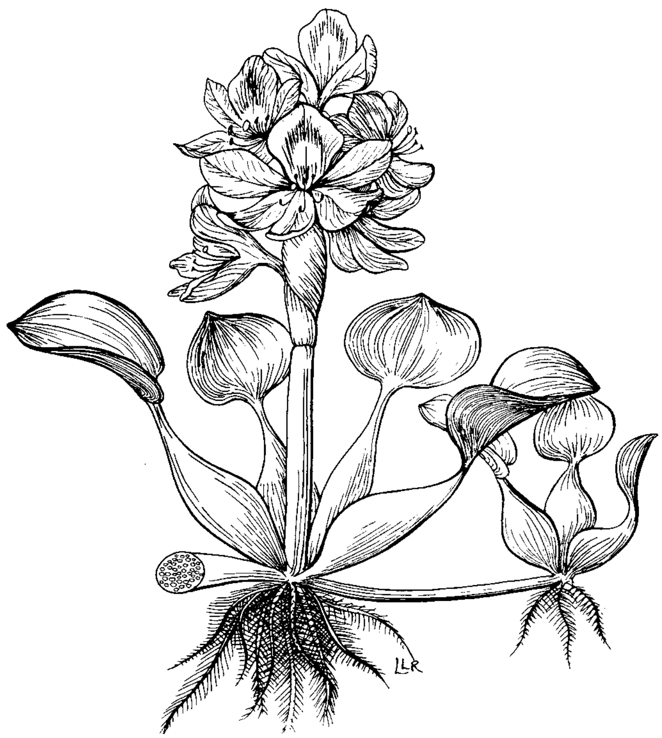
The Aquatic Plant Management Society, Inc.

44th Annual Meeting

"This is Not Your Father's APMS: Our Successful Past Meets a Challenging Future"



PROGRAM

July 11 - 14, 2004
Hyatt Regency Tampa
Tampa, Florida

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Bylaws and Resolutions	Jim Schmidt
Education and Outreach	Jeff Schardt
Exhibits	Joe Bondra
Finance	Richard Hinterman
Legislative	Mark Mongin
Meeting Planning	Bob Gunkel
Membership	Gerald Adrian
Nominating	Richard Hinterman
Past President's Advisory	Richard Hinterman
Program	Eric Barkemeyer
Publications	David Sutton
Regional Chapters	Jeff Schardt
Scholastic Endowment	Shaun Hyde
Student Affairs	Mike Netherland
Website	Mike Grodowitz and Dave Petty
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CAST Representative	Jim Petta
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Past APMS Presidents and Meeting Sites

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1962	T. W. 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	Lou V. 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

2004 Sustaining Members

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

Applied Aquatic Management, Inc.
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Meeting Sponsors

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

Griffin, LLC
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Scholastic Endowment Sponsors

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

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Aquatic Vegetation Control
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Fresno, California

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Brighton, Michigan

SePRO Corporation
Carmel, Indiana

Syngenta Professional Products
Greensboro, North Carolina

UAP Timberland, LLC
Memphis, Tennessee

General Information

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 and Luncheon, Banquet, and Awards and Installation of Officers Luncheon at the meeting registration desk.

Meeting Registration Desk

The meeting registration desk is located in the Atrium outside the Regency Ballroom of the Hyatt Regency. For specific times, please see the daily schedule pages in this program. Messages will be posted on the message board at the meeting registration desk.

Presenter's Preview Room

Need to check your PowerPoint presentation? The preview room will be located in Channelside II of the Hyatt Regency and will be equipped with a notebook computer, LCD projector, external zip drive, and an external CD writer. For specific times, please see the daily schedule pages in this program.

Exhibitors

Exhibits will be open for viewing from 8:00 a.m. Monday to 5:00 p.m. Tuesday in Regency Ballroom I of the Hyatt Regency. The following will be exhibiting their products and services.

Applied Biochemists
Milwaukee, Wisconsin

Aquarius Systems
North Prairie, Wisconsin

Aquatic Control, Inc.
Seymour, Indiana

BASF Corporation
Research Triangle Park, North Carolina

BioSafe Systems
Glastonbury, Connecticut

BioSonics, Inc.
Seattle, Washington

Brewer International
Vero Beach, Florida

Cerexagri, Inc.
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Syngenta Professional Products
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UAP Timberland, LLC
Memphis, Tennessee

Vertex Water Features
Pompano Beach, Florida

Poster Session and Reception

Posters will be open for viewing from 8:00 a.m. Monday to 5:00 p.m. Tuesday in Regency Ballroom I of the Hyatt Regency. A special Poster Session and Reception will be held on Monday from 5:30 p.m. to 7:00 p.m., graciously sponsored by BASF Corporation. Presenters of posters are required to attend the special Poster Session and answer questions as needed. In addition, presenters are requested to be in attendance during scheduled refreshment breaks.

APMS Annual Business Meeting

The APMS Annual Business Meeting will be held in Regency Ballrooms V - VII, Hyatt Regency on Monday, July 12 from 4:30 p.m. to 5:00 p.m. All APMS members are welcome to attend.

Regional Chapters Presidents' Breakfast

The Regional Chapters Presidents' Breakfast will be held Tuesday, 6:30 a.m. - 8:00 a.m. in the Harborview Room on the 16th floor of the Hyatt Regency. Two representatives from each APMS regional chapter are invited to attend this breakfast. Jeff Schardt, APMS Vice President and Regional Chapters Committee Chair, will be the moderator for discussions on aquatic plant management activities within each region.

Past President's Luncheon

The Past President's Luncheon will be held Tuesday, 12:00 p.m. - 1:30 p.m. in the Harborview Room on the 16th floor of the Hyatt Regency. Past Presidents of the APMS are invited to attend this breakfast. Richard Hinterman, Immediate Past President, will be the moderator for discussions on affairs of the Society. Please contact Richard by 12:00 p.m. Monday and confirm your attendance.

APMS Special Events

President's Reception*, Sunday, July 11, 7:00 p.m. – 9:00 p.m., City Center, Hyatt Regency.* The APMS cordially invites all registered delegates, guests, and students to the President's Reception, graciously sponsored by SePRO 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 on Sunday afternoon.

Guest Tour and Luncheon*, Monday, July 12, 9:30 a.m. – 3:30 p.m., meet in Lobby, Hyatt Regency.* The APMS cordially invites all registered guests to the Guest Tour and Luncheon, graciously sponsored by Applied Biochemists. The tour will begin with a visit to the Henry B. Plant Museum. Henry Plant built this spectacular building in 1891 while building the railroad along Florida's west coast. Lunch will be served in one of Tampa's most historic dining facilities, the Columbia Restaurant, located in the heart of Ybor City. Founded in 1905, the restaurant is now in its fifth generation of family ownership and operation. The afternoon will include shopping at Old Hyde Park Village, a beautiful outdoor area of brick-lined streets with numerous shops and sidewalk cafes. Non-registered guests may purchase tickets at the meeting registration desk on Sunday afternoon.

Banquet*, Tuesday, July 13, 6:00 p.m. – 10:00 p.m., meet in Lobby, Hyatt Regency, board buses from 6:00 p.m. to 6:30 p.m.* The APMS cordially invites all registered delegates, guests, and students to the APMS Banquet, graciously sponsored by Griffin, LLC. This year's banquet will once again prove to be a memorable occasion. For our banquet this year, we will board a sleek, 180-foot yacht for an evening of dinner, dancing, and entertainment. This three-level yacht has an open-air upper deck and two fully enclosed dining floors on the main and second level decks. A full host bar will be set in each dining room and will include premium brand drinks, beer, wine and soft drinks. The buffet dinner includes salad; entrees of oven roasted chicken, nut crusted fillet of grouper, and prime rib; accompaniments of parmesan scalloped potatoes, wild rice, and seasonal vegetables; and dessert. The Weeds Band, with members Dan Thayer, Wayne Corbin, J. B. Miller, Drew Leslie, Tommy Strowd, Jack Stites, and Alison Fox will provide music from the 70's for our listening and dancing pleasure. Non-registered guests may purchase tickets at the meeting registration desk on Sunday afternoon.

Awards and Installation of Officers Luncheon*, Wednesday, July 14, 12:00 p.m. – 2:00 p.m., Regency Ballroom I, Hyatt Regency.* The APMS cordially invites all registered delegates, guests, and students to the Awards and Installation of Officers Luncheon, graciously sponsored by Syngenta Professional Products. After an excellent lunch, we will recognize those who have served and contributed to the Society, welcome new officers and directors, and present awards to the student paper participants. Non-registered guests may purchase tickets at the meeting registration desk.

Membership Information

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.

Program

Sunday, July 11

Sunday's Program-at-a-Glance

7:30 am - 5:00 pm	Board of Directors Meeting *(Harborview, 16th Floor)*
1:00 pm - 5:00 pm	Meeting Registration *(Atrium)*
1:00 pm - 5:00 pm	Presenter's Preview Room *(Channelside II)*
1:00 pm - 5:00 pm	Exhibits Set-up *(Regency Ballroom I)*
1:00 pm - 5:00 pm	Posters Set-up *(Regency Ballroom I)*
7:00 pm - 9:00 pm	President's Reception *(City Center)* *Sponsored by SePRO Corporation*

Monday, July 12

Monday's Program-at-a-Glance

7:30 am - 8:00 am	Continental Breakfast *(Regency Ballroom I)* *Sponsored by Cerexagri, Inc.*
7:30 am - 5:00 pm	Meeting Registration *(Atrium)*
7:30 am - 5:00 pm	Presenter's Preview Room *(Channelside II)*
8:00 am - 5:00 pm	Exhibits Open *(Regency Ballroom I)*
8:00 am - 5:00 pm	Posters Open *(Regency Ballroom I)*
8:00 am - 11:45 am	Opening Plenary Session *(Regency Ballroom V - VII)*
9:30 am - 3:30 pm	Guest Tour and Luncheon *(Meet in Lobby)* *Sponsored by Applied Biochemists*
9:30 am - 10:00 am	Refreshment Break *(Regency Ballroom I)* *Sponsored by Cerexagri, Inc.*
11:45 am - 1:15 pm	Lunch
11:45 am - 1:15 pm	AERF Luncheon and Meeting - AERF Members and Invited Guests *(City Center)*
1:15 pm - 4:30 pm	Session I: Aquatic Plant Biology, Restoration, and Control *(Regency Ballrooms V - VII)*
2:45 pm - 3:15 pm	Refreshment Break *(Regency Ballroom I)* *Sponsored by Cerexagri, Inc.*
4:30 pm - 5:00 pm	Annual Business Meeting - APMS Members *(Regency Ballroom V - VII)*
5:30 pm - 7:00 pm	Poster Session and Reception *(Regency Ballroom I)* *Sponsored by BASF Corporation*

Opening Plenary Session
8:00 am - 11:45 am
Regency Ballroom V - VII
Moderator: Kenneth L. Manuel, APMS President, Duke Power Company, Huntersville, NC

8:00 am	Opening Remarks and Announcements **Kenneth L. Manuel**, APMS President, Duke Power Company, Huntersville, NC
8:05 am	Presidential Address **Kenneth L. Manuel**, APMS President, Duke Power Company, Huntersville, NC
8:35 am	Keynote Address - "Death and Taxes? Not Even Close" **Alva P. Burkhalter**, Monsanto Company (Retired), APMS Honorary Member, Bainbridge, GA
9:15 am	Aquatic Ecosystem Restoration Foundation: A Novel Experiment in Innovation **Michael D. Moore**, Aquatic Ecosystem Restoration Foundation (AERF), Lansing, MI
9:30 am	**Refreshment Break** *(Regency Ballroom I)*
10:00 am	Update on Federal Liaison Activities **Rob Hedberg**, National and Regional Weed Science Societies, Washington, DC
10:20 am	What is New in Herbicide Registrations **Donald R. Stubbs**, Herbicide Branch, Registration Division, Office of Pesticide Programs, Environmental Protection Agency, Washington, DC
10:40 am	Economic Impact of Aquatic Weeds - A Literature Review **Jennifer Vollmer**, BASF Corporation, Laramie, WY; H. William Rockwell, Strategic Systems, St. Johns, MI; and Michael D. Moore, Aquatic Ecosystem Restoration Foundation, Lansing, MI
10:55 am	Economic Impacts and Aquatic Plants: The Angler's Piece of the Puzzle **Jim E. Henderson** and James P. Kirk, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

11:10 am Chemical Control Research: Protecting the Nation's Water Resources
Kurt D. Getsinger, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

11:25 am APMS Regional Chapters Reports: Brazil, Florida, Midsouth, Midwest, Nile Basin, Northeast, South Carolina, Texas, Western

11:45 am **Lunch**

Session I: Aquatic Plant Biology, Restoration, and Control

1:15 pm - 4:30 pm
Regency Ballrooms V - VII
Moderator: Gregory E. MacDonald, Agronomy Department and Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL

1:15 pm Hydrilla in the Santee Cooper Reservoirs, South Carolina – Lessons Learned after 15 Years
James P. Kirk, Jim E. Henderson, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; and Steven J. de Kozlowski, South Carolina Department of Natural Resources, Columbia, SC

1:30 pm Integrated Control of Hydrilla
Michael J. Grodowitz, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; and R. Michael Smart, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX

1:45 pm Changes in Aquatic Vegetation Management Techniques Due to Artificial Water Level Fluctuation on Lake Kissimmee, Florida
Rue S. Hestand, Florida Fish & Wildlife Commission, Eustis, FL; Craig T. Mallison, Florida Fish & Wildlife Commission, Lakeland, FL; David R. Douglas, and Boyd Z. Thompson, Florida Fish & Wildlife Commission, Eustis, FL

2:00 pm Phytoplankton Ecology, Community Structure, and Harmful Algal Bloom Formation in Two Eutrophic South Carolina Ponds: A Baseline Study *(Student Presentation)*
Larissa J. Mason, Master of Environmental Studies Program, College of Charleston, Charleston, SC; Alan J. Lewitus, and Susan B. Wilde, Baruch Institute, University of South Carolina and South Carolina Department of Natural Resources, Charleston, SC

2:15 pm Effect of Native Macrophyte Presence on Productivity and Elemental Composition of *Hydrilla verticillata*
Iwona Staniszewska, Tom DeBusk, Azurea, Inc., Rockledge, FL; and Craig Duxbury, WDI Research and Development, Lake Buena Vista, FL

2:30 pm Responses of *Hyalella azteca* to Detritus from a Constructed Wetland Treatment System Designed to Mitigate Risks Associated with Flue Gas Desulfurization Wastewater *(Student Presentation)*
Sarah E. Sundberg, Ryan P. Jones, and John H. Rodgers, Jr., Department of Forestry and Natural Resources, Clemson University, Clemson, SC

2:45 pm **Refreshment Break** *(Regency Ballroom I)*

3:15 pm Broad-Scale Herbicide Efficacy Monitoring for *Egeria densa* Using Advanced Hydroacoustic Techniques at Multiple Sites, Sacramento-San Joaquin Delta, California
Scott A. Ruch, ReMetrix, LLC, Berkeley, CA; Julie Owen, California Department of Boating and Waterways, Sacramento, CA; Lars W. J. Anderson, U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, CA; and Doug Henderson, ReMetrix, LLC, Carmel, IN

3:30 pm A Potential Biological Control Agent, Bacterium SG-3: Mode of Action and Effect on Two Economically Important Cyanobacteria *(Student Presentation)*
Kathryn J. Wilkinson, Purdue University, West Lafayette, IN; H. Lynn Walker, Louisiana Tech University, Ruston, LA; and Carole A. Lembi, Purdue University, West Lafayette, IN

3:45 pm Sediment Resuspension and Light Attenuation in Peoria Lake: Can Macrophytes Improve Water Quality in this Shallow System?
William F. James, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Spring Valley, WI; Elly P. H. Best, and John W. Barko, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

4:00 pm Comparative Toxicity of a Copper-Containing Algaecide to Four Algal Species *(Student Presentation)*
B. Maurice Duke and John H. Rodgers, Jr., Department of Forestry and Natural Resources, Clemson University, Clemson, SC

4:15 pm Economic Impact Survey of Eurasian Watermilfoil Removal in Houghton Lake
Mark S. Mongin, SePRO Aquatic Specialty Products, Carmel, IN; Jim E. Henderson, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; Dick Pastula, Houghton Lake Improvement Board, Houghton Lake, MI; Jim Deamud, Houghton Lake Improvement Board, Prudenville, MI; and Mike Lennon, Aquatic Control Technologies, Sutton, MA

