washington, D.C.*

<sup>4</sup>*Center for Aquatic and Invasive Plants, University of Florida, Gainesville, Florida*

<sup>5</sup>*U.S. Environmental Protection Agency, Washington, D.C. (retired)*

<sup>6</sup>*U.S. Environmental Protection Agency, Washington, D.C.*

<sup>7</sup>*United Phosphorus, Incorporated, King of Prussia, Pennsylvania*

<sup>8</sup>*Norton Agricultural Research Consulting Services, Edmond, Oklahoma*

<sup>9</sup>*IR-4 Project, Rutgers University, Princeton, New Jersey (retired)*

**Large-scale Hydrilla Treatment Monitoring in Central Florida (Student Poster)**

**Sarah Berger**<sup>1</sup>, Jeremy G. Slade<sup>2</sup>, and Dean Jones<sup>3</sup>

<sup>1</sup>*Agronomy Department, University of Florida, Gainesville, Florida*

<sup>2</sup>*Center for Aquatic and Invasive Plants, University of Florida, Gainesville, Florida*

<sup>3</sup>*Osceola County Extension Services, University of Florida, Kissimmee, Florida*

**Hydrilla and Giant Salvinia Survey in Mississippi for 2009 (Student Poster)**

**Michael C. Cox**, John D. Madsen, and Ryan M. Wersal

*Geosystems Research Institute, Mississippi State University, Mississippi State, Mississippi*

**Using Deductive GIS Modeling Tools to Locate Suitable Macrophyte Habitat for Re-establishment Projects**

**Jonathan P. Fleming**<sup>1,2</sup>, John D. Madsen<sup>2</sup>, and Eric D. Dibble<sup>1</sup>

<sup>1</sup>*Department of Wildlife, Fisheries, and Aquaculture, Mississippi State University, Mississippi State, Mississippi*

<sup>2</sup>*Geosystems Research Institute, Mississippi State University, Mississippi State, Mississippi*

**Response of Selected Foliage Plants to Four Herbicides in Irrigation Water**

**Lyn A. Gettys** and William T. Haller

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

**Environmental Factors Contributing to Avian Vacuolar Myelinopathy and Stigonematales Abundance in J. Strom Thurmond Lake**

**James Herrin**<sup>1</sup>, Michael Hook<sup>2</sup>, Rebecca Haynie<sup>1</sup>, John Kupfer<sup>3</sup>, and Susan Wilde<sup>1</sup>

<sup>1</sup>*Daniel B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia*

<sup>2</sup>*Aquatic Nuisance Species Program, South Carolina Department of Natural Resources, West Columbia, South Carolina*

<sup>3</sup>*Department of Geography, University of South Carolina, Columbia, South Carolina*

**Raising Awareness Among Lake Users About Aquatic Weed Issues**

**Stacia Hetrick**

*Osceola County Extension Services, University of Florida, Kissimmee, Florida*

**A New Pocket Scouting Guide for Aquatic Plant Identification**

Bridget Robinson Lassiter, **Robert J. Richardson**, and Gail Wilkerson

*Crop Science Department, North Carolina State University, Raleigh, North Carolina*

**Allelopathic Effects of Cyanobacteria on *Prymnesium parvum* (Student Poster)**

**Michael Neisch**<sup>1</sup>, Michael Masser<sup>2</sup>, Daniel Roelke<sup>1</sup>, James Grover<sup>3</sup>, and Bryan Brooks<sup>4</sup>

<sup>1</sup>*Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas*

<sup>2</sup>*Texas AgriLife Extension, Texas A&M University, College Station, Texas*

<sup>3</sup>*University of Texas-Arlington, Arlington, Texas*

<sup>4</sup>*Department of Environmental Science, Baylor University, Waco, Texas*

**Biochemical and Physiological Studies to Optimize Imazamox Use Rates in Hydrilla**

**Atul Puri**<sup>1</sup>, William T. Haller<sup>1</sup>, and Greg MacDonald<sup>2</sup>

<sup>1</sup>*Center for Aquatic and Invasive Plants, University of Florida, Gainesville, Florida*

<sup>2</sup>*Agronomy Department, University of Florida, Gainesville, Florida*

**Attempts to Prevent Southern Naiad Growth in Arkansas Baitfish Ponds with the Application of Low Rates of Fluridone**

**George Selden**

*Aquaculture/Fisheries Center, University of Arkansas at Pine Bluff, Pine Bluff, Arkansas*

**Biology and Management of *Rotala rotundifolia* (Student Poster)**

**Courtney Stokes**<sup>1</sup>, Atul Puri<sup>2</sup>, William T. Haller<sup>2</sup>, and Greg MacDonald<sup>1</sup>

<sup>1</sup>*Agronomy Department, University of Florida, Gainesville, Florida*

<sup>2</sup>*Center for Aquatic and Invasive Plants, University of Florida, Gainesville, Florida*

**Absorption and Translocation of Fluridone, Penoxsulam, and Triclopyr by Eurasian Watermilfoil and Hydrilla (Student Poster)**

**Joseph D. Vassios**<sup>1</sup>, Scott J. Nissen<sup>1</sup>, and Tyler J. Koschnick<sup>2</sup>

<sup>1</sup>*Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, Colorado*

<sup>2</sup>*SePRO Corporation, Carmel, Indiana*

**Water Conditions Affecting Growth and Reproduction of *Pistia stratiotes***

**Ken-ichi Yamaguchi** and Aya Shimizu

*Minami Kysushu University, Miyazaki, Japan*

## Tuesday, July 13

### Tuesday's Agenda-at-a-Glance

- 6:30 am - 8:00 am APMS Regional Chapters Presidents' Breakfast (*Captiva*)  
*Sponsored by Florida Aquatic Plant Management Society*
- 7:30 am - 8:00 am Continental Breakfast (*Calusa D-H*)  
*Sponsored by Florida Aquatic Plant Management Society*
- 7:30 am - 5:00 pm Registration (*Calusa Prefunction*)
- 7:30 am - 5:00 pm Exhibits Open (*Calusa D-H*)
- 7:30 am - 5:00 pm Posters Open (*Calusa D-H*)
- 8:00 am - 12:00 pm Session III (*Calusa A-C*)
- 10:00 am - 10:30 am Refreshment Break (*Calusa D-H*)  
*Sponsored by Vertex Water Features*
- 12:00 pm - 1:30 pm Lunch on Your Own
- 12:00 pm - 1:30 pm APMS Past Presidents' Luncheon (*Captiva*)  
*Sponsored by Phoenix Environmental Care, LLC*
- 1:30 pm - 5:00 pm Session IV (*Calusa A-C*)
- 2:45 pm - 3:15 pm Refreshment Break (*Calusa D-H*)  
*Sponsored by Vertex Water Features*
- 4:00 pm - 4:30 pm Regional Chapter Updates (*Calusa A-C*)
- 4:30 pm - 5:00 pm APMS Annual Business Meeting (*Calusa A-C*)
- 5:30 pm - 7:00 pm Duck Race (*Belvedere Terrace Fountain*)  
*Sponsored by SePRO Corporation*

### Session III

8:00 am - 12:00 pm

Calusa A-C

**Moderator: Ken L. Manuel**, 2004 APMS President, Duke Energy, Huntersville, North Carolina

- 8:00 am **Non-native Aquatic Plant Introductions in the Southeast: An Historical Review**  
**Don C. Schmitz**  
*Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida*
- 8:15 am **Refining the New Zealand Aquatic Weed Risk Assessment for Florida and the U.S.**  
**Doria R. Gordon**<sup>1</sup>, Crysta A. Gantz<sup>2</sup>, Christopher L. Jerde<sup>3</sup>, and W. Lindsay Chadderton<sup>4</sup>  
<sup>1</sup>*The Nature Conservancy, University of Florida, Gainesville, Florida*  
<sup>2</sup>*Department of Biology, University of Florida, Gainesville, Florida*  
<sup>3</sup>*Center for Aquatic Conservation, University of Notre Dame, Notre Dame, Indiana*  
<sup>4</sup>*The Nature Conservancy, University of Notre Dame, Notre Dame, Indiana*
- 8:30 am **Identifying Unique Biotypes of Eurasian Watermilfoil Using a Genetic Fingerprinting Method**  
**(Student Presentation)**  
**Matthew Zuellig** and Ryan A. Thum  
*Annis Water Resources Institute, Grand Valley State University, Muskegon, Michigan*
- 8:45 am **Morphological and Genetic Taxonomic Analysis of Native and Nonnative Watermilfoil in Reservoirs of the Lower Clark Fork River System**  
**John Madsen**<sup>1</sup>, Joshua C. Cheshier<sup>1</sup>, Vipaporn Phuntumart<sup>2</sup>, Ryan A. Thum<sup>3</sup>, and Mark Welch<sup>4</sup>  
<sup>1</sup>*Geosystems Research Institute, Mississippi State University, Mississippi State, Mississippi*  
<sup>2</sup>*Department of Biological Sciences, Bowling Green University, Bowling Green, Ohio*  
<sup>3</sup>*Annis Water Resources Institute, Grand Valley State University, Muskegon, Michigan*  
<sup>4</sup>*Department of Biological Sciences, Mississippi State University, Mississippi State, Mississippi*
- 9:00 am **Uncovering Even More Genetic Diversity and Hybridization in Variable-leaf Watermilfoil and its Close Allies**  
**Ryan A. Thum** and Matthew Zuellig  
*Annis Water Resources Institute, Grand Valley State University, Muskegon, Michigan*

- 9:15 am **Eurasian Watermilfoil Response to Imazamox (Student Presentation)**  
**Trevor D. Israel**, Robert J. Richardson, and Steve T. Hoyle  
*Crop Science Department, North Carolina State University, Raleigh, North Carolina*
- 9:30 am **Development of Galleon™ and Clearcast™ for Control of the Exotic Submersed Weeds *Potamogeton crispus* (Curly Leaf Pondweed) and *Myriophyllum spicatum* (Eurasian Watermilfoil)**  
**Mark A. Heilman**<sup>1</sup>, Tyler J. Koschnick<sup>1</sup>, Todd Horton<sup>2</sup>, Cole Hulon<sup>3</sup>, and Bob Johnson<sup>4</sup>  
<sup>1</sup>*SePRO Corporation, Carmel, Indiana*  
<sup>2</sup>*SePRO Corporation, Anderson, South Carolina*  
<sup>3</sup>*SePRO Corporation, Whitakers, North Carolina*  
<sup>4</sup>*SePRO Corporation, Brownstown, Indiana*
- 9:45 am **Sampling of Herbicide Residuals Confirms Extended Exposure to Low Concentrations of 2,4-D and Triclopyr Can Control Eurasian Watermilfoil**  
**LeeAnn M. Glomski**<sup>1</sup>, Michael D. Netherland<sup>2</sup>, and John D. Skogerboe<sup>3</sup>  
<sup>1</sup>*U.S. Army Engineer Research and Development Center, Lewisville, Texas*  
<sup>2</sup>*U.S. Army Engineer Research and Development Center, Gainesville, Florida*  
<sup>3</sup>*U.S. Army Engineer Research and Development Center, Spring Valley, Wisconsin*
- 10:00 am **Refreshment Break (Calusa D-H)**
- 10:30 am **Response of Native Macrophyte Communities to Early Season Herbicide Treatments of *Potamogeton crispus* (Student Presentation)**  
**Ajay R. Jones**, James A. Johnson, and Raymond M. Newman  
*Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota, St. Paul, Minnesota*
- 10:45 am **Evaluation of Winter and Summer Drawdowns for Control of the Non-native Aquatic Plant *Myriophyllum aquaticum* (Vell.) Verdc.**  
**Ryan M. Wersal** and John D. Madsen  
*Geosystems Research Institute, Mississippi State University, Mississippi State, Mississippi*
- 11:00 am **A History of Hydrilla in North Carolina**  
**Steve T. Hoyle** and Robert J. Richardson  
*Crop Science Department, North Carolina State University, Raleigh, North Carolina*
- 11:15 am **Monoecious Hydrilla Response to Endothall (Student Presentation)**  
**Sarah L. True**, Robert J. Richardson, Justin J. Nawrocki, and Steve T. Hoyle  
*Crop Science Department, North Carolina State University, Raleigh, North Carolina*
- 11:30 am **Efficacy and Selectivity of Large-scale Herbicide Treatments for Hydrilla Control on the Kissimmee Chain of Lakes, Florida**  
**Jeremy G. Slade**<sup>1</sup>, Dean Jones<sup>2</sup>, and Michael D. Netherland<sup>3</sup>  
<sup>1</sup>*Center for Aquatic and Invasive Plants, University of Florida, Gainesville Florida*  
<sup>2</sup>*Osceola County Extension Services, Kissimmee, Florida*  
<sup>3</sup>*U.S. Army Engineer Research and Development Center, Gainesville, Florida*
- 11:45 am **Tradewind Herbicide: Summary of EUP and Laboratory Studies**  
**Joe Chamberlin**  
*Valent USA Corporation, Snellville, Georgia*
- 12:00 pm **Lunch on Your Own**

## Session IV

1:30 pm - 5:00 pm

Calusa A-C

**Moderator: Jim Schmidt**, 2001 APMS President, Applied Biochemists, Germantown, Wisconsin

- 1:30 pm      ***Phragmites australis* in Florida: Native or Introduced?**  
**Rodrigo Diaz**<sup>1</sup>, Megan Hanson<sup>2</sup>, Dean Williams<sup>2</sup>, and William A. Overholt<sup>1</sup>  
<sup>1</sup>Biological Control Research and Contaminant Laboratory, University of Florida, Fort Pierce, Florida  
<sup>2</sup>Department of Biology, Texas Christian University, Fort Worth, Texas
- 1:45 pm      **Japanese Knotweed Control with Aquatic Herbicides (Student Presentation)**  
**Rory L. Roten**<sup>1</sup>, Robert J. Richardson<sup>1</sup>, and Lloyd P. Hipkins<sup>2</sup>  
<sup>1</sup>Crop Science Department, North Carolina State University, Raleigh, North Carolina  
<sup>2</sup>Department of Plant Pathology, Physiology, and Weed Science, Virginia Tech, Blacksburg, Virginia
- 2:00 pm      **Evaluation of Aquatic-use Herbicides for Japanese Stiltgrass Control**  
**Karen R. Hall**<sup>1</sup>, Robert J. Richardson<sup>2</sup>, and Steve T. Hoyle<sup>2</sup>  
<sup>1</sup>Biological and Agricultural Engineering Department, North Carolina State University, Raleigh, North Carolina  
<sup>2</sup>Crop Science Department, North Carolina State University, Raleigh, North Carolina
- 2:15 pm      **Prospects for Classical Biological Control of the Federal Noxious Weed *Hygrophila, Hygrophila polysperma* (Roxb.)** T. Anders  
**James P. Cuda**<sup>1</sup>, Abhishek Mukherjee<sup>1</sup>, and William A. Overholt<sup>2</sup>  
<sup>1</sup>Department of Entomology and Nematology, University of Florida, Gainesville, Florida  
<sup>2</sup>Biological Control Research and Contaminant Laboratory, University of Florida, Fort Pierce, Florida
- 2:30 pm      **Overwintering Habitat Requirements of the Native Milfoil Weevil, *Euhrychiopsis lecontei*, in McDill Pond, Portage County, Wisconsin (Student Presentation)**  
**Amy T. Thorstenson**<sup>1</sup>, Ronald L. Crunkilton<sup>1</sup>, Michael A. Bozek<sup>1</sup>, and Nancy Turyk<sup>2</sup>  
<sup>1</sup>College of Natural Resources, University of Wisconsin-Stevens Point, Stevens Point, Wisconsin  
<sup>2</sup>Center for Watershed Science and Education, University of Wisconsin-Stevens Point, Stevens Point, Wisconsin
- 2:45 pm      **Refreshment Break (Calusa D-H)**
- 3:15 pm      **ALS Inhibitor Use Patterns for Management of *Hydrilla verticillata***  
**Mark A. Heilman**<sup>1</sup>, Tyler J. Koschnick<sup>1</sup>, and Todd Horton<sup>2</sup>  
<sup>1</sup>SePRO Corporation, Carmel, Indiana  
<sup>2</sup>SePRO Corporation, Anderson, South Carolina
- 3:30 pm      **Responses of Cabomba and Other Weeds to Flumioxazin (Student Presentation)**  
**Justin J. Nawrocki**, Robert J. Richardson, and Sarah L. True  
Crop Science Department, North Carolina State University, Raleigh, North Carolina
- 3:45 pm      **Results from Two Years of EUP Trials with Clipper Aquatic Herbicide**  
**Jason Fausey**  
Valent USA Corporation, Fremont, Ohio
- 4:00 pm      **Regional Chapter Updates (Calusa A-C)**  
Brazil, Florida, MidSouth, Midwest, Northeast, South Carolina, Texas, Western
- 4:30 pm      **APMS Annual Business Meeting (Calusa A-C)**
- 5:00 pm      **Adjourn**

## Wednesday, July 14

### Wednesday's Agenda-at-a-Glance

- 7:30 am - 8:00 am Continental Breakfast (*Calusa D-H*)  
*Sponsored by Florida Aquatic Plant Management Society*
- 7:30 am - 3:00 pm Registration (*Calusa Prefunction*)
- 7:30 am - 3:00 pm Exhibits Open (*Calusa D-H*)
- 7:30 am - 3:00 pm Posters Open (*Calusa D-H*)
- 8:00 am - 12:00 pm Session V (*Calusa A-C*)
- 9:45 am - 10:15 am Refreshment Break (*Calusa D-H*)  
*Sponsored by Crop Production Services*
- 12:00 am - 1:30 pm Lunch on Your Own
- 1:30 pm - 4:45 pm Session VI (*Calusa A-C*)
- 3:00 pm - 3:30 pm Refreshment Break (*Calusa D-H*)  
*Sponsored by Brewer International*
- 3:00 pm - 5:00 pm Exhibits Teardown (*Calusa D-H*)
- 3:00 pm - 5:00 pm Posters Teardown (*Calusa D-H*)
- 6:00 pm - 7:00 pm Reception (*Calusa Prefunction*)  
*Co-sponsored by Aquatic Systems, Incorporated and Aquatic Control, Incorporated*
- 7:00 pm - 11:00 pm Awards Banquet (*Calusa A-C*)  
*Sponsored by United Phosphorus, Incorporated*

