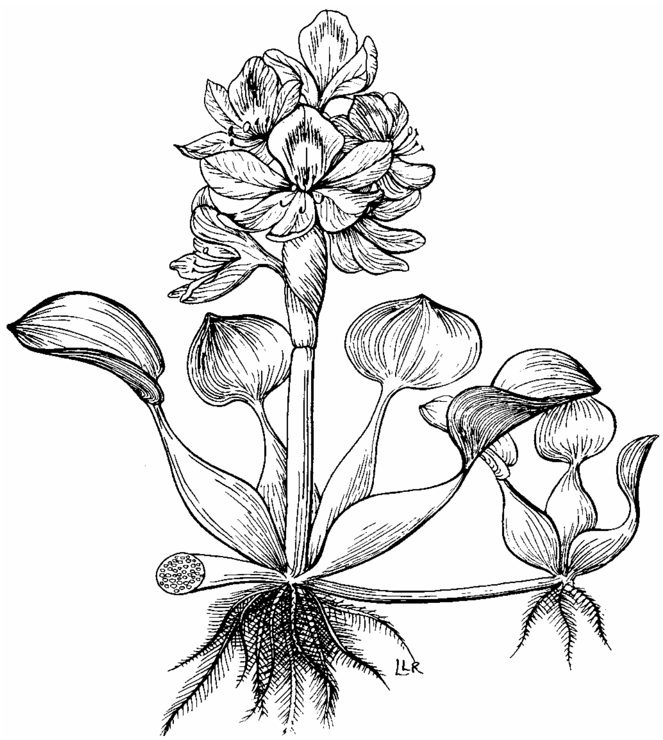
The Aquatic Plant Management Society, Inc.

45th Annual Meeting



PROGRAM

July 10 - 13, 2005
Hyatt Regency San Antonio
San Antonio, Texas

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Publications	Mike Netherland
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Scholastic Endowment	Shaun Hyde
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Website	Mike Grodowitz and Dave Petty
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Past APMS Presidents and Meeting Sites

1961	T. W. Miller, Jr.	Fort Lauderdale, Florida
1962	T. W. Miller, Jr.	Fort Lauderdale, Florida
1963	William Dryden	Tampa, Florida
1964	Herbert J. Friedman	Tallahassee, Florida
1965	John W. Woods	Palm Beach, Florida
1966	Zeb Grant	Lakeland, Florida
1967	James D. Gorman	Fort Myers, Florida
1968	Robert D. Blackburn	Winter Park, Florida
1969	Frank L. Wilson	West Palm Beach, Florida
1970	Paul R. Cohee	Huntsville, Alabama
1971	Stanley C. Abramson	Tampa, Florida
1972	Robert J. Gates	Miami Springs, Florida
1973	Brandt G. Watson	New Orleans, Louisiana
1974	Alva P. Burkhalter	Winter Park, Florida
1975	Lou V. Guerra	San Antonio, Texas
1976	Ray A. Spirnock	Fort Lauderdale, Florida
1977	Robert W. Geiger	Minneapolis, Minnesota
1978	Donald V. Lee	Jacksonville, Florida
1979	Julian J. Raynes	Chattanooga, Tennessee
1980	William N. Rushing	Sarasota, Florida
1981	Nelson Virden	Jackson, Mississippi
1982	Roy L. Clark	Las Vegas, Nevada
1983	Emory E. McKeithen	Lake Buena Vista, Florida
1984	A. Leon Bates	Richmond, Virginia
1985	Max C. McCowen	Vancouver, British Columbia
1986	Lars W. J. Anderson	Sarasota, Florida
1987	Dean F. Martin	Savannah, Georgia
1988	Richard D. Comes	New Orleans, Louisiana
1989	Richard Couch	Scottsdale, Arizona
1990	David L. Sutton	Mobile, Alabama
1991	Joseph C. Joyce	Dearborn, Michigan
1992	Randall K. Stocker	Daytona Beach, Florida
1993	Clarke Hudson	Charleston, South Carolina
1994	S. Joseph Zolczynski	San Antonio, Texas
1995	Steven J. de Kozlowski	Bellevue, Washington
1996	Terence M. McNabb	Burlington, Vermont
1997	Kurt D. Getsinger	Fort Myers, Florida
1998	Alison M. Fox	Memphis, Tennessee
1999	David F. Spencer	Asheville, North Carolina
2000	J. Lewis Decell	San Diego, California
2001	Jim Schmidt	Minneapolis, Minnesota
2002	David P. Tarver	Keystone, Colorado
2003	Richard M. Hinterman	Portland, Maine
2004	Ken L. Manuel	Tampa, Florida
2005	Eric P. Barkemeyer	San Antonio, Texas