Poster Session

5:30 pm - 7:00 pm
Regency Ballroom I

National Management Planning for the Genus *Caulerpa*
David Bergendorf and Erin Williams, U.S. Fish and Wildlife Service, Aquatic Nuisance Species Program, Stockton, CA

On the Competition for Light Between American Wildcelery and Sago Pondweed at High and Low Nutrient Availability: A Modeling Approach
Elly P. H. Best, Gregory A. Kiker, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; **William F. James**, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Spring Valley, WI; and William A. Boyd, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Air Boat Development to Herbicide Spray Application Evaluated by DGPS Systems in Brazil
Luís Fernandon N. Bravin, Technology Faculty of São Paulo State University, Brazil; Edivaldo D. Velini, São Paulo State University, Brazil; and Marcelo Henrique Buchighani, Neiva Aircraft

Combinations of Herbicides for Control of Torpedograss
Nora E. Fosman and David L. Sutton, University of Florida, IFAS, Research and Education Center, Fort Lauderdale, FL

Status of Releases of the Biological Control Agents *Neochetina* spp./*Hydrellia* spp. for Waterhyacinth/Hydrilla Management in the Lower Rio Grande Valley Cooperating Irrigation Districts
Jan E. Freedman, Michael J. Grodowitz, Lavon Jeffers, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; and Fred Nibling, U.S. Department of Interior, Bureau of Reclamation, Denver, CO

Diquat Gel Formulation for Control of Aquatic Weeds
Kurt D. Getsinger, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; John G. Skogerboe, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX; Lee Ann Glomski, Purdue University, Department of Botany and Plant Pathology, West Lafayette, IN; and **Angela G. Poovey**, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Comparison of Torpedograss and Pickerelweed Susceptibility to Glyphosate
Lyn A. Gettys and David L. Sutton, University of Florida, IFAS, Research and Education Center, Fort Lauderdale, FL

Mycoleptodiscus terrestris: A Comparison Between Isolates from the United States and New Zealand
Deborah E. Hofstra, Centre for Aquatic Biodiversity and Biosecurity, National Institute of Water and Atmospheric Research, Hamilton, New Zealand; Judy Shearer, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; Tracey Edwards, and John Clayton, Centre for Aquatic Biodiversity and Biosecurity, National Institute of Water and Atmospheric Research, Hamilton, New Zealand

Impacts of Lime Application on Aquatic Macrophyte Growth
William F. James, Harry L. Eakin, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Spring Valley, WI; and John W. Barko, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Microsporidia Infection in *Neochetina eichhorniae* and *N. bruchi* Populations in Texas
Sonya Lewis, Computer Science Corporation, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; Michael J. Grodowitz, and Jan E. Freedman, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Developing a State Invasive Species Alliance for Mississippi
John D. Madsen, John D. Byrd, Jr., David R. Shaw, Mississippi State University, GeoResources Institute, Mississippi State, MS; and Randy G. Westbrooks, U.S. Geological Survey, Biological Resources Discipline, Reston, VA

Chemical Control of Water Hyacinth Using Different Nozzles
Dagoberto Martins, Edivaldo D. Velini, Eduardo Negrisoli, Marcelo A. Terra, and Caio A. Carbonari, São Paulo State University, SP, Brazil

Integrating Triclopyr and a Fungal Pathogen (*Mycoleptodiscus terrestris*) for Control of Eurasian Watermilfoil (*Myriophyllum spicatum*)
Linda Nelson and Judy Shearer, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

What We Did on Our Summer Vacation: A Survey of the Invasive Aquatic Plants on the Lower Rio Grande
Chetta S. Owens, Analytical Services, Inc., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX; Michael J. Grodowitz, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; and Fred Nibling, U.S. Department of Interior, Bureau of Reclamation, Denver, CO

Eichhornia crassipes Control with Diquat and its Effects on Some Water Characteristics under Mesocosm Conditions
André T. Martins, Robinson A. Pitelli, Giulliana B. Lachi, and Luciano T. Bopp, Unesp, Jaboticabal, SP, Brazil

Aquatic Weed Control with 2,4-D and its Effects on Some Water Characteristics under Mesocosm Conditions
Guilherme L. Guimarães, Dow AgroSciences, São Paulo, SP, Brazil; **André T. Martins**, Robinson A. Pitelli, Rodrigo Borsari, Unesp, Jaboticabal, SP, Brazil; and Luiz L. Foloni, Unicamp, Campinas, SP, Brazil

Physiological Factors Affecting Management of Torpedograss
Rachel Tenpenny Sartain, Former Graduate Student, University of Florida, IFAS, St. Petersburg, FL; Greg E. MacDonald, Agronomy Department, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL; and David L. Sutton, University of Florida, IFAS, Research and Education Center, Fort Lauderdale, FL

Endophytic Fungi in Eurasian Watermilfoil Tissues
Judy Shearer, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Selective Removal of Curlyleaf Pondweed and Eurasian Watermilfoil Using Endothall and 2,4-D Combinations and the Effect on Fish Populations: Preliminary Data
John G. Skogerboe, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX; Angela G. Poovey, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; Jeremy Slade, Eric D. Dibble, Mississippi State University, Department of Wildlife and Fisheries, Mississippi State, MS; John D. Madsen, Mississippi State University, GeoResources Institute, Mississippi State, MS; and Kurt D. Getsinger, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Ecological Attributes of Exotic and Native Aquatic Plant Communities
R. Michael Smart, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX; Gary O. Dick, Joe R. Snow, David Honnell, and Dian H. Smith, University of North Texas, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX

Control of Hygrophila in Southern Florida
David L. Sutton, University of Florida, IFAS, Research and Education Center, Fort Lauderdale, FL

Overview of the U.S. National Early Detection and Rapid Response System for Invasive Plants
Randy G. Westbrooks, U.S. Geological Survey, Biological Resources Discipline, Reston, VA; John D. Madsen, John D. Byrd, Jr., David R. Shaw, Mississippi State University, GeoResources Institute, Mississippi State, MS; and Leslie Mehrhoff, Invasive Plant Atlas of New England, University of Connecticut, Storrs, CT

An Expert System Shell for Identifying Aquatic Plant Species
Sherry G. Whitaker and Michael J. Grodowitz, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Tuesday, July 13

Tuesday's Program-at-a-Glance

6:30 am - 8:00 am	Regional Chapters Presidents' Breakfast *(Harborview, 16th Floor)*
7:30 am - 8:00 am	Continental Breakfast *(Regency Ballroom I)* *Sponsored by Cerexagri, Inc.*
7:30 am - 5:00 pm	Meeting Registration *(Atrium)*
7:30 am - 5:00 pm	Presenter's Preview Room *(Channelside II)*
8:00 am - 5:00 pm	Exhibits Open *(Regency Ballroom I)*
8:00 am - 5:00 pm	Posters Open *(Regency Ballroom I)*
8:00 am - 8:50 am	Session II: Aquatic Plant Management in Florida *(Regency Ballrooms V - VII)*
8:50 am - 12:00 pm	Session III: A Special Session on Issues Pertaining to Plant Resistance and Tolerance to Aquatic Herbicides *(Regency Ballrooms V - VII)*
9:30 am - 10:00 am	Refreshment Break *(Regency Ballroom I)* *Sponsored by Cerexagri, Inc.*
12:00 pm - 1:30 pm	Lunch
12:00 pm - 1:30 pm	Past President's Luncheon *(Harborview, 16th Floor)*
1:30 pm - 4:45 pm	Session IV: Aquatic Resource Management and Invasive Species Control *(Regency Ballrooms V - VII)*
2:45 pm - 3:15 pm	Refreshment Break *(Regency Ballroom I)* *Sponsored by Cerexagri, Inc.*
6:00 pm - 10:00 pm	Banquet *(Meet in Lobby)* *Sponsored by Griffin, LLC*

Session II: Aquatic Plant Management in Florida

8:00 am - 8:50 am
Regency Ballrooms V - VII
Moderator: Michael D. Netherland, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL

8:00 am — Hydrilla Control in the Wakulla River Using an Aquathol K Drip System
Jess M. Van Dyke, Florida Department of Environmental Protection, Bureau of Invasive Plant Management, Tallahassee, FL; and Terrence M. McNabb, AquaTechnex, Inc., Centralia, WA

8:15 am — Evaluating Herbicide Strategies to Control *Hydrilla verticillata* and Minimize Injury to the Native Plant, *Sagittaria kurziana*
Linda Nelson, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; Michael D. Netherland, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL; Jeffrey D. Schardt, and Jess M. Van Dyke, Florida Department of Environmental Protection, Bureau of Invasive Plant Management, Tallahassee, FL

8:30 am — Meeting New Challenges in Controlling Aquatic Plants with Herbicides
Jeffrey D. Schardt, Florida Department of Environmental Protection, Bureau of Invasive Plant Management, Tallahassee, FL

Session III: A Special Session on Issues Pertaining to Plant Resistance and Tolerance to Aquatic Herbicides

8:50 am - 12:00 pm
Regency Ballrooms V - VII
Moderator: Michael D. Netherland, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL

8:50 am — Aquatic Plants and Herbicide Management: A Special Session to Discuss Resistance, Tolerance, and Environmental Factors that Impact Treatment Efficacy
Michael D. Netherland, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL

9:05 am — Factors Affecting the Selection of Herbicide-Resistant Weeds
Dale Shaner, U.S. Department of Agriculture, Agricultural Research Service, Fort Collins, CO

9:30 am — **Refreshment Break** *(Regency Ballroom I)*

10:00 am — Herbicide Resistance in Aquatic Plants
Gregory E. MacDonald, Agronomy Department and Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL

10:25 am — The Basis for Fluridone Resistance in *Hydrilla verticillata*
Brian E. Scheffler, U.S. Department of Agriculture, Agricultural Research Service, Stoneville, MS; Renee S. Arias, U.S. Department of Agriculture, Agricultural Research Service, Natural Products Utilization Research Unit, Oxford, MS; Michael D. Netherland, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL; Albrecht Michel, Stephen O. Duke, and Franck E. Dayan, U.S. Department of Agriculture, Agricultural Research Service, Natural Products Utilization Research Unit, Oxford, MS

10:50 am — Technical Approaches to Sonar Use in Management of Fluridone-Tolerant Hydrilla
Mark A. Heilman, SePRO Corporation, Carmel, IN

11:10 am — Weed Resistance to Bipyridylium Herbicides and Implications for Aquatic Plant Management
Tyler J. Koschnick, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL

11:30 am — Resistance and the Future of Aquatic Plant Control
William T. Haller, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL

11:45 am — Panel Discussion - Plant Resistance and Tolerance to Aquatic Herbicides

12:00 pm — **Lunch**

Session IV: Aquatic Resource Management and Invasive Species Control

1:30 pm - 4:45 pm
Regency Ballrooms V - VII
Moderator: Jeffrey D. Schardt, Florida Department of Environmental Protection, Bureau of Invasive Plant Management, Tallahassee, FL

1:30 pm — Dissipation and Target-Plant Uptake of Copper Following Applications of Komeen in the Sacramento-San Joaquin Delta
Lars W. J. Anderson, Doreen Gee, Deborah Holmberg, Aaron O'Callaghan, and Wailun Tan, U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, CA

1:45 pm — Designing Control Agents for Flowing Waters: A Modest Proposal
Dean F. Martin, Institute for Environmental Studies, Department of Chemistry, University of South Florida, Tampa, FL

2:00 pm — Does the Water Hyacinth Weevil *(Neochetina bruchi)* Respond to Changes in Host Plant Leaf Tissue Quality in Sacramento-San Joaquin Delta Populations?
Jason K. Brennan and **Lars W. J. Anderson**, U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, CA

2:15 pm — The Reward Rapid Release^{TM} Test: A Summary Update for 2004
James Brady, Syngenta Crop Protection, Inc., Greensboro, NC; and **James Petta**, Syngenta Crop Protection, Inc., New Braunfels, TX

2:30 pm — Carbohydrate and Nutrient Content of *Egeria densa* in Oregon and California *(Student Presentation)*
Toni G. Pennington and Mark D. Sytsma, Portland State University, Center for Lakes and Reservoirs, Portland, OR

2:45 pm — **Refreshment Break** *(Regency Ballroom I)*

3:15 pm — Effects of Preexisting Submersed Macrophytes on the Invasion Success of *Hydrilla verticillata*: Is Native Plant Restoration an Effective Biological Management Technique? *(Student Presentation)*
Todd Chadwell and Katharina Engelhardt, University of Maryland Center for Environmental Science, Appalachian Laboratory, Frostburg, MD

3:30 pm — SP-1019: A Potential New Herbicide for Large-Scale Aquatic Plant Management
Mark A. Heilman, SePRO Corporation, Carmel, IN; and David P. Tarver, SePRO Corporation, Tallahassee, FL

3:45 pm — *Lepomis* spp. Facilitate Invasion Success of *Myriophyllum spicatum (Student Presentation)*
Paul H. Lord, Biological Field Station, State University College at Oneonta, Cooperstown, NY

4:00 pm — Effects of Nitrogen Limitation on Turion and Tuber Production by *Hydrilla verticillata* (L.f.) Royle
Chetta S. Owens, Analytical Services, Inc., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX; Erin Tanski, University of North Texas, Denton, TX; and R. Michael Smart, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX

4:15 pm — Evaluation of the Potential to Selectively Control Eurasian Watermilfoil with Low Rates of Fluridone Herbicide in Minnesota
Wendy Crowell, **Chip Welling**, and Nick Proulx, Minnesota Department of Natural Resources, Division of Ecological Services, Saint Paul, MN

4:30 pm — Aquatic Adjuvants and Their Impact on Efficacy
Lucia G. I. Marshall and Richard L. Lowe, Trans America Product Technology, Inc., St. Charles, MO

Wednesday, July 14

Wednesday's Program-at-a-Glance

7:30 am - 8:00 am	Continental Breakfast *(Regency Ballroom I)* *Sponsored by Cerexagri, Inc.*
7:30 am - 12:00 pm	Meeting Registration *(Atrium)*
7:30 am - 12:00 pm	Presenter's Preview Room *(Channelside II)*
8:00 am - 10:00 am	Exhibits Tear-down *(Regency Ballroom I)*
8:00 am - 10:00 am	Posters Tear-down *(Regency Ballroom I)*
8:00 am - 11:45 am	Session V: Invasive Species Issues in Aquatic Habitat Management *(Regency Ballrooms V - VII)*
9:30 am - 10:00 am	Refreshment Break *(Regency Ballroom I)* *Sponsored by Cerexagri, Inc.*
12:00 pm - 2:00 pm	Awards and Installation of Officers Luncheon *(Regency Ballroom I)* *Sponsored by Syngenta Professional Products*
2:00 pm - 5:00 pm	APMS Board of Directors Meeting *(Harborview, 16th Floor)*
2:00 pm - 5:00 pm	APCRP Review, Corps of Engineer Representatives *(Esplanade Suites I & II)*

Session V: Invasive Species Issues in Aquatic Habitat Management

8:00 am - 11:45 am
Regency Ballroom V - VII
Moderator: John H. Rodgers, Jr., Department of Forestry and Natural Resources, Clemson University, Clemson, SC

8:00 am — Is Eradication of Hydrilla Achievable in New Zealand
Paul D. Champion, Deborah E. Hofstra, and John S. Clayton, National Institute of Water and Atmospheric Research, Hamilton, New Zealand

8:15 am — Continuing Investigations on Invasive Aquatic Vegetation, Cyanobacteria, and Avian Myelinopathy (AVM)
Susan B. Wilde, Sarah E. Habrun, Jason Kempton, Alan J. Lewitus, Baruch Institute, University of South Carolina and South Carolina Department of Natural Resources, Marine Resources Division, Charleston, SC; Thomas M. Murphy, Charlotte P. Hope, South Carolina Department of Natural Resources, Wildlife and Freshwater Fisheries Division, Green Pond, SC; Anna Birrenkott, Faith Wylie, and William W. Bowerman, Department of Environmental Toxicology, Clemson University, Pendleton, SC

