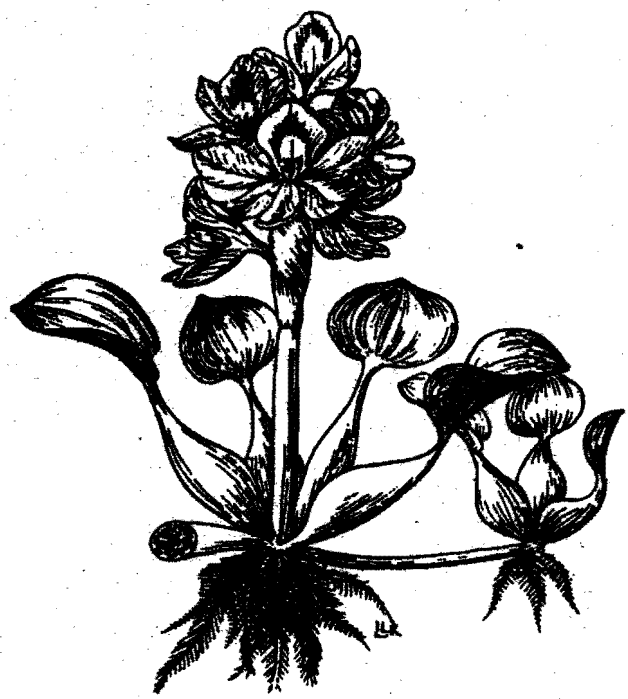
The Aquatic Plant Management Society, Inc.

43rd Annual Meeting

A Lobster in Every Pot

PROGRAM



Holiday Inn by the Bay Hotel and Convention Center
Portland, Maine
July 20-23, 2003

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APMS Officers

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Exhibits	Joe Bondra
Finance	Richard Hinterman
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Membership	Gerald Adrian
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Past President's Advisory	David Tarver
Program	Ken Manuel
Publications	David Sutton
Regional Chapters	Eric Barkemeyer
Scholastic Endowment	Greg Reynolds
Site Selection	Robert Gunkel
Student Affairs	Mike Netherland
Web Site	Mike Grodowitz and Dave Petty
BASS Representative	Michael Masser
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NALMS Representative	R. Michael Smart
RISE Representative	Terry McNabb
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Meeting Sponsors

Thank you to the following for their financial support. Through the generosity of their contribution, we are able to conduct a successful and enjoyable meeting.

U.S. Army Engineer R&D Center
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Scholastic Endowment Sponsors

Thank you to the following for their support. Through the generosity of their contribution, we are able to conduct a successful and enjoyable meeting.

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Dow AgroSciences
Indianapolis, Indiana

Resource Management
Bellingham, Washington

Syngenta Professional Products
Greensboro, North Carolina

General Information

Meeting Registration Desk
The Meeting Registration Desk will be located in the lobby of the Holiday Inn by the Bay. For specific times, please see the daily agenda 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 the Board Room of the Holiday Inn by the Bay 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 agenda pages in this program.

Sustaining Members and Exhibitors
Exhibits will be open for viewing from 8:00 a.m., Monday to 12:00 p.m., Wednesday in the Vermont, Connecticut, and Rhode Island Rooms of the Holiday Inn by the Bay. The following will be exhibiting their products and services.

Applied Biochemists
Milwaukee, Wisconsin

Aqua Solutions / Master's Dredging
Lawrence, Kansas

Aquatic Control, Inc.
Seymour, Indiana

Becker Underwood
Ames, Iowa

BioSafe Systems
Glastonbury, Connecticut

BioSonics, Inc.
Seattle, Washington

Brewer International
Vero Beach, Florida

Cerexagri, Inc.
Philadelphia, Pennsylvania

Cygnet Enterprises, Inc.
Flint, Michigan

Dow AgroSciences
Indianapolis, Indiana

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Hydrolab
Stoughton, Massachusetts

Lake Restoration
Rogers, Minnesota

ReMetrix LLC
Carmel, Indiana

SePRO Corporation
Carmel, Indiana

SonicSolutions LLC
West Hatfield, Massachusetts

Syngenta Professional Products
Greensboro, North Carolina

UAP Timberland LLC
Memphis, Tennessee

Poster Session
The poster session will be open for viewing from 8:00 a.m., Monday to 12:00 p.m., Wednesday in the Vermont, Connecticut, and Rhode Island Rooms of the Holiday Inn by the Bay. Presenters will be in attendance during scheduled refreshment breaks.

Special Events
President's Reception, Sunday, July 20, 7:00 p.m. – 9:00 p.m., New Hampshire and Massachusetts Rooms, Holiday Inn by the Bay. 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 21, 9:00 a.m. – 3:00 p.m., meet in Lobby, Holiday Inn by the Bay. The APMS cordially invites all registered guests to the Guest Tour and Luncheon, graciously sponsored by Applied Biochemists. Major points of interest and beautiful sights of the Portland area will be highlighted during the guided tour. The tour will include stops at the Portland Head Light, Spring Point Light, and Portland Museum of Art. Lunch will be served at DiMillo's Floating Restaurant. The Guest Tour is open to all registered guests (spouse, partner, or child over 12 years of age). Non-registered guests may purchase tickets at the Meeting Registration Desk on Sunday afternoon.

Regional Chapters Presidents' Breakfast, Tuesday, July 22, 6:30 a.m. – 8:00 a.m., Oxford and Somerset Rooms, Holiday Inn by the Bay. Two representatives from each APMS regional chapter are invited to attend this breakfast. Eric Barkemeyer, 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 Breakfast, Tuesday, July 22, 6:30 a.m. – 8:00 a.m., York Room, Holiday Inn by the Bay. Past Presidents of the APMS are invited to attend this breakfast. David Tarver, Immediate Past President, will be the moderator for discussions on affairs of the Society. Please contact Bob Gunkel or David Tarver on Monday and confirm your attendance.

Banquet, Tuesday, July 22, 5:30 p.m. – 10:00 p.m., meet in Lobby, Holiday Inn by the Bay, board buses from 5:30 p.m. to 5:45 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. We have arranged for a traditional New England clambake, featuring award-winning clam chowder, steamer clams and cultivated mussels, and Maine lobster caught by local fishermen. Barbequed chicken will be offered as an alternative to lobster and a children's menu will also be available. In addition to great food, the evening will include live entertainment and a lot of laughs. The Scholastic Endowment Grand Prize drawing featuring a Dell laptop with an Intel Pentium processor graciously sponsored by Cygnet Enterprises, Inc., and a Garman StreetPilot III DELUXE GPS navigation system graciously sponsored by Griffin LLC will highlight the evening. Non-registered guests may purchase tickets at the Meeting Registration Desk on Sunday afternoon.

Awards and Installation of Officers Luncheon, Wednesday, July 23, 12:00 p.m. – 2:00 p.m., Casco Bay Exhibit Hall, Holiday Inn by the Bay. 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.

Field Trip: Demonstration of a Digital Hydroacoustic/GPS System for Mapping Submersed Aquatic Plants (at Highland Lake), Sunday, July 20, 3:30 – 6:30 p.m. and Monday, July 21, 5:30 – 8:30 p.m., meet in Lobby of Holiday Inn for shuttle bus transportation. Participants will see the equipment in operation, observe processing of data, and generation of maps. This demonstration is jointly sponsored by the U.S. Army Engineer Research and Development Center, BioSonics, Inc., and ReMetrix LLC. It is intended to highlight technology developed under the U.S. Army Corps of Engineers Aquatic Plant Control Research Program and successfully transitioned to industry and the aquatic plant management community.

Annual Business Meeting

The APMS Annual Business Meeting will be held in the New Hampshire and Massachusetts Rooms, Holiday Inn by the Bay on Monday, July 21 from 4:20 p.m. to 5:00 p.m. All APMS members are welcome to attend.

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.

Agenda Summary

Sunday, July 20

7:30 am - 5:00 pm	Board of Directors Meeting *(Oxford and Somerset Rooms)*
2:00 pm - 5:00 pm	Meeting Registration *(Lobby)*
2:00 pm - 5:00 pm	Presenter's Preview Room *(Board Room)*
3:30 pm - 6:30 pm	Field Trip to Highland Lake: Demonstration of a Digital Hydroacoustic/GPS System for Mapping Submersed Aquatic Plants; Point of Contact, Bruce Sabol; Presented by U.S. Army Engineer Research and Development Center, Environmental Laboratory, BioSonics, Inc., and ReMetrix, LLC
4:00 pm - 7:00 pm	Exhibits Set-up *(Vermont, Connecticut, and Rhode Island Rooms)*
4:00 pm - 7:00 pm	Posters Set-up *(Vermont, Connecticut, and Rhode Island Rooms)*
7:00 pm - 9:00 pm	President's Reception *(New Hampshire and Massachusetts Rooms)*

Monday, July 21

6:15 am - 7:45 am	Breakfast and Video Presentation "Breakthroughs in Aquatic Plant Management Technology," Presented by Syngenta Professional Products - Open to All Interested Meeting Delegates *(Casco Bay Exhibit Hall)*
7:30 am - 8:00 am	Continental Breakfast (*Vermont, Connecticut, and Rhode Island Rooms*)
7:30 am - 5:00 pm	Meeting Registration *(Lobby)*
7:30 am - 5:00 pm	Presenter's Preview Room *(Board Room)*
8:00 am - 5:00 pm	Exhibits Open *(Vermont, Connecticut, and Rhode Island Rooms)*
8:00 am - 5:00 pm	Posters Open *(Vermont, Connecticut, and Rhode Island Rooms)*
8:00 am - 11:55 am	Session I: Plenary *(New Hampshire and Massachusetts Rooms)*
9:00 am - 3:00 pm	Guest Tour and Luncheon *(Meet in Lobby)*
9:40 am - 10:05 am	Refreshment Break *(Vermont, Connecticut, and Rhode Island Rooms)*
11:55 am - 1:15 pm	Lunch
11:55 am - 1:15 pm	AERF Luncheon and Meeting - AERF Members and Invited Guests *(Cumberland, Kennebec, and Lincoln Rooms)*
1:15 pm - 4:20 pm	Session II: Corps of Engineers Invasive Species Research and Operations *(New Hampshire and Massachusetts Rooms)*
2:55 pm - 3:20 pm	Refreshment Break *(Vermont, Connecticut, and Rhode Island Rooms)*
4:20 pm - 5:00 pm	Annual Business Meeting *(New Hampshire and Massachusetts Rooms)*
5:30 pm - 8:30 pm	Field Trip to Highland Lake: Demonstration of a Digital Hydroacoustic/GPS System for Mapping Submersed Aquatic Plants; Point of Contact, Bruce Sabol; Presented by U.S. Army Engineer Research and Development Center, Environmental Laboratory, BioSonics, Inc., and ReMetrix, LLC

Tuesday, July 22

6:30 am - 8:00 am	Regional Chapters Presidents' Breakfast *(Oxford and Somerset Rooms)*
6:30 am - 8:00 am	Past President's Breakfast *(York Room)*
7:30 am - 8:00 am	Continental Breakfast *(Vermont, Connecticut, and Rhode Island Rooms)*
7:30 am - 5:00 pm	Meeting Registration *(Lobby)*
7:30 am - 5:00 pm	Presenter's Preview Room *(Board Room)*
8:00 am - 5:00 pm	Exhibits Open *(Vermont, Connecticut, and Rhode Island Rooms)*
8:00 am - 5:00 pm	Posters Open *(Vermont, Connecticut, and Rhode Island Rooms)*
8:00 am - 11:45 am	Session III: Aquatic Plant Biology, Ecology, Restoration, and Biocontrol *(New Hampshire and Massachusetts Rooms)*
9:40 am - 10:05 am	Refreshment Break *(Vermont, Connecticut, and Rhode Island Rooms)*
11:45 am - 1:15 pm	Lunch
1:15 pm - 5:00 pm	Session IV: Aquatic Plant Biology, Ecology, Restoration, and Biocontrol *(New Hampshire and Massachusetts Rooms)*
2:55 pm - 3:20 pm	Refreshment Break *(Vermont, Connecticut, and Rhode Island Rooms)*
5:30 pm - 10:00 pm	Banquet - New England Clambake *(Meet in Lobby)*

Wednesday, July 23

7:30 am - 8:00 am	Continental Breakfast *(Vermont, Connecticut, and Rhode Island Rooms)*
7:30 am - 12:00 pm	Meeting Registration *(Lobby)*
7:30 am - 12:00 pm	Presenter's Preview Room *(Board Room)*
8:00 am - 12:00 pm	Exhibits Open *(Vermont, Connecticut, and Rhode Island Rooms)*
8:00 am - 12:00 pm	Posters Open *(Vermont, Connecticut, and Rhode Island Rooms)*
8:00 am - 12:00 pm	Session V: Mechanical Control and Chemical Control *(New Hampshire and Massachusetts Rooms)*
9:40 am - 10:05 am	Refreshment Break *(Vermont, Connecticut, and Rhode Island Rooms)*
12:00 pm - 2:00 pm	Awards and Installation of Officers Luncheon *(Casco Bay Exhibit Hall)*
2:00 pm - 5:00 pm	Board of Directors Meeting *(Oxford and Somerset Rooms)*
2:00 pm - 5:00 pm	Exhibits Tear-down (*Vermont, Connecticut, and Rhode Island Rooms)*
2:00 pm - 5:00 pm	Posters Tear-down (*Vermont, Connecticut, and Rhode Island Rooms)*
2:00 pm - 5:00 pm	APCRP Review, Corps of Engineers Only *(York Room)*

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7:30 am - 5:00 pm	Presenter's Preview Room *(Board Room)*
8:00 am - 5:00 pm	Exhibits Open *(Vermont, Connecticut, and Rhode Island Rooms)*
8:00 am - 5:00 pm	Posters Open *(Vermont, Connecticut, and Rhode Island Rooms)*
8:00 am - 11:55 am	Session I: Plenary *(New Hampshire and Massachusetts Rooms)*
9:00 am - 3:00 pm	Guest Tour and Luncheon *(Meet in Lobby)* *Sponsor: Applied Biochemists*
9:40 am - 10:05 am	Refreshment Break *(Vermont, Connecticut, and Rhode Island Rooms)* *Sponsor: Cerexagri, Inc.*
11:55 am - 1:15 pm	Lunch
11:55 am - 1:15 pm	AERF Luncheon and Meeting - AERF Members and Invited Guests *(Cumberland, Kennebec, and Lincoln Rooms)*
1:15 pm - 4:20 pm	Session II: Corps of Engineers Invasive Species Research and Operations *(New Hampshire and Massachusetts Rooms)*
2:55 pm - 3:20 pm	Refreshment Break *(Vermont, Connecticut, and Rhode Island Rooms)* *Sponsor: Cerexagri, Inc.*
4:20 pm - 5:00 pm	Annual Business Meeting *(New Hampshire and Massachusetts Rooms)*
5:30 pm - 8:30 pm	Field Trip to Highland Lake: Demonstration of a Digital Hydroacoustic/GPS System for Mapping Submersed Aquatic Plants; Point of Contact, Bruce Sabol; Presented by U.S. Army Engineer Research and Development Center, Environmental Laboratory, BioSonics, Inc., and ReMetrix, LLC