Past APMS Award Recipients

Honorary Members (year of honor)

William E. Wunderlich (1967)
F. L. Timmons (1970)
Walter A. Dun (1976)
Frank S. Stafford (1981)
Robert J. Gates (1984)
Herbert J. Friedman (1987)
John E. Gallagher (1988)
Luciano “Lou” Val Guerra (1988)
Max McCowen (1989)
James D. Gorman (1995)
T. Wayne Miller, Jr. (1995)
A. Leon Bates (1997)
Richard Couch (1997)
William Rushing (1997)
Alva Burkhalter (2002)
J. Lewis Decell (2004)

President’s Award (year of honor)

T. O. “Dale” Robson (1984)
Gloria Rushing (1991)
William T. Haller (1999)
David Mitchell (1999)
Jeff Schardt (2002)
Jim Schmidt (2003)
Robert C. Gunkel, Jr. (2004)

Max McCowen Friendship Award (year of honor)

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

2005 Sustaining Members

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

Applied Aquatic Management, Inc.
Eagle Lake, Florida

Applied Biochemists
Germantown, Wisconsin

Aquarius Systems
North Prairie, Wisconsin

Aquatic Control, Inc.
Seymour, Indiana

Becker Underwood
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Syngenta Professional Products
Greensboro, North Carolina

Meeting Sponsors

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

Platinum

BASF Corporation
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Cerexagri, Inc.
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Bronze

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Texas Aquatic Plant Management Society
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Germantown, Wisconsin

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BioSafe Systems, LLC
Glastonbury, Connecticut

Scholastic Endowment Sponsors

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Grand Prize

Cygnet Enterprises, Inc.
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Silent Auction

Allied Biological
Hackettstown, New Jersey

Applied Biochemists
Germantown, Wisconsin

Aquatic Vegetation Control
Riviera Beach, Florida

BioSafe Systems, LLC
Glastonbury, Connecticut

Brewer International
Vero Beach, Florida

Clean Lakes, Inc.
Martinez, California

Duke Power
Huntersville, North Carolina

Monterey Ag Resources
Fresno, California

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Carmel, Indiana

UAP Timberland, LLC
Memphis, Tennessee

Applied Aquatic Management, Inc.
Eagle Lake, Florida

Aquatic Control, Inc.
Seymour, Indiana

BASF Corporation
Research Triangle Park, North Carolina

BioSonics, Inc.
Seattle, Washington

Cerexagri, Inc.
King of Prussia, Pennsylvania

Cygnet Enterprises, Inc.
Flint, Michigan

FMC Corporation
Philadelphia, Pennsylvania

Professional Lake Management
Caledonia, Michigan

Syngenta Professional Products
Greensboro, North Carolina

Exhibitors

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

Applied Biochemists
Since 1968, Applied Biochemists has been dedicated to developing, manufacturing and marketing a variety of algaecides, aquatic herbicides and biological formulations for aquatic vegetation control and water quality improvement. Recognized brands include Aquashade, Cutrine-Plus and Navigate. Recent achievements have been made in successful development of targeted algal management programs through our funded university research.

Aquarius Systems
AQUARIUS SYSTEMS, a division of D&D Products, is the oldest manufacturer of surface water management equipment in the world. Our product line includes aquatic plant cutters and harvesters, amphibious excavators, canal cleaners and trash skimming vessels. Please stop by our exhibit booth or visit our website to learn more about how Aquarius Systems can help resolve your water management issues.

Aquatic Control, Inc.
Since 1966, Aquatic Control has been providing high quality products, services, and staff for managing lakes, ponds, and other water resources. Our professional staff includes: Certified fisheries scientists, fisheries biologists, factory trained fountain specialists, and licensed aquatic applicators. We supply quality products/services to companies and clients to fill their needs.

BASF Corporation
BASF is the world's leading chemical company, manufacturing a wide range of innovative products, including Habitat® herbicide for control of emerged, shoreline and floating aquatic vegetation. With its proven expertise, BASF provides vegetation management resources to protect and restore land and waterways threatened by non-native, invasive species. For more information, visit www.vmanswers.com.

Becker Underwood
Becker Underwood creates and produces specialty bio-agronomic and colorant products for turf management, agriculture, seed treatment, wood recycling, aquaculture, vegetation management, forestry, structural pest control and many other industries. Whatever the challenge, we're constantly seeking innovative answers, and turning customer challenges into opportunities.