8:30 am — Investigation of a Novel Cyanobacteria Linked to Avian Vacuolar Myelinopathy *(Student Presentation)*
Sarah E. Habrun, Graduate School of College of Charleston, Charleston, SC; Susan B. Wilde, Baruch Institute, University of South Carolina and South Carolina Department of Natural Resources, Marine Resources Division, Charleston, SC; Jason Kempton, South Carolina Department of Natural Resources, Marine Resources Research Institute, Charleston, SC; and Alan J. Lewitus, Baruch Institute, University of South Carolina and South Carolina Department of Natural Resources, Marine Resources Division, Charleston, SC

8:45 am — Physiological Aspects of Fluridone Resistance in Hydrilla *(Student Presentation)*
Atul Puri, Gregory E. MacDonald, and William T. Haller, Agronomy Department and Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL

9:00 am — A Comprehensive APM Web Site for the General Public
Vic Ramey, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL

9:15 am — Triploid Grass Carp: Practical Principles for Successful Use
Lowell Trent, Florida Wildlife Commission (Retired), Apopka, FL

9:30 am — **Refreshment Break** *(Regency Ballroom I)*

10:00 am	Biological Control of *Melaleuca quinquenervia* in South Florida **Thai K. Van**, Min Rayamajhi, and Ted Center, U.S. Department of Agriculture, Agricultural Research Service, Invasive Plant Research Laboratory, Fort Lauderdale, FL
10:15 am	The Lower Rio Grande and Lake Austin: Texas Hot Spots with Special Problems **Earl W. Chilton II**, Texas Parks and Wildlife Department, Austin, TX
10:30 am	The Southeast North Carolina Giant Salvinia Task Force **C. Wayne Batten**, County Cooperative Extension Director, Pender County, North Carolina Cooperative Extension Service, Burgaw, NC
10:45 am	Environmental Conditions Influencing the Growth of *Salvinia molesta* in North Carolina **Steve T. Hoyle**, North Carolina State University, Raleigh, NC; and C. Wayne Batten, County Cooperative Extension Director, Pender County, North Carolina Cooperative Extension Service, Burgaw, NC
11:00 am	Weeds in Waiting? - Experimental Assessment of the Competitive Risk Posed by Alien Aquatic Plants **Deborah E. Hofstra**, Paul D. Champion, and David Burnett, Centre for Biodiversity and Biosecurity, National Institute of Water and Atmospheric Research, Hamilton, New Zealand
11:15 am	Land Hydrilla, a.k.a. Old World Climbing Fern (*Lygodium microphyllum*) **Ken Langeland**, Agronomy Department and Center for Aquatic and Invasive Plants, University of Florida, IFAS, Gainesville, FL
11:30 am	Implications of Herbicide Applications for *Lygodium microphyllum* on Restoration of Floodplain Wetlands **Louis A. Toth**, Vegetation Management Division, South Florida Water Management District, West Palm Beach, FL

NEXT YEAR
45th Annual Meeting
July 10-13, 2005
Hyatt Regency San Antonio
San Antonio, Texas

Abstracts

Opening Plenary Session

What is New in Herbicide Registrations

Donald R. Stubbs
Herbicide Branch, Registration Division, Office of Pesticide Programs, Environmental Protection Agency, Washington, DC

A pesticide is anything that prevents, destroys, repels or mitigates any pest. This includes insecticides, fungicides, rodenticides and herbicides. Prior to allowing a pesticide on the market it must be registered by the Environmental Protection Agency (EPA). The Office of Pesticide Programs, EPA is responsible for registration of pesticide uses. The Registration Division is responsible for registering conventional chemical pesticides. In January of 2004 the Congress passed and the President signed the Consolidated Appropriations Act of 2004. This act established a new section in the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), which established a registration service fee system. This law dramatically changes how EPA will process registration requests under FIFRA and requires industry to pay fees for many services that were free in the past.

Economic Impact of Aquatic Weeds – A Literature Review

Jennifer Vollmer[1], H. William Rockwell[2], and Michael D. Moore[3]
[1] *BASF Corporation, Laramie, WY*
[2] *Strategic Systems, St. Johns, MI*
[3] *Aquatic Ecosystem Restoration Foundation, Lansing, MI*

The Aquatic Ecosystem Restoration Foundation (AERF) is a non-profit organization dedicated to the environmentally sound restoration and management of aquatic and wetland systems via research and development, public education, regulatory interactions and public/private/academic partnerships. The Board of Directors has established as one of the organization's goals the development of a clear, concise method of determining the economic impact of aquatic weeds. This information in the form of a model could aid resource managers in producing and defending management programs based on ecosystem-scale realities and cost/benefit economics. The AERF supported Dr. H. William Rockwell to survey the literature on the economic impact of aquatic weeds. His findings confirm the need for further investigation. A conservative estimate of lost values due to aquatic invasive species is in the billions of dollars annually in the U.S. Dr. Rockwell found an approximate $5-billion ($0.5 billion to $14 billion) national economic impact from aquatic weeds. Significant dollars are spent annually to control aquatic invasive plants with the estimated benefits much higher than costs. Resource managers addressing local or regional problems need help in formation, decision-making, and administration, not to mention in considering their decisions within the broader context of the prevention of the spread of aquatic weeds. From Dr. Rockwell's literature summary, a conservative 10:1 benefit/cost ratio for "values at risk" includes what could be lost, what has been lost, and what might be restored. This helps explain a more dynamic comprehension of the problem, including the considerations of weed spread and the prevention of spread.

Economic Impacts and Aquatic Plants: The Angler's Piece of the Puzzle

Jim E. Henderson and James P. Kirk
U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Economic impacts from recreation have become significant to the well-being of communities dependent on tourism. Establishing the relationships between aquatic plants, recreation use, and resulting economic impacts requires obtaining economic information through sometimes costly survey efforts. To determine economic impacts while minimizing costs, creel surveys at three South Carolina lakes were modified to obtain information on perceptions of aquatic plants, recreation trip expenditures, and angler use under different plant scenarios. Regional models were developed to predict economic impacts associated with anglers for current use and higher levels of use. Major findings from surveys at Lake Murray, Lake Moultrie, and Lake Greenwood, South Carolina are: 1) economic impacts to the region around the lake are significant on the order of $2 M to $4 M annually in goods and services, in addition to increases in income and jobs; 2) anglers perceive aquatic plants to be beneficial to their fishing; and 3) angler use increases with projected increases of plants to a point below the

historical high plant level. The economic sectors that receive the greatest input are hotels and lodging, eating and drinking, and food processing. This creel survey effort demonstrated that economic information could be collected in an efficient and inexpensive manner; results were comparable to other South Carolina surveys. Effective management of aquatic plants requires similar information from the other stakeholder groups, e.g., boaters. Efforts should be made to identify similar ongoing survey efforts for other recreation segments and residential groups.

Chemical Control Research: Protecting the Nation's Water Resources

Kurt D. Getsinger
U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Operating under the purview of the U.S. Army Corps of Engineers Aquatic Plant Control Research Program (APCRP), the Chemical Control and Physiological Processes Team develops and evaluates environmentally sound strategies for managing invasive aquatic and wetland plants using herbicides. These evaluations are conducted using a multi-tiered approach in customized controlled-environment chambers, greenhouses, and outdoor mesocosm and pond facilities in Vicksburg, MS, Lewisville, TX, and Gainesville, FL. Results of small-scale studies are verified in field sites (lakes, reservoirs, rivers, and wetlands) throughout the U.S. Research focus areas include: 1) selective control of nuisance vegetation; 2) integration of alternative control techniques; and 3) prevention of herbicide resistance. Work is conducted on a cost-reimbursable basis with sponsors and/or cooperators including the APCRP, Federal and state agencies, and the private sector. In addition, coordination with the U.S. Environmental Protection Agency and similar state agencies is undertaken to support the registration of new aquatic herbicides and amendments to established labels. Finally, information and technology developed via research efforts are transferred to natural resource agencies, the private sector, and the general public through workshops and symposia, and the publication of technical reports, popular articles, and the peer-reviewed scientific literature.

Session I: Aquatic Plant Biology, Restoration, and Control

Hydrilla in the Santee Cooper Reservoirs, South Carolina – Lessons Learned after 15 Years

James P. Kirk[1], Jim E. Henderson[1], and Steven J. de Kozlowski[2]
[1] *U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2] *South Carolina Department of Natural Resources, Columbia, SC*

Experiences, i.e., impacts of infestation and lessons learned, from a hydrilla infestation in the Santee Cooper reservoirs, South Carolina, are summarized. Hydrilla appeared during 1982, was unsuccessfully treated with herbicides through 1988, and a total of 768,500 triploid grass carp were stocked between 1989 thorough 1996. Hydrilla coverage peaked at 38,000 acres by 1994 but was significantly reduced by late 1996; since then aquatic vegetation remains sparse causing controversy. The effects of hydrilla were predominately negative in this multiple-use system. Impacts were both positive and negative for fisheries and waterfowl but boating, hydropower, and raw water use were negatively affected by hydrilla. Tourism appeared unaffected. While aquatic vegetation is usually deemed beneficial, invasive species such as hydrilla may represent an exception because they can rapidly expand, displace native species, and be difficult, as well as expensive, to manage with herbicides. Therefore, in highly managed reservoir systems, hydrilla should be eliminated as soon as it first appears rather than attempting management at some intermediate level of coverage. When hydrilla is first detected, aggressive herbicide applications should be initiated. If hydrilla becomes established, triploid grass carp are by far the cheapest method of long-term control. Grass carp may impact beneficial vegetation; therefore, consideration should be given to establishment of desirable native species using water level manipulation, plantings, and enclosures.

Integrated Control of Hydrilla

Michael J. Grodowitz[1] and R. Michael Smart[2]
[1] *U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2] *U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*

For the past 30 years, the management of hydrilla in the U.S. has relied mainly on the use of grass carp as well as chemical and mechanical control technologies. These technologies provide, at best, short-term control at a prohibitively high cost. In addition, the implementation of these strategies does not normally take into consideration other factors within the ecosystem, such as nutrient inputs and native plant diversity, which may be influencing the formation of economically important hydrilla infestations. Recently, two new technologies have emerged that offer the possibility of combining all available techniques into an integrated ecosystem management approach to hydrilla control. These new technologies include the use of host-specific insect agents, specifically two species of leaf-mining flies *Hydrellia pakistanae* and *H. balciunasi*, and an ecosystem approach where stable native aquatic plant communities are established in an effort to exclude or inhibit the formation of large infestations of hydrilla. The development of an integrated, ecosystem approach to hydrilla management, where all aspects of the environment from nutrient loading to native plant community structure are taken into consideration, represents a significant advance over more traditional management methods. This presentation will examine the promise of these new technologies, alone and in combination, with more traditional existing methods, for managing hydrilla within an ecosystem context.

Changes in Aquatic Vegetation Management Techniques Due to Artificial Water Level Fluctuation on Lake Kissimmee, Florida

Rue S. Hestand[1], Craig T. Mallison[2], David R. Douglas[1], and Boyd Z. Thompson[1]
[1] *Florida Fish & Wildlife Commission, Eustis, FL*
[2] *Florida Fish & Wildlife Commission, Lakeland, FL*

Florida's rainfall pattern is cyclic on an annual basis and for multi-year periods. These patterns produced historic extreme fluctuations of lake levels. Aquatic plants and animals evolved under this cyclic hydrological pattern of extreme water level fluctuations. From 1942 until Lake Kissimmee was stabilized in 1966, there was a natural fluctuation of 12.6 feet. Presently, it fluctuates 4 feet annually. This fluctuation is also the opposite of the natural pattern, with the managed highs in the winter and lows in the summer. This has caused major changes in the aquatic plant community. Dense growth of highly productive species such as pickerelweed (*Pontederia* sp.), cattail (*Typha* sp.) and lilies (*Nuphar luteum* and *Nymphaea odorata*) choked out prime nursery and spawning grounds for sport fish plus led to an accumulation of organic material which further degraded shoreline habitat. By mimicking natural processes through management, we have removed nuisance vegetation and

associated organic material and promoted the expansion of desirable native plants. In managed areas, most nuisance plant species have reverted to a coverage frequency similar to that seen in the 1970's. While desirable plants have not attained target coverages, they expanded in managed areas and the overall quality of habitat is much improved. Aggressive herbicide treatments have prolonged the effects of muck removal activities by preventing dense regrowth of undesirable plant communities, but may have suppressed some desirable emergent plants. Muck removal is an effective habitat enhancement tool in areas where excessive organic accumulation has occurred. Plants can be managed with herbicides and periodic muck removal, but the Florida lakes will probably never look or act like they did before water level regulation. Nonetheless, implementing the most effective management strategies can minimize further degradation of habitat and will allow managers to achieve the best habitat attainable within the established water level schedule.

Phytoplankton Ecology, Community Structure, and Harmful Algal Bloom Formation in Two Eutrophic South Carolina Ponds: A Baseline Study *(Student Presentation)*

Larissa J. Mason[1], Alan J. Lewitus[2], and Susan B. Wilde[2]
[1] *Master of Environmental Studies Program, College of Charleston, Charleston, SC*
[2] *Baruch Institute, University of South Carolina and South Carolina Department of Natural Resources, Charleston, SC*

Detention ponds are the predominant best management practices (BMPs) used to mitigate storm water in coastal South Carolina. The majority of these detention ponds are brackish and eutrophic. The pronounced nutrient loading in these ponds is frequently associated with mono-specific harmful algal blooms. Current research focuses on anthropogenic inputs and effects on phytoplankton ecology. This data will be used as a basis for understanding the ability of a restored wetland to function as a supplemental BMP to improve water quality and reduce harmful algal blooms in brackish detention ponds.

Effect of Native Macrophyte Presence on Productivity and Elemental Composition of *Hydrilla verticillata*

Iwona Staniszewska[1], Tom DeBusk[1], and Craig Duxbury[2]
[1] *Azurea, Inc., Rockledge, FL*
[2] *WDI Research and Development, Lake Buena Vista, FL*

A mesocosm study was performed to evaluate whether presence of native submerged aquatic macrophytes (SAV) can deter colonization by *Hydrilla verticillata*. The native SAV species *Bacopa* sp., *Najas guadalupensis, Nitella* sp. and *Micranthemum* sp. were stocked individually into three replicate mesocosms containing a sand-organic soil mixture. Following 11 weeks of acclimation and growth, the 12 native SAV mesocosms, as well as three unvegetated control mesocosms, were planted with four apical hydrilla tips (15 cm long). Hydrilla growth was then monitored for 10 weeks. Hydrilla exhibited growth in all treatments. Maximum hydrilla shoot growth occurred in the unvegetated control tanks, whereas presence of *Najas* and *Bacopa* reduced average hydrilla shoot growth by 78 and 57%, respectively. *Nitella* exhibited no impact on hydrilla shoot growth, and *Micranthemum* provided only a slight inhibitory effect (19% growth reduction). To assess whether growth inhibition was due to competition for soil nutrients, tissue N and P content of Hydrilla were measured in each treatment. Hydrilla tissue N content ranged from 33.4 to 42.4 mg/g, and tissue P levels ranged from 6.8 to 7.9 mg/g. Comparisons between growth and elemental composition yielded inconsistent results, but did indicate that in some treatments hydrilla growth may have been limited by nutrient availability.

Responses of *Hyalella azteca* to Detritus from a Constructed Wetland Treatment System Designed to Mitigate Risks Associated with Flue Gas Desulfurization Wastewater *(Student Presentation)*

Sarah E. Sundberg, Ryan P. Jones, and John H. Rodgers, Jr.
Department of Forestry and Natural Resources, Clemson University, Clemson, SC

The objective of this research was to measure the toxicity of detritus from a pilot-scale constructed wetland treatment system designed to treat selenium, mercury, and arsenic from flue gas desulfurization wastewater toxic to *Hyalella azteca* Saussure, an aquatic detritivore. The system consists of a 6,800-L upstream retention basin followed by four wetland cells in series, including two cells (Cells 1 and 2) planted with giant bulrush (*Schoenoplectus californicus* C.A. Meyer), a gravel manganese oxidation cell (Cell 3), and a final cell (Cell 4) planted with narrow-leaf cattail (*Typha angustifolia* L.*)*. One of the initial mechanisms of metal removal in this system is sorption to organic matter, including detritus and sediment. A series of 10-day toxicity experiments were conducted to determine the toxicity of detritus from each plant cell. Detritus dilutions were made using detritus collected from an uncontaminated source. Toxicity experiment endpoints include mortality and growth on a dry weight basis. Less than 50% mortality was observed in organisms feeding on undiluted detritus from Cell 1, 100%

mortality was observed at 50% detritus dilution from Cell 2 and undiluted detritus from Cell 4. Decreased growth (average dry weight per organism) of 30%, 30%, and 16% was observed in all test organisms exposed to detritus from Cells 1, 2, and 4, respectively. Results from this research have been beneficial in designing constructed wetland treatment systems to mitigate risks associated with flue gas desulfurization wastewater.