### Session V

8:00 am - 12:00 pm

Calusa A-C

**Moderator: Steven J. de Kozlowski**, 1995 APMS President, South Carolina Department of Natural Resources (retired), Columbia, South Carolina

- 8:00 am **Evaluation of Alligatorweed (*Alternanthera philoxeroides* [Mart.] Griseb.) Control with Nine Different Herbicides (Student Presentation)**  
**Michael C. Cox**, John D. Madsen, and Ryan M. Wersal  
*Geosystems Research Institute, Mississippi State University, Mississippi State, Mississippi*
- 8:15 am **Progress in Controlling Giant Salvinia in Louisiana**  
**Dearl Sanders**<sup>1</sup>, Wendell Lorio<sup>2</sup>, and Alex Perret<sup>3</sup>  
<sup>1</sup>*Louisiana AgCenter, Louisiana State University, Clinton, Louisiana*  
<sup>2</sup>*Louisiana AgCenter, Louisiana State University, Luling, Louisiana*  
<sup>3</sup>*Louisiana Department of Wildlife and Fisheries, Baton Rouge, Louisiana*
- 8:30 am **Response of Giant Salvinia to Static and Sequential Penoxsulam Treatments Coupled with Various Exposure Times**  
**Christopher R. Mudge**<sup>1</sup>, Linda S. Nelson<sup>1</sup>, and Mark A. Heilman<sup>2</sup>  
<sup>1</sup>*U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi*  
<sup>2</sup>*SePRO Corporation, Carmel, Indiana*
- 8:45 am **Release Dynamics of Granular Herbicides in an Aquatic Environment (Student Presentation)**  
**Brett W. Bultemeier** and William T. Haller  
*Center for Aquatic and Invasive Plants, University of Florida, Gainesville, Florida*
- 9:00 am **Endothall Use for Eradication of New Zealand Aquatic Weeds**  
**Paul D. Champion** and Rohan D. S. Wells  
*National Institute of Water and Atmospheric Research, Hamilton, New Zealand*

- 9:15 am **Developing Hydrogel® for Selective Management of Submerged Aquatic Weeds**  
**Nimal Chandrasena**<sup>1</sup>, Peter Harper<sup>2</sup>, and Bill Chisholm<sup>3</sup>  
<sup>1</sup>*ALS Environmental, Penrith, New South Wales, Australia*  
<sup>2</sup>*Betersafe Pest and Weed Management, Ingleburn, New South Wales, Australia*  
<sup>3</sup>*Aquatic Weed Control, Ltd., Dunedin, New Zealand*
- 9:30 pm **Evaluation of Six Herbicides for the Control of Water Primrose (*Ludwigia peploides* (Kunth) *P. H. Raven* spp. *peploides*) (Student Presentation)**  
**Joshua C. Cheshier**, Ryan M. Wersal, and John D. Madsen  
*Geosystems Research Institute, Mississippi State University, Mississippi State, Mississippi*
- 9:45 am **Refreshment Break (Calusa D-H)**
- 10:15 am **Charophyte Response to Herbicide and Mycoherbicide Treatment (Student Presentation)**  
**Chrystal Kelly**<sup>1</sup>, David Hamilton<sup>1</sup>, Mary de Winton<sup>2</sup>, and Deborah Hofstra<sup>2</sup>  
<sup>1</sup>*Department of Biological Sciences, University of Waikato, Hamilton, New Zealand*  
<sup>2</sup>*National Institute of Water and Atmospheric Research, Hamilton, New Zealand*
- 10:30 am **Algae on the Move: Recent Range Expansion of *Prymnesium parvum***  
**John H. Rodgers, Jr.**, West M. Bishop, and Brenda M. Johnson  
*Department of Forestry and Natural Resources, Clemson University, Clemson, South Carolina*
- 10:45 am **Responses of *Lyngbya wollei* to Copper-based Algacides: The Critical Burden Concept (Student Presentation)**  
**West M. Bishop** and John H. Rodgers, Jr.  
*Department of Forestry and Natural Resources, Clemson University, Clemson, South Carolina*
- 11:00 am **Investigations of Hydrilla, Toxic Cyanobacteria, Invasive Apple Snails and Potential for Toxin Transfer to Birds of Prey in Florida**  
**Susan B. Wilde**, Rebecca S. Haynie, and James Herrin  
*Daniel B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia*
- 11:15 am **On Ultrasound and Algae**  
**Jonathan R. Newman**  
*Aquatic Plant Management Group, Centre for Ecology and Hydrology, CEH Wallingford, Crowmarsh Gifford, Wallingford, Oxon, United Kingdom*
- 11:30 am **How to Reduce Negative Effects of Turbidity, Control Algae Blooms, and Meet Water Quality Standards**  
**Seva Iwinski**  
*Applied Polymer Systems, Woodstock, Georgia*
- 11:45 am **The Human Dimension of Nuisance Aquatic Species Management: An Investigation of Georgia Boaters (Student Presentation)**  
**James Herrin**, Rebecca Haynie, Susan B. Wilde, and Craig Miller  
*Daniel B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia*
- 12:00 pm **Lunch on Your Own**

## Session VI

1:30 pm - 4:45 pm

Calusa A-C

**Moderator: Kurt D. Getsinger**, 1997 APMS President, U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi

- 1:30 pm      **The Age of Partnership: Weed Science and the U.S. Environmental Protection Agency**  
**Kurt D. Getsinger**<sup>1</sup>, Jill Schroeder<sup>2</sup>, Dan Kenny<sup>3</sup>, and Lee Van Wychen<sup>4</sup>  
<sup>1</sup>U.S. Engineer Research and Development Center, Vicksburg, Mississippi  
<sup>2</sup>New Mexico State University, Las Cruces, New Mexico  
<sup>3</sup>U.S. Environmental Protection Agency, Washington, D.C.  
<sup>4</sup>Weed Science Society of America, Washington, D.C.
- 1:45 pm      **Evaluation of Imazamox for Control of Wild Taro (*Colocasia esculenta*) in Lake Okeechobee, Florida**  
**Mike Bodle**  
South Florida Water Management District, West Palm Beach, Florida
- 2:00 pm      **Research and Testing of a System for Precision Littoral Zone Application of Aquatic Herbicides**  
**Thomas McNabb**<sup>1</sup>, Thomas Moorhouse<sup>2</sup>, and Bruce Sabol<sup>3</sup>  
<sup>1</sup>Clean Lakes, Incorporated, Coeur d'Alene, Idaho  
<sup>2</sup>Clean Lakes, Incorporated, Westlake Village, California  
<sup>3</sup>U.S. Engineer Research and Development Center, Vicksburg, Mississippi
- 2:15 pm      **Mapping the Distribution of Invasive Aquatic Plants in Puerto Rico**  
**Wilfredo Robles** and Victor M. Gonzáles  
Department of Crops and Agroenvironmental Sciences, University of Puerto Rico, Mayaguez, Puerto Rico
- 2:30 pm      **High-density Aquatic Vegetation Baseline Surveys of the Kissimmee Chain of Lakes and Lake Istokpoga: Results and Implications for Habitat and Invasive Vegetation Management**  
**Ryan Moore**<sup>1</sup>, Jeremy G. Slade<sup>2</sup>, and Dean Jones<sup>3</sup>  
<sup>1</sup>ReMetrix, LLC, Lakeland, Florida  
<sup>2</sup>Center for Aquatic and Invasive Plants, University of Florida, Gainesville, Florida  
<sup>3</sup>Osceola County Extension Services, Kissimmee, Florida
- 2:45 pm      **Initial Attempts to Restore Native Plants after Carp Removal in a Twin Cities Minnesota Lake**  
**Raymond M. Newman** and James A. Johnson  
Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota, St. Paul, Minnesota
- 3:00 pm      **Refreshment Break (Calusa D-H)**
- 3:30 pm      **The Future of Aquatic Invasive Species Management at Lake Tahoe: A Consilience of Science and Public Trust**  
**Lars W. J. Anderson**  
U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, California
- 3:45 pm      **Clientele Evaluation of the AQUAPLANT Website**  
**Michael P. Masser** and Satoshi Kamata  
Texas AgriLife Extension, Texas A&M University, College Station, Texas



- 4:00 pm      **Aluminum Sulfate Application to Improve Under-water Light Condition for Native Submersed Macrophyte Restoration: Alum to Phosphorus Binding Ratio Considerations**  
**William F. James**  
*U.S. Engineer Research and Development Center, Eau Galle Aquatic Ecology Laboratory, Spring Valley, Wisconsin*
- 4:15 pm      **Nutrient Reduction and Recovery in a South Florida Retention Pond through Manipulation of Artificial Destratification Aeration**  
**Amanda Quillen**  
*Vertex Water Features, Pompano Beach, Florida*
- 4:30 pm      **Aquatic Weed Problems in Sri Lanka – A Review of Current Status and Planning for Effective Management**  
**Nimal Chandrasena**  
*ALS Environmental, Penrith, New South Wales, Australia*
- 4:45 pm      **Closing Remarks and Adjourn 50<sup>th</sup> Annual Meeting**  
**Greg MacDonald**  
*Agronomy Department, University of Florida, Gainesville, Florida*
- 6:00 pm      **Reception** (*Calusa Prefunction*)
- 7:00 pm      **APMS Annual Awards Banquet** (*Calusa A-C*)

## **Thursday, July 15**

### **Thursday's Agenda-at-a-Glance**

7:30 am - 12:00 pm APMS Board of Directors Meeting (*Captiva*)

**NEXT YEAR**  
**51<sup>st</sup> Annual Meeting**  
**Northeast U.S. Location TBA**  
**July 2011**

## Abstracts

Abstracts are printed as submitted by authors. Abstracts are listed alphabetically by presenting author. Presenting author appears in **bold**.

### **Hydrilla Eradication vs. “Management” - Lessons from the Western United States**

**Lars W. J. Anderson**

*U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, California*

Hydrilla was first identified in California in Ellis Lake (Yuba City, CA) and in the Imperial Irrigation District (IID) (Imperial, Brawley, CA) 35 years ago. The track record of hydrilla in Florida and other southeastern states, coupled with the immediate threats to the Sacramento River, and to the Sacramento-San Joaquin Delta system as well as the entire 1,500-mile IID system prompted it to be placed on the “A” list by the California Department of Food and Agriculture (CDFA). The “A” rating by CDFA necessitated actions for complete eradication. Successes at both sites, and continued vigilance through public education, regulatory actions and EDRR in newly found populations have prevented hydrilla from establishing in virtually all waters of California. Washington State took similar actions and has likewise prevented further spread. Small infestations in Arizona (golf course) evoked less stringent responses, and most recent infestations in Idaho (Bruneau River system, 2007) have yet to evoke the necessary strategies and action needed to contain and eradicate it. Lessons from successful programs suggest that the following need to be clearly understood by all: (1) long-term fiscal and ecological benefits (locally and regionally) are derived from well-crafted and coordinated eradication actions; (2) timely commitment of resources is absolutely essential for complete containment and removal/or killing of all propagules; (3) consultations with experts *with successful eradication project experience* is essential; (4) rational and scientifically based balance must be achieved between short-term risks (from aggressive actions) and long-term threats (from slow, indecisive or “partial” attempts); (5) public acceptance of decisive, unambiguous goals (i.e. eradication) *is far more easily attained- and far more defensible-* than ambiguous, “we will try to”, or “ultimate goal is..” positions. The bottom line is that over the past 15-35 years, Washington and California, respectively, have kept hydrilla out of every major and minor waterway and have sustained a far less costly approach by adopting true eradication programs than any other state *not* taking this tack. These states have very likely prevented hydrilla from appearing in Oregon as well.

### **The Future of Aquatic Invasive Species Management at Lake Tahoe: A Consilience of Science and Public Trust**

**Lars W. J. Anderson**

*U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, California*

The uniqueness and beauty of Lake Tahoe within the majestic Tahoe Basin has attracted naturalists with their preservation and conservation values, as well as developers with their attendant goals and impacts. From early gold rush driven logging days to the recognition of anthropomorphic-driven water quality degradation in the 1970's, science has provided a touch stone and common language from which divergent values and beliefs eventuated in effective remedial actions. A similar consilience on aquatic invasive species has been emerging in the past ten years in the wake of invasions by Eurasian watermifol, curlyleaf pondweed, Asian clam, warm water fish and recent threats of invasion by quagga and zebra mussels. In the short span of three years (2007-2010), the two primary regulatory agencies (Tahoe Regional Planning Agency, and Lahontan Regional Water Quality Control Board), together with several other state, federal, local, private and academic partners, formed an effective coalition that (1) produced a Tahoe Regional Aquatic Invasive Species Plan, (2) acquired funding for specific monitoring and control projects, (3) instituted mandatory boat inspections, (4) hired and reassigned key managers (U.S. Fish and Wildlife Service and TRPA) to direct AIS actions, and (5) formalized the multi-agency/stakeholder consortium as the Lake Tahoe Aquatic Invasive Species Advisory Council. One of the most significant shifts in policy resulting from this consilience is the pending change in the current (1995) Lahontan Basin Plan that will accommodate, under specific conditions, the use of aquatic herbicides. If adopted, Basin Plan amendments will provide, for the first time, a full suite of management tools to respond to current infestations of

aquatic invasive species, but also those that pose a clear and present threat such as quagga and zebra mussels. USDA-ARS directed studies with Rhoadamine WT (as surrogate for herbicides) in 2010 would provide information to optimize application methods, and help regulatory agencies establish monitoring criteria. Properly used, the full range of effective management methods, combined with proper monitoring and public trust should begin to reverse the current expansions of aquatic invasive species at Lake Tahoe.

### **The IR-4 Project: Forerunner of the Future – Collaborative Aquatic Herbicide Registrations**

**Marija Arsenovic**<sup>1</sup>, K. Getsinger<sup>2</sup>, J. Baron<sup>1</sup>, D. Kunkel<sup>1</sup>, J. Parochetti<sup>3</sup>, W. Haller<sup>4</sup>, D. Stubbs<sup>5</sup>, D. Kenny<sup>6</sup>, B. Madden<sup>6</sup>, J. Walz<sup>7</sup>, G. Adrian<sup>7</sup>, C. Gray<sup>7</sup>, J. Norton<sup>8</sup>, R. Holm<sup>9</sup>

<sup>1</sup>*IR-4 Project, Rutgers University, Princeton, New Jersey*

<sup>2</sup>*U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi*

<sup>3</sup>*U.S. Department of Agriculture, National Institute of Food and Agriculture, Washington, D.C.*

<sup>4</sup>*Center for Aquatic and Invasive Plants, University of Florida, Gainesville, Florida*

<sup>5</sup>*U.S. Environmental Protection Agency, Washington, D.C. (retired)*

<sup>6</sup>*U.S. Environmental Protection Agency, Washington, D.C. (retired)*

<sup>7</sup>*United Phosphorus, Inc., King of Prussia, Pennsylvania*

<sup>8</sup>*Norton Agricultural Research Consulting Services, Edmond, Oklahoma*

<sup>9</sup>*IR-4 Project, Rutgers University, Princeton, New Jersey (retired)*

Concerned about increasing invasive aquatic weed problems in irrigation conveyance systems, and the lack of registered herbicides to manage these plants, experts from the IR-4 Project, several Federal agencies, land grant universities, and scientific groups formed an Aquatic Herbicide Working Group (AHWG). In 2004, the group developed a white paper entitled, “New Missions for the IR-4 Project-Weed Control in Aquatic Sites and Irrigation Canals,” which was approved by the IR-4 Project Management Committee. Stakeholder support for the concept was obtained in 2005, and over the next two years, United Phosphorus, Inc. and IR-4 conducted a multi-faceted cooperative research project to develop an irrigation label for the herbicide, endothall. Because of the myriad of irrigated crops grown in the U.S., this unique use pattern required a large amount of residue studies. However, working through the AHWG, the EPA requested and received a reasonable data set to allow them to conduct a risk assessment on 20 different crop groupings. In December 2009, the USEPA established crop tolerances for endothall and a Section 3 irrigation label has been granted for the 2010 growing season. This regulatory action also included establishment of tolerances for meat, milk, eggs and poultry. Pending state approvals, both formulations of endothall (the dipotassium salt, Cascade<sup>®</sup>, and the dimethylalkylamine salt, Teton<sup>®</sup>) will be available for weed control in irrigation canals. The registration of endothall for irrigation use is a striking example of well planned and executed collaboration among agencies, industry, and stakeholders to develop environmentally compatible technology to protect and conserve the Nation’s water resources. This level of cooperation will be needed to meet the water resource management challenges of the future.