BioSafe Systems, LLC
BioSafe Systems, LLC manufactures reduced risk, peroxygen-based algaecides, fungicides and bactericides for use in agriculture, horticulture, turf management, and aquatics. GreenClean and GreenCleanPRO are the two main products used in the aquatics market. GreenClean Granular Algaecides are non-copper, EPA registered algaecides that have applications in professional lake management, aquaculture, and the residential water feature market. GreenClean is available through distributors throughout the country.

Biosorb, Inc.
Biosorb, Inc. offers new technology made from grain microsponges that is maximizing herbicide and algaecide treatments. TopFilm™, the new natural-based adjuvant for rainfastness, is out-performing current surfactants. Research data on algae, *Arundo donax*, and several emergent/floating aquatic weeds shows that TopFilm™ maximizes treatments by minimizing wash-off (www.biosorb-inc.com).

Brewer International
Brewer International offers surfactants, drift control agents, defoamers, and basal diluents for the weed and brush control market. Spray adjuvants enhance the performance of pesticides. Brewer International also manufactures a broad range of products used in the irrigation, industrial cleaning, and aquatic markets. Brewer is also a proud member of AERF, RISE, APMS, and regional aquatic plant management societies.

Cerexagri, Inc.
Cerexagri, Inc is a leader in the marketing and manufacturing of aquatic herbicides and algaecides and has been involved in the development and sale of these products for over 40 years. The current product line includes various formulations of Aquathol, Hydrothol and AquaKleen. Committed to the Aquatic Plant Management Industry, Cerexagri supports aquatic research in cooperation with universities, federal and state agencies. This research is dedicated to better aquatic plant management techniques resulting in improved aquatic habitat and enhancing future use of aquatic resources.

Cygnet Enterprises, Inc.
Cygnet Enterprises, Inc. and affiliates, is one of the largest distributors of aquatic herbicides, algaecides, and lake management devices in the United States. We are a distributor for all of the major manufacturers of aquatic products including Applied Biochemists, SePRO, Cerexagri, Syngenta, and many more. Our offices are located nation-wide in Michigan, California, Washington, Pennsylvania, Indiana, and North Carolina. For more information regarding our products and services, please feel free to contact us at 1-800-359-7531.

Helena Chemical Company
Helena Chemical Company is a national distributor of crop protection and crop production inputs. Helena has over 350 sales locations across the country that supply customers with crop protectants, fertilizer products, seed and related services. In addition, the Helena Product Group develops and markets a number of products in the following categories: Adjuvants, Nutritionals, BioScience, Value-Added Products and Seed Treatments.

Jenson Technologies
Jenson Lake Mower® - Boat-mounted underwater weed cutter. Restore property value or reclaim waterfront for recreational purposes. An environmentally friendly approach to lake weed removal. Affordable yet durable, for individual or commercial applications. Control anything from Eurasian milfoil or hydrilla to cattail or lilypads. Manage ponds without herbicides. Free video. (888)298-5253 www.lakemower.com

NuFarm Turf & Specialty

Parkway Research
Parkway Research is a manufacturer of blue and black dyes and microbial pond clarifiers for lake and ponds. Manufacturer of specialty chemicals and micronutrients for golf courses.

Peroxygen Solutions
Morgan & Associates, Inc. (doing business as Peroxygen Solutions) was incorporated in 2002 with the primary objectives of marketing, selling and supporting research and development of PAK™27 algaecide. PAK™27 has full EPA registration and 45 state registrations for use in ponds, lakes, drinking water reservoirs and aquaculture. This peroxide chemistry is environmentally ideal and is selective for blue-green algae (cyanobacteria), non-bioaccumulative, non-persistent and cost effective at low dosage rates. PAK™27 is a registered trademark of Solvay Chemicals, Inc.

SePRO Corporation
The industry leader in aquatic plant management, SePRO Corporation has provided professional focus on specialty markets since 1993. Current product line for the professional lake manager includes: Sonar* A.S. aquatic herbicide, Sonar SRP aquatic herbicide, Sonar PR Precision Release* aquatic herbicide, Sonar Q* Quick Release aquatic herbicide, Avast!® Aquatic Herbicide, FasTEST* immunoassay system, Nautique* aquatic

herbicide, Captain* algaecide, K-Tea™ algaecide, Komeen® Aquatic Herbicide, AquaPro* aquatic herbicide, Revive* biological water quality enhancer, and Renovate® aquatic herbicide. *(*Trademark of SePRO Corporation ®Trademark of SePRO Corporation, ™Trademark of SePRO Corporation, ®Renovate is a Trademark of Dow AgroSciences LLC, manufactured for SePRO Corporation)*

Syngenta Professional Products
Invasive weeds can devastate both natural and commercial habitats. Syngenta Professional Products provides high performance products to control these destructive weeds while helping to restore the habitat of aquatic environments. Proven herbicides for the weed control industry available from Syngenta include Reward® and Touchdown PRO®.