Session I: Plenary *(New Hampshire and Massachusetts Rooms)*
Moderator: Richard Hinterman, APMS President, Cygnet Enterprises, Inc., Flint, MI

8:00 am	Opening Remarks **Richard Hinterman**, APMS President, Cygnet Enterprises, Inc., Flint, MI
8:05 am	Announcements **Ken Manuel**, APMS President Elect and Program Chair, Duke Power Company, Huntersville, NC
8:10 am	Presidential Address - Building on a Solid Foundation **Richard Hinterman**, APMS President, Cygnet Enterprises, Inc., Flint, MI

8:40 am — Keynote Address - "So, You Do Aquatic Plant Management for a Living...Are You a Lawyer, a Lobbyist, or a Fund-Raiser?"
Randall Stocker, Director, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL

9:20 am — The Aquatic Ecosystem Restoration Foundation (AERF) Progress Through Innovative Management
Michael D. Moore, Aquatic Ecosystem Restoration Foundation, Lansing, MI

9:40 am — **Refreshment Break** *(Vermont, Connecticut, and Rhode Island Rooms)*

10:05 am — Update on Federal Liaison Activities
Rob Hedberg, National and Regional Weed Science Societies, Washington, DC

10:25 am — "Pest Alarm": Preparing for Early Detection and Rapid Response for Invasive Aquatic Plants
Lars W. J. Anderson, USDA-ARS Exotic and Invasive Weed Research Unit, University of California-Davis, Davis, CA

10:45 am — Expanding Functional Roles of Vascular Aquatic Plants: *Schoenoplectus californicus* as an Example
John H. Rodgers, Jr., Cynthia L. Murray-Gulde, and G. M. Huddleston III, Department of Environmental Toxicology, Clemson University, Pendleton, SC

11:05 am — Hydrilla... "The Perfect Weed" Gets a Foothold in New England
Gerald N. Smith and Marc Bellaud, Aquatic Control Technology, Inc., Sutton, MA

11:25 am — Linking Exotic Aquatic Plants and Epiphytic Cyanobacteria to Avian Vacuolar Myelinopathy (AVM)
Susan B. Wilde, Alan J. Lewitus, Belle W. Baruch Institute for Coastal Research, University of South Carolina and SCDNR Marine Resources Research Institute, Charleston, SC; Thomas M. Murphy, Charlotte Hope, SCDNR Wildlife Diversity, Green Pond, SC; Anna H. Birrenkott, William W. Bowerman, Department of Forestry and Natural Resources, Faculty of Environmental Toxicology, Clemson University, Clemson, SC; and John J. Hains, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Calhoun Falls, SC

11:55 am — **Lunch**

Session II: Corps of Engineers Invasive Species Research and Operations *(New Hampshire and Massachusetts Rooms)*
Moderator: William Zattau, U.S. Army Corps of Engineers, Jacksonville District, Jacksonville, FL

1:15 pm — Overview of the Biological Control Technology Area within the Aquatic Plant Control Research Program
Michael J. Grodowitz, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

1:35 pm — APCRP Chemical Control Research: A National R&D Agenda
Kurt D. Getsinger, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

1:55 pm — An Overview of Ecological Research within the APCRP
R. Michael Smart, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX

2:15 pm — The Corps of Engineers Aquatic Nuisance Species Research Program
Alfred F. Cofrancesco, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

2:35 pm Challenges in Controlling Floating Aquatic Plants within the Jacksonville District
Charles E. Ashton, U.S. Army Corps of Engineers, Jacksonville District, Jacksonville, FL

2:55 pm **Refreshment Break** *(Vermont, Connecticut, and Rhode Island Rooms)*

3:20 pm Manipulation of Sediment Nitrogen via Dewatering and Rehydration: Implications for Macrophyte Control and N Dissipation
William F. James, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Spring Valley, WI; John W. Barko, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; and Harry L. Eakin, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Spring Valley, WI

3:40 pm Economic Impacts of Aquatic Plant Management on Recreational Angling: Results From Three South Carolina Reservoirs
Jim E. Henderson and James P. Kirk, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

4:00 pm Operational Technology for Rapid Detection and Mapping of Submersed Aquatic Plants
Bruce Sabol, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; Ryan Moore, ReMetrix, LLC, Carmel, IN; and Robert McClure, BioSonics, Inc., Seattle, WA

4:20 pm **Annual Business Meeting**

5:00 pm **Adjourn**

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5:30 pm - 10:00 pm	Banquet - New England Clambake *(Meet in Lobby)* *Sponsor: Griffin, LLC*

Session III: Aquatic Plant Biology, Ecology, Restoration, and Biocontrol *(New Hampshire and Massachusetts Rooms)*
Moderator: Carole Lembi, Purdue University, West Lafayette, IN

8:00 am Trace Element Translocation in the Body of *Equisetum fluviatile* Growing in Submerged Sulfide Tailings
Elena I. Hozhina, Department of Geological Sciences, University of Manitoba, Winnipeg, MB, and M.Y. Kropatcheva, United Institute of Geology, Geophysics and Mineralogy, Novosibirsk, Russia

8:20 am Phosphate and Nitrate Uptake Using Duckweed (*Lemna minor* L.) *(Student Presentation)*
Matt E. McKenzie, Dean F. Martin, Institute for Environmental Studies, Department of Chemistry, University of South Florida, Tampa, FL; and Daniel P. Smith, Department of Civil and Environmental Engineering, University of South Florida, Tampa, FL

8:40 am Evolution and Success of Cooperative Revegetation Projects in Central Florida Lakes
David R. Douglas, Rue S. Hestand III, Boyd Z. Thompson, Bruce V. Jaggers, Florida Fish and Wildlife Conservation Commission, Eustis Fisheries Research Laboratory, Eustis, FL; and Craig T. Mallison, Florida Fish and Wildlife Conservation Commission, Southwest Regional Office, Lakeland, FL

9:00 am Longevity of Triploid Grass Carp in the Santee Cooper Reservoirs, South Carolina
James P. Kirk, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; and Robin Coller-Socha, U.S. Army Corps of Engineers, Charleston District, Charleston, SC

9:20 am Hybrid Watermilfoil (*Myriophyllum spicatum* x *M. sibiricum*; Haloragaceae) Distribution and Population Structure in Minnesota and Wisconsin *(Student Presentation)*
Michael L. Moody and Donald H. Les, Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, CT

9:40 am **Refreshment Break** *(Vermont, Connecticut, and Rhode Island Rooms)*

10:05 am Declines and Lack of Declines of Eurasian Watermilfoil Associated with the Milfoil Weevil
Raymond M. Newman, Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota, St. Paul, MN; Darren M. Ward, Department of Biological Sciences, Dartmouth College, Hanover, NH; and Michelle D. Marko, Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota, St. Paul, MN

10:25 am Impact of Deltamethrin Spray on Adults of *Cyrtobagous salviniae*, the Biological Control Agent of the Kariba Weed, *Salvinia molesta*
Chandrasekar Naidu Kurugundla, Water Affairs, Maun Botswana and Baraedi Jay, Water Affairs, Gaborone, Botswana

10:45 am Use of Real-Time PCR for the Rapid, Specific Detection of *Hapalosiphon* sp. from AVM-Affected Reservoirs *(Student Presentation)*
Sarah K. Habrun, College of Charleston and Belle W. Baruch Institute for Coastal Research, University of South Carolina, Charleston, SC; Susan B. Wilde and Alan J. Lewitus, Belle W. Baruch Institute for Coastal Research, University of South Carolina and SCDNR Marine Resources Research Institute, Charleston, SC; Jason W. Kempton, SCDNR Marine Resources Research Institute, Charleston, SC; and Alan Strand, Grice Marine Laboratory, Charleston, SC

11:05 am Estimating Shoot Emergence for *Arundo donax*
David F. Spencer, G. G. Ksander, and D. Thornby, USDA-ARS Exotic and Invasive Weeds Research Unit, University of California-Davis, Davis, CA

11:25 am Constructed Wetlands in Detention Ponds; Improving Water Quality and Preventing Harmful Algal Blooms *(Student Presentation)*
Larissa J. Mason, Environmental Studies Program, College of Charleston and SCDNR Marine Resources Research Institute, Charleston, SC; Alan J. Lewitus, Susan B. Wilde, Belle W. Baruch Institute for Coastal Research, University of South Carolina and SCDNR Marine Resources Research Institute, Charleston, SC; and Marianne K. Burke, USDA Forest Service, Southern Research Station, Center for Forested Wetlands Research, Charleston, SC.

11:45 am **Lunch**

Session IV: Aquatic Plant Biology, Ecology, Restoration, and Biocontrol *(New Hampshire and Massachusetts Rooms)*
Moderator: Alison Fox, University of Florida, Gainesville, FL

1:15 pm — Role of Allelopathy in Determining Plant Community Composition in Ledbetter Embayment Mudflat of Kentucky Lake *(Student Presentation)*
Melissa Engleman and William Spencer, Department of Biological Sciences and Hancock Biological Station, Murray State University, Murray, KY

1:35 pm — Blue-Green Algal Problems in the Midwest
Carole A. Lembi, Kathryn Wilkinson, and Alejandra Cota, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN

1:55 pm — Evaluation of an Aquatic Bacterium as a Potential Microbial Algicide
H. Lynn Walker, School of Biological Sciences, Louisiana Tech University, Ruston, LA

2:15 pm — Sensitivity of Mat-Forming Cyanobacteria to a Potential Biological Control Agent, Bacterium SG-3 *(Student Presentation)*
Kathryn Wilkinson, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN; H. Lynn Walker, School of Biological Sciences, Louisiana Tech University, Ruston, LA; and Carole A. Lembi, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN

2:35 pm — Development of *Mycoleptodiscus terrestris* as a Bioherbicide for Management of the Submersed Macrophyte, *Hydrilla verticillata*
Judy F. Shearer, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; Mark A. Jackson, USDA-ARS-NCAUR Crop Bioprotection Research Unit, Peoria, IL; and Mark A. Heilman, SePRO Corporation, Carmel, IN

2:55 pm — **Refreshment Break** *(Vermont, Connecticut, and Rhode Island Rooms)*

3:20 pm — Introduction of Exotic Vascular Plants (*Pistia stratiotes* and *Eichhornia crassipes*) in the West Nakdong River, South Korea *(Student Presentation)*
Kim Gu Yeon, Department of Biology, Pusan National University, Busan, South Korea; Hae Soon Yoon, Department of Biology, Dong-A University, Busan, South Korea; and Gea Jae Joo, Department of Biology, Pusan National University, Busan, South Korea

3:40 pm — Interactions of Egeria (*Egeria densa*) and American Pondweed (*Potamogeton nodosus*) Grown Under Four Light Regimes
Lars W. J. Anderson, Wailun Tan, and Aaron O'Callaghan, USDA-ARS Exotic and Invasive Weed Research Unit, University of California-Davis, Davis, CA

4:00 pm — Submersed Aquatic Plant Communities in Maryland Reservoirs: Management and Control *(Student Presentation)*
Todd Chadwell and Katharina Engelhardt, Center for Environmental Science, Appalachian Laboratory, University of Maryland, Frostburg, MD

4:20 pm — Hydroperiod Influence on Competition Between *Panicum repens* and *Eleocharis cellulose*
Dian H. Smith, University of North Texas, Denton, TX; and R. Michael Smart, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX

4:40 pm — Evaluation of Four Sonar Formulations: Influence of Sediment Type on Fluridone Residuals and Efficacy vs. Hydrilla *(Student Presentation)*
Tyler J. Koschnick, William T. Haller, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL; and Michael D. Netherland, SePRO Corporation, Carmel, IN

5:00 pm — **Adjourn**

Summary for Wednesday, July 23

7:30 am - 8:00 am	Continental Breakfast *(Vermont, Connecticut, and Rhode Island Rooms)* *Sponsor: Cerexagri, Inc.*
7:30 am - 12:00 pm	Meeting Registration *(Lobby)*
7:30 am - 12:00 pm	Presenter's Preview Room *(Board Room)*
8:00 am - 12:00 pm	Exhibits Open *(Vermont, Connecticut, and Rhode Island Rooms)*
8:00 am - 12:00 pm	Posters Open *(Vermont, Connecticut, and Rhode Island Rooms)*
8:00 am - 12:00 pm	Session V: Mechanical Control and Chemical Control *(New Hampshire and Massachusetts Rooms)*
9:40 am - 10:05 am	Refreshment Break *(Vermont, Connecticut, and Rhode Island Rooms)* *Sponsor: Cerexagri, Inc.*
12:00 pm - 2:00 pm	Awards and Installation of Officers Luncheon *(Casco Bay Exhibit Hall)* *Sponsor: Syngenta Professional Products*
2:00 pm - 5:00 pm	Board of Directors Meeting *(Oxford and Somerset Rooms)*
2:00 pm - 5:00 pm	Exhibits Tear-down *(Vermont, Connecticut, and Rhode Island Rooms)*
2:00 pm - 5:00 pm	Posters Tear-down *(Vermont, Connecticut, and Rhode Island Rooms)*
2:00 pm - 5:00 pm	APCRP Review, Corps of Engineers Only *(York Room)*

Session V: Mechanical Control and Chemical Control *(New Hampshire and Massachusetts Rooms)*
Moderator: Kurt Getsinger, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