Broad-Scale Herbicide Efficacy Monitoring for *Egeria densa* Using Advanced Hydroacoustic Techniques at Multiple Sites, Sacramento-San Joaquin Delta, California

Scott A. Ruch[1], Julie Owen[2], Lars W. J. Anderson[3], and Doug Henderson[4]
[1] *ReMetrix, LLC, Berkeley, CA*
[2] *California Department of Boating and Waterways, Sacramento, CA*
[3] *U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, CA*
[4] *ReMetrix, LLC, Carmel, IN*

Eighteen sites in the central Sacramento-San Joaquin Delta (SSJD) were monitored during 2003 for submerged vegetation species, health, coverage, and biovolume. The goal of the monitoring project was to measure the effects of aquatic herbicide use on vegetation. The target species for the herbicide was *Egeria densa*. Fifteen sites were treated and three sites were monitored as controls. Each of the sites monitored between two and four times, depending on various factors such as the herbicide used (fluridone, copper, diquat), site location, and treatment approach and schedule. The monitoring consisted of two to four GPS point sampling events at each site for various vegetation characteristics, including plant health. Monitoring also consisted of two to three hydroacoustic sampling events along multiple transects at each site. The transect results indicated the bottom coverage percentage and biovolume percentage of plants in the water column. In all, efficacy at each site was determined based on the combined suite of data for each site. This was the first time that a field-based *Egeria* monitoring project of this scope and detail has been conducted in the SSJD. Results from the initial year of this project will be presented and discussed.

A Potential Biological Control Agent, Bacterium SG-3: Mode of Action and Effect on Two Economically Important Cyanobacteria *(Student Presentation)*

Kathryn J. Wilkinson[1], H. Lynn Walker[2], and Carole A. Lembi[1]
[1] *Purdue University, West Lafayette, IN*
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Bacterium SG-3 (NRRL B-30043) is highly effective for control of both planktonic and mat-forming cyanobacteria. Laboratory assays were conducted to determine the method by which the bacterium lyses susceptible species of cyanobacteria. Is contact or penetration necessary or does a secreted compound cause cell death? Although the precise mechanism is still unknown, the probable hypothesis is that a large molecule is responsible for the lytic activity. Activity is retained after filtration of a bacterial culture through a 0.45-µm filter, but activity is lost after filtration through a 0.2-µm filter. *Pseudanabaena limnetica* and *Cylindrospermopsis raciborskii* are two genera of cyanobacteria that are of great concern to lake and reservoir managers. *P. limnetica* produces off-flavor compounds, and *C. raciborskii* produces numerous toxins including potent neurotoxins and hepatotoxins. *P. limnetica* and *C. raciborskii* were tested for their sensitivity to SG-3. Both organisms are highly sensitive to SG-3. For example, one isolate of *C. raciborskii* that had an initial concentration of 78,089 filament/mL was reduced to 14,601 filaments/mL after the addition of 132,500 plaque forming units (PFU)/mL of SG-3. This 86% reduction in filament number was caused by less than 2 PFU/filament.

Sediment Resuspension and Light Attenuation in Peoria Lake: Can Macrophytes Improve Water Quality in this Shallow System?

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Sediment resuspension and light attenuation were examined in relation to the potential for macrophytes to improve water quality conditions in Peoria Lake, Illinois (USA). The lake exhibited high total suspended solids (TSS) loading and retention of predominantly fine-grained particles. Large fetches along the prevailing wind rose, coupled with shallow morphometry and sediment particles composed of >90% silt and clay resulted in frequent periods of sediment resuspension. As calculated (wave theory) shear stress increased above the critical shear stress (measured experimentally), turbidity increased

substantially at a resuspension monitoring station. Resuspension model explorations suggested that establishment of submersed aquatic macrophytes could substantially reduce sediment resuspension in Peoria Lake. However, K_d is currently very high, while Secchi transparency is low, at in-lake stations. Thus, in order to establish a persistent macrophyte population in the lake to control resuspension, the underwater light regime will have to improve quite dramatically.

Comparative Toxicity of a Copper-Containing Algaecide to Four Algal Species *(Student Presentation)*

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Laboratory experiments with problematic algal species in site waters can provide information that can aid in achieving efficient and effective control. The toxicity of copper to vascular and nonvascular aquatic plants is affected by various physiochemical attributes of site waters, including hardness, alkalinity and pH. Specific objectives of this study were: 1) to compare the toxicity of Cutrine®-Plus, a copper-containing algaecide, to four different species of algae (*Prymnesium parvum*, *Raphidocelis subcapitata, Nanochloris* sp., *Anabaena* sp.); and 2) to compare the performance of Cutrine®-Plus in waters with different characteristics. Alkalinity and hardness of site waters ranged from 32 to 130 mg/L as $CaCO_3$, and 53 to 696 mg/L as $CaCO_3$, respectively, and the pH (which can greatly influence toxicity by changing the form of copper) ranged from 7.4 to 8.3. Algal control (loss of algae from the water column) was obtained at 0.2 mg Cu/L for all algae, except for *Nanochloris* sp., which was achieved at 0.75 mg Cu/L. Algal toxicity experiments using site-specific waters provide treatments for specific algal species and densities, while minimizing exposures that may be harmful to non-target species.

Economic Impact Survey of Eurasian Watermilfoil Removal in Houghton Lake

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It is common knowledge throughout the aquatic field that exotic plant infestations on a lake can have serious detrimental consequences to the ecology of the water body. We often discuss the logical significant economic impact that degraded water quality from excessive exotic plant growth can have on the local businesses and commerce connected with a given lake. It is, however, not very easy to quantify many of the economic values associated with the lake community, making even an extensive economic study still incomplete. The purpose of this report is to explain the documented impacts of the 2002 Sonar treatment of Houghton Lake. Through personal interviews, local economic data research and the analysis of an extensively distributed survey, the outcome of the Sonar treatment of Houghton Lake will be critically looked at both in terms of personal/communal satisfaction and overall satisfaction of project results for the property owners who paid for the treatment. A measurement will be made to estimate its impact on the local economy. Qualitative as well as quantitative analysis of this data will be reviewed to better understand the economic impact of the 2002 Sonar Eurasian watermilfoil treatment.

Poster Session

National Management Planning for the Genus *Caulerpa*

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Caulerpa is one of the most distinctive algal genera, being identifiable solely on the basis of its growth form and internal morphology. All species and subspecies of *Caulerpa* live in marine environments, but some can thrive in brackish lagoons. Reports on the number of *Caulerpa* species vary from 70 to approximately 1,000, most of which inhabit tropical waters. Three *Caulerpa* species have warranted special concern due to their historic and ongoing invasions of U.S. and foreign waters; *Caulerpa taxifolia, Caulerpa brachypus* and *Caulerpa racemosa*. The cosmopolitan introduction and spread of *C. taxifolia* has led to wide documentation of its history, biology, ecology and impacts on native ecosystems. *C. taxifolia* had been cultivated in aquariums of Europe since the late 1960s, providing a source population for introduction to the wild. A cold-tolerant strain of *C. taxifolia*, often called the Mediterranean strain, was first noticed in the wild, on the Mediterranean coast, in 1984. Since then, *C. taxifolia* (Mediterranean strain) has spread throughout the northwestern Mediterranean Sea colonizing over 130 km^2. In June 2000 *C. taxifolia* (Mediterranean strain) was detected in two sites on the coast of southern California. This early detection led to ongoing eradication efforts. In Florida concern has recently been raised about the introduction of *C. brachypus*, which has produced large blooms that overgrow sponges, hard corals, octocorals, and even other algal bloom species off the coast of northern Palm Beach County. Concerns have also been raised by international and national scientists about *C. racemosa*, which in the Mediterranean, has spread to coastal areas of eleven countries since 1991. The Aquatic Nuisance Species Taskforce, created through the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA), amended by the National Invasive Species Act of 1996 (NISA), authorized the creation of a *Caulerpa* Working Group (CWG) to create a National Management Plan that addresses *Caulerpa* in U.S. waters. The goals of the National Plan for the Genus *Caulerpa* are to: 1) Prevent the introduction and spread of *Caulerpa* species to areas in U.S. waters where they are not native; 2) Detect, rapidly respond to, and monitor *Caulerpa* species in U.S. waters where they are not native; 3) Eradicate *Caulerpa* populations in waters to which they are not native, where feasible; 4) Provide long-term adaptive management and mitigate impacts of populations of *Caulerpa* species in U.S. waters where they are not native and where eradication is not feasible; and 5) Educate and inform the public, agencies and policymakers to advocate for preventing the introduction and spread of *Caulerpa* species.

On the Competition for Light Between American Wildcelery and Sago Pondweed at High and Low Nutrient Availability: A Modeling Approach

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A simulation model has been developed that focuses on the ability of two competing submersed macrophytes, respectively meadow-forming and canopy-forming, to maintain their biomass at different environmental conditions. *Vallisneria americana* (American wildcelery) serves as the example for non-canopy-forming plants, and *Potamogeton pectinatus* (sago pondweed) for canopy-forming plants. The model can be used to predict changes in the species composition of submersed vegetation as a result of changes in the availability of resources in shallow freshwater bodies. In the model, the two plant species compete for light and exhibit different species-characteristic relationships between plant tissue nitrogen (N): phosphorus (P) ratio and reduction in plant biomass production. Competition for light proved to be a far more important determinant of species composition of the vegetation than the availabilities of N and P in the sediment. Intraspecific competition for light did not occur in wildcelery in a temperate climate, typical for the Upper Mississippi River System (UMRS) at La Crosse, WI. However, it was observed in a near-subtropical climate, typical for the freshwater systems near Davis, CA. It occurred in sago pondweed already at low plant densities. Coexistence of both species in mixed stands occurred only at wildcelery: sago pondweed plant density ratios of 28:2 to 26:4 without N and P limitation, irrespective of climate. At density ratios higher than 28:2 wildcelery wins, and at density ratio's lower than 26:4, sago pondweed wins. The density ratio range at which coexistence was possible increased with water turbidity between extinction coefficients of 0.43 and 2.00 m^{-1}. Low epiphyte shading allowed coexistence in clear water, but prevented it in turbid water. Under N limiting conditions for both species, sago pondweed wins the competition, but under P limiting conditions for sago pondweed wildcelery wins. Coexistence was expanded by fertilization with both N and P. These results indicate that sago pondweed has a high potential of replacing wildcelery when allowed to colonize gaps in dense wildcelery stands. N limiting conditions strengthen and P limiting conditions weaken the competitive potential of sago pondweed relative to that of wildcelery, while raised N and P availabilities enhance the potential for coexistence of both species. These notions can be used as a basis for management of submersed macrophytes. Model calibrations and simulation results are currently verified experimentally.

Air Boat Development to Herbicide Spray Application Evaluated by DGPS Systems in Brazil

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Airboats are being used to apply herbicide sprays at aquatic areas in Brazil, using electronic systems to control the spray. The airboats have engine aircraft (motor Lycomming with 300 hp) propellers with fixed step, and two helms steady on airflow behind the propeller. In Brazil, the use of common engines was prohibited in some aquatic areas, and the airboat was a good alternative. The spray application was developed with a volume application correction to speed navigation, and was combined with a DGPS (differential global positioning system) to check the speed and area of pesticide application. The airboat moves at 50 kmh^{-1} but the spray is applied at 8 to 20 kmh^{-1} speed, utilizing 6m of band width.

Combinations of Herbicides for Control of Torpedograss

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Torpedograss (*Panicum repens* L.) is a noxious weed of both natural and restored wetlands in Florida. Eradication programs implemented by state governmental agencies commonly use glyphosate to control this pest in lakes, wetlands, and canals. Rodeo, a non-selective herbicide, is the trade name of the glyphosate formulation approved for use in wetlands. Although Rodeo is effective in controlling torpedograss, multiple applications are required. Renovate (active ingredient triclopyr) is a selective broadleaf herbicide approved for use in wetlands. It has proven effective in controlling invasive exotic plants such as water hyacinth, alligator weed, and other aquatic weeds. Because it is a selective herbicide, it does not affect non-target native vegetation, thus it is less disruptive to natural systems. Using the least amount of herbicide, for the greatest amount of control, is the goal of invasive exotic plant management. Combining these herbicides may provide a synergism that is less disruptive to native systems, as well as less time-consuming, if it provides control with fewer repeat applications. Torpedograss plants grown in sand in 2-gallon pots for 12 weeks under overhead irrigation were sprayed to wet with a backpack sprayer. Treatments were 1% or 3% of both Rodeo or Renovate, plus combinations of each concentration. Each treatment, including the control, included a 0.5% concentration of the surfactant Sun Wet. Shoot dry weights 4 weeks after application of a combination of 1% Rodeo plus 1% Renovate suggest that combining these herbicides in concentrations lower than they are normally used separately, may provide effective control of torpedograss, while using less herbicide in wetland environments.

Status of Releases of the Biological Control Agents *Neochetina* spp./*Hydrellia* spp. for Waterhyacinth/Hydrilla Management in the Lower Rio Grande Valley Cooperating Irrigation Districts

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In September 1999, a joint project in the Lower Rio Grande Valley was initiated between the Texas Commission on Environmental Quality (TCEQ), the Bureau of Reclamation (BOR), and the U.S. Army Engineer Research and Development Center (ERDC). The purpose of the project was to determine if the use of biocontrol would aid in hydrilla and waterhyacinth management. For hydrilla management, both species of hydrilla flies, *Hydrellia pakistanae* and *H. balciunasi*, were introduced. Insects used for the 2001 releases were collected from the Lewisville Aquatic Ecosystem Research Facility (LAERF), Lewisville, TX. Approximately 350,000 hydrilla flies were released at three sites in 2001 and included Falcon No. 1, Falcon No. 2, and Anzulduas. In 2003, close to 2.5 million flies were released in the Lower Rio Grande Valley at the Roma and Lonesome Dove sites. Both species of *Hydrellia* spp. were obtained from mass-rearing facilities maintained at LAERF. A point intercept technique was utilized at the Roma site in order to better quantify observed hydrilla declines at release areas. For waterhyacinth management, both *Neochetina eichhorniae* and *N. bruchi* were introduced. In 2000, ca. 4000 weevils were released at one site, the Cameron No. 6 Canal site. In 2001, over 80,000 weevils were released - ca. 20,000 at four sites: 1) Delta Lake; 2) LaFeria; 3) T-192; and 4) T-241. While reasons are unclear, waterhyacinth and hydrilla declined at all of the original release sites but remained productive at sites where no releases were made. Hence, there is a need to continue monitoring the remaining waterhyacinth and hydrilla populations to determine if the observed declines were related to insect introductions.

Diquat Gel Formulation for Control of Aquatic Weeds

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An alginate gel formulation of diquat (AccuGel®) was evaluated for efficacy against several submersed aquatic plants, hydrilla (*Hydrilla verticillata*), Eurasian watermilfoil (*Myriophyllum spicatum*), sago pondweed (*Stukenia pectinatus),* American pondweed (*Potamogeton nodosus),* and Brazilian elodea *(Egeria densa),* and results compared to the effectiveness of the commonly used liquid formulation of diquat, Reward®. The study was conducted in the outdoor mesocosm facility near Lewisville, TX, consisting of thirty, 7000-L fiberglass tanks with three replicate tanks per treatment. Treatments were diquat gel and liquid diquat at 0.185 mg/L and 0.37 mg/L, and at water exchange half-lives of 3 and 6 hrs, respectively. In addition, a static exposure of diquat liquid at 0.37 mg/L and a 0 mg/L reference were evaluated. Both formulations showed 80 to >90% control for Eurasian watermilfoil, sago pondweed, and Brazilian elodea. However, in most cases the gel resulted in significantly improved control of four species compared to similar liquid treatments. Except for the liquid treatment at 0.37 mg/L static exposure, no treatment resulted in good control of hydrilla. While the published literature and extensive practical use of diquat show that Reward® provides good control of hydrilla, particularly when combined with chelated coppers, results from our study indicate that longer exposure times may be required to achieve acceptable control of that species.