### **Large-Scale Hydrilla Treatment Monitoring in Central Florida (Student Poster)**

**Sarah Berger**<sup>1</sup>, Jeremy G. Slade<sup>2</sup>, and Dean Jones<sup>3</sup>

<sup>1</sup>*Agronomy Department, University of Florida, Gainesville, Florida*

<sup>2</sup>*Center for Aquatic and Invasive Plants, University of Florida, Gainesville, Florida*

<sup>3</sup>*Osceola County Extension Services, University of Florida, Kissimmee, Florida*

Lake Tohopekaliga, located in central Florida, covers approximately 22,000 surface acres and is used for flood control, recreational boating, hunting, and fishing. The lake also serves as habitat for a multitude of wildlife including fish, reptiles, amphibians, mammals and birds, including the federally endangered snail kite. *Hydrilla verticillata* has been a nuisance weed in this lake for many years and was effectively controlled with the aquatic herbicide fluridone until the early 2000’s. As a result of fluridone resistance, fluridone use ceased and alternative herbicides for hydrilla control began to be evaluated. Large-scale applications of endothall alone and in combination with other aquatic herbicides are now the primary method of control for hydrilla infestations. In December 2008, approximately 7200 acres were treated with endothall to control a large population of hydrilla in Lake Tohopekaliga. Residue sampling sites were established both inside and outside of the treatment blocks to determine initial herbicide concentrations and residual longevity following the application. Endothall concentrations peaked immediately following the application, but remained in the water column at detectable levels for more than 20 days. Due to the rapid degradation of hydrilla tissue following such an application, water

quality parameters were observed to ensure the wildlife habitat was not adversely affected by the treatment. Of particular interest, dissolved oxygen concentrations did not drop below critical levels that would affect wildlife, specifically fish. Efficacy of the treatment was assessed by using fathometer readings to calculate Percent Volume Infested (PVI) and Percent Area Covered (PAC) within each treatment block. Although PAC had increased by August 2009, PVI remained at reduced levels. Herbicide residue and water quality collections ended shortly after the herbicide treatment, but macrophyte evaluations have continued to document efficacy and longevity of hydrilla control.

### **Responses of *Lyngbya wollei* to Copper-based Algaecides: The Critical Burden Concept (Student Presentation)**

**West M. Bishop** and John H. Rodgers, Jr.

*Department of Forestry and Natural Resources, Clemson University, Clemson, South Carolina*

Determining an effective amount of algaecide to apply in an aquatic system to control problematic algae is crucial in careful water resource management and can decrease costs, time invested and potential ecological impacts. The purpose of this research was to address the critical burden concept which measures the threshold concentration of a product required to sorb to a specific alga (i.e. dose) to achieve control (90% decrease in chlorophyll *a* concentrations). The objectives of this study were 1) to compare the masses of copper required to achieve control of *Lyngbya wollei* using the algaecide formulations Algimycin<sup>®</sup>-PWF, Clearigate<sup>®</sup>, and copper sulfate pentahydrate in laboratory toxicity experiments; 2) to relate the responses of *L. wollei* to the masses of copper adsorbed and absorbed (i.e. dose) as well as the concentrations of copper in the exposure water; and 3) to discern the relationships of the masses of copper required to achieve control of the masses of *L. wollei* present. The critical burden of copper for *L. wollei* averaged 3.3 and 1.9 mg Cu/ g algae for chelated algaecide exposures of Algimycin<sup>®</sup>-PWF and Clearigate<sup>®</sup>, respectively. With reasonable exposures in these experiments, control was not achieved in single applications of copper sulfate with copper sorption up to 13 mg Cu/ g algae. Factors governing the critical burden of copper required for control of problematic algae include the algaecide formulation and concentration, volume of water, and mass of algae. With better understanding of factors that influence the effectiveness of algaecide exposures and consequent responses of problematic algae, selection of an algaecide and its application at a specific site should be more successful.

### **Evaluation of Imazamox for Control of Wild Taro (*Colocasia esculenta*) in Lake Okeechobee, Florida**

**Mike Bodle**

*South Florida Water Management District, West Palm Beach, Florida*

Field trials to evaluate effectiveness of the (then) newly-aquatically label material imazamox (Clearcast<sup>®</sup>) were made in Lake Okeechobee, Florida in November 2008. Subsequent evaluations found thorough control resulted from applications of one-, two- and three-percent solutions. Since that time, operational control has progressed using 1½ percent solutions applied both aerially and on the ground. Discussion will include the Florida Department of Agriculture's interpretation of the product's label which enabled aerial treatment to proceed.

### **Release Dynamics of Granular Herbicides in an Aquatic Environment (Student Presentation)**

**Brett W. Bultemeier** and William T. Haller

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

Granular formulations of herbicides have been utilized in aquatics for many years and have been an essential part of many management strategies. There are approximately ten different granular formulations available for use in aquatics, ranging from shorter half-life contact herbicides, such as endothall, to the longer half-life systemic herbicides like fluridone. Many studies have been performed on herbicide dissipation, from granular and liquid formulations alike, but little work has been done to determine the factors that affect the release of the herbicide from the granule. Factors such as temperature, sediment type, and water movement potentially influence the release of herbicide from a granule. Under static conditions, in the laboratory, the amount of time required for 50% of the herbicide to release from the granule (ET<sub>50</sub>) ranged from rapid, 12 h for Renovate OTF, to slow, 61 d for Sonar SRP. The four fluridone formulations tested varied significantly from each other requiring from 27 d to 61 d to release 50% of the herbicide, for Sonar Q and SRP respectively. Preliminary studies that were conducted

similar to the static studies, but with the addition of gentle aeration to mix the water, yielded much different results. The addition of aeration (slight water movement) increased the ET<sub>50</sub> of both Renovate OTF and Sonar SRP by 10x, and the other formulations to a lesser but still significant degree. Further research is necessary to quantify the impact that water movement has on the release of these herbicides from aquatic granules.

### **Tradewind Herbicide: Summary of EUP and Laboratory Studies**

**Joe Chamberlin**

*Valent USA Corporation, Snellville, Georgia*

Tradewind Herbicide is an 80 SP formulation of bispyribac that is being developed by Valent USA Corporation for use as an aquatic herbicide, and is currently under review by EPA. Bispyribac is an ALS inhibitor, but is in a different chemical class than other ALS herbicides registered for aquatic use. Based on EUP studies, subsurface application of Tradewind at 30-45 ppb provides effective control of dioecious hydrilla for 4 months or more. In CET studies, Tradewind at >20 ppb reduced biomass of dioecious hydrilla and Eurasian watermilfoil by 90% following 8 weeks of continuous exposure. In mesocosm studies, a combination of bispyribac at 45 ppb and endothall at 500 ppb almost completely eliminated hydrilla, and was more effective than bispyribac or endothall alone. Surface and subsurface application of Tradewind at proposed labeled rates suppressed, but did not control giant salvinia. Selectivity studies conducted in the greenhouse demonstrated that grasses (cattail, knotgrass and maidencane) and *Nuphar* exhibit little sensitivity to proposed labeled rates. *Nymphaea* spp. and *Sagittaria* spp. are sensitive at rates above 15 ppb, and bull and spike rush are sensitive at 45 ppb. Field observations suggest that hydrocotyl, hyacinth and pickerelweed are sensitive to Tradewind, but no impact was observed on chara, frogsbit or smartweed.

### **Endothall Use for Eradication of New Zealand Aquatic Weeds**

**Paul D. Champion** and Rohan D. S. Wells

*National Institute of Water and Atmospheric Research, Hamilton, New Zealand*

Mesocosm and field trials conducted by NIWA had shown endothall provided good control of three of New Zealand's top ranked submersed pest species: hydrilla (*Hydrilla verticillata* (L.f.) Royle), lagarosiphon (*Lagarosiphon major* (Ridley) Moss) and hornwort (*Ceratophyllum demersum* L.). This led to the registration of this product for use in New Zealand in 2004. It is only the second herbicide targeting submerged weeds, with diquat registered for this purpose in the 1960's. This paper will report on field trials where lagarosiphon and hornwort were eradicated in whole of water body field trials with a single, total water body treatment of endothall. It will also discuss results where endothall was used at up to 50 times less herbicide than label rates in cool water ( $\leq 16^{\circ}\text{C}$ ) and planned further work to optimise the use of this product.

### **Aquatic Weed Problems in Sri Lanka – A Review of Current Status and Planning for Effective Management**

**Nimal Chandrasena**

*ALS Environmental, Penrith, New South Wales, Australia*

A recent study revealed that in tropical Sri Lanka, water hyacinth [*Eichhornia crassipes* (Mart.) Solms.] and salvinia (*Salvinia molesta* D. S. Mitchell) continue to dominate eutrophic lakes and lagoons in urban environments. In the last decade or so, several other highly invasive species have also become significant problems in waterways, and these include: alligator weed [*Alternanthera philoxeroides* (Mart.) Griseb], water spinach (*Ipomoea aquatica* Forssk.), and hydrilla [*Hydrilla verticillata* (L.f.) Royle]. Other aquatic species – hornwort (*Ceratophyllum demersum* L.), water lettuce (*Pistia stratiotes* L.) and azolla (*Azolla pinnata* R. Brown), are also abundant in various waterbodies across the island, but are not as major problems. Infestations of primrose willows – *Ludwigia peruviana* (L.) Hara and *L. octovalvis* are increasing in abundance in reclaimed marshlands and drainage canals, while *L. decurrens* and *L. hyssopifolia* continue to be major weed problems in rice agriculture. Giant mimosa (*Mimosa pigra* L.), which has now spread over a large area of irrigated land, is attributed to the equipment involved in the Mahaweli River diversion scheme of the 1980s. There is evidence that submerged plants – *Mayaca fluviatilis* Aubl. and *L. sedoides* (Himb. & Bonpl.) Hara, may have escaped from aquarium introductions and are now spreading, at least in one district. Sri Lanka has a poor record of managing

aquatic weeds, largely due to inadequate mechanisms to deal with them at an early stage, or prevent their entry through border protection. Recent consultations with stakeholders identified insufficient funding for on-ground works, research and development, resourcing, and absence of a centralized, coordination mechanism, as major constraints to successful management of aquatic invaders. Control options are also limited (i.e. limited array of herbicides or bio-control agents) and experience in integrated weed management planning and on-ground implementation of large-scale weed control programs is not well developed. To effectively tackle aquatic invaders in Sri Lanka, a stronger commitment from governmental authorities is needed. Increased training of weed managers is also essential, learning from international experiences, and educational campaigns are critical. Current *modus operandi* in Sri Lanka limits opportunities for community engagement in weed management projects; but, establishing multiple-stakeholder cooperation and participation frameworks should improve aquatic weed management across the island.

### **Developing Hydrogel® for Selective Management of Submerged Aquatic Weeds**

**Nimal Chandrasena<sup>1</sup>, Peter Harper<sup>2</sup>, and Bill Chisholm<sup>3</sup>**

<sup>1</sup>ALS Environmental, Penrith, New South Wales, Australia

<sup>2</sup>Bettersafe Pest and Weed Management, Ingleburn, New South Wales, Australia

<sup>3</sup>Aquatic Weed Control, Ltd., Dunedin, New Zealand

A new technique for applying the aquatic herbicide, diquat, for the control of submerged aquatics has been developed in New Zealand and is now being used widely in both New Zealand and Australia. This method involves the use of guar gum, and formulation a diquat gel form (Hydrogel®), which can then be applied to water as a surface spray. The gel droplets sink rapidly on to submerged plant beds, releasing diquat in the vicinity of target plants. This allows cost-effective “spot treatments,” targeting both containment of large infestations of an undesirable species, and eradication of small patches or colonies. Several case studies are discussed, in which Hydrogel® provided cost-effective control of large infestations of submerged aquatics – lagarosiphon (*Lagarosiphon major* (Ridley) Moss), egeria (*Egeria densa* Planch.) and hornwort (*Ceratophyllum demersum* L.) in drainage canal, wetlands and large lakes. Recent trials in shallow ponds indicate that dense infestations of hydrilla [*Hydrilla verticillata* (L.f.) Royle] could also be reduced by approximately 50-70% with one or two treatments. However, in deeper and larger lakes, hydrilla control has been variable. Hydrogel® treatments have also cost effectively controlled infestations of several pondweeds (i.e. curly pondweed – *Potamogeton crispus* L.; sago pondweed *P. pectinatus* L.; clasping-leaf pondweed – *P. perfoliatus* L.; red pondweed – *P. cheesmanii* A. Benn.) and thin-leaves naiad (*Najas tenuifolia* R.Br.) in lakes and ponds of various sizes and depths. In addition, Hydrogel® provides excellent control of filamentous green algal scum and submerged beds of Charophytes – *Chara* and *Nitella* at nominal costs. Results indicate that diquat residues rapidly dissipate from treated waterbodies after Hydrogel® treatments. The advantage of using Hydrogel® include reduced herbicide loads, savings in cost, increased confidence in treatment outcomes, and reduced risks of undesirable impacts on non-target species and aquatic ecosystems. There is further scope for expansion of using the Hydrogel® technique to control submerged aquatic weeds, and protect precious waterways. The method is versatile and should be amenable for testing other aquatic herbicides, which may broaden the spectrum of aquatic species that can be more cost-effectively managed. Opportunities are also there to optimize treatment regimes – either by dose adjustments, or changing the frequency of treatments in a given waterbody to maximize benefits.

### **Evaluation of Six Herbicides for the Control of Water Primrose (*Ludwigia peploides* (Kunth) P.H. Raven spp. *peploides*) (Student Presentation)**

**Joshua C. Cheshier, Ryan M. Wersal, and John D. Madsen**

Geosystems Research Institute, Mississippi State University, Mississippi State, Mississippi

Water primrose (*Ludwigia peploides* (Kunth) P.H. Raven ssp. *peploides*) is a native, creeping, herbaceous perennial aquatic plant that can form dense floating mats and cause significant nuisance problems in water bodies throughout the southeastern United States. Water primrose infestations can cause reductions in dissolved oxygen, species richness, navigation, and the overall aesthetic of infested water bodies. A replicated mesocosm study was conducted in 1136 liter tanks beginning in August 2009. Maximum and one-half maximum label rate applications of 2,4-D (2.2 and 4.3 kg ae ha<sup>-1</sup>), glyphosate (1.7 and 3.4 kg ai ha<sup>-1</sup>), imazamox (0.14 and 0.28 kg ai ha<sup>-1</sup>), imazapyr (0.85 and 1.7 kg ai ha<sup>-1</sup>), penoxsulam (0.05 and 0.1 kg ai ha<sup>-1</sup>), and triclopyr (3.4 and 6.7 kg ae ha<sup>-1</sup>)

were applied as a foliar application at 935 l ha<sup>-1</sup>. A non-ionic surfactant was included in the spray mixture at 0.25% v:v. Biomass was harvested at 3, 6, 9, and 12 weeks after treatment (WAT), healthy plant tissue was harvested, dried, and weighed. Data were analyzed using a mixed procedure in SAS to assess differences among herbicide treatments. Treatment means were separated using least squares means and grouped using the Least Significant Difference method at a p=0.05 significance level. Triclopyr at 9.3 l ha<sup>-1</sup> rate reduced water primrose biomass by 92 percent by 9 WAT. The maximum and one-half maximum label rate applications of 2,4-D, glyphosate, imazamox, imazapyr, and triclopyr all significantly (p<0.01) reduced water primrose biomass 3, 6, 9, and 12 WAT. Water primrose treated with 0.21 and 0.42 l ha<sup>-1</sup> rate of penoxsulam was not significantly different than untreated reference plants 12 WAT.

### **Evaluation of Alligatorweed (*Alternanthera philoxeroides* [Mart.] Griseb.) Control with Nine Different Herbicides (Student Presentation)**

**Michael C. Cox, John D. Madsen, and Ryan M. Wersal**

*Geosystems Research Institute, Mississippi State University, Mississippi State, Mississippi*

Alligatorweed (*Alternanthera philoxeroides* [Mart.] Griseb.) is an emergent, herbaceous perennial native to South America that has invaded over 32 countries around the world. Alligatorweed forms hollow stems that produce adventitious roots at the nodes and anchor into nearby sediment or organic matter. This aquatic invasive plant is capable of forming dense, floating mats that may impede boat traffic, harbor insects carrying pathogens, cause flooding, and reduce overall water quality. The objective of this study was to evaluate control of alligatorweed with nine different herbicides applied at both 0.5 and one times half the maximum label rate: diquat (2.24 and 4.48 kg ai/ha), glyphosate (isopropylamine salt at 2.27 and 4.54 kg ae/ha and diammonium salt at 2.10 and 4.20 kg ae/ha), 2,4-D (1.06 and 2.13 kg ae/ha), carfentrazone (0.11 and 0.22 kg ai/ha), penoxsulam (0.05 and 0.101 kg ai/ha), imazamox (0.28 and 0.56 kg ae/ha), imazapyr (0.56 and 1.12 kg ae/ha), and triclopyr (3.36 and 6.72 kg ae/ha). Visual control ratings (0-100%) were taken every 7 days, beginning after treatment. At 28, 56, and 84 DAT plant tissue was harvested at the soil line from each pot, dried at 70 C for 7-10 days, and weighed. Carfentrazone applied at both rates and penoxsulam at half the maximum label rate showed significantly the least control 28 DAT, with all other herbicides showing similar control results. Glyphosate, 2,4-D, imazamox, imazapyr, and triclopyr showed significantly more control 56 DAT, and carfentrazone showed the least. By 84 DAT, imazapyr, triclopyr, imazamox, glyphosate, 2,4-D, diquat, and penoxsulam at the maximum label rate showed significantly better control of alligatorweed than carfentrazone, diquat (1/2 rate) and penoxsulam (1/2 rate). Carfentrazone applied at the maximum label rate did not control alligatorweed at 84 DAT.