8:00 am	The Use of an Automated Weed Device as a Localized Control Method **Kevin Kretsch**, Lake Restoration, Inc., Rogers, MN
8:20 am	Carfentrazone-ethyl: A Potential New Herbicide for Aquatic Plant Management **Tyler J. Koschnick** and William T. Haller, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL
8:40 am	Sensitivity of Dotted Duckweed (*Landoltia punctata*) to Diquat (Reward®) in Florida **Les Glasgow**, Syngenta Crop Protection, Inc., Vero Beach, FL; Tyler Koschnick, and Bill Haller, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL
9:00 am	Selective Whole-Lake Management of *Myriophyllum spicatum* (Eurasian Watermilfoil) with Low-Dose Treatment of Fluridone Herbicide: Houghton Lake, Michigan **Mark A. Heilman**, Michael D. Netherland, SePRO Corporation, Carmel, IN; Craig Smith, South Florida Natural Resources Center, Everglades National Park, Homestead, FL; Kurt D. Getsinger, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; Douglas R. Henderson, Ryan Moore, ReMetrix LLC, Carmel, IN; and Paul Hausler, Progressive AE, Grand Rapids, MI
9:20 am	Parrot's Feather and Alligator Weed Versus Triclopyr Amine **Deborah E. Hofstra**, P. D. Champion, and T. Dugdale, National Institute of Water and Atmospheric Research (NIWA), Hamilton, New Zealand
9:40 am	**Refreshment Break** *(Vermont, Connecticut, and Rhode Island Rooms)*
10:05 am	The Reward Rapid Release™ Test: A Water Management Tool for Sensitive Use Sites Such as Reservoirs, Canals, and Lakes **James F. Brady**, Syngenta Crop Protection Inc., Greensboro, NC; and Jim Petta, Syngenta Professional Products, New Braunfels, TX
10:25 am	Reward AccuGel™: A Precision Placement Formulation of Diquat for the Management of Invasive and Nuisance Plants in Both Static and Flowing Systems **Renee Keese**, Syngenta Crop Protection Inc., Carmel, IN; Jim Petta, Syngenta Professional Products, New Braunfels, TX; and Les Glasgow, Syngenta Crop Protection Inc., Vero Beach, FL

10:45 am	Impact of Sonar Treatments on Turion Production of Hydrilla and Curlyleaf Pondweed **Michael D. Netherland**, SePRO Corporation, Carmel, IN
11:05 am	Hyperspectral Mapping of Submerged Aquatic Vegetation in Lake Rosalie, FL **Oliver Weatherbee**, 3Di Technologies, Easton, MD
11:25 am	APMS Regional Chapters Reports: Brazil, Florida, MidSouth, Midwest, Nile Basin, Northeast, South Carolina, Texas, Western **Chapter Officer or Delegate**
12:00 pm	**Adjourn 43rd Annual Meeting**

Poster Session *(Vermont, Connecticut, and Rhode Island Rooms)*

U.S. Army Corps of Engineers Aquatic Plant Control Research Program
Robert C. Gunkel, Jr., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

APCRP Chemical Control Research: A National R&D Agenda
Kurt D. Getsinger and Angela Poovey, 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; Joe R. Snow, Gary O. Dick, David R. Honnell, and Dian H. Smith, University of North Texas, Denton, TX

An Overview of Ecological Research within the APCRP
R. Michael Smart, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX

New Advancements and Understandings in the Use of Insect Biological Control for the Management of Aquatic Plants
Michael J. Grodowitz, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Major Blockages in the Okavango Delta, Botswana
Chandrasekar Naidu Kurugundla, Water Affairs, Maun, Botswana; Baraedi Jay and George Thabeng, Water Affairs, Gaborne, Botswana

Herbicides and Prescribed Burning for Control of *Phragmites australis* at St. Johns Marsh, Michigan
Linda Nelson, Kurt Getsinger, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; Lee Ann Glomski, Purdue University, West Lafayette, IN; Ernie Kafcas, Michigan Department of Natural Resources, Mt. Clemens, MI; Stuart Kogge and Michael Nurse, Wetland and Coastal Resources, Inc., Lansing, MI

Does the Alien *Potamogeton crispus* Hybridise with the Native *P. ochreatus* in New Zealand?
Deborah E. Hofstra, National Institute of Water and Atmospheric Research (NIWA), Hamilton, New Zealand, and C. E. C. Gemmill, Centre for Biodiversity and Ecological Research (CBER), Department of Biological Sciences, University of Waikato, Hamilton, New Zealand

Tissue C and N for Water Hyacinth in the Sacramento Delta: Implications for Biological Control
David F. Spencer and G. G. Ksander, USDA-ARS Exotic and Invasive Weeds Research Unit, University of California-Davis, Davis, CA

Pathogen Research on Aquatic Plants
Judy F. Shearer, Linda Nelson, and Dwilette McFarland, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Fragment Production of *Hydrilla verticillata* by a Boat Motor
Chetta S. Owens, Analytical Services, Inc., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX; John Madsen, GeoResources Institute, Mississippi State University, Mississippi State, MS; and R. Michael Smart, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX

Modeling Competition Between Submersed Macrophyte Species
Elly P. H. Best, Gregory A Kiker, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS; and William F. James, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Spring Valley, WI

Impact of Waterfowl Foraging on *Scirpus triqueter* in the Nakdong River Estuary, South Korea
Kim Gu Yeon, Jang Mi Yun, Young Sang Kim, and Gea Jae Joo, Department of Biology, Pusan National University, Busan, South Korea

Evaluation of Two Methods for Applying Dilute Acetic Acid for American Pondweed Winter Bud Control in the Nevada Irrigation District, California
David F. Spencer, USDA-ARS Exotic and Invasive Weeds Research Unit, University of California-Davis, Davis, CA; C. L. Elmore, Weed Science Program, Department of Vegetable Crops, University of California-Davis, Davis, CA; G. G. Ksander, USDA-ARS Exotic and Invasive Weeds Research Unit, University of California-Davis, Davis, CA; and J. A. Roncoroni, Weed Science Program, Department of Vegetable Crops, University of California-Davis, Davis, CA

Role of Flooding Stress Tolerance in Determining Plant Community Composition in Ledbetter Embayment Mudflat of Kentucky Lake
Joell Hill and William Spencer, Department of Biological Sciences and Hancock Biological Station, Murray State University, Murray, KY

Role of Competition in Determining Plant Community Composition in Ledbetter Embayment Mudflat of Kentucky Lake
Dava McCann and William Spencer, Department of Biological Sciences and Hancock Biological Station, Murray State University, Murray, KY

Effects of Soils and Hydrology in Determining Plant Community Composition in Ledbetter Embayment Mudflat of Kentucky Lake
Ronald L. Elder and William Spencer, Department of Biological Sciences and Hancock Biological Station, Murray State University, Murray, KY

The Impact of Copper on Aluminum in an Aquatic Environment
Jim Bone, Griffin LLC, Valdosta, GA

Aquatic Plant Management in Oregon Following the Talent Decision
Mark Sytsma, Center for Lakes and Reservoirs, Portland State University, Portland OR; and Mark Rosenkranz, Lake Oswego Corporation, Oswego, OR

NEXT YEAR
44th Annual Meeting
Hyatt Regency Tampa
Tampa, Florida
July 11-14, 2004

Abstracts

Session I: Plenary

The Aquatic Ecosystem Restoration Foundation (AERF) Progress Through Innovative Management

Michael D. Moore
Aquatic Ecosystem Restoration Foundation, Lansing, MI

Originally organized in 1996 the Aquatic Ecosystem Restoration Foundation has fulfilled its mission as 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. Our American society depends on adequate and high-quality water resources. Every day increased pressure is being placed on these unique and life-sustaining ecosystems. Unfortunately, invasive vegetation is causing significant ecological and economic impacts on critical aquatic, wetland, and riparian systems in the United States. These plant species degrade and/or diminish water quality, human health, fisheries, water-bird habitat, recreation, aesthetics, and property values. Although traditional plant management techniques and tools are available, there is a pressing need to develop new strategies and refine existing ones that can selectively control these aggressive weeds in an environmentally compatible fashion. The AERF has sponsored numerous activities over its seven years. A review of the successes of the organization in the areas of research, education, student support, and partnerships will be presented. In addition, a discussion of newly planned research and educational projects will be presented including what the Foundation is doing in the area of research on the economic impact of invasive aquatic species.

"Pest Alarm": Preparing for Early Detection and Rapid Response for Invasive Aquatic Plants

Lars W. J. Anderson
USDA-ARS Exotic and Invasive Weed Research Unit, University of California-Davis, Davis, CA

With very few exceptions, there is no U.S.- or State-level, ready-to-act team, plan, or resource pool available to effect a truly rapid and effective containment and eradication action against new aquatic weeds. "Rapid" is defined as a few days to 3 weeks at most, not months. Successful examples, however, such as responses to *Hydrilla verticillata* and *Caulerpa taxifolia* suggest that three components are essential, together with an immediately accessible source of funds: (1) adequate prior knowledge of the target weed biology, (2) experienced practitioners in containment and eradication methods, and (3) adequate understanding of the infested site (environmental constraints, legal authorities, and physical characteristics). "Pest Alarm" is actually a series of question-based decision trees that help identify who will be needed to respond and what lines of authority need to be clarified before a new pest is encountered. Given the three components needed, a crucial part of this model is a consensus on what species are likely to enter and what is the most likely pathway. This suggests the need for either state-level, regional, or U.S.-level evaluation panels to identify the "top 5 or 10" most likely new aquatic weeds, and to sound the "alarm" clock. The cost of implementing this preventative exercise will be reduced by evaluating several species simultaneously, but should result in actionable plans, as well as identify weaknesses in response capabilities.

Expanding Functional Roles of Vascular Aquatic Plants: *Schoenoplectus californicus* as an Example

John H. Rodgers, Jr., Cynthia L. Murray-Gulde, and G. M. Huddleston III
Department of Environmental Toxicology, Clemson University, Pendleton, SC

Schoenoplectus californicus, giant bulrush, was planted in an 8-acre constructed wetland treatment system receiving copper-contaminated water located in South Carolina. This constructed wetland treatment system was designed to decrease bioavailable copper concentrations in a waste stream (consisting of process water and stormwater) and eliminate associated toxicity to downstream biota by exploiting processes responsible for copper speciation. The design of this system involved coupling of the carbon, sulfur, and copper biogeochemical cycles. *S. californicus* is important in organic carbon production and contributes to physical, chemical, and biological removal of metals from the aqueous phase. In this system, *S. californicus* provides a sustainable carbon source for removal of copper by: 1) providing organic ligands for copper sorption, 2) continuous production of organic ligands through growth, 3) accretion of organic ligands through time due to detritus production and decomposition, and 4) production of organic carbon as an energy source for dissimilatory sulfate

reduction. Shoots and roots of *S. californicus* sorbed 0.6 and 1.9 percent, respectively, of copper entering the system. Production of *S. californicus* increased by 90 percent in the first year of growth and an additional 60 percent during the second growing season, representing a significant increase in organic ligands during the ontogeny of this system. The half-life for *S. californicus* detritus in the constructed wetland system was approximately 184 d, indicating that detritus will accrete over time, providing binding sites for copper as well as a continuous energy source for bacterial metabolic processes that contribute to copper immobilization. *S. californicus* does not significantly aerate its root zone allowing a negative redox (-100 to –250 mV) to be maintained and providing conditions necessary for the production of acid volatile sulfides. The multiple roles played by *S. californicus* in this constructed wetland treatment system contribute to a novel approach for phytoremediation of metals.

Hydrilla... "The Perfect Weed" Gets a Foothold in New England

Gerald N. Smith and Marc Bellaud
Aquatic Control Technology, Inc., Sutton, MA

The occurrence of hydrilla (*Hydrilla verticillata*) was first confirmed in a small, private pond located in the seaport town of Mystic, CT back in the mid-1980's. That pond was eventually drained and dredged and then treated with herbicides as a further measure. Several years later, however, the hydrilla was reported to have grown back completely. Biologists with Aquatic Control discovered two additional hydrilla infestations in CT – one site in 1997, at a small pond on Masons Island, located just a few miles from the earlier known hydrilla infestation in Mystic and a second site found in 2000 at a private pond in Wilton, some 70 miles south of Mystic. In 2001, hydrilla was first identified at Long Pond in Barnstable (Cape Cod), MA. The most recent discovery of hydrilla in New England was reported from Pickerel Pond in Limerick, ME during the fall of 2002. These hydrilla infestations raise a number of important questions. How did hydrilla find its way into these ponds in the first place? Are the known populations genetically linked? Is there a connection in the spread of these hydrilla infestations? Management responses to these known hydrilla infestations vary from one site to the next. In most cases, aggressive action has been taken to prevent the spread of hydrilla to other water bodies through closure of boat ramps, education programs, and treatment with fluridone herbicide.

Linking Exotic Aquatic Plants and Epiphytic Cyanobacteria to Avian Vacuolar Myelinopathy (AVM)

Susan B. Wilde[1], Alan J. Lewitus[1], Thomas M. Murphy[2], Charlotte Hope[2], Anna H. Birrenkott[3], William W. Bowerman[3], and John J. Hains[4]
[1] *Belle W. Baruch Institute for Coastal Research, University of South Carolina and SCDNR Marine Resources Research Institute, Charleston, SC*
[2] *SCDNR Wildlife Diversity, Green Pond, SC*
[3] *Department of Forestry and Natural Resources, Faculty of Environmental Toxicology, Clemson University, Clemson, SC*
[4] *U.S. Army Engineer Research and Development Center, Environmental Laboratory, Calhoun Falls, SC*

Reservoir surveys and duck feeding trials were conducted to determine the role of exotic plants as a substrate for the growth of toxic cyanobacteria (blue-green algae) that may be associated with the incidence of a fatal bird disease, avian vacuolar myelinopathy (AVM). AVM is diagnosed by observation of lesions in the white matter of the brain and spinal cord of affected birds. Since its discovery in 1994, AVM has caused mortality in untold numbers of bald eagles, Canada geese, great horned owls, American coots, mallards, and other waterfowl found in the southeastern U.S. Raptors were shown to contract AVM by ingesting affected coots. In this current study, AVM was reproduced experimentally by feeding hydrilla (*Hydrilla verticillata)* and associated epiphytes from an AVM-affected site to waterfowl. While the specific cause of the disease is still unknown, the most probable hypothesis is that they consume a neurotoxin associated with the plants. Hydrilla, Brazilian elodea (*Egeria densa*), and Eurasian watermilfoil (*Myriophyllum spicatum*) are the most abundant species occurring in AVM-positive reservoirs. Cyanobacterial epiphytes cover up to 90 percent of the leaf and stem surface of aquatic macrophytes in these systems. A strong relationship exists between the field abundance of specific blue-green algal epiphytes and the incidence of disease. Research is ongoing to determine whether these algae could cause the brain lesions seen in the affected birds. AVM has already adversely affected local breeding populations of eagles and has the potential to produce a regional impact if the disease continues to spread with new invasions of exotic aquatic macrophytes.