Comparison of Torpedograss and Pickerelweed Susceptibility to Glyphosate

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Torpedograss (*Panicum repens* L.) is one of the most invasive exotic plants in aquatic systems. Repeat applications of (N-phosphonomethyl) glycine (glyphosate) herbicides provide limited control of torpedograss; unfortunately, glyphosate often negatively impacts most non-target native species that grow alongside the weed. This experiment studied the effect of glyphosate on pickerelweed (*Pontederia cordata* L.), a native plant that shares habitats with torpedograss. Actively growing plants of torpedograss and pickerelweed were cultured in 8-liter containers and sprayed to wet with one of four rates of glyphosate: 0%, 0.75%, 1.0%, or 1.5%. Each treatment included a surfactant to aid in herbicide uptake and a surface dye to verify uniform application of the treatments. All herbicide treatments were applied with a backpack sprayer to intact plants and to cut stubble of both species. Four replicates were treated for each species-rate-growth combination during each of two experiment periods. Plant dry weights 8 weeks after herbicide application suggest that torpedograss was effectively controlled by the highest rate of glyphosate applied to cut stubble, while pickerelweed was unaffected by the same treatment. These data suggest that a cut-and-spray application of a 1.5% solution of glyphosate may be an effective strategy to control torpedograss without deleteriously affecting pickerelweed.

Mycoleptodiscus terrestris: A Comparison Between Isolates from the United States and New Zealand

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The use of indigenous fungal pathogens as biological control agents for invasive nuisance species offers a viable alternative to more traditional management techniques. One major advantage of using indigenous pathogens is that quarantine is not an issue because they are considered native organisms. Based on findings that *Mycoleptodiscus terrestris* (Gerd.) Ostazeski (Mt) has potential for use in aquatic plant management in the United States, efforts were undertaken to discover if the species might be present on invasive aquatic plants in New Zealand. One dematiaceous fungal isolate obtained from asymptomatic *Ceratophyllum demersum* was a possibility but it was notably different in culture from U.S. Mt isolates. Once induced to sporulate, the distinctive 2-celled appendaged spores made a positive identification possible and confirmed the presence of

Mt in New Zealand. Comparisons between the two isolates have shown differences in colony morphology, microsclerotia, spore size, spore production, and spore germination. Preliminary genetic studies also indicate differences between the U.S. and New Zealand isolates. However, similar disease symptoms were observed on hydrilla when liquid inoculum from U.S. and New Zealand Mt strains were applied at rates between 0.1 and 0.2 ml L^{-1}.

Impacts of Lime Application on Aquatic Macrophyte Growth

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Lime (CaO, $CaCO_3$, $Ca(OH)_2$) additions have typically been used as a rehabilitation technique for controlling internal phosphorus (P) loading in lakes. Supersaturation of the water with calcium leads to coprecipitation of P and Ca as hydroxyapatite and removal of P and burial to the sediments. However, field evidence also suggests that aquatic macrophytes may be susceptible to lime applications. Although the exact mechanism for lime-induced biomass loss is not precisely known, it may be related to increased pH and accompanying CO_2 limitation and/or light limitation induced by Ca precipitation on macrophyte leaves. If macrophyte growth is predictably affected by lime additions, this technique could be beneficial in both controlling internal P loading and the growth of nuisance species in eutrophic lakes. The impacts of lime additions on the growth of sago pondweed (*Stukenia pectinatus* (L.)) were examined using experimental mesocosms. Plants grown for 6 weeks were subjected to lime concentrations of 250, 500, and 1000 mg/L for initial studies. Lime additions > 250 mg/L resulted in suppressed plant growth, a milky white, blanched tissue, and low concentrations of tissue chlorophyll (nearly zero). These responses were associated with high pH (> 11) and alkalinity, suggesting possible CO_2 limitation. For plants subjected to lime concentrations of 250 mg/L, tissue blanching also occurred; however, strong regrowth on blanched stems was evident within 2 weeks of treatment, coincident with declines in pH to < 11. These results suggest that lime additions may impact growth by affecting photosynthesis at high pH. However, further work is needed in order to identify the exact impacts of lime additions on macrophyte growth.

Microsporidia Infection in *Neochetina eichhorniae* and *N. bruchi* Populations in Texas

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In the early 1970's, *N. eichhorniae* and *N. bruchi* were released in the United States as biological control agents for waterhyacinth, *Eichhornia crassipes*. The weevils have been successful in reducing plant height and stature as well as reducing flowering and seed set. In some instances, large reductions in biomass have been observed; however, in other cases the biocontrol agents are producing little, if any, overall impact. These observations have prompted researchers to examine factors that might explain variation in agent effectiveness. One such possible factor may be the presence of microsporidia in *Neochetina* populations. Microsporidiosis is a chronic disease that often infects and becomes symptomatic when insects are stressed. Once the disease has invaded the insect it begins to spread rapidly within tissues and organs. Insects infected with the disease become lethargic, exhibit abnormal feeding habits, have reduced longevity, and even die. Therefore, it is imperative to have qualified personnel screen the weevils for the disease using a reliable microscopic detection method. Researchers in Florida have observed that weevil infection rates at some sites exceed 25 percent. Recent surveys in Texas have shown infection rates never exceeding 1 percent overall. With such a large difference in infection rates, it is important that proper screening and detection be performed prior to introduction to significantly reduce the possibility of further spreading of the disease.

Developing a State Invasive Species Alliance for Mississippi

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Invasive species are a multi-billion-dollar problem in the mid-south states. While a number of federal, state, and local agencies have responded with small programs to manage these problems, cost-effective management requires early detection and management. The proliferation of programs lacks effective communication and coordination between states and agencies. Individual development of tracking new infestations and data sharing would be wasteful duplication of funds. We are developing a task force of federal, state, and local government agencies, nongovernmental organizations and concerned citizens focused on the early detection and management of invasive noxious species in Mississippi, the Mississippi Invasive Species Alliance (MS-ISA). The organization will be tiered, having an executive council of decision-makers from each state, a technical steering committee, and an advisory council composed of those interested in participating. The MS-ISA will coordinate the sharing of data, act as a clearing house for locations of invasive species in the region, facilitate information exchange at the appropriate federal level, and act to coordinate regional management efforts.

Chemical Control of Water Hyacinth Using Different Nozzles

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The experiment was carried out in Brazil in 2003 to study the effect of diquat on water hyacinth plants using different nozzles and drop depositions. The dose of diquat used was 960 g a.i. ha^{-1} and the nozzles were TXVK 8, AI 110.02 VS, XR 110.02 VS, and XR 110.03 VS from Spraying System Company. The trial was arranged in a randomized complete block design with four replications. The plots were placed in a little reservoir and presented 1m x 5m. The CO_2 pressurized sprayer was used in the study. Diquat showed an excellent control on water hyacinth independent of the nozzle model; however, the deposition of drops was the best with AI 110.02 VS following by XR 110.03 VS, TXVK 8, and XR 110.02 VS. No residue of diquat was found in the water.

Integrating Triclopyr and a Fungal Pathogen (*Mycoleptodiscus terrestris*) for Control of Eurasian Watermilfoil (*Myriophyllum spicatum*)

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Growth chamber experiments were conducted in 55-L aquaria to evaluate the efficacy of the aquatic herbicide triclopyr and the fungal pathogen *Mycoleptodiscus terrestris* (Gerd.) Ostazeski, applied alone and in combination against Eurasian watermilfoil (*Myriophyllum spicatum* L.). Treatments included 0.15, 0.40, and 1.50 mg L^{-1} triclopyr, 100, 200, and 400 colony forming units (CFU) ml^{-1} *M. terrestris*, combinations of both agents at all rates, and untreated controls. Plants were exposed to all treatments for a 24-hr contact time and plant biomass (shoot and root) was recorded 6 weeks after application. For both triclopyr and *M. terrestris* applied alone, the degree of plant control increased with treatment concentration. Compared with untreated plants, 1.5 mg L^{-1} triclopyr and 400 CFU ml^{-1} *M. terrestris* reduced Eurasian watermilfoil by 100 and 91%, respectively. Lower doses of either agent were less effective and plant recovery was observed from surviving root tissues. Although *M. terrestris* at 100 CFU ml^{-1} did not significantly reduce shoot or root biomass and 0.15 mg L^{-1} triclopyr provided only 56% control of plants, combining both agents at these rates reduced Eurasian watermilfoil >90%. The results demonstrate that integrating low doses of triclopyr (0.15 mg L^{-1}) with an endemic pathogen, *M. terrestris*, can effectively control Eurasian watermilfoil. Lower use rates of triclopyr would minimize impacts to non-target vegetation, reduce application costs, and may allow for product use near potable water intakes. The current maximum contaminant level (MCL) for triclopyr near functioning potable water intakes is 0.4 mg L^{-1}.

What We Did on Our Summer Vacation: A Survey of Invasive Aquatic Plants on the Lower Rio Grande

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The Rio Grande is the second longest river in the U.S., with almost 2000 miles of the river forming an international boundary water between the United States and Mexico. The river has been impounded to create several reservoirs, including Amistad (Del Rio) and Falcon (Zapata County), and both reservoirs have large infestations of hydrilla. Hydrilla as well as water hyacinth has been problematic below Falcon Reservoir for several years and has been implicated as one of the reasons for the Rio Grande's inability to flow to the Gulf. In 2002, hydrilla fragments were observed in plant material collected from the Maverick County Irrigation District trash racks (above Falcon), which pulls water directly from the river. The presence of hydrilla fragments indicated the presence of hydrilla in the river and a 2003 survey became a priority. The 2003 survey was conducted to more thoroughly determine the presence of hydrilla, as well as other invasive aquatic and riparian species. Twenty-one aquatic and riparian plant species were observed during the survey, which was conducted from Amistad to immediately below Falcon reservoirs. Six introduced species were observed including hydrilla, giant cane, elephant-ear, parrotfeather, Eurasian watermilfoil and salt cedar.

Eichhornia crassipes Control with Diquat and its Effects on Some Water Characteristics under Mesocosm Conditions

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Research was conducted to evaluate the possible impact of water hyacinth control using diquat (7.0 L/ha of Reward®) on some water quality parameters under mesocosm conditions (1.86 m of diameter and 0.40 m depth). The experimental treatments were: 1) Mesocosm with the macrophyte control using diquat; 2) Mesocosm with the macrophyte control by freezing; 3) Mesocosm colonized by macrophytes without control; 4) Mesocosm without macrophytes and with diquat spraying on water surface, and 5) Mesocosm without macrophytes and no herbicide spraying. The mesocosms were arranged in a completely randomized block design with four replications. The diquat promoted a complete control of the waterhyacinth, but the mesocosms were re-colonized by *Salvinia herzogii* even in the mesocosms where the *E. crassipes* was killed by freezing. We believe that *S. herzogii* come from spore germination. Waterhyacinth colonization reduced the oxygen content, pH, TDS, and electrical conductivity of the water. After waterhyacinth death, regardless of the weed control technique, electrical conductivity and TDS increased, but the oxygen content remained low due to the quick growth of the *S. herzogii* colonization. Comparing the uncolonized mesocosm with the mesocosm that received diquat sprayed directly on the water surface showed that there was no significant variation in these water parameters, leading to the conclusion that the observed impact in the water quality was related to plant elimination and decomposition.

Aquatic Weed Control with 2,4-D and its Effects on Some Water Characteristics, under Mesocosm Conditions

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This research, conducted under mesocosm conditions, evaluated the effects of macrophyte control by freezing or 2,4-D on some water quality parameters compared to conditions with and without macrophyte colonization. The mesocosms were colonized by *Eichhornia crassipes*, *Pistia stratiotes*, and *Salvinia auriculata*. The mesocosms were arranged in a completely randomized experimental design with four replications. The treatments were: 1) no colonized mesocosms; 2) no colonized mesocosms sprayed with 2,4-D on the water surface; 3) mesocosms colonized by macrophytes without control, 4) mesocosms colonized with macrophyte which were controlled by freezing; and 5) mesocosms colonized by macrophytes, which were controlled using 2,4-D (DMA 806 BR at 8.0 L/ha). The 2,4-D spraying did not affect the water parameters studied even when applied directly on the water surface. The herbicide was selective to *S. auriculata* and promoted its population growth maintaining the cover effects. Covering of the mesocosm by the aquatic weeds reduced the temperature variation and the oxygen contents in the water. In the mesocosm where the aquatic weeds were killed by freezing, there was an initial decreasing of the oxygen content and a permanent increase following days, so that at the end of the evaluation period the water had values similar to the mesocosm without any macrophytes colonization. The residues of 2,4-D decreased in an exponential model, indicating fast dissipation in the aquatic environment.

Physiological Factors Affecting Management of Torpedograss

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Torpedograss (*Panicum repens* (L.) Beauv.), a rhizomatous perennial grass, is a prominent weed in agricultural and non-agricultural areas of 27 countries throughout the world. It was first introduced to the United States in the early 1900's and has since become a major weed in terrestrial, wetland, and aquatic environments. Greenhouse studies from fragmented stem sections to determine individual leaf-node reproductive potential showed torpedograss shoots have the same regenerative capacity as the rhizome tillers. Studies of apical dominance determined no differences between vegetative growth patterns of apical and non-apical torpedograss shoots. However, 2 weeks after shoots were removed from the parent plant, buds formed on a majority of leaf-nodes. Torpedograss and maidencane (*Panicum hemitomon* Schult.), a Florida native, within the greenhouse exhibited the same vegetative reproductive potential. It was also determined that torpedograss preferred to establish growth in shallow standing water rather than well-drained or submersed conditions. In containerized field trials conducted over 1 year's time, torpedograss produced more vegetative growth than maidencane. Seed viability tests resulted in complete failure of seeds to germinate within 28 days.

Endophytic Fungi in Eurasian Watermilfoil Tissues

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The purpose of the study was to identify which tissues and regions of Eurasian watermilfoil plants were most likely to harbor three endophytic fungal species *Mycoleptodiscus terrestris*, *Plectosphaerella cucumerina*, and *Colletotrichum gloeosporioides*. Past research has indicated that at least one or all can be expected to be present in plants collected from the field or from culture tanks. Entire plants were washed to remove debris, surface sterilized, sectioned, and plated incrementally from root tip to inflorescence (if present) onto plates of Martin's agar. The three endophytes were commonly found in stems, leaves, and root crowns but infrequently in roots and inflorescences. Infected leaves were not always associated with sections of stems that were also infected. Presence of one endophyte did not exclude another and although no tissues were found where all three coexisted *P. cucumerina* frequently co-occurred with both *M. terrestris* and *C. gloeosporioides*. In healthy Eurasian watermilfoil plants *M. terrestris*, *P. cucumerina*, and *C. gloeosporioides* exist benignly and asymptomatically and their role in plant tissues is poorly understood. However plants stressed by biotic or abiotic factors may induce them to become pathogenic and contribute to population declines.

Selective Removal of Curlyleaf Pondweed and Eurasian Watermilfoil Using Endothall and 2,4-D Combinations and the Effect on Fish Populations: Preliminary Data

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Early spring applications of endothall in combination with 2,4-D will be used to control both Eurasian watermilfoil (*Myriophyllum spicatum* L.) and curlyleaf pondweed (*Potamogeton crispus* L.). Selectively removing these exotic plants may result in a more diverse and abundant native plant community. A shift from predominately exotic to native plants may alter abundance, size and richness of fish populations. Two treatment and two reference lakes were selected in the vicinity of Minneapolis, MN, USA. Pre-treatment evaluation of littoral plant communities was conducted during June and August 2003 by determining percent occurrence (n = 790) and harvesting shoot biomass (n = 120). Percent occurrence of Eurasian watermilfoil was 62 to 80% and 37 to 75% in June and August, respectively, for all lakes. Percent occurrence of curlyleaf pondweed was 8 to 41% and 0 to 2% in June and August, respectively, for all lakes. Native plants occupied over 60% of all points. These included coontail (*Ceratophyllum demersum* L.), elodea (*Elodea canadensis* Michx.), fragrant waterlily (*Nymphaea odorata* Ait.) and numerous pondweeds (*Potamogeton* spp.). Shoot biomass was greater for coontail than Eurasian watermilfoil or curlyleaf pondweed. Pre-treatment measurement of fish populations was conducted during June and September 2003. Total number of fish collected by night-time sampling with a boat electro-fishing ranged from 345 to 466 in all lakes in June and 244 to 538 in September. Bluegill (*Lepomis macrochirus* Rafinesque) was the most common species comprising 82% of the sample in June and 88% in September. Pop-nets were used to sample the littoral zone (n = 130) where bluegill also was the most common species followed by green sunfish (*Lepomis cyanellus* Rafinesque) and largemouth bass (*Micropterus salmoides* Lacepede). Plant and fish monitoring will continue through a two-year post-treatment period.