### **Hydrilla and Giant Salvinia Survey in Mississippi for 2009 (Student Poster)**

**Michael C. Cox, John D. Madsen, and Ryan M. Wersal**

*Geosystems Research Institute, Mississippi State University, Mississippi State, Mississippi*

Nuisance aquatic plants pose major threats to our state waterways and river systems. Two species of concern in Mississippi are hydrilla (*Hydrilla verticillata* (L.f.) Royle) and giant salvinia (*Salvinia molesta* Mitchell). Hydrilla is a submersed macrophyte native to Asia but now thriving in the southeastern United States and some northern and western states. Giant salvinia is a free-floating aquatic fern native to southeastern Brazil that is also becoming widespread throughout the southern United States. Both of these aquatic plants are on the Federal Noxious Weed List and the State Noxious Weed List for Mississippi. Mississippi State University and the Mississippi Bureau of Plant Industry developed a memorandum of agreement in 2005 as part of USDA APHIS Cooperative Agricultural Pest Survey (CAPS) program for the state of Mississippi. This agreement is to survey water bodies in the state of Mississippi for the presence of hydrilla or giant salvinia. In the last five years, hydrilla has been observed in the Noxubee National Wildlife Refuge near Brooksville, MS, in the Ross Barnett Reservoir near Rankin County, in the Tennessee-Tombigbee Waterway near Monroe and Itawamba counties, in fairway ponds on Fallen Oak Golf Course near Harrison County, and in Wall Doxey Lake near Marshall County. Giant salvinia has been observed in the Pascagoula River near Jackson County and in Wedgeworth Creek near Forrest County. Successful treatments of these species have detained present populations in some areas of the state but not eradicated them. This survey is representative of the Early Detection and Rapid Response Program for invasive plants in Mississippi.

## **Prospects for Classical Biological Control of the Federal Noxious Weed *Hygrophila*, *Hygrophila polysperma* (Roxb.) T. Anders**

**James P. Cuda**<sup>1</sup>, Abhishek Mukherjee<sup>1</sup>, William A. Overholt<sup>2</sup>

<sup>1</sup>*Department of Entomology and Nematology, University of Florida, Gainesville, Florida*

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Recently, the invasive aquatic weed hygrophila, *Hygrophila polysperma* (Roxb.) T. Anders (Acanthaceae) has created major problems for navigation, irrigation and flood control structures in Florida's waterways. Hygrophila is listed as a federal noxious weed, a state listed Category II prohibited plant, and is classified as a Category I invasive species by Florida Exotic Pest Plant Council. Managing large scale infestations of hygrophila by conventional mechanical and chemical methods has been largely unsuccessful. Existing control measures, including the grass carp, are not only ineffective but also costly. Several of the biological and economic attributes of the plant makes it a good candidate for classical biological control. However, no information on natural enemies of hygrophila was available until recently. In September 2008 and 2009, exploratory field surveys were undertaken in a range of habitats in India and Bangladesh as a part of an ongoing classical biological control project against hygrophila. The objective of these surveys was to collect and identify natural enemies damaging hygrophila in its native range. In total, 56 different sites were surveyed. The geoposition and altitude of each survey site also was recorded. Several different sampling methods were employed, (e.g., hand picking, sweep net and clip vegetation sampling, as well as Berlese funnel extraction) to collect natural enemies associated with hygrophila. Several insects were collected, including two lepidopterous caterpillars (*Precis alamana* L., Nymphalidae; and an unidentified moth, Noctuidae) that defoliate emerged plants; one unidentified aquatic leaf cutting caterpillar (Lepidoptera: Crambidae) and a leaf mining beetle (*Trachys* sp., Coleoptera: Buprestidae). Efforts are underway to identify the collected specimens to species level. A very damaging aecial *Puccinia* rust fungus also was discovered. Plant parasitic nematodes associated with the hygrophila roots were extracted using standard extraction protocols. Several common phytoparasitic nematode species (e.g. *Helicotylenchus* spp., *Tylenchorhynchus mashhoodi* Siddiqi and Basir, *Hoplolaimus indicus* Sher, *Criconemoides* spp.) were found to be associated with hygrophila roots. Detailed soil (% Organic C, available nitrogen, phosphorous and potassium) and water (pH, EC and DO) analyses also were conducted to characterize the native habitat of hygrophila.

## **Managing Hydrilla with Triploid Grass Carp in Large Reservoirs: the Carolina's Experience**

**Steven J. de Kozlowski**

*South Carolina Department of Natural Resources (retired), Columbia, South Carolina*

Hydrilla was first identified in South Carolina in 1982 and shortly after in 1985 the use of triploid (sterile) grass carp was approved for use in the state. Beginning in 1989, the largest triploid grass carp stocking project in the country was initiated in the Santee Cooper. Success of that stocking effort led to the use of sterile grass carp in other large impoundments. Discussion will focus on the results of over 20 years of grass carp use to manage hydrilla in large impoundments in South Carolina, the challenges of stocking large impoundments, maintenance stocking decisions, and lessons learned....so far.

## ***Phragmites australis* in Florida: Native or Introduced?**

**Rodrigo Diaz**<sup>1</sup>, Megan Hanson<sup>2</sup>, Dean Williams<sup>2</sup>, and William A. Overholt<sup>1</sup>

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Over the past 150 years, the distribution of *Phragmites australis* in North America has greatly expanded, and it is now considered to be invasive in parts of its range. The spread of *P. australis* in North America has been attributed to the cryptic invasion of a Eurasian genetic lineage. In North America, there are three genetic groupings of *P. australis*; native North America lineages, a Gulf Coast lineage and the exotic Eurasian lineage. The Eurasian lineage is an aggressive invader that has outcompeted and replaced nearly all native types along the central and northern east coast of the United States, and is now moving into the Midwest and western states. The origin of the Gulf Coast lineage is uncertain, as it also occurs in South America and Asia, but it has been in the Gulf Coast since at least the 1800s. Hybridization between native and Eurasian types can occur, and may further threaten the genetic integrity of North American lineages. We sampled populations of *P. australis* at 60 locations



in Florida, two in Alabama and one location in Mississippi, and used molecular chloroplast markers to determine their lineages. All populations sampled were the Gulf Coast lineage. Morphological observations revealed that the inflorescence of the Gulf Coast type differed from those of the native and Eurasian types, with the Gulf Coast inflorescence being much less compact than other types. Additionally, no seeds were found in flowers of the populations sampled, despite sampling in the fall soon after flowering, suggesting that reproduction may largely be clonal. Future studies will examine variation in microsatellite DNA to determine the extent of sexual and clonal reproduction.

## **Results from Two Years of EUP Trials with Clipper Aquatic Herbicide**

**Jason Fausey**

*Valent USA Corporation, Fremont, Ohio*

Weed management is an issue for most bodies of water. Over the years, few new active ingredients for weed management have been introduced in the aquatic market, leaving applicators few innovative weed control options. Over time in the Midwestern United States, there has been an influx of weeds such as fanwort (*Cabomba caroliniana* A. Gray), Eurasian watermilfoil (*Myriophyllum spicatum* L.) and watermeal (*Wolffia* spp.) that no commercially available herbicide provides consistent effective control. Due to lack of control, these weeds are becoming more prevalent in water bodies throughout the Midwest. This common shift in weed populations has required applicators to increase their use of certain selective herbicides as the primary means for weed control, but success has been limited. Clipper Aquatic Herbicide, which contains the active ingredient flumioxazin, is a new product being developed by Valent USA Corporation for use in aquatics. Clipper has shown to be a potentially valuable tool to manage weeds in water bodies and provides options to control several aggressive weeds such as fanwort and watermeal. Due to the recent increase in reports of herbicide resistant weeds, applicators throughout the Midwest are looking for alternative weed control programs. Experimental Use Permit (EUP) trials were established in 2008 and 2009 at several locations near Valparaiso, Indiana, and Old Fort, Ohio to evaluate the potential use of Clipper as an aquatic herbicide. The objective of these trials was to evaluate the performance of Clipper applications to ponds that contained algae and other difficult to control weeds. Aquatic weeds often have tremendous reproductive capabilities, thus implementation of control practices, which include the use of a more effective material is critical in preventing widespread infestations. Data taken from these trials confirmed Clipper is an effective management option for controlling aquatic weeds in ponds.

## **Using Deductive GIS Modeling Tools to Locate Suitable Macrophyte Habitat for Re-establishment Projects**

**Jonathan P. Fleming<sup>1,2</sup>, John D. Madsen<sup>2</sup>, and Eric D. Dibble<sup>1</sup>**

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Diverse native aquatic macrophytes serve a number of physical and biological functions in the aquatic environment and provide essential habitat for several fish species. In systems that lack submersed macrophytes due to age or disturbance, native macrophyte re-establishment can be used to revitalize the aquatic community. Planning re-establishment projects requires knowledge of the system along with the growth requirements of macrophytes. Prior studies have identified factors that are important for macrophyte colonization, persistence, and dispersal. However, deductive approaches to identify macrophyte habitat that are suitable for management application have not been developed. A potential solution to this problem is the incorporation of waterscape-wide variables into a Geographic Information System (GIS) and the use of spatial modeling techniques to identify suitable macrophyte habitat. This provides a scientifically based approach to macrophyte re-establishment planning to make efforts more efficient and to recognize potential coverage. Not only can these modeling techniques be used for re-establishment projects; the flexibility, scalability, and topological advantages of using a GIS to identify and visualize habitat make it a tool that can be integrated with a number of other spatial ecological factors to improve the management of aquatic resources from plants to fish, including invasive species mitigation. Using Little Bear Creek Reservoir, Alabama as an example system, a GIS modeling process will be illustrated that can be applied to any system where the identification of macrophyte habitat is relevant to fisheries or aquatic plant management goals. Other potential uses of the model such as invasive species risk assessment and energetic implications for aquatic biota will be discussed.

## **The Age of Partnership: Weed Science and the U.S. Environmental Protection Agency**

**Kurt D. Getsinger**<sup>1</sup>, Jill Schroeder<sup>2</sup>, Dan Kenny<sup>3</sup>, and Lee Van Wychen<sup>4</sup>

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The modern age of invasive plant management created the need for herbicide registrants, weed scientists, regulators and weed control practitioners to embrace a cooperative approach for developing environmentally compatible products to protect the Nation's critical natural resources. To lead and focus this collaboration, subject matter expert (SME) positions were established with the concurrence of the U.S. Environmental Protection Agency's (EPA) Office of Pesticide Programs (OPP). An Aquatics SME, supported by the U.S. Army Corps of Engineers and the Aquatic Ecosystem Restoration Foundation, was fashioned in 2005; followed by a Terrestrial Weed Science SME, supported by the Weed Science Society of America, in 2007. These positions are designed as a partnership between the weed science community and the EPA-OPP's Registration Division – Herbicide Branch. This affiliation is developing relationships between weed scientists and EPA personnel to provide technical information to the Agency that is useful for addressing aquatic and non-crop terrestrial weed issues which impact stakeholders - particularly those relating to invasive plants. The interaction allows the Agency better access to current information when dealing with the broad range of issues that arise, as well as answering highly specific technical questions. The SMEs work collaboratively with other allied groups (e.g. the IR-4 Project, FICMNEW, SFIREG, OPMP, AFPMB, and professional/scientific societies) to represent the overall weed science discipline, and to identify recognized experts who can provide additional input on topics of mutual concern to the Agency and operational stakeholders. Key issues that are being addressed include: the impact of a U.S. court decision to require National Pollution Discharge Elimination System permits for application of pesticides on, near, or over water under the Clean Water Act; and, management of herbicide resistant weeds. The success, benefits, and momentum generated by the new SME relationships clearly indicate the importance of maintaining a long-term partnership between the Agency and the weed science community.

## **Response of Selected Foliage Plants to Four Herbicides in Irrigation Water**

**Lyn A. Gettys** and William T. Haller

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

'Frieda Hemple' caladium (*Caladium × hortulanum*), 'Miami Beauty' anthurium (*Anthurium andreanum*), 'Debbie' spathiphyllum (*Spathiphyllum 'Debbie'*) and 'Regina Red' syngonium (*Syngonium podophyllum*) were irrigated with water treated with quinclorac, topramezone, bispyribac and trifloxysulfuron sodium to identify herbicide concentrations that cause phytotoxic effects. Plants were irrigated four times over a 10-d period with the equivalent of 0.5 inch of treated water during each irrigation, then irrigated with tap water until they were harvested 43 d after the first herbicide treatment. Visual quality and dry weight data revealed that caladium was the most sensitive of the foliage plants, regardless of herbicide mode of action. Noticeable reductions in visual quality and dry weight of caladium were evident after exposure to 144, 186, 182 and 1135 ppb of quinclorac, topramezone, bispyribac sodium and trifloxysulfuron sodium, respectively. Of the four herbicides evaluated in these experiments, only quinclorac caused noticeable damage to plants when applied at a concentration similar to the proposed use rate.

## **Sampling of Herbicide Residuals Confirms Extended Exposure to Low Concentrations of 2,4-D and Triclopyr can Control Eurasian Watermilfoil**

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Eurasian watermilfoil (*Myriophyllum spicatum* L.) and curlyleaf pondweed (*Potamogeton crispus* L.) are invasive submersed plants found throughout the Great Lakes Region. Herbicide programs targeting selective control of these species in Minnesota and Wisconsin have recently relied on the systemic auxin mimics triclopyr and 2,4-D, and the contact herbicide endothall. In conjunction with numerous operational treatments, a rigorous herbicide

residue sampling program has been implemented to improve our understanding of how treatment scale and timing can impact herbicide concentration and exposure time relationships. Recent data generated in mesocosm systems indicate that Eurasian and hybrid watermilfoil can be controlled following extended exposures to low concentrations of triclopyr and 2,4-D (50 to 250  $\mu\text{g L}^{-1}$ ). Field sampling of herbicide residues has shown that larger scale applications can result in whole lake use patterns that result in extended exposures to the lower concentrations described above. While the efficacy of this use pattern has been documented at a lake-wide scale, the factors that influence selectivity remain under investigation. In contrast to large-scale applications, smaller spot applications in larger lake systems have resulted in significant variation in herbicide residuals and a resultant wide range of treatment outcomes. Despite many anecdotal claims of variable efficacy results being linked to factors such as milfoil hybridity, our sampling efforts suggest that large differences in water exchange rates within treatment plot have the greatest impact on treatment efficacy. Examples from operational treatments in Minnesota and Wisconsin will be discussed in conjunction with recent mesocosm data generated to simulate the concentration and exposure time profiles observed in the field.

### **Refining the New Zealand Aquatic Weed Risk Assessment for Florida and the U.S.**

**Doria R. Gordon**<sup>1</sup>, Crysta A. Gantz<sup>2</sup>, Christopher L. Jerde<sup>3</sup>, and W. Lindsay Chadderton<sup>4</sup>

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The U.S. spends well over \$100 million annually on management of invasive aquatic plants. Simultaneously, trade in aquatic species for home aquaria and water gardens has increased exponentially. As a result, development of an effective method for preventing import of new species with a high probability of becoming invasive and identifying priority species for management and regulation is critical. We are testing the accuracy of the risk assessment system for aquatic plants developed by New Zealand's Biosecurity Program in Florida and the U.S. The system includes a suite of questions with additive scores for biological, historical, and environmental tolerances for each species. We have identified 78 aquatic plant species that have naturalized in the continental U.S. and 88 that have not. The species are from 57 families and span all aquatic growth forms. We had sufficient data to use 129 species for initial trials. We were able to identify a threshold score that correctly differentiated invaders and non-invaders with 88% accuracy. However, non-invaders were more accurately identified than were invaders. We subsequently separated the naturalized category into invaders and species that are naturalized but not extensively invasive. We also modified the questions to increase the sample size of species available. These refinements increased the prediction accuracy for both invaders and non-invaders and reduced the proportion requiring further evaluation. Differences in threshold scores and accuracy for a regional (Florida) or national (U.S.) approach were minimal, suggesting that a regionally-scaled system is not necessary. Our results should facilitate prevention activities within Florida and provide data to enable the U.S. Department of Agriculture (APHIS-PPQ) to evaluate incorporating this tool within the revisions to the plant quarantine regulations (Q-37).

### **Evaluation of Aquatic-use Herbicides for Japanese Stiltgrass Control**

**Karen R. Hall**<sup>1</sup>, Robert J. Richardson<sup>2</sup>, and Steve T. Hoyle<sup>2</sup>

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Japanese stiltgrass, *Microstegium vimineum* (Trin.) A. Camus, is an annual invasive grass native to Asia that is infesting riparian areas throughout the southeastern United States. It is extremely shade tolerant and forms dense monocultures after invasion. A study began in 2009 to evaluate herbicides that are registered or are pending registration for aquatic-use for Japanese stiltgrass control. Herbicides were applied at various rates to natural stands of *Microstegium vimineum* located alongside restored stream channels. Studies were performed to determine effectiveness of herbicides for both preemergence (PRE) and postemergence (POST) control. The PRE study utilized five aquatic-use registered herbicides including carfentrazone, fluridone, imazamox, imazapyr, and penoxsulam and two aquatic-use registration pending herbicides of bispyribac and flumioxazin. The POST study employed six aquatic-use registered herbicides including diquat, fluridone, glyphosate, imazamox, imazapyr, penoxsulam and two aquatic-use registration pending herbicides including bispyribac and flumioxazin.

Preliminary results indicated good PRE herbicide effectiveness with flumioxazin, fluridone, imazamox, and imazapyr. POST effective herbicides included flumioxazin, imazamox, and imazapyr. The study will continue in 2010 and preliminary data from 2009 will be discussed in this presentation.