Session II: Corps of Engineers Invasive Species Research and Operations

Overview of the Biological Control Technology Area within the Aquatic Plant Control Research Program

Michael J. Grodowitz
U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

This presentation will address current research in the biological control technology area within the Aquatic Plant Control Research Program. Within pathogen biological control, four major areas are being addressed, including: 1) development of mycoherbides; 2) pathogens as aquatic plant endophytes; 3) effects of biotic and abiotic factors on pathogenicity; and 4) integrating pathogens and herbicides. Major accomplishments include the development of a compositional matter patent for pathogens and the development of a pathogen/herbicide integration that is significantly more effective than either technology applied alone. For the insect biocontrol area, three major endeavors are being pursued, including: 1) developing cost-effective methods for mass-rearing and releasing insect agents; 2) elucidating the role various abiotic and biotic factors have on insect effectiveness; and 3) understanding mechanisms of insect impact in relationship to plant competition. Major accomplishments include the development of a mass-rearing facility for hydrilla agents at the Lewisville Aquatic Ecosystem Research Facility (LAERF). Since this facility was put into operation, costs have decreased over 25-fold from $0.50 per larva to $0.02 per larva. Rearing activities have included the release of over 1 million *Hydrellia* immatures into sites along the Rio Grande, central Texas, and south central Florida. To understand how plant nutritional factors impact the agents, physiological age-grading systems based on ovarian morphology have been developed for *Hydrellia pakistanae* and *Euhrychiopsis lecontei*. In addition, a series of experiments have elucidated how parasitism, predation, and plant nutritional composition influence *Hydrellia pakistanae* development and egg production.

APCRP Chemical Control Research: A National R&D Agenda

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

The U.S. Army Corps of Engineers' Aquatic Plant Control Research Program (APCRP) is the only federally authorized research program for aquatic plant management. Operating under the purview of the 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 in customized controlled-environment chambers, greenhouses, outdoor mesocosms, and ponds in Vicksburg, MS and Lewisville, TX. Results of small-scale studies are verified in field sites (lakes, reservoirs, rivers, and wetlands) throughout the United States. Research focus areas include: a) selective control of target plants to restore native plant communities; b) protection of threatened and endangered plant species; c) low-dose application technology; d) product tolerance and resistance issues; and e) integration of control strategies with ecological principles. Work is conducted in collaboration with Federal and state agencies, academia, and the private sector. In addition, frequent 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 the publication of technical reports, popular articles, and the peer-reviewed scientific literature.

An Overview of Ecological Research within the APCRP

R. Michael Smart
U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX

The U.S. Army Corps of Engineers' Aquatic Plant Control Research Program (APCRP) is the only federally authorized research program for aquatic plant management. Research conducted within the ecological technology area of the program focuses on the biology and ecology of invasive plants, on the role that aquatic plants play in aquatic ecosystems, and on the development of holistic, ecosystem approaches to aquatic plant management. The goal of this research is to develop an understanding of aquatic plants (both native and exotic) and their interactions with other components of the ecosystem, so that chemical, mechanical, cultural, and biological methods of control can be integrated within an ecosystem-based approach to managing vegetation in our aquatic resources. In many cases the goal of aquatic plant management will be the development of self-sustaining and diverse communities dominated by native plants.

The Corps of Engineers Aquatic Nuisance Species Research Program

Alfred F. Cofrancesco
U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Invasive aquatic nuisance species (ANS) are serious threats to U.S. ecosystems decreasing biodiversity, impacting human health, and imposing enormous costs on eradication and management efforts. They infest portions of almost all the navigable waterways in North America. In 1990 the Corps of Engineers (CE) established the Zebra Mussel Research Program to address problems specifically caused by this aquatic nuisance species. In 2002 the Corps of Engineers established a new research program, the Aquatic Nuisance Species Research Program (ANSRP) that incorporated the responsibilities of the Zebra Mussel Research Program, but expanded it to include other aquatic fauna problems that impact the Corps of Engineers and Public Facilities. Since its establishment, the program has taken an aggressive position in examining the full range of aquatic nuisance species problems. The new research program will focus efforts in five general areas: Introduction/ Dispersal; Control/Management; Species of Concern; Risk Assessment; and Technology Transfer. These focus areas are further subdivided to cover problems that have been identified for CE activities. Special emphasis will be placed on developing management options that will reduce negative impacts of ANS.

Challenges in Controlling Floating Aquatic Plants within the Jacksonville District

Charles E. Ashton
U.S. Army Corps of Engineers, Jacksonville District, Jacksonville, FL

The District utilizes an integrated approach, biological and chemical, to control water hyacinth and water lettuce on the St. Johns River and Lake Okeechobee. Biological control agents have been released and are established throughout the system, but the use of diquat, 2,4-D and glyphosate are the primary control methods employed to keep these plants under maintenance control. The Corps and State maintenance control programs have been so successful that the average person does not know that these plants can be a problem. Five years of chemical control data from St. Johns and Lake Okeechobee will be discussed. Working around fishermen and fishing tournaments has always been and will continue to be a challenge. The education of special interest groups, fishermen, recreational users, and water users is also a challenge. The increased utilization of surface water for irrigation, and domestic and potable water sources in the State of Florida has the potential to conflict with the control of floating aquatics with herbicides.

Manipulation of Sediment Nitrogen via Dewatering and Rehydration: Implications for Macrophyte Control and N Dissipation

William F. James[1], John W. Barko[2], and Harry L. Eakin[1]
[1] *U.S. Army Engineer Research and Development Center, Environmental Laboratory, Spring Valley, WI*
[2] *U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*

River sediments were experimentally dewatered via exposure to air from an initial moisture content of 75 percent to 61 percent (~20 percent dewatered), 32 percent (~60 percent dewatered), and 4 percent (~95 percent dewatered). Sediments dewatered by 20 percent and 60 percent and rehydrated exhibited lower exchangeable ammonium nitrogen (NH_4-N) concentration and lower rates of nitrate-nitrite-N and NH_4-N release from sediments. In contrast, sediments dewatered by 95 percent and rehydrated exhibited marked increases in exchangeable sediment NH_4-N and much higher rates of nitrate-nitrite-N (under oxic conditions) and NH_4-N-N (under oxic and anoxic conditions) release from sediments. Sediment dewatered by 60 and 95 percent and rehydrated lost total N (18 percent), suggesting denitrification. Growth of *Potamogeton pectinatus* responded as a function of exchangeable sediment NH_4-N concentrations; it was lower on partially dewatered and rehydrated sediments that exhibited lower exchangeable sediment NH_4-N and elevated on sediment that was dewatered by 95 percent. Our results suggest that sediment N may be manipulated via sediment dewatering and rehydration (i.e., a pool elevation drawdown) to affect macrophyte growth and to dissipate total sediment N concentrations.

Economic Impacts of Aquatic Plant Management on Recreational Angling: Results from Three South Carolina Reservoirs

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

The impact of recreational angling on local economies has increased scrutiny of aquatic plant control plans. Unfortunately, acquisition of needed plant perception and economic expenditure data can be time-consuming and expensive. Utilizing ongoing angler creel surveys, necessary economic expenditure and plant impact data have been collected, and then used in economic impact models developed by the Engineer Research and Development Center. Increases in local economic sectors ranging from 18 percent to 63 percent were estimated for changes in hydrilla infestations at Lakes Murray and Moultrie, South Carolina. At Lake Greenwood, South Carolina, local economic impacts of angling were estimated and the impact of a *Pithophora* infestation on angling use was evaluated.

Operational Technology for Rapid Detection and Mapping of Submersed Aquatic Plants

Bruce Sabol[1], Ryan Moore[2], and Robert McClure[3]
[1] *U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2] *ReMetrix, LLC, Carmel, IN*
[3] *BioSonics, Inc., Seattle, WA*

Rapid and accurate measurement of the abundance and distribution of submersed vegetation has been achieved with the Submersed Aquatic Vegetation Early Warning System, developed at the U.S. Army Engineer Research and Development Center (ERDC). The system consists of off-the-shelf commercially available digital echo sounder, global positioning system, and PC components. Data are post processed with an ERDC-developed and patented digital signal processing code. The system has been tested on most commonly occurring freshwater and estuarine species of submersed vegetation in the United States. The patent for the processor has been licensed to BioSonics, Inc., manufacturer of the echo sounder used, which distributes the package under the name EcoSAV as part of a suite of software for characterization of shallow-water environments. Numerous organizations in this country and worldwide are currently using the system operationally for various resource and nuisance plant assessments. ReMetrix, LLC., an environmental resource assessment firm, utilizes hydroacoustic detection as a preferred assessment technique and has partnered with BioSonics to assist in the advanced development of EcoSAV and related products. Mapping and change detection capabilities of the system are demonstrated using data collected from a nearby Maine lake as part of a system demonstration held in conjunction with this meeting.

Session III: Aquatic Plant Biology, Ecology, Restoration, and Biocontrol

Trace Element Translocation in the Body of *Equisetum fluviatile* Growing in Submerged Sulfide Tailings

Elena I. Hozhina[1] and M.Y. Kropatcheva[2]
[1] *Department of Geological Sciences, University of Manitoba, Winnipeg, MB*
[2] *United Institute of Geology, Geophysics and Mineralogy, Novosibirsk, Russia*

The investigation is directed at studying trace element (Cd, Pb, Cu, Zn, Fe, Mn) movement in the body of horsetail (*Equisetum fluviatile*) growing in submerged sulfide tailings of Salair OMPE. The main task is to extract information about priority locations of trace elements in plant cells and to study changes happening with elements in these locations as the result of cell death. The biggest element concentrations are in roots, where Cd, Pb, and Fe are mostly contained in cell membranes and C and Zn are found in the protoplasm. Trace elements penetrate from roots into the aboveground parts of the plant via bleeding sap. Element concentrations in bleeding sap vary depending on precipitation (rain) but on average exceed element concentrations in the protoplasm of root cells. Then trace elements come to conductive vessels, where their concentration is lowest, likely because elements quickly penetrate into other tissues. According to results in the aboveground part of horsetail, more than 97 percent of each trace element is contained in the cell and microbody membranes (CMMs), which are the main location of elements. The remaining percentages are contained in soluted organic and inorganic cell compounds and in the free space of blind pits. Small amounts of trace elements penetrate into the atmosphere with evapotranspiration (0.26-14 g/ga per year). After cell death, organic compounds in CMMs continue to uptake trace elements so that Cd, Zn, and Mn concentrations in the dead aboveground portions of plants deposited on the bottom of a tailing impoundment exceed element concentrations in the sediment by 9.0, 1.6, and 1.3 times, respectively.

Phosphate and Nitrate Uptake Using Duckweed (*Lemna minor* L.)

Matt E. McKenzie[1], Dean F. Martin[1], and Daniel P. Smith[2]
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Pollution by elevated nitrogen and phosphorus levels in fresh water sources from wastewater, storm water, and agricultural run-off is a problem faced by many states. This study investigated a purifying wastewater via duckweed, *Lemna minor* L., an emergent technology that has proven to be effective in uptake and control of macronutrients. A continuous flow approach was used where the influent and effluent are being measured. There were two groups of studies using two modified Hillman's solutions, a high nitrogen/ low phosphorus medium (50-percent spike potassium nitrate) and a low nitrogen/ high phosphorus medium (50-percent spike potassium hydrogen phosphate). During the two-week study while the duckweed was in its growth phase, analysis of nitrate and phosphate concentrations, biomass change, and chlorophyll *a* concentrations were used to monitor overall plant physiology. Mass balance calculations were performed to find where the nitrogen and phosphorus accumulated. The duckweed competed for the nitrogen in the low nitrate medium, which had a higher removal of nitrogen and phosphorus and greater biomass increase. In the low nitrate medium, the duckweed absorbed 1001 grams of phosphorus/m^2/day and 1220 grams of nitrogen/m^2/day. In the high nitrate study, it removed 196 g P/m^2/day and 607 g N/m^2/day by the end of the two-week study. Extrapolating the results for the high nitrogen/low phosphorus medium indicated duckweed could remove 10,900-kg/ha phosphorus and 13,300-kg/ha nitrogen in a two-week period.

Evolution and Success of Cooperative Revegetation Projects in Central Florida Lakes

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Central Florida's degraded lakes have experienced a loss of desirable aquatic plants that provide critical fish and wildlife habitat. Reductions in nutrient loading in some lakes over the past decade and recent plans to increase lake level fluctuation compelled the Florida Fish and Wildlife Conservation Commission (FWC) to conduct habitat enhancement projects to "jump start" littoral zone aquatic plant communities. Since 1997 the FWC has conducted over 40 successful cooperative revegetation projects in central Florida lakes ranging in size from a few hundred to over one-half million plants. These projects have been conducted by FWC with the assistance and cooperation of private citizens, volunteer groups, and local and state governmental entities. The structure of these projects has evolved since the inception of this program to take advantage of new funding sources and increased involvement of other governmental entities. Techniques used to conduct these revegetation projects have been modified to improve plant survival and overall success. The major plant species utilized were *Eleocharis interstincta, Nuphar luteum, Panicum hemitomon, Paspalidium geminatum, Scirpus validus, S. californicus,* and *Vallisneria americana.* One major factor in these successful revegetation projects was having the flexibility with scheduling and funding to take advantage of natural and/or man-induced low water periods. The FWC has developed several recommendations on how to conduct these projects for use by other groups and agencies.

Longevity of Triploid Grass Carp in the Santee Cooper Reservoirs, South Carolina

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Triploid grass carp, *Ctenopharyngodon idella,* in the Santee Cooper reservoirs, South Carolina were collected to determine longevity and persistence of 768,500 fish stocked from 1989 through 1996 to control hydrilla, *Hydrilla verticillata.* A total of 477 triploid grass carp were aged from collections made annually from 1998 through 2002. The oldest triploid grass carp were age 11 and these fish were rare. Total annual mortality rates ranged from 22 to 39 percent, suggesting biologically significant numbers (10 percent of a cohort) could persist for 5 to 10 years. Longevity and population persistence were similar to that inferred in other studies. Annual stockings as high as 150,000 during the 1990's could potentially leave many (~15,000) fish a decade after stocking. Conversely, control of hydrilla, achieved in 1997, is unlikely to last more than a few more years. The persistence of triploid grass carp for extended periods requires that benefits of hydrilla control and risks to non-target organisms be impartially evaluated.