Ecological Attributes of Exotic and Native Aquatic Plant Communities

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While the adverse effects of nonindigenous aquatic vegetation on water resources are fairly well known, there are those who favor Eurasian watermilfoil or hydrilla as habitat for fisheries. In many cases, anglers, attempting to safeguard fish populations, have opposed management of problem-level infestations of these plants. Most environmental scientists and resource managers realize that monospecific populations of hydrilla and other nonindigenous species do not provide the best aquatic habitat, but definitive data are lacking. Information on the relative habitat quality of ecosystems based on monospecific populations of nonindigenous species and diverse communities of native species are needed in order to help justify both management of exotic plant species and restoration of native aquatic plant communities. Ponds were planted with exotic or native species, and composition of the developing vegetative communities were assessed at regular intervals over a 2-year period. Each pond was stocked with largemouth bass and bluegill to assess fish survival and growth. Although similar initially, several water quality parameters, including DO, pH, and light intensity (PAR) at near-surface and mid-depth waters diverged as exotic species achieved increasing dominance in their respective ponds. Differences were detected in biotic components measured in each pond, which included periodic assessments of phytoplankton, zooplankton, macroinvertebrates, amphibians, fish, reptiles, and waterfowl. For the most part, overall ecological conditions in ponds dominated by exotic plant species were relatively poor when compared with ponds dominated by native plant species. Differences among the pond ecosystems appeared to be attributable to canopy structure of the vegetation.

Control of Hygrophila in Southern Florida

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Hygrophila (*Hygrophila polysperma* (Roxb.) T. Anderson) is a major, invasive aquatic weed in many canals and other bodies of water in southern Florida. Reinfestation after herbicide treatments occurs rapidly. New plants appear to be produced primarily from vegetative material. Under mist in the greenhouse, stem sections with a single node produced roots and one to three shoots within 2 weeks. More than 90% of all single-node sections produced one shoot with roots. Shoots and roots formed at a rate of greater than 90% on the basal portions of hygrophila leaves held under mist in the greenhouse. Leaves cut into halves, quarters, and eighths produced shoots and roots at the basal portions of the leaf sections but at a lower rate than for entire leaves. Leaves floating on water under outdoor conditions produced fewer shoots and roots as compared to those held under greenhouse conditions. These data indicate a high potential for vegetative production of new plants by hygrophila. Control methods need to remove all plant material to prevent vegetative production of hygrophila plants.

Overview of the U.S. National Early Detection and Rapid Response System for Invasive Plants

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Currently, the U.S. Geological Survey (USGS), Mississippi State University (MSU), and the Invasive Atlas of New England (IPANE) are cooperating with the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW) to develop and implement a National Early Warning and Rapid Response System for Invasive Plants in the United States. Ultimately, the system will be part of an All Taxa Early Detection and Rapid Response System under the National Invasive Species Management Plan. The overall purpose of developing such a system for invasive plants is to provide a coordinated framework of public and private partners to more effectively address new invasive plants through: 1) Early detection and reporting of suspected new plants to appropriate officials; 2) Identification and vouchering of submitted specimens by designated botanists; 3) Verification of suspected new state, regional, and national plant records; 4) Archival of new records in designated regional and national plant databases; 5) Rapid assessment of confirmed new records; and, 6) Rapid response to new records that are determined to be invasive. Beginning in 2004, active partner groups are developing and field testing elements and processes that were identified in the Conceptual Design Plan. Once fully implemented across the nation, the proposed system will provide an important second line of defense against invasive plants that complements federal efforts to prevent unwanted introductions at the ports of entry. With both prevention and early warning systems in place, the nation will be better able to defend against future economic and environmental losses due to "plants out of place."

An Expert System Shell for Identifying Aquatic Plant Species

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One of the growing problems in the world today is the introduction, whether accidentally or purposely, of exotic plant species. Although many of these species have been of some benefit to the environment, certain introductions have had disastrous consequences. Exotic aquatic plants can obstruct navigation, hinder water uptake and access, cause damage to bridges and other structures during flooding, and substantially increase the risk of human health hazards by forming large areas of mosquito breeding habitats. Due to the potential problems caused by these plants, management and control of these exotic species are required. In order to determine the best method of control, the first step is to correctly identify the problem plant. While trained and knowledgeable personnel may use dichotomous keys or other references, non-trained personnel also need a means of identifying problem plant species. For this reason, new and more innovative methods of identification are needed. One such approach that is being utilized more frequently is the use of expert system programming to allow for rapid and more efficient identification of plant and animal species through simulation of how an expert approaches an identification. Toward this goal, an identification expert system shell has been developed and is currently being utilized within several information systems (i.e. PMIS, APIS, ZMIS and EMRIS). This presentation will address the concepts of the design and implementation of this expert system shell.

Session II: Aquatic Plant Management in Florida

Hydrilla Control in the Wakulla River Using an Aquathol Drip System

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South of Tallahassee, Wakulla Springs State Park encompasses 2,860 acres of natural Florida, one of the world's largest springs, and 3 isolated miles of the Wakulla River. In April of 1997, hydrilla was discovered near the park's only boat dock. Despite repeated efforts at physical removal, hydrilla dominated the upper river by the summer of 1998. By 1999, nearly 2,000,000 lb of hydrilla had been mechanically harvested in the park. Biological control was also attempted via the introduction of *Hydrellia pakistanae* in 1999. Hydrilla continued to expand, while applesnails, crawfish, and wildlife declined. The Park Service's initial reluctance to use herbicides gave way to reality. The Bureau of Invasive Plant Management was asked to take care of the problem. Fortunately, successful hydrilla control in the flowing waters of Merritt's Millpond provided the necessary direction. In that 202-acre spring run, hydrilla had been effectively controlled on an annual basis using Aquathol K @ 2 ppm/48 hr via airboat. Meanwhile, AquaTechnex had developed a simple herbicide delivery system. Using a 12-volt pump, manifold, regulating orifices, and 10 hoses, Aquathol K has been evenly applied to the headwaters of the Wakulla River for 48 hr on four occasions. The initial treatment at 4 ppm resulted in a dramatic decline in the hydrilla and the water level of the river. Increased flow velocity scoured organic sediments. Two subsequent Aquathol drip treatments at 2 ppm were successful in controlling hydrilla for 6 months each. The results of the May 2004 treatment at 1.5 ppm will be presented.

Evaluating Herbicide Strategies to Control *Hydrilla verticillata* and Minimize Injury to the Native Plant, *Sagittaria kurziana*

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Sagittaria kurziana Glueck is an important, native submersed plant threatened by the invasion of *Hydrilla verticillata* (L.f.) Royle in Florida spring-fed rivers. The contact herbicide endothall has been successfully used (2 mg L^{-1} for 48 hr) to control *H. verticillata* in Wakulla Springs; however, little is known about the selective potential of this product and other contact herbicides applied alone or in combination, on *S. kurziana*. Growth chamber studies were conducted to evaluate and compare the efficacy and selectivity of endothall, diquat, and endothall + diquat against these two plant species. Herbicide concentration and contact time were varied in each test. Results showed that exposures of 48 hr to either 1.0 mg L^{-1} endothall or 0.185 mg L^{-1} diquat controlled >90% of *H. verticillata* biomass 6 weeks after treatment (WAT). A 48-hr exposure to lower rates of either herbicide applied alone was ineffective for controlling *H. verticillata*, however combining 0.5 mg L^{-1} endothall with 0.09 mg L^{-1} diquat reduced shoot and root biomass by $\geq$96% compared to untreated plants. *S. kurziana* was sensitive to all chemical treatments that were efficacious on *H. verticillata*. Although viable *S. kurziana* root biomass remained following treatment, plant recovery (new shoot growth) was not observed during the course of study. Additional growth chamber and small-scale outdoor experiments are ongoing to determine whether selectivity can be improved by further altering endothall concentration and contact time.

Meeting New Challenges in Controlling Aquatic Plants with Herbicides

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Managers are facing perhaps their greatest challenges entering the 105th year of aquatic plant management in Florida's public waterways. The previous 30 years are characterized by increased cooperation among agencies and expanded research, regulatory, education, and outreach programs. A legislatively mandated philosophy, maintenance control, requires that invasive aquatic plants be controlled at the lowest feasible levels. These strategies, coupled with innovative early detection and rapid response programs, and sufficient funding to support them, have enabled managers to reduce invasive plants, especially water hyacinth and hydrilla to their lowest levels in many years. Two alarming events may now threaten managers' abilities to continue providing cost-effective, selective hydrilla control. Most of Florida's $18 million hydrilla

control budget for public waters is spent in 20-25 waters; among them are some of the largest and most important multiple-use reservoirs in the state. Most large-scale hydrilla control has been achieved during the past 15 years using the systemic herbicide fluridone. In 2000, differing fluridone tolerances were documented among various hydrilla clones found in the state. Managers responded to this challenge by determining hydrilla tolerance within each water before treating, monitoring fluridone levels in treated waters, and testing hydrilla's response to fluridone treatments. Different fluridone formulations were developed to sustain higher concentrations. Since 2002, fluridone half-lives shortened dramatically in a few waters, apparently attributable to enhanced microbial activity, and perhaps triggered by increased fluridone use. Consequently, managers and researchers must act quickly to better understand tolerance and microbial issues and readdress hydrilla management strategies to preserve maintenance control.

Session III: A Special Session on Issues Pertaining to Plant Resistance and Tolerance to Aquatic Herbicides

Aquatic Plants and Herbicide Management: A Special Session to Discuss Resistance, Tolerance, and Environmental Factors that Impact Treatment Efficacy

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The development of plant resistance to herbicides has been well documented in terrestrial agriculture, yet it had been thought that this topic was not particularly relevant to the discipline of aquatic plant management. Recent issues with hydrilla (*Hydrilla verticillata)* and Landoltia (*Landoltia punctata*) developing an increased resistance to registered aquatic compounds, and the recent Section 3 and 24-C aquatic registrations of enzyme-specific ALS compounds suggest that managers need to be aware of ongoing and potential issues regarding plant resistance, and other factors that can impact herbicide efficacy. To address this topic, a special session that focuses on current issues surrounding herbicide resistance in aquatic sites has been organized. This session provides a historical background of resistance development and resistance management practices in terrestrial agriculture as a model. The differences between plant resistance, tolerance, and species shifts due to management practices will also be discussed and related to the aquatic manager. In order to gain a better understanding of what is happening at the physiological and biochemical levels, specific examples of the mechanism of resistance will be presented for compounds such as diquat, fluridone, and glyphosate. These talks will be followed by presentations that focus on the broader operational implications of plant resistance, and current response to ongoing resistance issues. Due to the complexity of aquatic systems, a discussion of various environmental factors that can impact herbicide efficacy will be presented to prevent confusion between environmental variables and true plant tolerance or resistance. Finally, emphasis will be placed on putting the issue of herbicide resistance in aquatic plant management in perspective, with guidance on operational and research needs for the future.

Factors Affecting the Selection of Herbicide-Resistant Weeds

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The selection of herbicide-resistant weed populations began in the late 1960s with the triazine herbicides. Currently there are over 280 herbicide-resistant biotypes worldwide and the number is increasing at an average of nine new biotypes per year. The greatest resistance is to the triazines (65) and ALS inhibitors (83), but there are resistant biotypes to almost all herbicide mechanisms of action, including glyphosate. The common factors that have selected for resistance are: continuous use of the same herbicide mechanism of action for extended periods, lack of other weed management practices and the presence of a genetically diverse weed population. Effective resistance management requires that we reduce our reliance on one herbicide or herbicide mechanism of action by rotating herbicides, using tank mixtures, as well as other weed management practices including mechanical, cultural and biological methods. In order for these systems to be adopted they have to be relatively easy to implement and cost-effective. Strategies need to be put in place to provide answers to resistance problems as they arise and resistance needs to be detected as early as possible, to prevent the rapid spread of resistance.

Herbicide Resistance in Aquatic Plants

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Herbicide resistance is common in many terrestrial cropping systems, even to glyphosate (Roundup™). The Weed Science Society of America defines herbicide resistance as: *"Herbicide resistance is the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type. In a plant, resistance may be naturally occurring or induced by such techniques as genetic engineering or selection of variants produced by tissue culture or mutagenesis."* In contrast, tolerance is defined as: *"Herbicide tolerance is the inherent ability of a species to survive and reproduce after herbicide treatment. This implies that there was no selection or genetic manipulation to make the plant tolerant; it is naturally tolerant."* These definitions are often confused, modified or used incorrectly; and much discussion and debate has surrounded the development of these definitions. The second question that comes to mind is how resistant is resistant? This is also a difficult question to answer, but it basically comes down to rate of application. Most researchers feel that a 10X rate change (i.e., 10 times the rate is required to cause a lethal effect) best qualifies resistance. Another important aspect to remember is that resistance is not caused by the herbicide mutating the plant. Generally, a few plants with pre-existing resistance or a natural mutation are selected by the use of an herbicide. As the susceptible plants are killed, the resistant plants begin to increase. In terrestrial systems, the selection process occurs as the weed population persists from year through the production of seeds. Seed development occurs through sexual reproduction, which results in a mixing of the gene pool. Therefore, a small mutation can be transferred and resistance develops very quickly for some herbicides. In many aquatic weeds, particularly submersed species, the primary spread and persistence mechanisms are through asexual means, which does not result in gene transfer. This also suggests that the genetic makeup of aquatic plants is fairly streamlined, i.e. multiple clones of the same plant. Given these parameters, the development of herbicide resistance in aquatic plants was discounted and thought to be a non-issue. However, herbicide resistance has occurred in aquatics, namely hydrilla to fluridone herbicide. This was unexpected, discredited and questioned for some time, but research has confirmed resistance through a change in the target enzyme. This suggests two things; 1) populations of aquatic plants such as hydrilla are not genetically the same, and 2) the potential for random mutation is much greater than expected. Random mutation from vegetatively propagated horticultural plants occurs frequently, giving rise to such traits as variegation. Hydrilla is also polyploid, meaning the chromosome number is variable within different cells on the same plant. This also suggests a degree of variability that could allow for mutations/pre-existing differences that confer resistance. Given this, it is highly possible that many vegetatively propagated aquatic plants can become resistant to herbicides, particularly if the selection pressure is adequate. Aquatic plant managers and researchers must not discount this phenomenon with hydrilla and fluridone as a one-time event. Variability does exist in aquatic plants and this will lead to herbicide resistance if not properly managed.

The Basis for Fluridone Resistance in *Hydrilla verticillata*

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Hydrilla is considered the most problematic submersed aquatic plant in the United States. In recent years, biotypes with resistance to the herbicide fluridone have been detected in several Florida lakes. We have demonstrated that somatic mutations in the pds gene, encoding for phytoene desaturase, are associated with the herbicide-resistant forms of hydrilla. Constructs for bacterial expression of the wild type and mutated forms of pds, including a histidine tag for protein purification and in vitro testing, were made. Plant expression constructs for the wild type pds and for the three mutations observed in hydrilla were used to transform *Arabidopsis thaliana* via *Agrobacterium*. Mutations associated with fluridone resistance detected in the wild also conferred herbicide resistance in in vitro assays and *Arabidopsis*.

Technical Approaches to Sonar Use in Management of Fluridone-Tolerant Hydrilla

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Since discovery in the late 1990's, fluridone-tolerant hydrilla (FTH) has posed a unique challenge for management of this species in the state of Florida. Multiple strains of FTH with varying levels of tolerance have been identified in different lakes and even within the same waterbody. In the absence of rotation options for large-scale hydrilla control, knowledge of the distribution of various FTH strains and their specific level of tolerance has become critical to proper planning of Sonar treatments. Since 2000, pre-treatment laboratory assays (PlanTESTs) of field-sampled hydrilla have been used to screen for FTH and ascertain fluridone levels that will provide effective control of any detected FTH strains. Post-treatment assays (EffecTESTs) have also been used to determine plant biochemical response to Sonar treatment. The monitoring and analysis conducted in the latter stages of treatments are critical for early detection and rapid response to FTH in a system. With intensive field monitoring and use of pre- and post-treatment assays, the distribution of FTH in most large Florida lakes is being quantified with varying levels of resolution. Related technical challenges associated with FTH management will also be discussed including the scale of monitoring effort on large lakes, management strategies for containment of FTH outbreaks, and sporadic occurrences of enhanced fluridone degradation.