### **ALS Inhibitor Use Patterns for Management of *Hydrilla verticillata***

**Mark A. Heilman<sup>1</sup>**, Tyler J. Koschnick<sup>1</sup>, and Todd Horton<sup>2</sup>

<sup>1</sup>SePRO Corporation, Carmel, Indiana

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In the last three years, two acetolactate synthase (ALS) inhibiting herbicides, Galleon™ SC (a.i. penoxsulam) and Clearcast™ (a.i. imazamox), have been registered for treatment of aquatic vegetation. The initial development of both herbicides focused on the control of the submersed weed hydrilla (*Hydrilla verticillata*). These ALS inhibiting compounds have proven to have very divergent use patterns for hydrilla management. Galleon has provided effective control of hydrilla with extended exposure. A synergistic interaction has also been discovered between Galleon and the contact herbicide, endothall. This combination reduces overall use rates for both herbicides with a nearly contact-like use pattern with respect to herbicide exposure in contrast to the longer exposures required with Galleon alone. Mesocosm and field evaluations document effective hydrilla control with combined herbicide exposures as short as 72 hours with good selectivity on a variety of desirable native aquatic plants. Latest research into the efficacy, weed control spectrum, selectivity, and mode of action of the combination treatment (termed Galleon Plus) will be discussed. In contrast to Galleon or Galleon combinations, Clearcast has been documented to provide less control of hydrilla standing biomass in a traditional sense, but rather has a unique and unexpected property for hydrilla management: sustained growth regulation following rather short exposures. The ability of Clearcast to provide extended growth regulation with relatively short exposure times has supported on-going development of multiple use patterns for aquatic habitat enhancement, including: 1) targeted inhibition of nuisance hydrilla conditions in partial treatment sites subject to dilution, 2) extending effective control following contact herbicide treatments, and 3) maintenance of non-nuisance levels of hydrilla as habitat for fish and other aquatic fauna. Further, because of their distinct uses, combinations of Clearcast and Galleon are also being developed for hydrilla management. Recent studies examining Clearcast's use as an aquatic plant growth regulator will be reviewed, and the role of ALS-inhibitors in long-term hydrilla management will be discussed.

### **Development of Galleon™ and Clearcast™ for Control of the Exotic Submersed Weeds *Potamogeton crispus* (Curly Leaf Pondweed) and *Myriophyllum spicatum* (Eurasian Watermilfoil)**

**Mark A. Heilman<sup>1</sup>**, Tyler J. Koschnick<sup>1</sup>, Todd Horton<sup>2</sup>, Cole Hulon<sup>3</sup>, and Bob Johnson<sup>4</sup>

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The registered acetolactate synthase (ALS) inhibiting herbicides Galleon™ SC (a.i. penoxsulam) and Clearcast™ (a.i. imazamox) are labeled for in-water treatment of a variety of noxious submersed aquatic weeds. Recent studies have documented significant potency and activity with both these compounds on curly leaf pondweed (CLP) and Eurasian watermilfoil (EWM). In lab aquarium and outdoor mesocosm trials, Galleon™ concentrations of 10 ppb or less have produced effective control of both CLP biomass and inhibited turion formation. While more gradual in biomass reduction, Galleon™ can provide EWM control at similar concentrations with extended exposure times, and combinations with other herbicides including endothall and Renovate™ (a.i. triclopyr) accelerate speed of EWM control. Additionally, a synergistic interaction has been discovered between penoxsulam and the contact herbicide, endothall. Additional controlled studies and early field evaluations have demonstrated that Clearcast™ can also provide effective control of CLP or sustained growth regulation of CLP and EWM with short exposures. Aquarium and mesocosm studies indicate that rates of 25-100 ppb with exposures between 3 – 14 days can provide effective reductions in CLP and EWM biomass and CLP turion abundance at 3 months post treatment. Pond and other small field treatments in the Midwest have confirmed this activity. The latest findings of on-going research to establish use patterns and selectivity profiles of these two ALS chemistries for CLP and EWM management will be presented.

## **Environmental Factors Contributing to Avian Vacuolar Myelinopathy and Stigonematales Abundance in J. Strom Thurmond Lake**

**James Herrin**<sup>1</sup>, Michael Hook<sup>2</sup>, Rebecca Haynie<sup>1</sup>, John Kupfer<sup>3</sup>, and Susan Wilde<sup>1</sup>

<sup>1</sup>Daniel B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia

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J. Strom Thurmond Lake (JSTL) is a U.S. Army Corps of Engineers multiple-use reservoir on the Savannah River, between Georgia and South Carolina. Hydrilla (*Hydrilla verticillata*), is the most prevalent aquatic macrophyte, covering approximately 10% of the lake's 28,700-ha surface. The epiphytic Stigonematalan cyanobacterium that has been linked to Avian Vacuolar Myelinopathy (AVM) is also present in the reservoir and grows predominantly on hydrilla. AVM is an emerging wildlife disease affecting chiefly waterfowl and their avian predators. Since the disease was diagnosed on the reservoir in 1998, active bald eagle (*Haliaeetus leucocephalus*) nests are in decline and breeding territories have been reduced by over half. In order to better understand the seasonality of this disease, historic limnologic and epizootic data collected at JSTL were analyzed using a Pearson's Correlation. There was a significant difference between cases when AVM was detected and when disease was not detected based on destratification ( $X^2=10.588$ ,  $p<0.001$ ). A strong significant relationship was found between the presence of brain lesions in test animals, which are indicative of AVM, and both measures of destratification--local or whole-lake mixing ( $R^2=1.00$ ,  $p<0.01$ ). The role of seasonality on the disease at JSTL was further investigated during an intensive 2009-2010 sampling regime. Abiotic water quality parameters, water and hydrilla samples were collected monthly from 20 sites. The water samples were analyzed for nutrients and metals and the hydrilla samples were screened microscopically to document Stigonematales density. The statistical and spatial analyses results from this investigation are pending. The results will allow us to identify relationships between the reservoir's seasonal limnologic fluctuations, nutrient and metal levels and Stigonematales abundance.

## **The Human Dimension of Nuisance Aquatic Species Management: An Investigation of Georgia Boaters (Student Presentation)**

**James Herrin**, Rebecca Haynie, Susan B. Wilde, and Craig Miller

Daniel B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia

Boaters have frequently been implicated in the spread of aquatic invasive species between disparate bodies of water. Aquatic resource management agencies in the United States spend many hours and dollars annually on efforts to limit the spread and impact of invasive species. Increased understanding of the mechanisms of introduction will aid managers in developing and employing effective educational campaigns. Agencies in Georgia are currently dealing with a number of invasive plants and animals—including lion fish, flathead catfish, hydrilla and apple snails. These species disrupt the function of both ecosystems and economies. A survey was conducted to investigate Georgia boaters' perceptions of nuisance aquatic species (NAS), boat cleaning behaviors and use of the agency's website. More than one-third of respondents indicated uncertainty about the meaning of NAS. Results indicated that boaters' perceptions of NAS were related to angling-participation and visitation to the website, but not to the distance from launch sites to residence ( $p<0.001$ ,  $p<0.001$ , and  $p=0.805$ ). Frequency of boat cleaning behaviors was related to the distance traveled and angling-participation, but not to use of the website ( $p<0.001$ ,  $p<0.001$ , and  $p>0.05$ ). A higher proportion of respondents owning fishing boats properly cleaned crafts after use ( $p<0.001$ ) relative to respondents with other types of boats. This study identified some goals for management agencies charged with preventing the spread and limiting the impact of NAS. Over half of respondents did not purchase a fishing license; therefore, educational material should also be targeted at non-anglers. Efforts should be made to increase traffic to the website—less than one-third of respondents visited the website. Georgia could limit the spread of NAS in the state by augmenting and increasing the appeal of available educational materials.

## **Raising Awareness Among Lake Users about Aquatic Weed Issues**

**Stacia Hetrick**

*Osceola County Extension Services, University of Florida, Kissimmee, Florida*

Aquatic weeds, including hydrilla (*Hydrilla verticillata*) and hygrophila (*Hygrophila polysperma*), cause serious environmental and economic impacts in Florida. Although we have been struggling with invasive plant problems for more than a century in Florida, most people are unaware of the severity of the situation and have misconceptions about managing aquatic weeds. Osceola County's Hydrilla and Hygrophila Demonstration Project seeks to find new methods to manage hydrilla and other nuisance weeds. One of the components of the project is a concerted public information campaign to bring lake users (i.e., boaters, duck hunters, and anglers) "up to speed" with the problems our state is facing regarding aquatic weeds. Numerous public outreach strategies have been implemented by UF/IFAS Osceola County Extension to raise awareness among lake users, including 1) kiosks at major boat ramps, 2) waterproof pocket guides, 3) educational exhibits at events (i.e., bass fishing tournaments), 4) promotional key chains and magnets, 5) articles in various lake user group's magazines and newsletters, 6) educational newspaper inserts, and 7) presentations at various meetings (i.e., duck hunting conventions). Evaluation of these strategies is in progress. The objective is to create a more educated stakeholder group that will be supportive of the state's aquatic plant management program and will help to prevent the spread of aquatic weeds to new areas. So far, 4 permanent kiosks have been erected at major boat ramps and educational posters have been posted in 12 additional kiosks. Over 1,000 pocket guides have been distributed to lake users and exhibits have been displayed at various community events. A 12-page full-color educational insert entitled "Aquatic Invaders" was created for our local newspaper, the Osceola News-Gazette with a distribution of 39,000. Lastly, articles have been published in various magazines and newsletters and presentations have been delivered to many stakeholder groups. As a result of these efforts, we have received numerous requests for presentations and copies of publications, and numerous inquiries regarding aquatic weeds.

## **A History of Hydrilla in North Carolina**

**Steve T. Hoyle** and Robert J. Richardson

*Crop Science Department, North Carolina State University, Raleigh, North Carolina*

Hydrilla was first identified in North Carolina at Umstead Park (Wake County) in 1980. A survey conducted by the North Carolina Department of Agriculture in 1981 found hydrilla in 11 locations, primarily in Wake County. Hydrilla spread rapidly and now is scattered in 35 or more counties from the coastal plain to the mountains. These infestations include small to medium sized impoundments and also includes such large reservoirs as Lake Gaston, Lake Norman, and Lake Tillery. Early control methods focused on contact herbicides and control was marginal. Triploid grass carp were first introduced in the early 1980's and provided excellent hydrilla control in many impoundments. The systemic herbicide fluridone has also been used successfully in many North Carolina systems, but success is very dependent on proper application and sites with relatively little water flow. Current management strategies in North Carolina include a mixture of contact and systemic herbicides as well as triploid grass carp.

## **Eurasian Watermilfoil Response to Imazamox (Student Presentation)**

**Trevor D. Israel**, Robert J. Richardson, and Steve T. Hoyle

*Crop Science Department, North Carolina State University, Raleigh, North Carolina*

Imazamox is an imidazolinone herbicide that inhibits the acetolactate synthase (also known as acetohydroxyacid synthase) enzyme (EC 4.1.3.18). Research was conducted to evaluate the response of Eurasian watermilfoil to in-water applications of imazamox. In trial 1, imazamox was applied with a single application of 25, 50, 75, 100, and 200 ppb and four sequential applications of 25 ppb. A comparison treatment of 10 ppb fluridone and a non-treated control were included. At 3 months after treatment (MAT), control reached a maximum of 65% with imazamox compared to 100% control with fluridone. Dry weight was 0 g with fluridone, 5.23 g with 100 ppb imazamox, and 10.19 g with the non-treated control. Minimal control was observed with 25 ppb imazamox applied once or in four sequential applications. In trial 2, a three by four factorial treatment arrangement was used with exposure times of 2, 7, and 14 days and imazamox rates of 25, 50, 75, and 100 ppb. A non-treated control was included for comparison. At 2 MAT, control was 95% with 100 ppb imazamox and 14 day exposure. Control

was 70% with 75 ppb imazamox and 14 day exposure and 73% with 100 ppb imazamox and 7 day exposure. Control with other treatments did not exceed 23%. Eurasian watermilfoil height was 3 cm with 100 ppb imazamox and 14 day exposure and fresh weight was 0.42 g. Measurements for the non-treated control were 61 cm and 26.17 g, respectively.

### **How to Reduce Negative Effects of Turbidity, Control Algae Blooms, and Meet Water Quality Standards** **Seva Iwinski**

*Applied Polymer Systems, Woodstock, Georgia*

Eutrophication is caused by agricultural runoff, and other land disturbing activities, sewer overflows, and urban runoff. Runoff coming from these sources such as sedimentation and excess nutrient loads, including phosphorus, contribute to algal blooms and water quality impairments. Unpleasant aesthetic effects caused by eutrophication does not compare to the detrimental effects that turbid ponds, lakes and various water bodies can have on overall water quality, aquatic organisms and other animal populations. Such negative effects include high nutrient levels, such as phosphorus that produce algal blooms that die and decay, which in turn uses up available dissolved oxygen. Fish need oxygen to survive and if oxygen is depleted fish kills can result. Fine particulates in the water column are also a point of attachment for contaminants of not only nutrients but also bacteria, heavy metals, pesticides, and endocrine disruptors. These particulates make up turbidity which we measure in Nephelometric Turbidity Units (NTU's). Through various studies it has been found that as low as 10-100 NTU's aquatic organisms will begin to show signs of stress. This happens through decreased light, food, and oxygen, mechanical effects, and temperature increases due to darker water. Once we understand the effects turbidity has when it escapes into our waterways we need to determine what we can do to prevent or remove it. This is where Polymer Enhanced Best Management Practices (PEBMP's) are beneficial. Anionic water soluble polymer technologies are used to enhance best management practices (BMP's) to reduce sediment and nutrients from moving into a water body. If sediment and nutrients have already entered a water body it can be reduced by using polymer enhancements in conjunction with aeration systems, fountains, water falls, etc. Through various tests and case studies using polymer enhancement in conjunction with known BMP's a 75-90 percent reduction in phosphorus has been found as well as a 95 percent reduction in NTU's. Therefore PEBMP's including water clarification systems to reduce turbidity from a water column and soil stabilization used to control sedimentation at the source so that it is not transported into our waters will be discussed.

### **Aluminum Sulfate Application to Improve Under-water Light Condition for Native Submersed Macrophyte Restoration: Alum to Phosphorus Binding Ratio Considerations**

**William F. James**

*U.S. Army Engineer Research and Development Center, Eau Galle Aquatic Ecology Laboratory, Spring Valley, Wisconsin*

Native submersed macrophyte growth is often limited by underwater light availability in eutrophic aquatic systems. Control of canopy-forming exotic species does not necessarily lead to greater light penetration because eutrophic systems usually sustain high algal biomass in the form of cyanobacterial blooms that can rapidly attenuate light near the lake surface. High phosphorus (P) loading from bottom sediments often represents an important source for algal uptake that needs to be controlled in order to drive aquatic systems toward P-limitation of growth and improve underwater light condition for restoration of native submersed macrophyte populations. Aluminum (Al) sulfate application represents an effective management technique for binding P in sediment and reducing flux into the water column for algal uptake. However, research is needed to determine the dosage of alum required to bind sediment P. The objective of this research was to examine Al:P stoichiometry in relation to extractable forms of sediment P in order to improve the accuracy of alum dosage determination to control sediment P loading in aquatic systems.

## **Response of Native Macrophyte Communities to Early Season Herbicide Treatments of *Potamogeton crispus* (Student Presentation)**

**Ajay R. Jones**, James A. Johnson, and Raymond M. Newman

*Departments of Fisheries, Wildlife, and Conservation Biology, University of Minnesota, St. Paul, Minnesota*

Within the Midwestern United States, curlyleaf pondweed (*Potamogeton crispus* L.) is one of the most invasive aquatic plants. Curlyleaf invasions are characterized by dense mats of nuisance growth, which cause extensive obstruction to boat traffic and negative impacts to lake habitats. Monotypic curlyleaf stands supply excess nutrients upon senescence and hinder native macrophyte growth. Lake-wide, early-season herbicide treatments of curlyleaf pondweed may provide an effective control strategy that would also reduce harm to native macrophyte communities. We examined the response of native plant communities to spring herbicide treatments of curlyleaf pondweed from 2006 through 2009. Thirteen lakes were examined during our study; ten were treated with herbicide and three were used as non-treatment reference lakes. Plant communities were assessed in the littoral zone (<4.6 cm depth) with the point intercept method (100 to 400 points per lake) in early spring (before treatment), late spring and late summer. For each survey, approximately 40 random biomass samples (0.33 m<sup>2</sup>) were taken throughout each study lake to estimate plant biomass. In the reference lakes, curlyleaf persisted in moderate to high frequencies over the four years, and no consistent changes in native frequencies were seen. Herbicide treatments proved effective for controlling curlyleaf; curlyleaf decreased in occurrence within 1 month following treatment. In the treatment lakes, early spring (pre-treatment) curlyleaf occurrence declined between 2006 and 2009. The total frequency of occurrence of native plants did not decrease in most of the treatment lakes. Native macrophyte species richness also showed little change with continued treatment, although shifts in abundance of some species were observed. Native plant biomass increased between 2006 and 2009 in most treatment lakes, while native biomass varied in untreated lakes. Much of the change in biomass was attributed to a single species in most treatment lakes. We observed increases of *Chara* spp. frequency and biomass throughout treated lakes. However, multiple years of treatment may be needed to obtain increases in native plant abundance as the biggest increases occurred after 3 years of treatment. Early-season lake-wide herbicidal treatments of curlyleaf pondweed can reduce curlyleaf occurrence and density without major harm to native plants.

## **Charophyte Response to Herbicide and Mycoherbicide Treatment (Student Presentation)**

**Chrystal Kelly**<sup>1</sup>, David Hamilton<sup>1</sup>, Mary de Winton<sup>2</sup>, and Deborah Hofstra<sup>2</sup>

<sup>1</sup>*Department of Biological Sciences, University of Waikato, Hamilton, New Zealand*

<sup>2</sup>*National Institute of Water and Atmospheric Research, Hamilton, New Zealand*

Charophytes are a submerged aquatic plant that is native to New Zealand and is recognised as a beneficial component of lake ecosystems. They have the ability to reduce water turbidity by binding sediment and are amongst the first plants to re-colonise revegetated environments. A contributing factor to rapid re-colonisation is the fact that New Zealand lake sediments (seed banks) are dominated by charophyte oospores. Invasive aquatic plants are known to exclude and replace charophytes through the formation of dense mono-specific stands. They require control for purposes of managing biodiversity, oxygen consumption rates and water quality in lake ecosystems. The current chemical control methods used in New Zealand for invasive aquatic plants include the use of two registered aquatic herbicides; diquat and endothall. Fluridone, which is currently used in the USA, has not been registered in New Zealand but has potential as a selective control agent. More recently, a naturally occurring aquatic fungus, prepared as a mycoherbicide, has been evaluated for use. These control methods have been successful on target weeds and have shown no impact on mature charophyte species, however, the potential for impact on germling and oospore germination has received little attention. The effects of three herbicides (diquat, endothall and fluridone) and a mycoherbicide are described in relation to charophyte germination, germling susceptibility and species response, in a laboratory scale study. This research has important implications for management of aquatic plants in New Zealand as it demonstrates the need to consider relative efficacy of the treatments over the full life cycle of native charophytes.