Hybrid Watermilfoil (*Myriophyllum spicatum* × *M. sibiricum*; Haloragaceae) Distribution and Population Structure in Minnesota and Wisconsin

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Eurasian watermilfoil (*Myriophyllum spicatum*) has been considered the most problematic submerged aquatic invasive in freshwater lakes throughout North America. It was first recognized in North America in 1942 and is now known from 45 states and 3 Canadian provinces. Hybridization has been linked to aggressiveness and invasiveness in several wetland plants. Invasiveness in hybrid plants is often attributed to hybrid vigor or novel genotypes with a selective advantage. Recently invasive populations of hybrids between the nonindigenous *M. spicatum* and the indigenous *M. sibiricum* were identified in lakes of Minnesota and Wisconsin. Further evidence now shows that in lakes where the invasive hybrid is found, pure *M. spicatum* is absent. In addition, 13 lakes throughout Minnesota and Wisconsin, previously believed to have invasive *M. spicatum*, have now been found to be infested with hybrid plant populations. The extent of the geographic range of the invasive hybrid has yet to be determined, but the increasing number of hybrid populations being uncovered suggests the hybrid genotype may be common. There is correlative data that may suggest environmental differences exist in lakes where either pure *M. spicatum* or the hybrid is robust. There is also some correlative evidence suggesting the hybrid genotype may influence the effectiveness of the watermilfoil weevil (*Euhrychiopsis lecontei*) as a biocontrol agent.

Declines and Lack of Declines of Eurasian Watermilfoil Associated with the Milfoil Weevil

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The native weevil *Euhrychiopsis lecontei* is a potential biological control agent for Eurasian watermilfoil (*Myriophyllum spicatum*). The weevil can cause declines and control the plant when it attains adequate densities (≥ 0.25/stem) that persist throughout the summer. The weevil has been associated with milfoil declines in four lakes in Minnesota; declines have persisted (≥ 3years) in two lakes (Cenaiko and Otter) and in the shallow (<2.5-m depth) portion of Smith's Bay. At other lakes or in previous years, weevil densities were too low to control the plant. Our research suggests that in-lake factors are more limiting than overwinter conditions. Because the weevil is iteroparous, laying 2-5 eggs per day, adult reproductive longevity and fecundity is critical to end-of-summer density. Enclosure/exclosure experiments indicate that sunfish can limit control agents. In exclosure experiments in a lake with high sunfish density, fish suppressed milfoil weevil density. In an enclosure experiment in a lake with low sunfish density, the milfoil weevil and *Parapoynx* sp. (Lepidoptera) were suppressed in fish enclosures. The reduction in *Parapoynx* resulted in a significant increase of *Zosterella dubia*, one of its food plants. On a larger scale, among lakes and years, we found significant negative relationships of sunfish and weevil (total and adult) densities. These results indicate that sunfish can be an important limiting factor in achieving adequate weevil densities for control. Comparisons of fecundity of weevils on Eurasian and northern watermilfoil suggests that plant nutritional status, which can affect daily fecundity, may also be important.

Impact of Deltamethrin Spray on Adults of *Cyrtobagous salviniae*, the Biological Control Agent of the Kariba Weed, *Salvinia molesta*

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An insecticide, deltamethrin, was sprayed at a dosage rate of 0.3 grams per hectare in the first and second cycles and 0.26 grams/hectare in the subsequent three cycles in the southern part of Okavango Delta, Botswana in the winter 2002 to control tsetse fly, *Glossina morsitans* (Westwood). The impact of deltamethrin spray was investigated on the beneficial non-target weevil, *Cyrtobagous salviniae* (Calder & Sands), which controls the floating salvinia weed, *Salvinia molesta* (Mitchell) in Moremi Game Reserve of the delta. Static short-term bioassay methods were adapted in the studies. Three sets of experiments were carried out (Basin-bank, Basin-water, and Field-water). In the Basin-bank studies, the materials in the plastic basins were placed in the banks of Khwai River water bodies whereas the Basin-water studies include the perforated basins kept in shallow water to expose their rims. In the third set, field salvinia samples at various sites were collected to determine the impact of spray on weevils in pre-spray and post-spray periods. The materials in the plastic containers include sediments, river water, 0.5 kg salvinia and 50 adult weevils. Similarly control basins were maintained at 30 km outside the spray block. The weevil mortalities were determined in the first sample after 12 hours of the spray and at 24, 48, and

72 hours from the 12-hour sampling period. Temperature, pH, electrical conductivity and dissolved oxygen determined fro the three sets of experiments were compared under pre-spray and post-spray conditions. The adult weevils were susceptible to deltamethrin spray and the mortalities during the 72-hour time span of the experiment were statistically significant at 5- and 1-percent levels. The death of weevils exhibited no difference between Basin-bank and Basin-water and the percent mortality was in the range of 5.5 and 46.8, with overall mean mortalities in the five cycles at 27.5 and 27.3 percent in Basin bank and Basin-water, respectively. Weevils extracted from the field salvinia mat did not show significant mortalities between the pre-and post-spray periods and they were highly variable in time and space. No differences existed in pH or dissolved oxygen, except in the conductivity, which was relatively higher in the closed Basin-bank compared to Basin-wate and Field-water. Cold and warm temperature factors did not increase the toxicity of deltamethrin on the weevil populations Aluminium foil sheets that spread across the bottom of the plastic basins were placed along with salvinia containers to colle the impingement of spray drift. The quantity of insecticide deposit was uneven and related to the toxicity to weevils in basi and in the field. Drift sprays of less than 1 $\mu g/m^2$did not decrease the survival of weevils as compared to controls. The mortality rates of salvinia weevils could be due to deltamethrin toxicity drifted into the closed systems as demonstrated in basins. The insecticide toxicity in the field conditions could be transient and the effects might be minimal.

Use of Real-Time PCR for the Rapid, Specific Detection of *Hapalosiphon* sp. from AVM-Affected Reservoirs

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Avian Vacuolar Myelinopathy (AVM) is a newly discovered fatal bird disease killing bald eagles (*Haliaeetus leucocephalu* and waterfowl in southeastern U.S. reservoirs. The cause of the disease is unknown, but one hypothesis is that eagles consume waterfowl that feed on the exotic invasive plant, *Hydrilla verticillata*, with associated toxic epiphytic cyanobacteri The dominant epiphyte found on collected hydrilla is a *Hapalosiphon* sp., tentatively identified as *Hapalosiphon fontinalis*. 16S rRNA sequence identity will be determined from reference culture (ATCC 39694) and South Carolina isolates of *Hapalosiphon* sp. 16S rRNA sequence data will be aligned to confirm the identity of the South Carolina isolates. Based on sequence variability, a real-time PCR assay will be developed for rapid, specific detection of *H. fontinalis* from environmental samples. Use of gene probes will enhance determination of the presence and distribution of *H. fontinalis* fro impacted areas.

Estimating Shoot Emergence for *Arundo donax*

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Invasive plant species significantly alter ecosystem structure and function. *Arundo donax* is an invasive weed of riparian zones. Once established, it spreads by clonal expansion, which is dependent on the production of new shoots from rhizome We performed experiments to test the hypotheses that temperature (7, 8, 14, 16, or 20 °C) and nitrate concentration (0, 0.3, 0.6,1.2, 2.4, 3.6, 4.8, 6.0 mg/l nitrate) regulated the initiation of shoot production. No shoots emerged from rhizome sectior at 7 °C or 8 °C, but shoots emerged at 14 °C, 16 °C, and 20 °C. Neither time to shoot emergence nor the number of shoots that emerged was influenced by nitrate level in the watering solution. We used the above results in combination with shoot emergence data from rhizomes planted outdoors at Davis, California to develop degree-day equations for three separate cohorts of shoots. When compared to shoot emergence from different plants in a different year, there was very good agreement between predicted and actual shoot emergence, indicating that these equations provide a realistic representation processes involved in shoot emergence. This is an important step in developing integrated management plans for this invasive plant species.

Constructed Wetlands in Detention Ponds; Improving Water Quality and Preventing Harmful Algal Blooms

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Kiawah Island is a 13-mile barrier island located 21 miles south of Charleston, South Carolina. Like other coastal communities and barrier islands, Kiawah Island is buffered by detention ponds and small lakes, most of which are found near housing developments and golf courses. The water bodies are meant to filter non-point source pollution, reduce flooding, and often provide an aesthetic and recreational benefit. In recent years, the South Carolina Harmful Algal Bloom Program (SCHABP) has been monitoring Kiawah Island detention ponds and lakes for harmful algal blooms (HABs). In samples collected from the 2001 and 2002 sampling seasons, high concentrations of potentially toxic algal species (*Pfiesteria* spp., *Prymnesium parvum, Prorocentrum minimum, Chattonella* spp, *Fibrocapsa japonica, and Heterosigma akashiwo*) were observed and were associated with fish kill events in several instances. In addition to these toxic algal species, lake managers are also faced with nuisance macro-algal blooms that are a source of a large amount of complaints logged in a complaint database. Based on the eutrophic nature of the detention ponds and lakes, degraded water quality, high abundances of HAB species, and an increase in nuisance macro-algal species, proposed research efforts are concentrating on constructed wetlands as a best management practice (BMP) for these systems. The proposed constructed wetlands will act as a biofilter for nutrients and other contaminants that presumably stimulate bloom formation and maintenance.

Session IV: Aquatic Plant Biology, Ecology, Restoration, and Biocontrol

Role of Allelopathy in Determining Plant Community Composition in Ledbetter Embayment Mudflat of Kentucky Lake

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Observations of monotypic communities of *Eleocharis acicularis* within the Ledbetter embayment mudflat of Kentucky Lake suggested the presence of allelopathic interactions. Allelopathy is the direct or indirect effect of one plant on another mediated by organic chemicals that escape into the environment. Allelochemicals produced in the leaves escape as leachates, while those produced in the roots escape as exudates. Laboratory experiments using lettuce seed assays and photosynthetic rate comparisons suggested that allelopathic interactions occur. Experiments using plants that co-occur with *E. acicularis* indicate the presence of allelopathy in the mudflat environment. Species including *Potamogeton diversifolius, Rotala ramosior, Sagittaria montevidensis, Justicia americana, Xanthum strumarium,* and *Carex* spp. exhibited differential response to leachates from *E. acicularis*. Preliminary results suggest that allelopathy plays a role in determining plant community composition within the Ledbetter embayment mudflat.
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Blue-Green Algal Problems in the Midwest

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Planktonic blue-green algae (Cyanobacteria) have been problems in eutrophic lake systems around the world for many years. As elsewhere, the dominant genera in the Midwest are *Anabaena, Aphanizomenon,* and *Microcystis*. The reduction of blooms of these organisms has been the goal of numerous watershed management efforts and copper treatments through the years. New problem blue-greens have appeared in the Midwest within the past 10 years. For example, the discovery of blooms of the toxic planktonic species *Cylindrospermopsis raciborskii* in Ball Lake and Eagle Creek Reservoir in Indiana in 2001 spurred a great deal of concern. In addition, the mat-forming (*Oscillatoria*) and gelatinous mass-forming (*Nostoc*) blue-greens are proving to be difficult to control with copper. Life history details and responses of these problem blue-greens to algicides in bioassays will be discussed.

Evaluation of an Aquatic Bacterium as a Potential Microbial Algicide

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Bacterium SG-3 (NRRL B-30043) isolated from a commercial catfish pond in Louisiana lysed selected cyanobacteria (blue-green algae), including species of *Oscillatoria* and *Anabaena*. Sequence analysis of the 16S rRNA gene indicated a phylogenetic relationship to *Xanthomonas* spp. and that bacterium SG-3 could represent an undescribed genus and species. Lytic activity of the bacterium was quantified through assays of plaque forming units (PFU) produced in lawns of host cyanobacteria. When cultured on laboratory shakers, the bacterium produced 10^9 to 10^{10} PFU/mL of culture broth. Bacterium SG-3 was evaluated as a potential microbial algicide using 757-L polypropylene tanks containing 568-L of pond water and 10 channel catfish fingerlings per tank. In replicated studies using inoculum containing 2 x 10^9 PFU/mL, bacterium SG-3 consistently controlled *Oscillatoria* spp., including *O. perornata*, a species associated with 2-methylisoborneol (MIB) off-flavor in channel catfish. In one experiment *O. perornata* was reduced from an initial densi of 3,900 filaments/mL to 0 filaments/mL within 2 days after application of 5.7-L of bacterium SG-3 inoculum. In another experiment filament counts of an *Oscillatoria* sp. (*O. agardhii*) were reduced from an initial density of 3,700 filaments/mL 0 filaments per mL within 2 days after application of 1.9-L of bacterium SG-3 inoculum. A number of algal and cyanobacterial species, including *Microcystis* spp., were resistant to the bacterium. No adverse effects attributed to bacteri SG-3 were noted for the channel catfish fingerlings. Bacterium SG-3 has been patented for use as a microbial algicide (U.S. Patents 6,322,782 and 6,482,635).

Sensitivity of Mat-Forming Cyanobacteria to a Potential Biological Control Agent, Bacterium SG-3

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A bacterium (SG-3) (NRRL B-30043) lyses a number of planktonic species of cyanobacteria including bloom-forming species of *Anabaena* and *Oscillatoria*. The objective of this research was to determine the sensitivity to SG-3 of mat-formi cyanobacteria isolated from ponds in Indiana. The development of a biological control agent to manage cyanobacterial ma would be extremely useful since these organisms tend to be difficult to control with copper compounds. Ten isolates of mat-forming cyanobacteria representing seven species within the genera *Oscillatoria*, *Lyngbya*, and *Phormidium* were teste Plugs (0.5 cm diameter) were cut from mats of the cyanobacterium, inoculated with liquid cultures of SG-3, and incubated static cultures. The reduction in dry weights ranged from –0.5 percent to 90 percent compared to the untreated controls anc appeared to be species specific. For example, dry weight reductions of *Oscillatoria deflexoides* and *O. amoena* ranged fro 80 to 90 percent whereas the reduction of *O. limosa* tended to be lower at 36 to 72 percent. Although results varied among and within species, they indicate that this bacterium could have potential for use as a biological control for mat-forming cyanobacteria. Light microscopic observations indicate the bacteria do not penetrate the cyanobacteria cells. Currently, w are studying the possible causes of the observed cell lysis.

Development of *Mycoleptodiscus terrestris* as a Bioherbicide for Management of the Submersed Macrophyte, *Hydrilla verticillata*

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The indigenous fungal pathogen *Mycoleptodiscus terrestris* (Mt) has shown significant potential for use as a bioherbicide management of the invasive aquatic macrophyte *Hydrilla verticillata*. Liquid fermentation methods have been developed patented that yield stable, effective bioherbicidal propagules of Mt. Under appropriate nutritional conditions, aerated Mt cultures produce high concentrations of vegetative biomass that differentiates to form compact hyphal aggregates that we have termed microsclerotia (ms). The microsclerotia germinate both vegetatively and sporogenically thus improving thei potential to infect and kill hydrilla. Current research is focusing on optimization of fermentation in 100-liter fermentors t reduce fermentation times and costs while maintaining pathogen efficacy. Initial results suggest that these newly develop procedures where inoculum is harvested between 2 and 3 days provides better efficacy than that achieved previously with V-8 medium harvested at 6 days.