Weed Resistance to Bipyridylium Herbicides and Implications for Aquatic Plant Management

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Diquat (1,1'-ethylene-2,2'-bipyridylium dibromide) is a contact herbicide, first registered for aquatic use in 1961, belonging to the bipyridylium herbicide family and chemically related to the terrestrial herbicide paraquat (1,1'-dimethyl-4,4'-bipyridylium dichloride). Since 1980, there have been 22 terrestrial species with documented resistance to the bipyridylium herbicides in 13 countries, but no aquatic plant species have been suspected of being resistant. However, observations in Florida suggested there might be reduced activity of diquat on aquatic species that historically were effectively managed using diquat. Recently, maximum-labeled rates of diquat failed to provide control of these species. Preliminary trials conducted with accessions of landoltia (*Landoltia punctata)* from this Florida site have shown increased levels of diquat tolerance compared to accessions that have never been exposed to diquat. Landoltia is the first aquatic species documented with developed resistance to diquat, and with its reduced vascular tissue, might be a good candidate to elucidate the exact mechanism of diquat resistance. Research has investigated the potential resistance mechanism, using populations that are mainly paraquat resistant, as resistance after exposure to diquat has occurred less frequently. Discrepancies in the literature regarding the exact mechanism of resistance exist; however, the mechanism appears to be similar for paraquat and diquat. Resistance is not likely due to reduced herbicide uptake, herbicide distribution in the plant, enhanced metabolism or due to an altered site of action in resistant plants. This paper will review the competing hypothesis regarding the mechanism of weed resistance to the bipyridylium herbicides and detail current results using landoltia.

Resistance and the Future of Aquatic Weed Control

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Some 20 years ago, when simazine (Aquazine®) was registered for aquatics, Kevin Murphy from the University of Glasgow, Scotland asked me to work with him on resistance of aquatic plants to herbicides, particularly *Potamogeton* species and triazines. From 1980-1985 we were heavily involved in registration and developing fluridone for hydrilla control, had few pondweeds in Florida, and didn't use much simazine, so I respectfully declined. What's more, hydrilla does not sexually reproduce, so resistance development was not a relevant issue; so I thought! A search of the APIRS (University of Florida) database shows only 54 papers reported on aquatic weeds and resistance. Of these, 80% were written since 2000, and prior to 2000, most covered resistant weeds in rice. Thus, development of resistance to herbicides by aquatic plants in natural areas is the newest impediment to developing further sound, cost-effective aquatic plant management programs. So, does every dark cloud have a silver lining? I hope so, but following this session, so timely organized by Dr. Netherland, it's going to be a challenge for the most optimistic of us. As a great philosopher has stated, it's a lot easier to be a pessimist than an optimist, but let's take the high road. From 1985 to 2000, no new herbicides were registered for aquatic use. The industry managed pretty well with six products, copper, 2,4-D, diquat, endothall, glyphosate and fluridone. With the exception of Florida, and even in most areas of Florida (except for hydrilla), we can handle existing problems. So documented resistance in aquatic plant management remains nationally a minor problem, but admittedly with a large potential. From 2000 to present, four "new aquatic" products have been registered or granted 24C labels (imazapyr, triclopyr, carfentrazone and metsulfuron-methyl). In addition, industry has responded to our pleas for help and new products, as well as some old ones, are being re-examined for possible registration. The issue of the environmental impacts of invasive species is becoming well known to the public, state legislatures, Congress and the regulatory agencies. We have to maintain this process. While I doubt we will find a "silver bullet," at least the timing is right to roll up our sleeves and develop technologies required to continue to protect our aquatic and wetland systems from degradation and associated negative economic impacts of unchecked growth of invasive species. This requires close cooperation of industry, academic and government scientists, and regulatory agencies. It will take time and money, and decisions based upon sound science.

Session IV: Aquatic Resource Management and Invasive Species Control

Dissipation and Target-Plant Uptake of Copper Following Applications of Komeen in the Sacramento-San Joaquin Delta

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Expanding populations of *Egeria densa* in the Sacramento-San Joaquin Delta interfere with beneficial uses and ecosystem services, including commercial and recreational vessel traffic, fishing, irrigation water withdrawal, and fish and waterfowl habitat. Diurnal tidal fluctuations can produce limited herbicide contact time due to rapid dilution and transport. Chronically high turbidity also restricts optimal uses of herbicides such as diquat. Since Komeen (chelated copper) has shown excellent efficacy against *E. densa*, we examined the fate of copper during mid- to late summer applications in two ca. 25-acre sites in 2002 and 2003 (total of four applications). Peak copper levels in water (ca. 0.25 to 0.75 ppm) occurred ca. 2 hr post-treatment, and typically fell to pretreatment (baseline) level within 48 hr after applications. The peak copper levels in *E. densa* shoots occurred 24-48 hr post-treatment (ca. 100 to 400 ppm), or approximately 26-28 hr after the maximum level in the water column were attained. Tidal movement resulted in transport of copper in the water column from 0.1 to 0.5 miles beyond the treated plot, which resulted in lesser uptake in *E. densa* in these areas (ca. 10% to 25% of the levels in plants within the treated plot). Differential analysis of filtered water indicated that most copper within treated plots was soluble, whereas a larger proportion of copper was associated with particulate matter in areas outside the plots. Total copper levels in the upper 10 cm of bottom sediment were extremely variable (from 4 to 143 ppm) and showed no correlation with treatments inside or adjacent to the plots in samples taken bi-weekly for 114-119 DAT. These data suggest that even with tidal flows, relatively localized effects on *E. densa* can be achieved.

Designing Control Agents for Flowing Waters: A Modest Proposal

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Treating benthic nuisance aquatic plants in flowing water is a truly significant challenge to water managers. This presentation examines some approaches that have been used in Florida including the "Sulfuric Acid Knife" and the use of herbicide-laced polymers. The present investigation is concerned with the potential use of supported agents containing the copper ion that have densities that would allow bottom placement and slow release of the copper ion. The general formulation is Solid-A-Y-Z where the solid is a clay or silica gel, A is an attachment group, Y is a spacer group, and Z is a coordinating (or chelating) agent. Successful methods of synthesis include: 1) the "corkscrew method" (A is a long chain hydrocarbon, the solid is silica gel); 2) ionic (A is a charged species, the solid is an ion-exchange resin); and 3) covalent attachment (A is -O-; pat. pending). Each of the approaches has been successfully used to form the appropriate copper compounds so that a range of materials is available. In addition, the potential for the use of floating materials is under study. The implications and potential of these compounds will be considered.

Does the Water Hyacinth Weevil *(Neochetina bruchi)* Respond to Changes in Host Plant Leaf Tissue Quality in Sacramento-San Joaquin Delta Populations?

Jason K. Brennan and **Lars W. J. Anderson**
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The water hyacinth weevil *Neochetina bruchi* was introduced into the Sacramento-San Joaquin Delta almost 20 years ago, but impacts are limited even though feeding by adults and larvae is fairly widespread. Host plant quality is known to affect herbivory in such floating plants as *Salvinia molesta*. In order to determine if *N. bruchi* responds to petiole quality at this site, we began a three-year study to examine the influence of slow-release nutrient amendments on petiole quality (CHN) in replicated, 3.3- by 3.3-meter PVC quadrats (i.e., 10 m^2) in Seven Mile Slough (June 2003). Amendment treatments were: background (no amendments), 900 g (total) and 2700 g (total) of Osmocote in nine evenly spaced mesh bags per quadrat. Two weeks after establishing water hyacinth in quadrats, 300 *N. bruchi* adults were introduced into half the quadrats (12). Biomonthly measurements included plant growth characteristics and sampling for petiole CHN analysis, and feeding frequency. Plants were also sampled at the end of the growing season for presence of larvae, eggs, adults, and adult feeding scars. After the first season (2003), a slight trend was observed toward increased numbers of weevils on leaves of plants growing within the quadrats containing slow-release nutrients and petiole N levels were slightly elevated during the second

month after release of fertilizer. However, no significant differences in biomass were observed. Lamina growth appeared to be slightly higher in nutrient-amended quadrats, but differences were small. In year two (2004), insects were released earlier and levels and dispersion of fertilizer were increased. This study will be continued through 2005 with new initial introductions of plants.

The Reward Rapid Release™ Test: A Summary Update for 2004

James F. Brady[1] and **James Petta**[2]
[1] Syngenta Crop Protection, Inc., Greensboro, NC
[2] Syngenta Crop Protection, Inc., New Braunfels, TX

The limitation in aquatic herbicides and the proliferation of aquatic invasive weed species has created the need for improved technology in herbicide use and water quality. In order to assist water resource managers, Syngenta has developed a new fast-acting test to facilitate the use and release of diquat-treated water (the Reward Rapid Release™ test). It is based on an immunochromatographic test strip developed by Syngenta for use in water management systems. The test strip utilizes diquat antibodies to detect low levels of diquat in water. The strips were field tested in 2003 and 2004 and found to be highly accurate and user friendly. These results will be discussed.

Carbohydrate and Nutrient Content of *Egeria densa* in Oregon and California *(Student Presentation)*

Toni G. Pennington and Mark D. Sytsma
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The submersed macrophyte *Egeria densa* (Brazilian elodea) is native to South American and has become widely naturalized and highly invasive in waterways outside its native range and disturbed habitats within its native range. In the western U.S., *E. densa* is one of the most problematic macrophytes, disrupting navigation and altering water quality. To enhance the understanding of the life history of *E. densa* in the western U.S., and thereby improve efficacy of control measures, seasonal changes in total nonstructural carbohydrate (TNC) and nutrient content were examined. Plants were collected monthly in 2002 and 2003 from a drinking water supply reservoir in Newport, Oregon, USA. Plants were separated into upper (first 15 cm from tip) and lower stems (first 15 cm above root crown), root crowns, roots, and flowers, followed by analysis for TNC, carbon, and nitrogen. On average, percent TNC was lowest in roots (8%) and highest in root crowns (13%) and lower stems (11%). Lower stems generally contained a higher percentage of TNC than upper stems (9%); however, in May and June of each year, little difference was observed between them. Percent C was greater in upper stems and flowers (38% and 39%, respectively) compared to lower stems (33%). Percent N in photosynthetic tissues averaged 4% N (upper stems) while roots and root crowns contained slightly less than 3% N. To determine plant growth rate, plants were tagged with plastic electrical ties and the distance from tag to tip was measured before and after approximately three weeks. Growth rate was highest when the mean water temperature was 16ºC and comparatively lower around 7ºC and 20ºC, indicating a lower tolerance for increased temperature than plants collected in the southeastern U.S. Similar research on carbohydrate and nutrient content, photosynthetic rate, and growth rate is currently being conducted on plants collected from the Sacramento-San Joaquin Delta of California.

Effects of Preexisting Submersed Macrophytes on the Invasion Success of *Hydrilla verticillata*: Is Native Plant Restoration an Effective Biological Management Technique? *(Student Presentation)*

Todd Chadwell and Kathatina Englehardt
University of Maryland Center for Environmental Science, Appalachian Laboratory, Frostburg, MD

In some cases, plants that arrive first have a competitive advantage over later arrivals and inhibit subsequent colonizations. In other cases, early arrivals may facilitate the colonization of other species. We chose to evaluate 1) the effects of the native species *Vallisneria americana* on the colonization success of *Hydrilla verticillata* through field and greenhouse experiments, and 2) the effects of increasing *H. verticillata* propagule density on colonization success. Results of the field study, located in a tidal freshwater estuary of Chesapeake Bay, show no significant pre-existing native vegetation effects on the colonization success of *H. verticillata*. However, pre-existing *H. verticillata* biomass and *H. verticillata* colonization success were strongly related. Results from the greenhouse study showed that *V. americana* had a strong inhibitory effect on *H. verticillata* colonization by fragments. Increasing *H. verticillata* fragment density did not alter colonization success. Reduced water column nutrients decreased successful rooting and subsequent colonization by *H. verticillata*. These observations suggest that large-scale plantings of native macrophytes such as *V. americana* could potentially reduce

H. verticillata colonization success in some situations. Additionally, the threat of colonization by *H. verticillata* fragments may be reduced in areas of low nutrient availability, suggesting mechanical weed removal may be a feasible management strategy at some *H. verticillata* infested sites.

SP-1019: A Potential New Herbicide for Large-Scale Aquatic Plant Management

Mark A. Heilman[1] and David P. Tarver[2]
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SP-1019 is a new chemistry being developed by SePRO Corporation for large-scale control of a variety of problem aquatic species, including *Hydrilla verticillata*. The active ingredient in SP-1019 is penoxsulam. With an extremely favorable and complete toxicological profile and slow mode of action, SP-1019 will have some of the same key use characteristics as Sonar Aquatic Herbicide (fluridone). As an alternative mode of action, SP-1019 will represent an excellent complement to Sonar for large-scale integrated control programs designed for resistance management. The overall use profile of SP-1019 for hydrilla control will be highlighted.

Lepomis spp. Facilitate Invasion Success of *Myriophyllum spicatum (Student Presentation)*

Paul H. Lord
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The recreationally impeding, exotic aquatic macrophyte Eurasian watermilfoil *Myriophyllum spicatum* (L.) has been the target of control attempts in North America using physical, chemical, and biological methods. Much recent focus has been on the use of the latter, particularly the use of herbivorous insects. This work describes an attempt to augment existing populations of a milfoil herbivore considered to have Eurasian watermilfoil control potential in North America, an aquatic macrophyte moth *Acentria ephemerella* (Denis and Schiffermüller), and follow-up work monitoring insect herbivores of Eurasian watermilfoil, plant community structure, and fish community structure in nine central New York lakes. Results show poor recruitment of the aquatic macrophyte moth after emergence of the initially introduced larvae with no significant control of Eurasian watermilfoil. Fish predation on the aquatic macrophyte moth was suspected to be responsible, leading to another season's work contrasting populations of fish, Eurasian watermilfoil, and milfoil herbivores found in Otsego Lake, a lake with controlled Eurasian watermilfoil, with those same communities found in the moth augmentation site, Lebanon Reservoir. Bluegill *Lepomis macrochirus* (Rafinesque) was identified as the most likely controlling predator on milfoil herbivores. A final season's work contrasted those same communities in eight Madison County, NY lakes with varying degrees of dominance by Eurasian watermilfoil. Results indicate that bluegill and pumpkinseed *L. gibbosus* (L.) are effective controls on the aquatic macrophyte moth while substantial walleye *Sander vitreus* (Mitchill) populations may limit sunfish populations, permitting aquatic macrophyte moth insect herbivore densities to expand.

Effects of Nitrogen Limitation on Turion and Tuber Production of *Hydrilla verticillata* (L.f.) Royle

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Hydrilla verticillata is an invasive aquatic plant that can utilize either CO_2 or bicarbonate as a carbon source for photosynthesis. Under fertile conditions, hydrilla has a high demand for inorganic carbon and has been shown to cause depletion of inorganic carbon from solution. Under high rates of inorganic carbon supply, hydrilla has been shown to deplete sediment nitrogen supplies, resulting in growth limitation by this element. This study examined the effects of high alkalinity (maintained by increasing CO_2 supply) on the growth, mineral nutrition, and tuber and turion production of hydrilla. Hydrilla grown in high alkalinity tanks produced significantly more aboveground biomass as compared to hydrilla grown under low alkalinity conditions. Increased growth caused an increased demand for nitrogen that could not be met by sedimentary nitrogen, resulting in N-limited growth of hydrilla. These N-limited plants produced approximately twice as much total biomass and three times as many turions as did the plants grown under low alkalinity conditions. Increased turion production was preceded by an approximate 2.8-fold increase in shoot total nonstructural carbohydrate concentration. It is hypothesized that, under nitrogen-limiting conditions, shoot TNC concentrations increase, providing increased photosynthate for turion production. Production of additional turions for dispersal would confer advantages to plants growing under nitrogen-limiting conditions.