## **A New Pocket Scouting Guide for Aquatic Plant Identification**

Bridget Robinson Lassiter, **Robert J. Richardson**, and Gail Wilkerson

*Crop Science Department, North Carolina State University, Raleigh, North Carolina*

A new identification guide for common aquatic plants of the southern Mid-Atlantic region of the United States has been created by North Carolina State University. This guide is designed to be field portable; it will fit in a large pocket and is printed on water tolerant stock. Color photographs, comparison tables, line drawings, and text descriptions of approximately 60 species are included to aid users in identification. These species include selected algae, ferns, and vascular plants that are common and/or problematic. Both invasive species and common natives are included. Sample pages and ordering information for this guide will be displayed.

## **What Challenges Lie Ahead for Hydrilla Management?**

**John D. Madsen**

*Geosystems Research Institute, Mississippi State University, Mississippi State, Mississippi*

The challenges lying ahead for hydrilla management come from numerous sources, and will confront manufacturers, applicators, stakeholders, and natural resource managers alike. These challenges can be characterized as new territories, new pests, new chemistries, product stewardship, and regulatory compliance. New territories, meaning that hydrilla has continued to expand its range, with both monoecious and dioecious biotypes finding their way to new states. Despite the widespread availability of information on the internet, each state insists on reinventing the wheel in their state. We need to be more aggressive in getting good science to these state resource managers. We will have new pests in two senses: new species (such as *Rotala rotundifolia*) will be introduced through the aquarium and water garden trades, introducing new management challenges. Likewise, as we are successful in managing hydrilla, other invasive plants will take its place. New chemistries, products and formulations will undoubtedly continue to enter the aquatic market, which is a good thing; but we also need to recognize that each product will have a learning curve. While some may dispute the next assertion, the timeline to learn how to use fluridone effectively was easily one decade or more; we will be tempted to fit new products into a box with known products, which may be erroneous. Strong guidelines for product stewardship have not yet appeared in the aquatic industry; which is hardly surprising since stewardship guidelines for agricultural applications have yet to be widely adopted. Strong product stewardship guidelines, such as rotating mode of action, will ensure that we have these products long into the future. Regulatory compliance costs and complications will only expand in the future, with NPDES, ESA, and the new CWA leading the federal expansion of regulations, and states expanding their regulatory compliance issues to meet federal expectations. Public expectations are constantly shifting, and with more of the public raised in urban settings, aversion to using herbicides will undoubtedly increase. We will continue to have a challenge in public education regarding invasive plant prevention, and acceptable management solutions to these problem plants. Competing interests include coping with supposed experts from other disciplines (such as fisheries biologists and aquatic ecologists), fishing enthusiasts, and other users among stakeholder groups. The diversity of interests and divergence of perceived appropriate solutions will continue in the future. While these challenges may appear daunting, they are also opportunities for us to respond both individually and as the Aquatic Plant Management Society.

## **Morphological and Genetic Taxonomic Analysis of Native and Nonnative Watermilfoil in Reservoirs of the Lower Clark Fork River System**

**John D. Madsen**<sup>1</sup>, Joshua C. Cheshier<sup>1</sup>, Vipaporn Phuntumart<sup>2</sup>, Ryan A. Thum<sup>3</sup>, and Mark Welch<sup>4</sup>

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<sup>4</sup>*Department of Biological Sciences, Mississippi State University, Mississippi State, Mississippi*

Eurasian watermilfoil (*Myriophyllum spicatum* L.) was introduced to the Lower Clark Fork River system late in the decade of 2000, although it has been lower in the Pend Oreille River system for some time beforehand. The Lower Clark Fork River reservoirs (Thompson Falls, Noxon Rapids, Cabinet Gorge, and Pend Oreille Lakes, respectively, from upstream to downstream) have several native watermilfoil species, predominantly northern watermilfoil (*Myriophyllum sibiricum*). In 2008, we collected Eurasian watermilfoil and northern watermilfoil

samples from six sites in each of the four reservoirs of the Lower Clark Fork River (only *M. sibiricum* was collected in Thompson Falls Reservoir, which did not have *M. spicatum*). We evaluated key morphological parameters on all specimens, including internode length, leaf length, leaflet length, number of leaflets per leaf, and stem thickness from six internodes per stem. Three independent laboratories performed three separate genetic analyses on all 42 specimens. Morphologically, reliable indicators between Eurasian watermilfoil versus northern watermilfoil were flattened (EWM) versus rounded (NM) apical meristem, flattened (EWM) versus rounded (NM) leaf tip, and more than 12 leaflet pairs (EWM) fewer than 12 leaflet pairs (NM). Genetic analysis from all three laboratories confirmed that morphological factors correctly identified the watermilfoil species. Also, genetic analysis did not indicate any evidence of hybridization of Eurasian watermilfoil with northern watermilfoil or any other native watermilfoil species.

### **Clientele Evaluation of the AQUAPLANT Website**

**Michael P. Masser** and Satoshi Kamata

*Texas AgriLife Extension, Texas A&M University, College Station, Texas*

Aquatic plants are a problematic issue for most private waters. To assist private impoundment managers and others, a web-base identification and management tool (i.e. AQUAPLANT) was developed for the Texas Agricultural Extension Service (i.e. Texas AgriLife Extension) in 2000. AQUAPLANT went through a major revision in 2005 and continues to be updated semi-annually. The AQUAPLANT site consists of 72 species/families of aquatic plants common to the Southern states and most of the U.S. For each specie or group the site assists in **Identification** through photographs, drawings, and simple descriptions. Once identification is made, **Management Options** are provided for possible Mechanical, Biological, or Chemical control. Links are provided to MSDS herbicide labels for all the major aquatically registered (i.e. EPA) herbicides. AQUAPLANT has proven to be a heavily used resource with over 152,000 unique visitors in 2007, over 210,000 in 2008, and over 231,500 2009. Pages downloaded were 664,440 pages in 2007, over 900,000 in 2008, and over 1,120,000 in 2009. A user satisfaction on-line survey was conducted in 2007 (June – December). The survey revealed that the site was used mostly by private impoundment owners to identify a problem plant, although in most cases no management was to be applied. However, satisfaction was good as users were “Highly Likely” to recommend the site to others. AQUAPLANT has proven to be a useful tool for aquatic plant identification and management.

### **Research and Testing of a System for Precision Littoral Zone Application of Aquatic Herbicides**

**Thomas McNabb**<sup>1</sup>, Thomas Moorhouse<sup>2</sup>, and Bruce Sabol<sup>3</sup>

<sup>1</sup>*Clean Lakes, Incorporated, Coeur D’Alene, Idaho*

<sup>2</sup>*Clean Lakes, Incorporated, Westlake Village, California*

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The U.S. Army Engineer Research and Development Center, Environmental Laboratory (ERDC-EL), and Clean Lakes, Inc. entered into a Cooperative Research and Development Agreement for the “Research and Testing of a System for Precision Littoral Zone Application of Aquatic Herbicides.” The Scope of the Cooperative Research and Development Program is to provide for the joint conduct of research and development investigations related to coupling the LittLine<sup>®</sup> System (Littoral Zone Treatment Technology) with ERDC-EL Hydroacoustic Submersed Plant Mapping capabilities (SAVEWS<sup>™</sup> and related developments). The technologies will be used together to achieve precision application of herbicide to submerged, nuisance aquatic vegetation. The Project Objective is to design a LittLine<sup>®</sup> System that utilizes SAVEWS<sup>™</sup> or variations of that technology in an optimized system for automated aquatic herbicide applications. Field testing and modifications will yield a new real-time application system capable of delivering excellent plant control with a reduction in the amount of herbicide required by conventional delivery methods. The research team began the initial CRADA investigations in Florida during the period of January 5 through January 12, 2010 within Hydrilla control zones within Lake Tohopekaliga, or Lake Toho. Lake Toho is an 18800 acre lake in Osceola County known as one of the best lakes in Florida for bass fishing, and is located within the Kissimmee Chain of Lakes. For the initial investigations, aquatic herbicide treatments were mock treatments using water rather than aquatic herbicides. Through the initial research investigations, the ability of combining the two systems was demonstrated, and an update on the efforts will be presented.

## **High-density Aquatic Vegetation Baseline Surveys of the Kissimmee Chain of Lakes and Lake Istokpoga: Results and Implications for Habitat and Invasive Vegetation Management**

**Ryan Moore**<sup>1</sup>, Jeremy G. Slade<sup>2</sup>, and Dean Jones<sup>3</sup>

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Competing hypotheses have developed regarding the longer-term habitat impacts resulting from proliferation and management of invasive submerged aquatic vegetation (SAV) in the Kissimmee Chain of Lakes and Lake Istokpoga. All parties seek to optimize and maximize beneficial submerged habitat though disagree as to which management strategies can best reach that goal, especially in light of all stakeholder needs. Assumptions about the status and trends of native SAV species have been a central factor in the discussion. These assumptions are difficult to test and explore because, prior to 2009, a detailed SAV survey of the lakes had never been performed. To fill this data gap, a very highly detailed submerged aquatic vegetation survey was conducted in 2009 at Lakes Tohopekaliga, Cypress, Hatchineha, Kissimmee, and Istokpoga. Emergent vegetation was also surveyed in significant detail. A total of 72 species were inventoried across the lakes. Now that the status of these species is determined, subsequent surveys can shed light on the changes and trends of native species at the lakes in response to invasive vegetation management and other environmental factors. This understanding will help make progress toward a consensus approach. The key results of the 2009 baseline survey will be showcased in this presentation, including how to access the data. Many interesting insights have already been drawn from the baseline data. Also covered will be the implications that the data have for informing invasive vegetation management strategies and aquatic habitat optimization within the Kissimmee Chain system.

## **Response of Giant Salvinia to Static and Sequential Penoxsulam Treatments Coupled with Various Exposure Times**

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Giant salvinia (*Salvinia molesta*) has become problematic in water bodies throughout the southeastern U.S. dominating coves and quiescent bays where dense infestations disrupt transportation, hinder water uptake, impact desirable native plant communities, and increase mosquito breeding habitat. Aquatic herbicides have traditionally been applied as foliar applications with moderate to good success, but repeated applications are often required to prevent re-growth of the plant. Subsurface injection techniques are currently being evaluated to increase plant uptake of herbicides in an effort to achieve more complete control. Mesocosm trials were conducted in 2008 and 2009 to determine the effects of the ALS herbicide penoxsulam on giant salvinia. In the first experiment, penoxsulam was applied as a subsurface treatment at various concentrations (5 to 40  $\mu\text{g a.i. L}^{-1}$ ) and exposure times (1 to 12 wk) with plants harvested 16 wk after treatment (WAT). Higher concentrations and longer exposures resulted in increased giant salvinia control. In particular, penoxsulam at 5, 10, and 20  $\mu\text{g a.i. L}^{-1}$  exposed for 12 wk provided 77 to 99% control. Plants exposed to penoxsulam for 1 to 4 weeks, regardless of concentration, demonstrated symptoms of injury and growth regulation; however, new growth was observed within a week after removal from treatment. In the second experiment, single (5 to 160  $\mu\text{g a.i. L}^{-1}$ ) and sequential (1.25 to 20  $\mu\text{g a.i. L}^{-1}$ ) penoxsulam applications were compared to determine if stand-alone treatments could provide better control than sequential treatments. All herbicide treatments resulted in a decrease in giant salvinia dry weight 16 WAT with all but three of the treatments decreasing biomass to less than pre-treatment levels. Single higher dose treatments (20  $\mu\text{g a.i. L}^{-1}$ ) maintained for 16 wk resulted in 100% control, but higher dose followed by lower dose treatments or lower dose static treatments still provided 76 to 92% control. Results from these experiments indicated giant salvinia control can be achieved by implementing sequential or single high dose treatments and maintaining penoxsulam residues for an extended period of time (>12 wk). Although lower dose static treatments (5  $\mu\text{g a.i. L}^{-1}$ ) can result in acceptable control, increased control can be attained by exposing plants to higher penoxsulam concentrations (10 or 20  $\mu\text{g a.i. L}^{-1}$ ) for longer periods of time (16 wk).

## **Responses of Cabomba and Other Weeds to Flumioxazin (Student Presentation)**

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In 2009, flumioxazin was evaluated in the field for the control of cabomba (*Cabomba caroliniana*; ‘aquarium’ biotype), variable leaf-milfoil (*Myriophyllum heterophyllum*) and watermeal (*Wolffia spp.*). In the first trial, cabomba response was evaluated to an application of 200 ppb flumioxazin to 5 sites within a 175 acre cove of a large multipurpose reservoir. Rake tosses were conducted at permanent points within the treated areas to determine cabomba presence/absence and dry weight. Across all sites, cabomba presence/absence and dry weight were reduced by 65 and 73%, respectively, at 2 months after treatment (MAT). Similar results were found in a second trial conducted in a 1 acre pond. Cabomba presence/absence was reduced by 80% and dry weight was reduced by 65% at 2 MAT. Remaining biomass in both cabomba trials indicated that a follow up application would be necessary for complete control. In the variable leaf-milfoil trial, little biomass remained at 4 MAT following application of 200 ppb flumioxazin or 100 ppb flumioxazin plus 100 ppb diquat. In the watermeal trial, twelve ponds were treated with 100 or 200 ppb flumioxazin with or without diquat and 30 ppb fluridone followed by 100 ppb flumioxazin two weeks after initial application. Across all ponds, watermeal coverage was reduced to 15% or less in nine of the twelve treated ponds by 4 MAT.

## **Allelopathic Effects of Cyanobacteria on *Prymnesium parvum* (Student Poster)**

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In recent years, *Prymnesium parvum* blooms have become more frequent in Texas lakes, leading to significant ecological and economic impacts. It is hypothesized that the increased frequency is the result of a shift from a macrophyte dominated stable state to a plankton dominated state. The catalyst for this shift in stable states might be the increase in introduced exotic fish such as grass carp. Currently, many methods are being studied to mitigate the harmful effects of *P. parvum* and prevent toxic blooms. Allelopathic effects between cyanobacteria and *P. parvum* have been documented and previous studies have shown that a cyanobacteria rich community suppresses the development of *P. parvum* blooms. This research focused on the effects of the cyanobacteria *Anabaena sp.* culture on *P. parvum*. Over a 6 day period, daily exchanges of *Anabaena* culture filtrate were made to *P. parvum* cultures in log phase growth. All treatments suffered reduced fluorescence readings over the experiment, with the *Anabaena* filtrate treatment having the highest end fluorescence. This unexpected result can likely be explained by the increased bacteria stimulated by cyanobacteria exudates on which *P. parvum* cells could feed. Microscopy confirmed the presence of bacteria in the *Anabaena* filtrate treatment. Future research should focus on the effects of multiple cyanobacteria species on the growth of *P. parvum*. It is possible that the allelopathic effects between species are additive and greater than the effects of any individual cyanobacteria.

## **A Workshop to Discuss Use of Registered Herbicides for Hydrilla Management in Florida Provides a Window into the Mind of Managers**

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In November 2009, a two-day workshop was held in Crystal River, Florida to discuss the use of existing and recently registered aquatic herbicides for managing hydrilla in Florida public waters. The program for managing hydrilla is funded and administered by the Florida Fish and Wildlife Conservation Commission (FWC) Invasive Plant Management Section and for this workshop there were approximately 60 invited cooperators from the FWC, and local, state, and federal agencies. The objective of this workshop was to disseminate to managers the latest research and operations information on registered herbicides (and herbicide combinations) and to discuss factors that influence efficacy, selectivity, herbicide use patterns, herbicide resistance and resistance management, and how environmental variables can influence herbicide activity and longevity. There was also significant discussion

regarding hydrilla biology and expansion, and rationales used by some stakeholders and managers to consider promoting hydrilla for ecological services. The workshop was designed to encourage cooperator participation by including extended time for discussion during and following oral presentations, and by asking participants to submit written questions for response at a later date. To summarize, the views regarding hydrilla management amongst the state managers and cooperators were quite varied and ranged from individuals who would like to see more hydrilla to support ecological services to managers who feel we are not being aggressive enough for a plant with proven invasive potential. In discussing technical options, some managers would like to see greater integration of low stocking rates of triploid grass carp with herbicide use to extend control and reduce reliance on herbicides. There were also numerous questions regarding herbicide rotation, the strong reliance on a single mode of action, better defining herbicide selectivity, and the pros and cons of using herbicide combinations. This talk will focus on many of the specific questions (and responses) that resulted from this workshop, as the nature of the questions provides a window into the current thinking of different managers who are dealing with a range of problems related to hydrilla and large-scale hydrilla management in multiple use public waters.