Introduction of Exotic Vascular Plants (*Pistia stratiotes* and *Eichhornia crassipes*) in the West Nakdong River, South Korea

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The distribution and change of aquatic vascular plant communities in the west Nakdong River were examined from 2001 to 2002. The west Nakdong River (length: 18km, width: 300 ~ 400m, mean depth: ~ 4m) is a branch river in which both inlet and outlet are controlled by floodgates and it serves as an agricultural water supply. A total of 26 species were observed, and the dominant species were *Phragmites australis* and *Trapa japonica*. When compared with a previous survey in 1985 (Yoon), we observed a reduction in standing crop (1985: 182.1, 2001: 113.9 g/dw/m2). Due to the accelerated eutrophication at the river-reservoir, the standing crop of submerged plants was markedly reduced and four species (*Najas marina, N. minor, Myriophyllum spicatum, Nymphoides indica*) had disappeared since the 1985 survey. After June 2001, exotic species, *Pistia stratiotes* and *Eichhornia crassipes*, were introduced from tributary to the river and they dominated (biomass ca. 75 percent) and covered the surface of the water (ca. 70 percent). This is the first reported case of proliferation of the exotic species. Introduction of the exotic species caused a decrease of indigenous plants including endangered species and food plants for waterfowl such as *T. japonica*, *Vallisneria asiatica* and *Potamogeton crispus*. In 2001, excessive growth of introduced floating plants (*P. stratiotes* and *E. crassipes*) caused serious ecological problems such as the decrease of water quality, biodiversity, and aquaculture. Busan Metropolitan City physically removed these species from the surface. In 2002, the exotic species did not appear again. Further studies should address the sudden proliferation of these species and systematic management strategies.

Interactions of Egeria (*Egeria densa*) and American Pondweed (*Potamogeton nodosus*) Grown Under Four Light Regimes

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Egeria densa, an invasive submersed macrophyte, has spread to ca. 7,000 acres in the California Sacramento-San Joaquin Delta during the past 5 to 7 years. Current management programs include understanding how *E. densa* interacts with native plants, whose revegetation will be important to overall ecosystem restoration. Since light is highly variable in this system due to seasonal changes in turbidity, tidal flows and stream-flow, we examined responses of plants grown from rooted cuttings of *E. densa* and winter buds of *P. nodosus* at 17-19 °C, alone, or together in various relative density ratios (e.g. 4PN, 1 PN, 3ED:1PN, 2ED:2PN, 1ED:3PN) under four light / water levels in recirculating, artificially illuminated columns (0.4, 0.8, 1.2 and 1.6 m deep having bottom irradiance of 517, 279, 158, and 87 μmoles/m^2/sec, respectively) for 3 months. Plant propagules (4) per replicate (3) were constant. Due to allocations of photosynthate to roots and winter buds, *P. nodosus* exhibited a bi-modal distribution (surface and sediment) in biomass at all depths whereas *E. densa* produced more evenly distributed biomass vertically. Intraspecies competition was evident since *P. nodosus* had lower leaf, root, stem, rhizome and winter bud production when four plants were planted per container versus one. *E. densa* appeared to inhibit winter bud production when 1, 2, or 3 cuttings were grown with *P. nodosus* at higher light, but less so at mid-light levels. *E. densa* showed similar intraspecies interaction, though vertical distribution remained more uniform than that of *P. nodosus*. These data as well as changes in tissue nitrogen in propagules and root crowns suggest that both species respond to irradiance as well as the presence of neighboring plants by altering allocation of photosynthate to standing crop in the water column as well as number and quality of storage tissues. This information may be useful in manipulating conditions for revegetation and understanding influences of invasive plant canopy structure on fish and invertebrate habitat.

Submersed Aquatic Plant Communities in Maryland Reservoirs: Management and Control

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Reservoirs are engineered to supply a reliable source of water and are not primarily created as functioning ecosystems. Thus, reservoirs are often dominated by non-native species that can colonize and establish competitive dominance first. We surveyed nine of mid-Maryland's reservoirs to determine the species composition of submersed aquatic plant communities. We then explored linkages between macrophyte control strategies (no control, mechanical control, chemical control, and sediment removal), biodiversity of submersed aquatic macrophytes and the abundance of non-native species. Six of the nine

reservoirs were dominated by *Hydrilla verticillata*. Reservoirs receiving no control (3) and mechanical control (2) were dominated by *H. verticillata* and were low in species diversity, whereas reservoirs that were treated with herbicides (3) and had sediment removed (1) had low abundance of plants. Our ongoing study shows that herbicide treatment is still the best strategy for controlling non-native species and for managing a high diversity of native species. We are now looking into strategies of planting native species to control the colonization and competitive ability of non-native species.

Hydroperiod Influence on Competition between *Panicum repens* and *Eleocharis cellulosa*

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Torpedograss (*Panicum repens*), a non-indigenous, terrestrial species, was intentionally introduced to Florida in the early 1900s as cattle fodder. Since its first observation in Lake Okeechobee in the 1970s, it has displaced an estimated 15,800 acres of native plants such as spikerush (*Eleocharis cellulosa*). Two studies were conducted to evaluate responses c spikerush and torpedograss to variations in water depth and hydroperiod to test the hypothesis that decreased hydroperiod would increase the likelihood of torpedograss expansion into spikerush-dominated habitat. Both competition studies were conducted in a 0.6-acre manmade experimental pond at the Lewisville Aquatic Ecosystem Research Facility. In the first study, bare or spikerush-covered substrates were subjected to exposure periods at 0 cm (moist soil) for 0, 4, 8, and 18 week during which time they were invaded by a 30-cm torpedograss fragment. Treatments were then subjected to one of two flooding conditions: 20 and 80 cm. In the second study, effects of sediment drying conditions (-25 cm) on the ability of spikerush to resist torpedograss invasion were analyzed. Bare or spikerush-covered substrates were invaded with a 30-cm torpedograss fragment for 2 weeks at 0 cm, after which, each treatment was subjected to one of two hydrologic conditions f the first growing season: -25 or 10 cm. After wintering in a greenhouse, treatments grown during the first year at –25 cm were inundated to one of three water depths (-25, 0 or 10 cm) and treatments grown during the first year at 10 cm were returned to depth. Results of these studies revealed that spikerush produced significantly more biomass when continually inundated to shallow depths (10 to 20 cm) compared with plants subjected to prolonged drying conditions (-25 cm) or deep inundations (80 cm). In contrast, torpedograss established more readily on exposed sediment (-25 to 0 cm) and biomass production increased as sediment exposure interval increased. Regardless of treatment, spikerush suppressed torpedograss invasion; however, invading torpedograss had no effect on established spikerush.

Evaluation of Four Sonar Formulations: Influence of Sediment Type on Fluridone Residuals and Efficac vs. Hydrilla

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An outdoor mesocosm study was designed to determine aqueous fluridone residuals following application of Sonar SRP, Sonar PR, Sonar Q, and Sonar A.S. to three different sediment types. Sediments were characterized as sand (>98 percent sand and <1 percent organic), organic (50 percent sand and 7 percent organic), and a flocculent muck layer (40 percent silt and 31 percent organic). Mesocosms were divided into three cells (each containing either sand, organic, or muck soils) via plexiglass dividers, and each cell was planted with a strain of fluridone-tolerant hydrilla. The plexiglass dividers were designed to allow free exchange of surface water, but no exchange of interstitial water between cells. Sonar pellets were applied to the center cell of each mesocosm to achieve a theoretical total of 50 ug/L in the 900-L mesocosms. Fluridone residues were collected on a weekly basis to determine fluridone release following application to each sediment type. Sediment type was found to have a significant influence on the release of fluridone from each formulation. Up to six-fold differences in fluridone residues were noted between sand and muck sediments for both Sonar PR and SRP. Comparison c formulations suggested that Sonar PR consistently provided higher residues in the water column compared to Sonar SRP regardless of sediment type. This trend remained consistent through the 168-day sampling period. Despite treating each mesocosm at the same nominal fluridone concentration, efficacy results varied widely. Application of Sonar SRP to the muck sediment resulted in biomass levels that were similar to untreated controls. Sonar A.S. provided the greatest reducti in hydrilla biomass. Despite application of Sonar pellets to the center mesocosm cell, no differences in efficacy were note between cells. Results suggest that pellet applications influence hydrilla control due to release of fluridone into the water column compared to root uptake. Comparisons of Sonar Q and Sonar PR are ongoing and residue results will be presente To date, data collected for Sonar SRP, PR, and Q release in a variety of sediment types indicates that sediments have a str influence on the release of fluridone from pellet formulations.

Session V: Mechanical Control and Chemical Control

The Use of an Automatic Weed Device as a Localized Control Method

Kevin Kretsch
Lake Restoration, Inc., Rogers, MN

The lake area next to a dock is the primary area for wading and swimming. Lake homeowners prefer this area to be free of aquatic weeds. An automatic weed device accomplishes this goal through repetitive movement. One automatic weed device is the Lake Sweeper. This product is strapped to a dock post. It takes about 15 minutes to install and is lightweight. A floating arm extends across the water 24 to 42 feet from the dock. Lightweight rakes attached to the arm brush the lake weeds with each pass. A pump provides the force to move a floating arm back and forth. This presentation will review the use of an automatic weed device on various types of aquatic plants at four separate sites. Species controlled in the test sites included: *Myriophyllum spicatum*, *Myriophyllum exalbescens*, *Elodea canadensis*, *Potamogeton richardsonii*, and *Vallisneria americana*. Lake weeds are eliminated in 3 to 5 days. The biomass at the end of 5 days approaches zero. The length of time depends upon the species and density of aquatic plants and the force provided by the pump. The repetitive brushing action causes the plants to be gradually worn down. A very limited amount of vegetation came to shore even on the windward side of the lakes. In addition, the effects of flowing water and wind will be discussed. How the device is affected by obstructions, lake bottom type etc. will also be presented.

Carfentrazone-ethyl: A Potential New Herbicide for Aquatic Plant Management

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Carfentrazone-ethyl is a phenyl triazolinone herbicide that inhibits protoporphyrinogen oxidase (Protox inhibitor) in the chlorophyll biosynthesis pathway. Currently, it is used in a variety of cropping systems to selectively control broadleaf weeds at low use concentrations (i.e. corn $\leq$ 9 grams a.i. ha^{-1}). The activity of carfentrazone-ethyl was evaluated on salvinia (*Salvinia minima*), duckweed (*Landoltia punctata*), water lettuce (*Pistia stratiotes*) and water hyacinth (*Eichhornia crassipes*). Each species was grown in dishpans (32-cm by 28-cm, 12-cm deep) in a greenhouse at the University of Florida, Center for Aquatic and Invasive Plants. Plants were treated using a CO_2-powered sprayer with a total spray volume equivalent to 748-L ha^{-1} containing a surfactant with 3 replications per concentration. A concentration causing a 90-percent reduction (EC_{90}) in dry weight was calculated using non-linear regression. Water lettuce was the most susceptible species with the EC_{90} being 33.6 grams ha^{-1} in two replicated trials. The EC_{90} for two replicated experiments on water hyacinth was 112.1 grams ha^{-1}, and for salvinia it was 44.8 grams ha^{-1}. Duckweed was the most tolerant with an EC_{90} value of 784.7 grams ha^{-1}. Carfentrazone-ethyl provided acceptable levels of control for all species except duckweed in approximately 30 days from the time of treatment.

Sensitivity of Dotted Duckweed (*Landoltia punctata*) to Diquat (Reward®) in Florida

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Recent reports of decline in control of duckweed with diquat in Lake County, FL led to the initiation of a series of studies at Syngenta's Vero Beach Research Center and the University of Florida's Center for Aquatic Plants to compare the response of different accessions. Data will be presented that show there was significant variation in response of duckweed accessions to diquat. *Landoltia punctata*, a non-indigenous species, was predominant in the areas of control failure in Lake County. Greenhouse and field studies confirmed the insensitivity of this accession to diquat at normal use rates compared to very sensitive *L. punctata* biotypes. The addition of chelated copper (Komeen®) to diquat provided excellent control of insensitive *L. punctata*.

Selective Whole-Lake Management of *Myriophyllum spicatum* (Eurasian Watermilfoil) with Low-D Treatment of Fluridone Herbicide: Houghton Lake, Michigan

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In May 2002, fluridone aquatic herbicide (tradename: Sonar A.S.) was applied in a whole-lake treatment of Hough the largest inland lake in the state of Michigan, to control *Myriophyllum spicatum* (Eurasian watermilfoil). Previou lake fluridone treatments had demonstrated the principle of selective control of this species. Nonetheless, at 20,100 (8,134 ha), Houghton Lake represented a 25-fold increase in size compared to prior treatments for selective *M. spic* control. In 2001, satellite and field monitoring indicated *M. spicatum* presence in 10,000+ acres, with moderate to c coverage in 5,300 acres. Due to the magnitude of the problem and concerns with water quality, the slow-acting car synthesis inhibitor fluridone was identified as the best management alternative. Pre-treatment sampling and assays *M. spicatum* from Houghton Lake confirmed a phytoxic response to fluridone was likely using low-dose protocol. 15 and June 5, 2002, fluridone was applied to the top 10 feet of the lake in two separate treatments of 6 and 2.8 µg l (658 and 307 gallons Sonar A.S.) respectively. Post-treatment monitoring of fluridone residues (ELISA) and bioch response of treated *M. spicatum* confirmed that theoretical target fluridone residues were reached and maintained ar *M. spicatum* showed a phytoxic response throughout the three-month treatment period. Late summer 2002 satellite measurements documented a 91-percent reduction in the overall presence of *M. spicatum* versus 2001 and a decreas of topped-out / near-surface *M. spicatum* from 3,100 acres in 2001 to near-zero in 2002.

Parrot's Feather and Alligator Weed Versus Triclopyr Amine

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National Institute of Water and Atmospheric Research (NIWA), Hamilton, New Zealand

The sprawling marginal aquatic weeds parrot's feather and alligator weed are invasive alien plants in New Zealand. weed was introduced to New Zealand via ballast, and parrot's feather as an ornamental garden pond plant. Today, t spread is largely by contaminated drainage machinery and subsequent water movement. Both species pose a seriou waterways in New Zealand as they continue to spread south and increase their range and deleterious impacts on ind biodiversity, and drainage and irrigation systems. Control methods include mechanical harvesting or excavation, w provides immediate control but also results in fragmentation and potential spread of the weeds. Classical biocontro are present for alligator weed, which reduce floating mats of alligator weed in the late summer and autumn (fall), b successful in cooler regions, nor on terrestrial alligator weed. Chemical control is achieved with metsulfuron and t amine plus picloram in terrestrial alligator weed, and glyphosate is used to control alligator weed and parrot's feath over water. However, only short-term control is achieved in aquatic situations, and several repeat applications are per growing season. Both contained and field trials have been undertaken over the last three years to evaluate alter products to those currently used, for their efficacy on parrot's feather and alligator weed in aquatic habitats. Result that triclopyr amine provides effective control of both parrot's feather and alligator weed, and is significantly bette glyphosate. The registration of triclopyr amine for aquatic use in New Zealand is advocated.