Evaluation of the Potential to Selectively Control Eurasian Watermilfoil with Low Rates of Fluridone Herbicide in Minnesota

Wendy Crowell, **Chip Welling**, and Nick Proulx
Minnesota Department of Natural Resources, Division of Ecological Services, Saint Paul, MN

In 2000, new information from Michigan suggested that application of fluridone at low rates of about 5 ppb might provide more selective control of Eurasian watermilfoil than had previously been observed in Minnesota. Consequently, the Minnesota Department of Natural Resources (MnDNR) decided to evaluate the potential to use fluridone at rates of 4 to 5 ppb to control Eurasian watermilfoil without causing unacceptable harm to non-target native plant species or a decrease in water clarity. In 2001, the MnDNR selected six study lakes; three that were treated with fluridone in 2002 and three that were untreated reference lakes. The six lakes were monitored from 2001-2003. Treatment with fluridone reduced the frequency of Eurasian watermilfoil to zero. Treatment also reduced the biomass of native submersed plants by an average of 94%. Following treatment with fluridone, the frequency of curly-leaf pondweed increased. Treatment with fluridone did not reduce the distribution or abundance of waterlilies. Following treatment with fluridone and resulting lake-wide reductions in the distribution and abundance of submersed plants, Secchi depth in one of the lakes decreased by half during the year after treatment in comparison to the preceding year.

Aquatic Adjuvants and Their Impact on Efficacy

Lucia G. I. Marshall and Richard L. Lowe
Trans America Product Technology, Inc., St. Charles, MO

Adjuvants can improve the performance of aquatic herbicidal applications by various modes of action. Traditional adjuvants have been designed for herbicidal use as surfactants, crop oil concentrates, and spreader/stickers for wetting, spreading, cuticle penetration, polymerization, defoaming, drift control and compatibility. Unfortunately, some of these adjuvants have properties that can minimize the transport of the herbicide to its target. New patented microsponge technology, called Biocar®, derived from grain by-products, is currently being used in the adjuvant TopFilm™ for absorption of herbicide and adherence of treatments preventing wash-off due to rain and irrigation. The Biocar® microsponge system in TopFilm™ adjuvant attaches the herbicide to the foliage and protects treatments from being further washed away by rains and by water drifts from airboat turn-around procedures. Data with the new adjuvant is showing maximized performance of aquatic herbicide through rainfastness. More information: www.top-film.com.

Session V: Invasive Species Issues in Aquatic Habitat Management

Is Eradication of Hydrilla Achievable in New Zealand?

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Hydrilla verticillata (L.f) Royle is currently restricted to four lakes in a geographically isolated region of New Zealand. Prevention of spread to other sites is seen as a high priority by management agencies, with eradication the most desirable outcome. Eradication of several aquatic weed species including *Pistia stratiotes* L. and *Nymphoides peltata* (Gmel.) Kuntze has been achieved nationally in New Zealand, and programs to eradicate *Salvinia molesta* Mitchell, *Eichhornia crassipes* (Solms.) Mart. and *Phragmites australis* Cav. are progressing well. Several submerged species, including *Egeria densa* Planch., *Lagarosiphon major* (Ridley) Moss and *Elodea canadensis* Mich., have been successfully eradicated from some water bodies, but to date eradication of hydrilla has not been achieved although management for this outcome was initiated in 1988. Problems encountered relate to the biology of the plant (e.g., production of subterranean turions (tubers), which remained viable for approximately 10 years after removal of weed beds), poor efficacy of available herbicides and lack of community acceptance for parts of the program. Control techniques including the use of sterile grass carp (*Ctenopharyngodon idella* (Val.)), endothall (Aquathol K), bottom-lining and the removal of obstructions to fish browsing are discussed as methods in a program to achieve eradication. Should this not eventuate, biomass and extent of hydrilla would be reduced to such a level that further spread within New Zealand is extremely unlikely.

Continuing Investigations on Invasive Aquatic Vegetation, Cyanobacteria, and Avian Myelinopathy (AVM)

Susan B. Wilde[1], Sarah E. Habrun[1], Jason Kempton[1], Alan J. Lewitus[1], Thomas M. Murphy[2], Charlotte P. Hope[2], Anna Birrenkott[3], Faith Wylie[3], and William W. Bowerman[3]
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Field surveys and feeding studies implicate invasive aquatic plants and an associated epiphytic cyanobacteria species in an emerging avian disease to herbivorous waterfowl and their avian predators. The disease, Avian Vacuolar Myelinopathy (AVM), was first noted in 1994 and has been the cause of death for > 90 American bald eagles (*Haliaeetus leucocephalus*) and thousands of American coots (*Fulica americana*) and other waterfowl. The disease causes neurological dysfunction in the birds prior to death but no known neurotoxins or disease agents have been detected at the sites or within the birds. It is proposed that the agent for the disease is a neurotoxin produced by a novel cyanobacterial epiphyte of the order Stigonematales. This undescribed species covers up to 95% of the surface area of the leaves of the invasive aquatic weed hydrilla (*Hydrilla verticillata*) in the reservoirs associated with the disease. The disease was induced experimentally in laboratory feeding trials and a sentinel study using naturally occurring blooms of the cyanobacteria on hydrilla leaves and farm-raised mallard ducks (*Anas platyrhynchos*). Toxin testing of the hydrilla and associated epiphytic cyanobacteria has been initiated using cell line bioassays. Identity of the toxin agent is critical to determining the potential role the expanding distribution of hydrilla/cyanobacteria plays in spreading the disease.

Investigation of a Novel Cyanobacteria Linked to Avian Vacuolar Myelinopathy *(Student Presentation)*

Sarah Habrun[1], Susan Wilde[2], Jason Kempton[3], and Alan J. Lewitus[2]
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[3] *South Carolina Department of Natural Resources, Marine Resources Research Institute, Charleston, SC*

Reservoir surveys were conducted to investigate exotic macrophytes (e.g., *Hydrilla verticillata*) as a substrate for the growth of toxic cyanobacteria that may be associated with the incidence of a fatal bird disease, Avian Vacuolar Myelinopathy (AVM). While the specific cause of the disease has not been confirmed, the most probable hypothesis is that birds ingest a neurotoxin produced by epiphytic cyanobacteria. A strong relationship exists between the field abundance of a specific

undescribed epiphytic cyanobacterium and the incidence of the disease. 16S rRNA sequence identity was determined from environmental isolates of this unknown Stigonematalan species using DGGE (denaturing gradient gel electrophoresis). 16S rRNA sequence data have been aligned with additional cyanobacteria sequences to determine designations for probe development, and will be used to determine phylogeny and formally describe this species. Real-time PCR and fluorescent *in situ* hybridization assays have been developed for the rapid, specific detection of Stigonematales species from environmental samples. AVM has already adversely affected local breeding populations of American bald eagles (*Haliaeetus leucocephalus*) and has the potential to spread with new invasions of exotic aquatic macrophytes.

Physiological Aspects of Fluridone Resistance in Hydrilla *(Student Presentation)*

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Management of the invasive aquatic plant hydrilla (*Hydrilla verticillata*) in Florida relies heavily on the use of fluridone herbicide. Hydrilla is usually controlled (since 1980) for a year or longer by single applications of fluridone at 6-12 parts per billion (ppb) at a cost of usually less than $100/acre. Fluridone disrupts the carotenoid biosynthetic pathway by non-competitive inhibition of enzyme phytoene desaturase (PDS) and results in bleached (white) tissue. Only the dioceous form of hydrilla is found in Florida, with spread and reproduction limited to asexual means (subterranean turions, axillary turions, fragments, root crowns). Therefore, the development of resistance to herbicides was not expected. However, in recent years, there are hydrilla populations in some Florida lakes not being controlled at doses greater than 30 ppb. Investigating this unexplained phenomenon of fluridone resistance is the main objective of this research. Experiments were conducted under laboratory and greenhouse conditions to monitor changes in pigment levels (phytoene and β-carotene) as a function of population and fluridone treatment. Herbicides with similar modes of action as fluridone were also included. Phenotypic studies were also performed to assess differences in biomass and turion development. Significantly higher β-carotene content was observed in all resistant hydrilla populations compared to susceptible. However, there was a high degree of variability in phytoene content in susceptible and resistant hydrilla populations with respect to fluridone and other herbicides. In addition, there was little correlation between resistant/susceptible populations and turion development and plant biomass. Research is ongoing to further characterize fluridone resistant hydrilla in Florida.

A Comprehensive APM Web Site for the General Public

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

Florida aquatic plant managers fight more than 20 non-native aquatic weeds, spending more than $70 million annually (not including private expenditures). This is high-profile work – most of the state's 8,000 lakes, 1,700 rivers and thousands of miles of canals have houses on the shorelines and millions of swimmers, boaters and fisherman enjoying the subtropical waters. Florida's water users are highly aware of herbicidal and mechanical control activities year-round. Residents and tourists constantly ask questions and call to task APM field workers and office managers of the state's more than 100 public agencies that perform APM activities. APM workers themselves experience a 25% annual turnover. This represents a problem. From the beginning, APM workers have needed a constant and reliable source of training and information for themselves and for their public. With the Internet, this is now possible. The University of Florida Center for Aquatic and Invasive Plants and the Department of Environmental Protection Bureau of Invasive Plant Management have collaborated in the two-year creation of a 500+ page web site (plus 2,000 pictures) that addresses more than 400 APM topics that are of interest to Florida's public. This meeting is the official unveiling of this web site: **http://plants.ifas.ufl.edu/guide.**

Triploid Grass Carp: Practical Principles for Successful Use

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Florida Wildlife Commission (Retired), Apopka, FL

Often the success or failure of triploid grass carp in controling an aquatic weed problem depends on the attention given to common sense matters. Barrier construction and maintenance have been a problem since the first stocking near Live Oak in 1974. Although barriers are not always required for permit approval, an evaluation by an experienced professional is better than a "stock and hope" approach. Most sites can be properly prepared on the initial inspection and ready for permit approval and stocking, even if barriers are needed. Escape is seldom limited to an individual fish. When one finds an opening the others quickly follow. In addition other issues are discussed: 1) need for other control measures; 2) stocking size and growth issues; 3) time of stocking; 4) obtaining fish, checking on dealers; and 5) what to do and not do after stocking and other issues that may affect desired results.

Biological Control of *Melaleuca quinquenervia* in South Florida

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Melaleuca (*Melaleuca quinquenervia*) is spreading rapidly in the Everglades and other natural ecosystems in south Florida. Comparative studies of melaleuca in Florida and in its native Australia indicated much higher regenerative capacity in the U.S. Reproductive allocation was 15-fold higher in Florida (7.3%) than in Australia (0.5%). Presently, the melaleuca biological control program in Florida consists of two agents, the melaleuca weevil (*Oxyops vitiosa*) released in 1997, and the melaleuca psyllid (*Boreioglycaspis melaleucae*) in 2002. Additionally, a rust fungus, *Puccinia psidii*, was discovered on melaleuca in 1996. These biological control agents prefer healthy new growth of melaleuca, and cause substantial damage to trees of all ages. Comparing data of stand structure before (1996) and after (2003) insect release indicated over 70% defoliation and 83% mortality of melaleuca saplings in Broward County. This high mortality of juvenile trees directly interferes with natural regeneration of melaleuca stands at the release sites.

The Lower Rio Grande and Lake Austin: Texas Hot Spots with Special Problems

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The lower Rio Grande is a major source of water for agriculture as well as municipal use along the South Texas border with Mexico. In the late 1990's water hyacinth and hydrilla infestations began to interfere with the free flow of water downstream to needed areas. At times the Mexican city of Matamoras was unable to get adequate drinking water, and the mouth of the river closed. Bi-national jurisdiction made the use of herbicides difficult and mechanical techniques were the primary form of vegetation management from 1998-2003. The additional use of triploid grass carp and herbicides in 2003, as well as cooperative weather has drastically reduced exotic plant infestations in the river. Lake Austin is a 1609-acre main channel impoundment on the lower Colorado River in Austin, Texas. Hydrilla was discovered in the lake in 1999 and by 2002 had spread to cover approximately 320 acres of the lake. Herbicide use has been problematic since the lake provides drinking water for the City of Austin. Additionally, various groups have had concerns about possible fragmentation and re-growth caused by mechanical harvest, as well as the cost, and Texas Parks and Wildlife Department had concerns about escapement if triploid grass carp were used. However, two radio-tracking studies have indicated triploid grass carp may not leave the lake, even during flood conditions.

The Southeast North Carolina Giant Salvinia Task Force

C. Wayne Batten
County Cooperative Extension Director, Pender County, North Carolina Cooperative Extension Service, Burgaw, NC

The Southeast North Carolina Giant Salvinia Task Force was formed to implement a control and eradication program against Giant Salvinia, *Salvinia molesta*, from the waters of Southeastern North Carolina. This invasive aquatic fern currently infests over 40 acres of swamp land and ponds in Pender, Onslow and New Hanover Counties. The Task Force has secured grants and is currently treating infested sites and surveying surrounding areas to determine if the weed has spread. Treatment options and application techniques are being studied to best manage the weed.

Environmental Conditions Influencing the Growth of *Salvinia molesta* in North Carolina

Steve T. Hoyle[1] and C. Wayne Batten[2]
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[2] *County Cooperative Extension Director, Pender County, North Carolina Cooperative Extension Service, Burgaw, NC*

Giant salvinia (*Salvinia molesta*) has survived for at least 5 years in a swampy area and adjacent canals in Pender County, North Carolina. (≈34 36' 46.8"N) This is a site of the largest infestation found to date in North Carolina. Following several colder than normal years, *Salvinia* has continued to expand its coverage in this area. In an effort to more accurately determine the potential range of *Salvinia* in the United States, air and water temperature, water flow, and water quality are being measured at this site. Current literature suggests that *Salvinia* may survive a light freeze or frost event (air temperature measurements at the NC location have been recorded as low as –3° C). During the winter of 2003, *Salvinia* survived in an ice-covered area of the canal.

Weeds in Waiting? - Experimental Assessment of the Competitive Risk Posed by Alien Aquatic Plants

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New Zealand is an island nation, with a wealth of lakes and rivers that are increasingly under threat from invasive alien species. Historical invasions of alien aquatic plants have resulted in relatively few water bodies retaining their natural or original indigenous aquatic vegetation. Increasingly indigenous biodiversity, and amenity values are under threat from the spread of known aquatic weeds; however, as yet undetermined threats may also be present from alien aquatic plants that are in New Zealand, but are not naturalized (i.e., plants that are in containment that have not formed self-perpetuating populations in the wild). Some of these alien species or weeds in waiting (e.g., *Cabomba caroliniana* and *Hygrophila polysperma*) are widely distributed through the aquarium and pond plant trade. To assess the competitiveness and invasive risk posed in New Zealand, experimental evaluation of alien plants with known aquatic weeds and desirable native aquatic plant species was undertaken. This paper reports on the findings of those studies.

Land Hydrilla, a.k.a. Old World Climbing Fern (*Lygodium microphyllum*)

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Old world climbing fern, native to Africa and Australia, is a newcomer to Florida that has spread at an alarming rate and devastates native plant communities reminiscent of hydrilla, only in wetland and terrestrial habitats. The first record of old world climbing fern in florida was collected at a Delray Beach nursery in 1958. In 1999, dense infestation of the fern totaled over 100,000 acres of Everglade tree island, Pineland, wetland marsh, and cypress marsh habitats. The fern climbs high into the tree canopy where it can kill mature trees along with their associated epiphytic orchids and bromeliads, smothers understory vegetation, and alters fire ecology.

Implications of Herbicide Applications for *Lygodium microphyllum* on Restoration of Floodplain Wetlands

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Invasion of the channelized Kissimmee River (central Florida, USA) by *Lygodium microphyllum* poses a potential threat to the success of a federally authorized plan to restore the ecological integrity of this subtropical river/floodplain ecosystem. Accordingly, herbicide applications have been employed to treat *Lygodium* infestations on the floodplain. The effectiveness of aerial applications of glyphosate on cover of *Lygodium* and non-target plant species was evaluated in five 100-m^2 plots that were treated in January 2003. Data collected one year after treatments indicate that *Lygodium* was eliminated from four plots and exhibited only minor regrowth in the other plot. The effectiveness of these treatments may be attributable to continuous inundation, which likely sustained unfavorable conditions for reestablishment of sporophytes and gametophytes. Treated plots showed increased plant species richness and diversity relative to baseline (pre-treatment) characteristics, which suggests that use of glyphosate to control *Lygodium* will not interfere with restoration of the floodplain plant community. Post-treatment plant species composition of treated plots will be compared to plant community structure of nearby untreated sites.