### **On Ultrasound and Algae**

**Jonathan R Newman**

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The use of ultrasound to control algae in open water systems and bacteria in closed recirculating systems has benefits in reducing the use of pesticides in water. The driving force for development of cost effective alternative methods of algal control in Europe has been the loss of all herbicides for control of algae and submerged macrophytes. The popular, well publicised, myths about how ultrasound interacts with, and kill algae, are based mostly on fundamental misunderstandings of algal cellular processes, and also on observations of indirect effects under the microscope, not the physiological causes of these effects. Ultrasound is classed as sound above 20 KHz. Most algae show physiological responses to most ultrasound frequencies between 24 and 55 KHz, but exposure time and pulse length are also important variables. The use of harmonic wave structures generated by the use of pulsed square waveforms has improved the efficacy of prototype laboratory scale instruments. In work undertaken in 2009 at both laboratory scales and in field tests of new equipment developed on the basis of laboratory trials, it has been demonstrated that the main effect of ultrasound in water is to alter the chemistry of water in the boundary layer surrounding algal particles and filaments, leading eventually to visible changes of cell structure in some species, but not in others, often associated with loss of photosynthetic integrity. Ultrasound produces micro-cavitation effects in the gas-enriched boundary layer surrounding organisms that photosynthesise and respire, causing actual physical damage to membranes and production of H<sub>2</sub>O<sub>2</sub> in close proximity to susceptible membrane structures. We have previously shown that exposure to low dose H<sub>2</sub>O<sub>2</sub> is responsible for the mode of action of barley straw on algae. This study shows that ultrasound produces approximately three times the concentration of H<sub>2</sub>O<sub>2</sub> under certain open water conditions. Immediate oxidative stresses, combined with direct pressure effects resulting in electroporation of membranes, are the most likely cause of cell death in algae exposed to ultrasound.

### **Initial Attempts to Restore Native Plants after Carp Removal in a Twin Cities Minnesota Lake**

**Raymond M. Newman** and James A. Johnson

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Native plant communities are limited by water clarity and invasive species in many eutrophic lakes. Poor water clarity may be due to excessive nutrient loading, but sediment resuspension and nutrient mobilization by common carp (*Cyprinus carpio*) may also be important. Carp may further limit native plant communities by direct rooting and disruption of plants. Recent work in Minnesota is assessing the removal and control of carp to enhance water quality. If water clarity improves, the next concern will be to restore native plants and prevent dominance by invasive plants. We initiated a project in a Twin Cities Metro lake, to determine if we can promote establishment of native plants and prevent dominance by invasive curlyleaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*) following carp removal. After carp removal in the winter of 2008-2009, spring water clarity improved compared to previous years and macrophytes expanded their distribution. A June point intercept survey indicated that 56% of the littoral area (depth ≤ 4.6 m) was vegetated, with 7 native and

2 invasive species present. Coontail (*Ceratophyllum demersum*) was the most frequent taxon (43%) followed by Eurasian watermilfoil (35%), curlyleaf pondweed (17%) and narrow leaf pondweeds (15%). Eurasian watermilfoil had the highest biomass (27 g dm<sup>2</sup>), followed by coontail (13 g/m<sup>2</sup>) and curlyleaf (12 g/m<sup>2</sup>). By August, the frequency and biomass of curlyleaf decreased and coontail became dominant. Eurasian watermilfoil also decreased, likely due to herbivory by the milfoil weevil, *Euhrychiopsis lecontei*. Survival and growth of 5 native plant species transplanted from a nearby lake was assessed. Muskgrass (*Chara sp.*), water celery (*Vallisneria americana*), northern watermilfoil (*Myriophyllum sibiricum*), water stargrass (*Zosterella dubia*) and bushy naiad (*Najas sp.*) plants were transplanted into Lake Susan in 0.3 to 0.75m water depth. All plants initially established but by 6 weeks muskgrass and water celery fared poorly. Bushy pondweed and water stargrass did well at all locations followed by northern watermilfoil. Plants performed slightly better in caged areas but this appeared to be due to protection from waves and debris rather than herbivory. The plant community and performance of transplants will be further assessed in 2010.

### **Biochemical and Physiological Studies to Optimize Imazamox Use Rates in Hydrilla**

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The need to discover and develop new aquatic herbicides for use in Florida has arisen due to the development of resistance of hydrilla to fluridone. Recently, imazamox has received an aquatic label from the U.S. Environmental Protection Agency, and is currently being evaluated in field to develop a management program for hydrilla. Imazamox inhibits acetolactate synthase (ALS) activity in hydrilla, the first enzyme in the biosynthesis of branched-chain amino acids valine, leucine and isoleucine. We are conducting physiological and biochemical studies in the laboratory to study imazamox absorption, translocation, and metabolism in hydrilla. *In vitro* studies were conducted by extracting the ALS enzyme from hydrilla plants to determine sensitivity to imazamox. Hydrilla tips were exposed to <sup>14</sup>C labeled herbicides to evaluate the optimum imazamox application rate for maximum loading in hydrilla, and to evaluate the herbicide concentration and exposure time relationships in hydrilla. The absorption of imazamox in hydrilla is passive and occurs at slow rate. The imazamox absorption increased significantly from 6 h to 10 d after treatment. There was not much herbicidal absorption in hydrilla up to 4 days after application. The highest absorption of imazamox occurred at 7 d or 10 d after herbicide treatment. These results suggested that imazamox needs 7-10 days of contact exposure time with hydrilla for maximum absorption in the plants. Metabolism studies confirmed that there were no metabolites of imazamox in hydrilla plants at 7 d after treatment. We recovered more than 90% of <sup>14</sup>C recovery of parental compound (imazamox) after the study period of 7 days. Such physiological studies provide a better understanding of the use of new aquatic herbicides for the control of this invasive weed. Understanding these mechanisms involved will improve our ability to better integrate current and potential herbicide management strategies and provide environmentally sound and cost effective approaches to hydrilla management in Florida.

### **Nutrient Reduction and Recovery in a South Florida Retention Pond Through Manipulation of Artificial Destratification Aeration**

**Amanda Quillen**

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I conducted a pilot study with the goal of tracking the processes that take place during the startup and shutdown of an aeration system. An existing system was turned off in the early spring of 2009, and the lake stratified normally as summer progressed. The system was restarted in June, after the lake had fully stratified. Several water quality parameters were tracked during and following startup in order to further our understanding of how aeration may help control algae growth and otherwise benefit the lake. Water column ammonia and phosphates declined, which may be attributed to the measured increase in oxidation-reduction potential at the sediment-water interface resulting from increasing dissolved oxygen. The system was turned off again in April 2010, and phosphates at the sediment-water interface began increasing again immediately. Considerations before installing aeration, especially in reference to salinity gradients, application of bubble aeration to lakes with cold-water fisheries, and proposals for future investigations will also be discussed.

## **Monoecious Hydrilla Biology, Distribution, and Management**

**Robert J. Richardson**

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Monoecious hydrilla was first documented in the United States at Umstead State Park in 1980 near Raleigh, NC and shortly later in 1982 in the Potomac River near Seneca, MD. From these initial infestations, it has spread north along the Atlantic Coast to Maine, emerged in California and Washington along the Pacific Coast, and is now spreading rapidly in the Midwest. This distribution is in contrast to dioecious hydrilla, which is prolific across the Southern tier of the United States. Differences in distribution are likely due to the significant differences that exist in the biology of dioecious and monoecious hydrilla. Dioecious hydrilla commonly overwinters, while monoecious hydrilla shoots typically do not persist through winter in the respective naturalized ranges. Dioecious hydrilla has been reported to form tubers (subterranean turions) from October through April, while monoecious forms tubers from June to October. Monoecious hydrilla forms more tubers than dioecious, but these tubers are also smaller. Monoecious hydrilla tuber densities as high as 1,700/m<sup>2</sup> (17,000,000/ha) have been documented in North Carolina lakes with individual tuber weights ranging from 20 to 320 mg. Monoecious hydrilla tubers can emerge from at least 30 cm in depth, although formation is usually limited to the upper 12 cm of hydrosol. The rate of tuber sprouting and loss under effective management is greater during the first year of management and declines over time. Predictions based upon this indicate that monoecious hydrilla tubers can persist for 6 to 10 years. Monoecious hydrilla forms turions late in the growing season and their formation is likely triggered by short days and shoot fragmentation. Turions are not persistent and are probably more important for long distance dispersal than for local propagation. Management of monoecious hydrilla has generally utilized the same tools used for dioecious hydrilla. Herbicides and triploid grass carp have been the most effective techniques employed for monoecious hydrilla control. Herbicides are typically utilized in early to mid summer after tuber sprouting and before topping out in mid to late summer. Historically, fluridone and copper products have been most commonly used, although diquat, endothal, and newer herbicide chemistries should have similar effectiveness as reported with dioecious hydrilla. Triploid grass carp have been commonly used in North and South Carolina for controlling both biotypes of hydrilla. Regulation of triploid grass carp north of the Carolina's is more restrictive and will limit grass carp utility if current regulations are maintained. Mechanical harvesting has been used in some states, but should not be expected to decrease hydrilla tubers over time. Due to the biological attributes of monoecious hydrilla and *Hydrellia* spp., it is unlikely that this biocontrol agent would impact monoecious hydrilla growth. When historic management effectiveness is considered, there is no reasonable probability that states with broad hydrilla distributions like North Carolina can eradicate the species on a state-wide level. However, it is reasonable that effective management programs can eliminate hydrilla from specific impoundments.

## **Mapping the Distribution of Invasive Aquatic Plants in Puerto Rico**

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The presence of waterhyacinth, alligatorweed, and waterlettuce has been well documented in Puerto Rico since the early 1900's. However, their distribution and extent of infestation is not known. The recent introductions of hydrilla and giant salvinia into Puerto Rico in 2000 are also poorly documented. Such information is important in developing public education and outreach programs for these species; as well as providing management agencies information for the development and implementation of control programs. Therefore, the University of Puerto Rico initiated an island-wide survey in January 2010 to map invasive plants including the five aforementioned aquatic species. Surveys were performed using accuracy GPS enabled handheld device with 3 m accuracy. Waterhyacinth and waterlettuce are the most common invasive aquatic plants in Puerto Rico. These species heavily infest Lakes La Plata, Guayabal and Carraízo as well as the Laguna Cartagena Wildlife Refuge. Alligatorweed was observed at many water bodies; however, its area of infestation is minimal and does not represent nuisance problems. Hydrilla was observed at a small creek in the Aguadilla municipality and golf course ponds at Bahia Beach Resort (BBR) in Rio Grande. The hydrilla population in Aguadilla has not been under management; whereas in BBR grass carp have been stocked for hydrilla management. Giant salvinia was observed at the botanical garden of University of Puerto Rico and golf course ponds at Dorado del Mar. The

salvinia weevil has been released at both sites however, heavy infestations of giant salvinia still persist causing nuisance problems. Surveys will continue and biomass data will be added to document invasive species productivity in Puerto Rico.

### **Japanese Knotweed Control with Aquatic Herbicides (*Student Presentation*)**

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Japanese knotweed (*Polygonum cuspidatum* Siebold & Zucc.) is an herbaceous, perennial Polygonaceae that has invaded wetland to upland sites across the United States and worldwide. It can rapidly invade sites creating a dense, monospecific canopy disrupting the natural ecosystem. It is regulated as a noxious weed in at least 8 states. Current management options for this invasive species are limited. Research was conducted in North Carolina and Virginia to determine the response of Japanese knotweed to selected aquatic herbicides. In the first trial, treatments included 0.38 lb ai/A flumioxazin, 2 lb ai/A fluridone, 1.8 lb ai/A glyphosate, 1.5 lb ai/A imazamox, 1 lb ai/A imazapyr, 0.0875 lb ai/A penoxsulam, glyphosate plus imazamox, glyphosate plus imazapyr, glyphosate plus penoxsulam, and flumioxazin plus fluridone. At 7 months after treatment, control with glyphosate, imazapyr, glyphosate plus imazamox, and glyphosate plus imazapyr was at least 93%. Glyphosate plus penoxsulam controlled the plant 75%. Control did not exceed 20% with other treatments. A second trial was conducted to evaluate multiple glyphosate applications and glyphosate timing of application for maximum efficacy on Japanese knotweed. Results from this trial will also be presented.

### **Algae on the Move: Recent Range Expansion of *Prymnesium parvum***

**John H. Rodgers, Jr.**, West M. Bishop, and Brenda M. Johnson

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*Prymnesium parvum* can be problematic in water resources due to production of toxins and can prohibit the beneficial use of the water. These haptophytes can pose risks for fish as well as other biota in the water resource. *Prymnesium parvum* “blooms” can be “triggered” by a variety of factors and predictions of algal blooms from nutrient concentrations have been less than successful due to factors such as internal recycling of elements, aeolian transport and enrichment, as well as anthropogenic factors. *Prymnesium parvum* was first identified in 1985 in North America and it is not known if it was introduced artificially (e.g., an invasive species or missed in previous surveys). It has recently expanded its range into West Virginia and Pennsylvania. The rapid range expansion of these haptophytes and adverse impacts on affected water resources signal the need for advance planning and management strategies. *Prymnesium parvum* grows in a salinity range of <0.1%-10% with an optimum around 0.3-6% although strains collected in different places had different salinity tolerances. Further investigations are underway to determine the environmental requirements and tolerances of this species or strain as well as potential genetic changes that may have facilitated these expansions into areas and water resources previously considered invulnerable.

### **Progress in Controlling Giant Salvinia in Louisiana**

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Giant salvinia, *Salvinia molesta*, has infested most of the major lakes in northwest Louisiana and much of the coastal freshwater marsh in southeast and south central Louisiana. While herbicide control programs have continued and even increased over the past two years, giant salvinia infestations have continued to increase in number and size. An “industrial size” effort to rear, harvest and release salvinia weevils, *Cyrtobagous salviniae*, was initiated in 2007. Five nursery ponds totaling approximately 3.2 ha have been established. One primary nursery located near Gheens, LA was in full production in 2009. Approximately 80,000 pounds of infested salvinia containing 1.6 million adult salvinia weevils were harvested and transplanted to 14 infested water bodies



between late May and mid-July of 2009. Monitoring in late 2009 of release sites made in late 2007 and early 2008 revealed a 90% reduction in coverage area at sites previously 100% covered in 2007.

## **Adapting to Evolving Hydrilla Management Issues in Florida**

**Jeffrey D. Schardt**

*Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida*

The dioecious biotype of hydrilla (*Hydrilla verticillata*) was introduced into Florida in the 1950s. It has since spread throughout the state and occurs in about 40% of Florida's 460 public lakes and rivers that account for more than 1.25 million acres of surface waters. Hydrilla has presented management problems in Florida waters since the mid 1960s. The State of Florida has spent more than \$5.3 million (25% of the research budget) on 43 projects (21% of the total projects) since 1970 to understand and integrate biological, chemical, mechanical, and physical control strategies. During the past 30 years, Florida has spent more than \$210 million controlling over 400,000 acres of hydrilla to conserve or enhance the multiple uses associated with public lakes and rivers. Most hydrilla management in Florida is conducted using EPA-registered herbicides, and prior to 2004, most large-scale hydrilla management was accomplished using fluridone herbicide. Increasing fluridone resistance in Florida hydrilla triggered activity to develop new hydrilla management tools and strategies. Assertive management efforts combined with environmental events like alternating drought and floods, and three major hurricanes in the mid-2000s, enabled managers to regain and sustain hydrilla control. While hydrilla has been reported in as many as 357 of Florida's 460 public waters (maximum total coverage of 97,000 acres in 1994), 27,300 acres were reported in 183 public waters during 2009; the third lowest acreage reported since the state began conducting annual inventories in 1982. Resource managers face continual pressures; on one hand to allow hydrilla to expand for fish and wildlife habitat, and on the other to keep hydrilla at current or lower levels to reduce long-term management costs and herbicide use. Managers have seen hydrilla expand from a few plants to cover thousands of contiguous acres matted at the water surface in as little as 1-2 years. However, hydrilla is now nearly non-detectable in some of these waters. Additional discussion and research is needed to establish thresholds that trigger hydrilla management and to explain why hydrilla continues to remain highly aggressive in some water bodies and has failed to recolonize other waters that have previously supported dense infestations.

## **Steps Toward Implementing NPDES Regulations in Florida**

**Jeffrey D. Schardt**

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On January 9, 2009, a 6<sup>th</sup> Circuit Court Panel overturned the U.S. Environmental Protection Agency (EPA) Rule that stated in essence a National Pollution Discharge Elimination System (NPDES) Permit was not necessary if pesticides were applied to, over, or near waters of the U.S. according to label specifications under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The Court granted a two year stay to EPA to implement an NPDES program in five states in which there was no state NPDES regulatory presence, and to work with the remaining states to develop their own regulatory programs for pesticide applications that may impact U.S. waters. The State of Florida has a long history regulating pesticide applications that may impact waters, especially for mosquito and aquatic plant control. This presentation addresses Florida's developing cooperative interagency approach to implementing NPDES regulations. The Florida Departments of Environmental Protection (DEP) and Agriculture and Consumer Services (DACS), and the Fish and Wildlife Conservation Commission (FWC) are incorporating existing regulatory programs to the extent possible into the EPA Pesticide General Permit (PGP) framework to ensure coverage for all pesticide applications to waters of the U.S. within Florida boundaries. DEP is responsible for implementing NPDES regulations in Florida. DACS coordinates mosquito control, and FWC is the lead agency for regulating aquatic plant management. Although the states are authorized to develop NPDES procedures, individual programs must meet (and may exceed) nationwide EPA standards. Legislation and interagency agreements are under revision in Florida through frequent consultation among representatives from state agencies and EPA Region IV staff in Atlanta to meet the PGP April 10, 2011 implementation date.