The Reward Rapid Release™ Test: A Water Management Tool for Sensitive Use Sites Such as Re Canals, and Lakes

James F. Brady[1] and Jim Petta[2]

[1] *Syngenta Crop Protection, Inc., Greensboro, NC*

[2] *Syngenta Crop Protection, Inc., New Braunfels, TX*

The Reward Rapid Release™ test is based on an immunochromatographic test strip developed by Syngenta for us management systems. The test strip utilizes diquat antibodies to detect low levels of diquat in water. A test kit w developed to allow plant managers and water treatment personnel to qualitatively determine the concentration of c sensitive areas such as potable water intakes, reservoirs, and irrigation canals. Negative test results may enable uti treated water much sooner than the table listed within the Reward® label. Laboratory validation studies indicate

is accurate and reliable. The development and technical attributes of the monitoring system will be discussed along with its practical application merits for aquatic plant managers.

Reward AccuGel™: A Precision Placement Formulation of Diquat for the Management of Invasive and Nuisance Plants in Both Static and Flowing Systems

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Reward AccuGel™ is a novel, gel formulation of diquat which can be precisely placed to remove invasive and nuisance vegetation in sensitive aquatic and wetland areas. Reward AccuGel™ is a viscous gel, specially formulated for the control of submersed weeds in both static and flowing systems. The gel sinks down to the target plants where it binds because it is heavier than water and releases diquat at the target sites. In flowing waterways such as irrigation canals and streams, Reward AccuGel™ can be applied upstream and allowed to sink and move to the target area, where it binds in the plant biomass with enough exposure time to provide control. Lower use rates may be realized since the material is applied directly to the plants. Reward AccuGel™ was found to be highly effective for controlling hydrilla, milfoil, sago pondweed, and duckweed. Data from various trials around the United States will be discussed.

Impact of Sonar Treatments on Turion Populations of Hydrilla and Curlyleaf Pondweed

Michael D. Netherland
SePRO Corporation Carmel, IN

The exotic submersed species hydrilla (*Hydrilla verticillata* (L.f.) Royle) and curlyleaf pondweed (*Potamogeton crispus* L.) both exhibit prolific production of turions. These vegetative propagules can easily be found in the millions per acre and they are key in the life histories of both plants. Moreover, the turion's quiescent nature and lack of response to aquatic herbicides has presented significant long-term challenges in managing hydrilla and curlyleaf pondweed. The aquatic herbicide Sonar (active ingredient fluridone) has been widely used to manage submersed vegetation; however, impacts on turions have not been well-documented. Field sampling efforts were initiated on two lakes in 1999 to document the impact of fall and early spring Sonar treatments on curlyleaf pondweed turion populations over several seasons. Results suggest that timing of Sonar treatments is critical in reducing curlyleaf pondweed turion production. Moreover, while a single Sonar application significantly reduced turion populations, the number of viable turions that remained was at a level that would likely lead to a significant infestation the following year. Sequential low-rate treatments yielded long-term (4 years) turion reduction. Field sampling efforts for hydrilla were initiated to determine subterranean turion (tuber) population response following 2 years of intense management. Tuber sampling in a 300-acre lake suggested that the majority of the tubers remained quiescent in 2000, 2001, and the spring of 2002. In the fall of 2002, *in situ* tuber sprouting increased from an average of 4 percent to 91 percent. Subsequent tuber sampling in the spring of 2003 confirmed that the tuber population had decreased by over 86 percent compared to sampling done in the fall of 2002. Sampling in lakes with hydrilla that exhibits increased fluridone tolerance suggests that while the growth response is muted, tuber production remains impacted by low rates of fluridone.

Hyperspectral Mapping of Submerged Aquatic Vegetation in Lake Rosalie, FL

Oliver Weatherbee
3Di Technologies, Inc., Easton, MD

3Di performed an aerial survey on Lake Rosalie with an AISA hyperspectral sensor to locate and map the aquatic vegetation in the lake. ENSR International provided water quality, vegetation verification, and bathymetry surveys in support of the aerial surveys. The 3Di aerial data were analyzed to provide a location and density map which was used by Griffin, LLC to recommend a treatment program to eradicate unwanted aquatic vegetation in the lake.

Poster Session

U.S. Army Corps of Engineers Aquatic Plant Control Research Program

Robert C. Gunkel, Jr.
U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

The U.S. Army Corps of Engineers (CE) Aquatic Plant Control Research Program (APCRP) is the Nation's only fed authorized research program directed to develop technology for the management of invasive aquatic plants. The AP designed to provide cost-effective, environmentally compatible aquatic plant management technologies, which addre national needs and priorities. Research efforts are focused on the biology, ecology, and management of invasive aqu plants; developing biological, chemical, ecological, and integrated management methods. The APCRP is committed development, transfer, and implementation of aquatic plant management technologies, and will continue to lead the I the future.

APCRP Chemical Control Research: A National R&D Agenda

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

The U.S. Army Corps of Engineers' Aquatic Plant Control Research Program (APCRP) is the only federally authori research program for aquatic plant management. Operating under the purview of the APCRP, the Chemical Control Physiological Processes Team develops and evaluates environmentally sound strategies for managing invasive aquat wetland plants using herbicides. These evaluations are conducted in customized controlled-environment chambers, greenhouses, outdoor mesocosms and ponds in Vicksburg, MS and Lewisville, TX. Results of small-scale studies ar verified in field sites (lakes, reservoirs, rivers, and wetlands) throughout the United States. Research focus areas incl a) selective control of target plants to restore native plant communities; b) protection of threatened and endangered p species; c) low-dose application technology; d) product tolerance and resistance issues; and e) integration of control with ecological principles. Work is conducted in collaboration with Federal and state agencies, academia, and the pr sector. In addition, frequent coordination with the U.S. Environmental Protection Agency and similar state agencies undertaken to support the registration of new aquatic herbicides and amendments to established labels. Finally, infor and technology developed via research efforts are transferred to natural resource agencies, the private sector, and the public through the publication of technical reports, popular articles, and the peer-reviewed scientific literature.

Ecological Attributes of Exotic and Native Aquatic Plant Communities

R. Michael Smart[1], Gary O. Dick[2], Joe R. Snow[2], David R. Honnell[2], and Dian H.Smith[2]
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The objective of this Aquatic Plant Control Research Program work unit is to document the ecological attributes of e and native plant communities. This information is needed to help justify management of exotic plants and restoratio native aquatic plant communities. Replicate ponds were planted with hydrilla, Eurasian watermilfoil, or with a dive assemblage of native plants. Species composition of the developing vegetative communities was assessed at regular during 2000, as exotic species achieved increasing dominance in their respective ponds. Although similar initially, water quality parameters, including DO and pH diverged as plant communities matured. Percent light transmission differed by vegetation type as canopies developed. Differences in biotic components measured in each pond, which periodic assessments of phytoplankton, zooplankton, macroinvertebrates, amphibians, reptiles, and waterfowl, were dependent upon the group surveyed. In some cases, the dominant plant community influenced population structures pond was stocked with largemouth bass and bluegill to assess fish habitat values, and differences were detected in s growth, and reproduction of both fish species dependent upon dominant plant species.

An Overview of Ecological Research within the APCRP

R. Michael Smart
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The U.S. Army Corps of Engineers' Aquatic Plant Control Research Program (APCRP) is the only federally authorized research program for aquatic plant management. Research conducted within the ecological technology area of the program focuses on the biology and ecology of invasive plants, on the role that aquatic plants play in aquatic ecosystems, and on the development of holistic, ecosystem approaches to aquatic plant management. The goal of this research is to develop an understanding of aquatic plants (both native and exotic) and their interactions with other components of the ecosystem, so that chemical, mechanical, cultural, and biological methods of control can be integrated within an ecosystem-based approach to managing vegetation in our aquatic resources. In many cases the goal of aquatic plant management will be the development of self-sustaining and diverse communities dominated by native plants.

New Advancements and Understandings in the Use of Insect Biological Control for the Management of Aquatic Plants

Michael J. Grodowitz
U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

The biological control technology area has been pursuing three major research areas, including 1) developing cost-effective mass-rearing methods; 2) elucidating how various factors affect insect agents; and 3) understanding mechanisms of insect impact. The ability to produce and introduce large numbers of quality insects is an important determinant of success. Toward this goal, a mass-rearing facility has been developed at the Lewisville Aquatic Ecosystem Research Facility. Over one million *Hydrellia* immatures have been reared and released at locations in Texas and Florida for hydrilla management. A series of pond manipulations have been attempted at this facility to produce higher numbers including fertilization and culturing hydrilla during different times of the growing season. While fertilization appears to be logistically difficult, maintaining new growth hydrilla at different times of the year seems to promote higher and longer-lasting fly numbers. Experiments have been accomplished understanding the influence of nutrition, parasitism, and predation on the agents. Toward this goal, small-scale pond experimentation, now into the second growing season, has been conducted in an effort to evaluate impact on hydrilla growth and competitive advantage. In order to better evaluate nutritional effects in the hydrilla fly and the Eurasian watermilfoil weevil, age-grading systems based on ovarian morphology have been developed. The behavior of a hydrilla fly parasite has been studied and quantified in an effort to understand its basic biology and potential impact. Future studies include developing mass-rearing capabilities for other species including the salvinia weevil, determining nutritional impacts, and re-evaluating the importance of overseas research to identify new agents.

Major Blockages in the Okavango Delta, Botswana

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The Okavango Delta system in Botswana is the largest 'Ramsar Site' under the "Ramsar Convention of Wetlands." It lies between $18^0 15' S$, $021^0 45' E$ and $20^0 45' S$, $023^0 53' E$. The water flow regimes are bound to remain unstable and unpredictable, as the factors such as sedimentation, erosion, waterweeds and vegetation blockages that govern the system are complex. The floating living and non-living material determine the water flow pattern in the channels. The poster deals with the sites of the blockages in the various channels, indigenous and exotic plants of blockages, bush fires and their impact on the potential distal wetlands of the ecosystem.

Herbicides and Prescribed Burning for Control of *Phragmites australis* at St. Johns Marsh, Michigan

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A field study was conducted to evaluate and compare the effectiveness of herbicide treatments applied with and without prescribed burning for control of the invasive wetland plant, *Phragmites australis* (Cav.) Steudel. Herbicide treatments included 3.36 kg ae ha^{-1} glyphosate, 0.84 kg ae ha^{-1} imazapyr, and 1.12 kg ae ha^{-1} glyphosate + 0.56 kg ae ha^{-1} imazapyr. Herbicides were applied in mid-August when *P. australis* was mature and flowering; controlled burning was conducted on designated plots seven months following herbicide application. Changes in percent cover of *P. australis* and the native wet-prairie plants were determined using quadrat sampling along permanently marked transects established in each plot. All of the herbicides significantly reduced *P. australis* compared to untreated controls 1 year after treatment (YAT). Reductions in *P. australis* cover ranged from 87 to 98 percent; there were no statistical differences among herbicides. There was no interaction between burning and herbicide application with respect to control of *P. australis*. Plots treated with herbicide followed by burning showed a 12-percent increase in recovery of native plant species 1 YAT. Herbicide-treated plots without burning did not show a significant post-burn release of native species. Native plant recruitment in herbicide-burn plots can be attributed to the removal of dead *P. australis* biomass, which increased light and heat penetration to the soil surface thus enabling rapid seed germination. Future post-treatment evaluations will provide additional information on the duration of *P. australis* control as well as the diversity and recovery of native wet-prairie plants.

Does the Alien *Potamogeton crispus* Hybridise with the Native *P. ochreatus* in New Zealand?

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In New Zealand there are five pondweed species, four of which are native and one of which, *Potamogeton crispus,* is alien. Although *P. crispus* has high wildlife utilization value it can be a serious weed problem in waterways, and may also be impacting on the biodiversity of a desirable native pondweed species, *Potamogeton ochreatus* as a result of putative hybridization. Lake surveys have frequently shown the occurrence of pondweeds with intermediate morphology, exhibiting characteristics of both *P. crispus* and *P. ochreatus*. Among other species of pondweed, both extensive morphological variation and known hybrids including *P. crispus* hybrids are recognized. This study was undertaken to determine if the observed morphological differences among some New Zealand pondweeds were due to genetic differences, from the hybridization of *P. crispus* and *P. ochreatus,* or the result of phenotypic plasticity. Pondweeds were collected from distinct populations of each species and morphologically intermediate populations, cultured and analyzed for genetic variation. Genetic variation was assessed using DNA sequences that have previously been used to confirm hybrid origin in other plant species. Preliminary results show that the ITS (Internal Transcribed Spacer) region is useful at delimiting between these two species, and a putative hybrid individual has been identified.

Tissue C and N for Water Hyacinth in the Sacramento Delta: Implications for Biological Control

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USDA-ARS Exotic and Invasive Weeds Research Unit, University of California-Davis, Davis, CA

Water hyacinth (*Eichhornia crassipes* (Mart.) Solms), is a serious problem in the Sacramento Delta. Two weevil species have been introduced as biological control agents. To date, they have not had long-term impact on water hyacinth abundance. Many factors such as weather, disease, predators, and plant quality affect growth and reproduction of insect herbivores. The purpose of this study was to test the hypothesis that water hyacinth tissue N was not sufficient to support weevil growth and reproduction. Water hyacinth in Whiskey Slough were sampled at 2- to 3-week intervals in 1995, 1996, and 1997. Leaf samples were analyzed for tissue C and N. Tissue C varied less (coefficient of variation (CV) = 7 percent) than either tissue N (CV = 50 percent) or the C:N ratio (CV = 65 percent). Tissue N was greatest in the leaf lamina, followed by leaf petioles, and lowest values were measured in stem bases. Lamina tissue N was higher in spring and somewhat reduced in late summer and winter. The lamina C:N ratio was generally < 15 after mid-May. Comparing tissue N levels for Delta water hyacinth with published data relating weevil growth to tissue N indicates that tissue N should be sufficient for growth and reproduction of either weevil species in the Delta. However, because it grows better on plants with high N

content and because it has a greater impact on the growth of high N plants, *N. bruchi* would be a more effective biological control agent in the Sacramento Delta.

Pathogen Research on Aquatic Plants

Judy F. Shearer, Linda Nelson, and Dwilette McFarland
U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Biocontrol pathogen research at the U.S. Army Engineer Research and Development Center, Vicksburg, MS currently addresses four areas: development of mycoherbides for aquatic plant control; role of pathogens as endophytes in aquatic plants; effect of biotic and abiotic factors on pathogenicity; and integration of pathogens with herbicides for aquatic plant control. In our goal to develop *Mycoleptodiscus terrestris* as a mycoherbicide for hydrilla management, cooperative research with the USDA/ARS/NCAUR has led to a compositional matter patent for pathogens of aquatic plants. Endophytes have only recently been documented in aquatic plants. Plants usually remain asymptomatic to their presence; however, in recent studies on Eurasian watermilfoil it appears that when stress conditions compromise the host plant these usually benign organisms may become pathogenic. The nutritional condition of the host may also render it more or less susceptible to invasion by a pathogen. Nutritional studies have indicated that hydrilla plants that have high nitrogen content in their leaves are more susceptible to pathogen ingress and subsequent disease development. Finally, using an integrated approach to aquatic plant control we have shown that low rates of pathogens and herbicides applied in combination are significantly more effective in providing excellent control than either applied alone.

Fragment Production of *Hydrilla verticillata* by a Boat Motor

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Hydrilla verticillata (L.f.) Royle is an invasive, nonindigenous submersed aquatic plant, which was first discovered in the United States in the 1960's. Once hydrilla invades an aquatic ecosystem, several possible factors can contribute to its spread throughout the system, including localized spread via development of stolons, and dispersal via turion and stem fragments. It has long been suspected that one of the chief methods of hydrilla fragmentation and dispersal in some aquatic systems has been via boat traffic; however, little data has been published on fragmentation of hydrilla by boating activities. This study focuses on quantifying the generation of hydrilla fragments by a boat powered by a 75-hp outboard motor in canopies ranging from 30 to 120 cm below the water surface. Significantly greater hydrilla fragment numbers and biomass were produced when the lower unit of the outboard (60 cm below water surface) was in direct contact with the hydrilla canopy. Much less fragmentation occurred when the canopy was below the depth of the boat unit (> 70 cm). This research indicates that fragment dispersal within lakes could be reduced if boating traffic was restricted in areas of topped-out hydrilla.

Modeling Competition Between Submersed Macrophyte Species

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A simulation model has been developed that focuses on the ability of two competing submersed plant groups, (canopy-forming and non-canopy-forming, respectively) to maintain their biomass at different environmental conditions. Sago pondweed serves as the example for canopy-forming plants, and American wildcelery for non-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 groups compete for light and exhibit different species-characteristic elemental use efficiencies for nitrogen (N) and phosphorus (P). A direct relationship between submersed plant growth, and N and P availability in the sediment has not been found. However, indirect relationships between N and P use efficiency and total N and P accumulated in the plants (g dry weight per mg element accumulated) have successfully been established for several species. These relationships indicate that relatively more biomass is produced per unit of element at low levels of plant elemental accumulation than at high levels. This model is based partly on insights gained from previously developed growth models for macrophyte species with light as a limiting

factor. Initial simulation results will be verified by comparison with new experimental data on the growth responses of both plant species to different interstitial N and P concentrations.

Impact of Waterfowl Foraging on *Scirpus triqueter* in the Nakdong River Estuary, South Korea

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The Nakdong River Estuary (S. Korea), an area of approximately 125 km^2, consists of well-developed delta and tidal mudflats. The Nakdong River estuary is an important habitat for wintering birds in the East Asia-Australia flyway. *Phragmites australis* and *Scirpus triqueter* of the Nakdong Estuary are generally regarded as ecologically beneficial plants providing habitat and a food source for wildlife. The foraging influence and distribution of food plants for waterfowl was evaluated using enclosures. *Scirpus triqueter*, a major food plant for wintering waterfowl (ca. 60,000 ind.), was dominant in the estuary. This species occupied about 250 ha in 1993. However, construction of a residential area recently caused a reduction of 50 ha. Enclosures (12 plots 1.5 m^2 in size, mesh size 3 cm) were placed to compare the impact of waterfowl (mainly swan, ca. 30,000 ind.) grazing on aboveground and underground biomass from October 2002 to February 2003. Ten-day to monthly interval measurements indicated that the waterfowl foraged mainly on *S. triqueter* tubers. Waterfowl extensively grazed over 60 percent of tubers in the first 10 days since their arrival in mid October; thereafter, the feeding rate gradually decreased. Statistical differences could be observed between the grazed (1.1 ± 0.9 g/·dw/m^{-2}, n=10) and ungrazed sites (86.1 ± 19.3 g/·dw/m^{-2}, n=10) ($|t|=13.9$, $p<0.001$, $\alpha=0.05$). The impacted plant bed became an almost plant-free mudflat, while decomposition of plants in the covered area was very slow. *S. triqueter* plays an important role as a habitat and food source in the Nakdong estuarine ecosystem. Thus, a management plan for the *S. triqueter* bed, including restoration, should be considered to maintain the ecosystem integrity of the estuary.

Evaluation of Two Methods for Applying Dilute Acetic Acid for American Pondweed Winter Bud Control in the Nevada Irrigation District, California

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American pondweed (*Potamogeton nodosus* Poir.) is commonly found in northern California irrigation canals. The purposes of this study were to evaluate novel methods for applying dilute acetic acid to exposed sediments and to test the hypothesis that exposure of American pondweed winter buds to dilute acetic acid under field conditions would result in reduced survivorship and subsequent biomass. The treatment consisted of adding either 1703 or 3406 L of 2.3-percent acetic acid per 83-m^2 plot. Acetic acid was applied using either drip tape (six plots) or soaker hoses (three plots). Six weeks after treatment, we collected nine samples from each plot for biomass determination. American pondweed biomass was reduced (ANOVA, $P < 0.001$) by the acetic acid application. The reduction was observed for samples collected from the sides as well as the canal bottom when 3406 L per plot were applied. At the lower rate, there was slightly more biomass on the sides of the canal. These results confirm findings from earlier laboratory/greenhouse experiments, and suggest that application of dilute acetic acid solutions (2.3 percent) by drip irrigation tape may be useful in the management of American pondweed in systems that can have the water removed temporarily.

Role of Flooding Stress Tolerance in Determining Plant Community Composition in Ledbetter Embayment Mudflat of Kentucky Lake

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Chlorophyll fluorescence is the emission of energy as light from excited electrons in plants. Under "normal" conditions the energy would be used to produce ATP and NADPH. When the light-dependent reactions of photosynthesis are decoupled from the light-independent reactions, fluorescence occurs. Fluorescence estimates the amount of absorbed quanta that are not used in photosynthesis. The more light that is emitted, the more stressed the plant. Two hypotheses were defined: Aerial leaves from *Justicia americana* plants exhibit acclimation to the aerial environment; and submersed leaves do not exhibit acclimation to the aerial environment. Using pulse-modulated chlorophyll fluorescence, it was found that aerial leaves exhibit less stress in the submersed environment than submersed leaves in the aerial environment. When the environment

was changed, the amount of stress increased in both submersed and aerial leaves suggesting that each leaf type performs best in the environment in which it developed.
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Role of Competition in Determining Plant Community Composition in Ledbetter Embayment Mudflat of Kentucky Lake

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Distinct plant communities exist within the mudflat of Kentucky Lake reservoir. Annual plant communities dominate locations that are frequently disturbed by vegetation-killing flooding, while perennial communities dominate less disturbed locations. Combinations of greenhouse and field studies provide data concerning competition for above- and below-ground resources, and the distribution of annual species throughout the mudflat.
*Undergraduate Research Fellow supported by NSF-CRUI DBI-9978797.

Effects of Soils and Hydrology in Determining Plant Community Composition in Ledbetter Embayment Mudflat of Kentucky Lake

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Ledbetter Embayment mudflat is a hydrologically dynamic system within Kentucky Lake reservoir. Extreme heterogeneity exists in soil composition throughout the mudflat. Soils are reworked by frequent changes in Ledbetter Creek channel meandering. Sediment laden runoff from adjacent uplands, and slack-water deposition of clay and silt during recreation pool levels also contributes materials to the soils. Distinct plant community boundaries appear to be related to soil composition and hydrology.
*Undergraduate Research Fellow supported by NSF-CRUI DBI-9978797.

The Impact of Copper on Aluminum in an Aquatic Environment

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In an attempt to answer questions regarding interaction of copper-based aquatic herbicides and aluminum boats in some southern waters, cooperative university and industry studies have been conducted over the past two years. Water and sediment samples were collected to facilitate development of controlled environments where interaction between aluminum and as many different variables as might be controlled, could be studied. Chemical analysis was conducted to determine presence or absence of copper before initiation of testing as well as during studies to assure that intended study levels were in place. In preparation for evaluation, the water collected for the study from a lake where corrosion of aluminum boats had been reported was characterized and found to be high in dissolved minerals; it is worth noting that this lake was in a heavy drought area and in a state of significant pull-down. Water from a lake up chain from the problem and characterized as oligotrophic, was also sampled for testing. Results indicated that copper level variation did affect corrosion of aluminum, but that the source of copper salt used in the commercial products tested or products from multiple manufacturers show no variation in regard to impact on corrosion. There were differences in the level of corrosion observed between waters characterized as oligotrophic and those high in dissolved minerals; as the literature suggests the greatest opportunity for corrosion existed in the water high in dissolved minerals. In an attempt to determine if copper was causative for some of the differences in corrosion level observed, oxidative samples were scrapped from corroded aluminum strips from the testing and analyzed for copper. Little or no copper was found, suggesting copper to be only catalytic if involved at all in the process. Further testing of aluminum in the problem water confirmed literature references for the use of zinc anodes to protect aluminum boats from corrosion. The literature broadly describes corrosion resulting from a variety of causes relating to a cathodic reaction set up by a variety of fugitive electrical currents from numerous sources. It was clearly shown that the addition of a zinc anode, as widely recommended by the boating industry, protected aluminum from corrosion under all test conditions. It was concluded that copper herbicides commercially available for control of weeds in aquatic environments are not in themselves the primary cause for corrosion of aluminum boats, though they may be indirectly involved. Testing showed a rapid reduction of copper from the water column, most gone in 12 hours, with that not absorbed by the target organism going to the sediment. Testing to dislodge copper from sediment using commonly accepted methods failed to

create detectible levels in water as measured analytically or in bio-assay using extremely sensitive species – *Hyalella azteca* Soussure and *Ceriodaphnia dubia* Richard.

Aquatic Plant Management in Oregon Following the Talent Decision

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Washington and California have developed NPDES permits for aquatic herbicide application in response to the Ninth Circuit Court of Appeals decision in the Talent vs. Headwaters case in 2001. Oregon, where the case originated, has yet to develop a permit, which limits options for aquatic weed management in the state. The Lake Oswego Corporation, which manages Oswego Lake, a 400-acre lake located near Portland, has pioneered aquatic weed management in Oregon since the court decision. The corporation developed a Memorandum of Agreement and Order (MAO) with the Oregon Department of Environmental Quality in lieu of an NPDES permit. The MAO details an integrated approach for managing aquatic weeds in the lake that includes use of herbicides. While not protective from third-party lawsuits, the MAO contains the detailed restrictions and monitoring typical of a NPDES permit. The Corporation has implemented weed management in Oswego Lake for two years under the MAO. Management of aquatic weeds in the lake is truly integrated, and includes prevention of new introductions, chemical treatments, mechanical harvesting, and hand-pulling by divers. Environmental organizations reviewed the MAO prior to its approval and no problems have been encountered using herbicides in this highly visible urban lake. The Oswego Lake MAO can be used as a template for developing integrated management plans for Oregon lakes that include use of herbicides.

Past Meeting Sites and Presidents

1961	Boca Grande, Florida	Alfred S. Chipley
1962	Fort Lauderdale, Florida	T. W. Miller, Jr.
1963	Tampa, Florida	William Dryden
1964	Tallahassee, Florida	Herbert J. Friedman
1965	Palm Beach, Florida	John W. Woods
1966	Lakeland, Florida	Zeb Grant
1967	Fort Myers, Florida	James D. Gorman
1968	Winter Park, Florida	Robert D. Blackman
1969	West Palm Beach, Florida	Frank L. Wilson
1970	Huntsville, Alabama	Paul R. Cohee
1971	Tampa, Florida	Stanley C. Abramson
1972	Miami Springs, Florida	Robert J. Gates
1973	New Orleans, Louisiana	Brandt G. Watson
1974	Winter Park, Florida	Alva P. Burkhalter
1975	San Antonio, Texas	Lou V. Guerra
1976	Fort Lauderdale, Florida	Ray A. Spirnock
1977	Minneapolis, Minnesota	Robert W. Geiger
1978	Jacksonville, Florida	Donald V. Lee
1979	Chattanooga, Tennessee	Julian J. Raynes
1980	Sarasota, Florida	William N. Rushing
1981	Jackson, Mississippi	Nelson Virden
1982	Las Vegas, Nevada	Roy L. Clark
1983	Lake Buena Vista, Florida	Emory E. McKeithen
1984	Richmond, Virginia	A. Leon Bates
1985	Vancouver, British Columbia	Max C. McCowen
1986	Sarasota, Florida	Lars W. J. Anderson
1987	Savannah, Georgia	Dean F. Martin
1988	New Orleans, Louisiana	Richard D. Comes
1989	Scottsdale, Arizona	Richard Couch
1990	Mobile, Alabama	David L. Sutton
1991	Dearborn, Michigan	Joseph C. Joyce
1992	Daytona Beach, Florida	Randall K. Stocker
1993	Charleston, South Carolina	Clarke Hudson
1994	San Antonio, Texas	S. Joseph Zolczynski
1995	Bellevue, Washington	Steven J. de Kozlowski
1996	Burlington, Vermont	Terence M. McNabb
1997	Fort Myers, Florida	Kurt D. Getsinger
1998	Memphis, Tennessee	Alison M. Fox
1999	Asheville, North Carolina	David F. Spencer
2000	San Diego, California	J. Lewis Decell
2001	Minneapolis, Minnesota	Jim Schmidt
2002	Keystone, Colorado	David P. Tarver
2003	Portland, Maine	Richard Hinterman

The Program was developed from the best information available at the time of printing. Please bring any omissions or errors to the attention of Ken Manuel, Program Chair. Thank you for your understanding.