## **Non-native Aquatic Plant Introductions in the Southeast: An Historical Review**

**Don C. Schmitz**

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Water hyacinth (*Eichhornia crassipes*) growth and spread in Florida since the 1890s was the impetus for the creation of the Hyacinth Control Society in the early 1960s, which is now the Aquatic Plant Management Society. It is generally believed the introduction of this floating South American plant into North America occurred during the World's Industrial and Cotton Centennial Exposition that was held in 1884-85 in New Orleans, Louisiana. However, historical material about the Cotton Centennial Exposition is devoid of references to water-hyacinth, leaving some doubt as to when, where, and how this floating non-native plant was first introduced into North America. The introduction of water hyacinth into Florida is better documented and apparently occurred in the mid-1880s near a farm grove a few kilometers north of the City of Palatka. Several of the plants were placed in a lawn fountain near the banks of the St. Johns River. The plants in the lawn fountain quickly multiplied and the excess plants were innocently discarded into the St. Johns River. The discharge of ship ballast in Mobile, Alabama during the late 1800s was the likely means of introduction into North America of alligatorweed (*Alternanthera philoxeroides*) and torpedograss (*Panicum repens*). Eurasian watermilfoil (*Myriophyllum spicatum*) was likely first introduced into North America via ballast discharge into the Chesapeake Bay Region in the late 19<sup>th</sup> century. The 1800s also saw the introduction and establishment of anacharis (*Egeria densa*), parrot-feather (*Myriophyllum aquaticum*), and salvinia (*Salvinia minima*). After World War II, with the advent of new air-freight shipping techniques, there was a rapid expansion of all aspects of the pet industry, including increased importations of non-native aquarium plants into North America. By the early 1950s, the aquarium plant industry had introduced additional non-native plants such as the southeastern Asian hydrilla (*Hydrilla verticillata*), and Indian hygro (*Hygrophila polysperma*) into Florida's waterways.

## **Attempts to Prevent Southern Naiad Growth in Arkansas Baitfish Ponds with the Application of Low Rates of Fluridone**

**George Selden**

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Arkansas leads the nation in the farming of bait and feeder fish, providing 61% of all cultured baitfish in the country. These are predominantly fathead minnows, golden shiners and goldfish. The typical culture practice is to stock fry into recently filled ponds and stimulate a phytoplankton bloom with the application of organic or inorganic fertilizer. Often, plants such as southern naiad will grow instead of phytoplankton. This can lead to reduced growth of the baitfish and great difficulty harvesting the pond. As a result, farmers frequently need to treat the plant growth with herbicides. At times, the cost of treatment can be greater than the profit that could be realized from the baitfish crop. During the spring of 2010, very low rates of fluridone (as low as 5 ppb) were added at the time of pond filling to prevent the growth of southern naiad.

## **Efficacy and Selectivity of Large-scale Herbicide Treatments for Hydrilla Control on the Kissimmee Chain of Lakes, Florida**

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The Kissimmee Chain of Lakes (KCOL; Lakes Tohopekaliga, Cypress, Hatchineha, Kissimmee) are located in central Florida and cover approximately 70,000 surface acres. These lakes are a valuable aquatic resource and serve multiple human uses (flood control, recreation, fishing, and hunting) as well as providing habitat for a variety of fish, reptiles, amphibians, mammals, and birds including the federally endangered snail kite. The invasive exotic macrophyte, hydrilla (*Hydrilla verticillata*), has been established in these lakes for many years. From the early 1990's to 2004, fluridone was the primary herbicide used to manage hydrilla in the KCOL. However, the development of fluridone resistance in the early 2000's resulted in cessation of fluridone use. As a result of fluridone resistance, new methods for hydrilla control have been evaluated on the KCOL for the last several years. Currently, large-scale applications of endothall alone and in combination with imazamox or

penoxsulam are being used. Between December and February 2008-2009 and 2009-2010, herbicide applications of 10,750 acres (range 640 to 7,250 acres) and 7,750 acres (range 640 to 3,045 acres) were applied to the KCOL, respectively. As the new use patterns with these herbicides are being refined it has been important to document efficacy and selectivity. In late 2008, vegetation grids were established on Lakes Tohopekaliga, Hatchineha, and Kissimmee prior to the aforementioned herbicide treatments. These grids were set in macrophyte beds composed of hydrilla and vallisneria (*Vallisneria americana*) at three density ratios (hydrilla:vallisneria; 50:50, 80:20, 20:80). Within each grid four biomass samples were collected quarterly, dried to a constant weight (g DW), and means calculated for each macrophyte and ratio type. To date, the herbicide treatments have been effective at removing hydrilla with no significant reduction in vallisneria biomass. In conjunction with the efficacy and selectivity data, herbicide residues, water quality, and fathometer data is also being collected during and after treatments as additional long-term monitoring components.

### **Biology and Management of *Rotala rotundifolia* (Student Poster)**

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In the past decade, the exotic species *Rotala rotundifolia* has escaped the ornamental plant trade and become established in South Florida canals. This species is native to India and is a member of the Lythraceae family, which also includes purple loosestrife (*Lythrum salicaria*). *R. rotundifolia* is perennial, and grows in both submersed and emergent forms. The emergent form of this species produces rose-colored inflorescences on terminal spikes. Studies have been conducted at the Center for Aquatic and Invasive Plants at the University of Florida, Gainesville in mesocosm as well as in South Florida canals to develop best herbicidal management programs for these weed species. Plants were planted in 30 cm diameter plastic pots filled with 2/3 potting media covered with 1-2 inches of sand. After one month, these plants were transferred to 900 L concrete vaults (two pots per vault), with each vault serving as a replication. Treatments included imazamox (50, 100, 200 and 400 ppb), endothall (0.25, 0.5, 1.5 and 2.5 ppm), triclopyr (0.5, 1, 2 and 2.5 ppm), flumioxazin (50, 100, 200 and 400 ppb) and 2,4-D (0.25, 0.5, 1.5 and 2.5 ppm). Triclopyr was the most effective herbicide in the mesocosm experiments. Triclopyr at 1 or 2 ppm provided 100% control of *R. rotundifolia*. 2,4-D at 1 ppm provided 93% control and at 2 ppm provided 99% control. Other herbicide treatments were not effective in controlling this weed species. Further studies are being conducted in mesocosm and in the field to develop management programs for this weed species.

### **Overwintering Habitat Requirements of the Native Milfoil Weevil, *Euhrychiopsis lecontei*, in McDill Pond, Portage County, Wisconsin (Student Presentation)**

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Eurasian watermilfoil (*Myriophyllum spicatum* L.) is a non-native, invasive aquatic plant that can easily be spread across lakes by anthropogenic activities. Once in a lake, it spreads rapidly and aggressively out-competes native vegetation. The dense growth affects the water chemistry, biota, recreation, and aesthetics of the waterbody. Management of EWM has traditionally relied heavily on chemicals, which offer quick, but temporary relief. Annual or semi-annual herbicide applications are usually needed, with increasing risks of side effects. Growing concerns from lake groups and lake managers has spurred research in recent years on using biological control. Research shows that the native milfoil weevil, *Euhrychiopsis lecontei* (Dietz), can be an effective biological control agent Eurasian watermilfoil, but more research concerning factors that limit milfoil weevil populations is needed. To better define habitat requirements for overwintering success of the milfoil weevil, univariate and multivariate (discriminant analysis) methods were used to assess weevil hibernation habitat at 52 shoreline sample sites on McDill Pond, an impoundment of the Plover River, in Portage County, Wisconsin. Both univariate analyses and discriminant analysis did not show statistically significant differences between shoreline habitats where weevils were present and where they were absent which may be partially attributed to low sample size. However, there are some trends in weevil distribution: weevils appear to occur more frequently in shoreline habitat that is higher above the water level and has lower soil organic matter, lower soil moisture, higher duff

depth, and higher percent of woody debris than habitats where weevils did not occur. Additional work on other lakes is needed to provide more insight into habitat requirements of the milfoil weevil.

### **Uncovering Even More Genetic Diversity and Hybridization in Variable-leaf Watermilfoil and its Close Allies**

**Ryan A. Thum** and Matthew Zuellig

*Annis Water Resources Institute, Grand Valley State University, Muskegon, Michigan*

Genetic variation and hybridization are widely recognized as important factors in the evolution of invasiveness in plants in general, and these two factors are increasingly recognized in aquatic plant management. Variable-leaf watermilfoil (*Myriophyllum heterophyllum*; VLM) is a species of special management concern because it is considered invasive in the northeastern and western US, and can grow quite aggressively in portions of its native range. Earlier genetic studies of these species revealed cryptic invasions of different VLM genotypes (including hybrids), and current work on these genotypes focuses on understanding the invasiveness of hybrids relative to non-hybrids. My lab group has been furthering studies on genetic variation in variable-leaf watermilfoil (*Myriophyllum heterophyllum*; VLM) and its closest relatives (*M. hippuroides*, *M. farwelli*, *M. laxum*, *M. pinnatum*, *M. humile*, and *M. tenellum*) using hundreds of molecular markers. Here, I will present results from these new markers that reveal additional genetic diversity and hybridization not recognized with the small number of markers in earlier studies. Based on these findings, we continue to stress that emerging genetic information about populations may play a critical role in guiding aspects of APM, including predicting the spread, impacts, and control efficacy of nonnative genotypes and species.

### **Monoecious Hydrilla Response to Endothall (Student Presentation)**

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Hydrilla (*Hydrilla verticillata* (L.f.) Royle) is an exotic, submersed weed that has invaded many waterbodies in the U.S. and continues to expand its range. There are two biotypes present in the U.S., monoecious and dioecious. On the east coast, the monoecious form is predominant from North Carolina to New England, while the dioecious form is predominant from South Carolina to Florida. In the past, most research has focused on the dioecious biotype of hydrilla. Laboratory, greenhouse, and field trials were conducted to determine the efficacy of endothall (Aquathol<sup>®</sup>, dipotassium salt) and combinations of endothall plus other aquatic herbicides on monoecious hydrilla. Laboratory results showed that endothall is efficacious against both monoecious and dioecious hydrilla, reducing biomass by >85% with concentrations of 2 mg ai L<sup>-1</sup>, coupled with exposure times of 48 hours for dioecious and 72 hours for monoecious plants grown from shoot fragments. Higher concentrations (4 mg ai L<sup>-1</sup>) or longer exposure times (96 hours) were required to control hydrilla grown from tubers. In greenhouse trials, an increase in exposure time (12 to 48 hours) increased monoecious hydrilla control from 68 to 80% and increased endothall concentration (2 to 4 ppm) increased monoecious hydrilla control from 65 to 78%, when data was pooled by factor. In field trials, monoecious hydrilla was controlled with endothall alone (2 or 3 mg ai L<sup>-1</sup>), endothall (1 or 2 mg ai L<sup>-1</sup>) plus 0.37 mg ai L<sup>-1</sup> diquat (Reward<sup>®</sup>), and 2 mg ai L<sup>-1</sup> endothall plus 0.5 mg ai L<sup>-1</sup> copper (Nautique<sup>®</sup>). Results from these studies indicate that endothall has the potential to be utilized in monoecious hydrilla management programs. Future research will focus on quantifying changes to the hydrilla tuber bank in response to endothall treatments to determine if tuber populations can be reduced over time.

### **Absorption and Translocation of Fluridone, Penoxsulam, and Triclopyr by Eurasian Watermilfoil and Hydrilla (Student Poster)**

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Fluridone (Sonar<sup>™</sup>), penoxsulam (Galleon<sup>™</sup>), and triclopyr (Renovate<sup>™</sup>) are herbicides registered for use in aquatic systems. Although these herbicides are widely used in aquatic plant management, there has been relatively little work examining absorption or translocation in target species. Eurasian watermilfoil (*Myriophyllum spicatum*) (EWM) and hydrilla (*Hydrilla verticillata*) are both invasive aquatic species that occur across much of

the United States. Both are submersed species that form dense monocultures and impact recreational and ecological values of affected sites. During the summer of 2009 a series of laboratory experiments was initiated to examine the absorption and translocation of these herbicides following shoot exposure to a treated water column. Plants were propagated using shoot tips and then allowed to produce roots. Prior to treatment, the belowground portion of the plant was isolated using a layer of agarose gel to prevent root herbicide exposure from the treated water column. Plants were treated with 10 ppb fluridone, 10 ppb penoxsulam, or 1000 ppb triclopyr radiolabeled herbicide. Plants were harvested at 6, 12, 24, 48, 96, and 192 hours after treatment (HAT) and separated into aboveground and belowground sections. After harvest, plants were dried, oxidized, and radioactivity quantified using liquid scintillation spectroscopy. EWM accumulated two to four times more herbicide than hydrilla when compared on the basis of internal concentration. For both species, internal concentration was significantly higher than the water column concentration for all herbicides. Fluridone reached an internal concentration of 180 and 90 ppb for EWM and hydrilla, respectively. Compared to the water column concentration this represents an 18 and 9 fold accumulation, respectively. Penoxsulam accumulated the least in both species with 4-fold (EWM) and 1.3-fold (hydrilla) accumulation. Surprisingly, the greatest accumulation occurred with triclopyr in EWM, whose internal concentration was 32 times the external concentration of 1ppm. Based on chemical properties we had expected fluridone to have the greatest absorption.

### **Evaluation of Winter and Summer Drawdowns for Control of the Non-native Aquatic Plant *Myriophyllum aquaticum* (Vell.) Verdc.**

**Ryan M. Wersal** and John D. Madsen

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Non-native aquatic plants can often invade and rapidly outgrow native species in shallow waterbodies resulting in the establishment of monotypic populations of the invading plant. Parrotfeather (*Myriophyllum aquaticum* Vell. Verdc.) is a non-native species that is becoming an increasing nuisance in shallow waterbodies across the southeastern United States, with few effective management options. Therefore, we simulated a 0, 2, 4, 8, and 12 week winter and summer drawdown under controlled mesocosm conditions to evaluate *M. aquaticum* response to seasonal effects of drawdown events. We tested the hypothesis that a summer drawdown would be more effective than a winter drawdown, as sediments should completely dry during summer months. Overall, both the winter and summer drawdowns were effective at reducing *M. aquaticum* biomass. The winter drawdown reduced ( $p=0.003$ ) biomass by 99% at 4 weeks when compared to pre drawdown levels. The summer drawdown reduced ( $p<0.01$ ) biomass by 98% at 2 weeks when compared to pre drawdown levels. Regrowth of *M. aquaticum* was evident in all drawdown treatments upon reflooding, indicating that this species can survive drawdowns of 12 weeks, and longer drawdown durations may be required for complete control.

### **Investigations of Hydrilla, Toxic Cyanobacteria, Invasive Apple Snails and Potential for Toxin Transfer to Birds of Prey in Florida**

**Susan B. Wilde**, Rebecca S. Haynie, and James Herrin

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Our research effort was initiated to determine whether the suspect AVM toxin could be transferred from aquatic vegetation to bald eagles (*Haliaeetus leucocephalus*) or snail kites (*Rostrhamus sociabilis*) in Florida. We are conducting field monitoring to document the occurrence of the Stigonematalan cyanobacterium throughout sites where both apple snails (*Pomacea*) and snail kites occur. Hydrilla collection during September 2009 included five lakes and a canal that have invasive apple snails and snail kites co-occurring; Lake Orange, Lake Tohopekeliga, Lake Cypress, Rutland Canal, Lake Hatchineha, and Lake Kissimmee. The Stigonematalan cyanobacterium was abundant on a site within Lake Tohopekeliga. Based on these screening results, we returned to Lake Toho in November and collected an additional 14 samples for analysis. The Stigonematales species was abundant (>50% leaf coverage) at two sites and present/common at 5 more. Additional potentially toxic cyanobacterial species were noted growing epiphytically on hydrilla leaves including *Pseudanabaena*, *Anabaena*, *Nostoc*, *Oscillatoria*, *Lyngbya*, *Microcystis*, and *Cylindrospermopsis*. Hydrilla and *Utricularia* leaves were screened for all algal species, but cyanobacteria were the dominant group, with 87 species noted in the microscopy presence screening. The second phase of the project, which is underway, is feeding exotic island apple snails (*P. insularum*) hydrilla (*Hydrilla verticillata*) containing Stigonematales to determine impacts on the

snails and potential for toxin transfer. We documented the AVM suspect algae throughout the digestive system of the apple snails and found it present even after gut passage. In order to determine the potential for disease, we are testing for toxins in the tissues of the experimental snails. These tissues will also be used in future feeding trials to investigate the potential for cyanotoxin transfer to predators.

### **Water Conditions Affecting Growth and Reproduction of *Pistia stratiotes***

**Ken-ichi Yamaguchi** and Aya Shimizu

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In Kyushu, the southern part of Japan, rivers, creeks, and lakes have been infested with alien aquatic plants, *Alternanthera philoxeroides*, *Hydrocotyle ranunculoides*, *Myriophyllum brasiliense*, and *Pistia stratiotes*. *Pistia stratiotes* L. (water lettuce), known as one of the most troublesome aquatic weeds, has colonized especially in the lake Ezu, Kumamoto. The biomass of the weed is removed by a mechanical method there. However, it costs too much every year. The purpose of our experiments was to determine the conditions in water, which affect the growth and reproduction of *P. stratiotes*, to provide information for the management of the weed. Effects of temperature (15-35 C), pH (4-10), and photo-period (8 or 12 hrs of daylight) on the growth and reproduction were examined under growth chamber and greenhouse conditions using the seedlings of *P. stratiotes*. Around 30 C, seedlings grew well and produced new plants from rhizomes more than at the other temperatures. Also, they grew and reproduced very well in the water of pH 5.0-5.5 at 28 C, while seedlings in the alkaline water were depressed. Under the condition of 12 hrs of day light, *P. stratiotes* showed vegetative regeneration vigorously. We continue to investigate the control measures including biological and chemical approaches for IPM system of the aquatic weeds.

### **Identifying Unique Biotypes of Eurasian Watermilfoil Using a Genetic Fingerprinting Method**

**Matthew Zuellig** and Ryan A. Thum

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Aquatic plant managers increasingly recognize the role of unique biotypes that exhibit unique growth responses to management practice. One challenge to identifying biotypes is that they are often indistinguishable from one another based on morphology. I am exploring approaches involving the utilization of molecular markers to identify potentially unique biotypes. Here, I present the results of a genetic survey of Eurasian watermilfoil in North America using highly polymorphic molecular markers. These data reveal several genetically distinct populations, which may correspond to the presence of unique biotypes. This research emphasizes the degree of genetic variation that occurs within this system and how this variation may correspond to attributes of management concern.