UAP Timberland, LLC

Vertex Water Features
Vertex is the world leader in diffused air aeration systems providing proven technology, quality construction and rugged dependability for over twenty years. Certified and independent testing of our AirStations™ proves our bottom aeration systems lift far more water than our competitors. Together with our QuietAir™ compressor cabinets and BottomLine™ self-weighted tubing, Vertex offers the most efficient and cost effective aeration systems available. Please visit our website at www.vertexwaterfeatures.com or call 800-432-4302.

General Information

Name Badges
For all events and functions at the meeting, your name badge is your ticket. Wear it to all activities during the meeting. All individuals participating in any of the meeting events or activities must be registered and have a name badge. Non-registered guests may purchase tickets for the President's Reception, Guest Tour and Luncheon, Poster Session Reception, and Banquet at the meeting registration desk.

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

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

Exhibits
Exhibits will be open for viewing from 8:00 a.m. Monday to 12:00 p.m. Wednesday in the Rio Grande Ballroom of the Hyatt Regency.

Posters
Posters will be open for viewing from 8:00 a.m. Monday to 12:00 p.m. Wednesday in the Rio Grande Foyer and Los Rios Foyer of the Hyatt Regency. A special Poster Session and Reception will be held on Monday from 5:30 .m. to 7:00 p.m. in Chula Vista Room. Presenters of posters are required to attend the special Poster Session and answer questions as needed. In addition, presenters are requested to be in attendance during scheduled refreshment breaks.

APMS Annual Business Meeting
The APMS Annual Business Meeting will be held Monday, 4:30 p.m. - 5:00 p.m. in Regency Ballroom East of the Hyatt Regency. All APMS members are welcome to attend.

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

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

Refreshment Breaks
A continental breakfast, morning refreshment break, and afternoon refreshment break, graciously sponsored by Cerexagri, Inc. will be served each day of the meeting in the Rio Grande Ballroom of the Hyatt Regency. For specific times, please see the daily schedule pages in this program.

APMS Special Events

***President's Reception**, Sunday, July 10, 7:00 p.m. – 9:00 p.m., Garden Terrace, Hyatt Regency.* The APMS cordially invites all registered delegates, guests, and students to the President's Reception, graciously sponsored by SePRO Corporation. Enjoy a casual gathering visiting with old friends and meeting new friends, while savoring delicious hors d'oeuvres and your favorite beverage. Non-registered guests may purchase tickets at the meeting registration desk on Sunday afternoon.

***Guest Tour and Luncheon**, Monday, July 11, 9:00 a.m. – 3:00 p.m., meet in Lobby, Hyatt Regency.* The APMS cordially invites all registered guests to the Guest Tour and Luncheon, graciously sponsored by Applied Biochemists. A very entertaining program has been arranged for the Guest Tour. The tour will begin just outside the Hyatt Regency with a river barge tour of the beautiful San Antonio River. After disembarking from the river barges, guests will tour the Alamo, the most famous monument in Texas. Lunch will be served at the historic Menger Hotel, with all the ghost stories included. After lunch, guests will board a motor coach for a tour of the City of San Antonio with visits to the King William Historic District, the Guenther House, San Fernando Cathedral, and Mission San Jose. Non-registered guests may purchase tickets at the meeting registration desk on Sunday afternoon.

***Poster Session and Reception**, Monday, July 11, 5:30 p.m. – 7:00 p.m., Chula Vista Room, Hyatt Regency.* The APMS cordially invites all registered delegates, guests, and students to the Poster Session and Reception, with the reception graciously sponsored by Syngenta Professional Products. This reception will provide for the viewing of posters and professional interactions/discussions in a casual setting, while enjoying delicious hors d'oeuvres and your favorite beverage. Non-registered guests may purchase tickets at the meeting registration desk on Sunday afternoon.

***Banquet**, Tuesday, July 12, 6:00 p.m. – 10:00 p.m., Regency Ballroom West and Foyer, Hyatt Regency.* The APMS cordially invites all registered delegates, guests, and students to the APMS Banquet, graciously sponsored by BASF Corporation. This year's banquet will once again prove to be a memorable occasion. For our banquet this year, we will have our very own fiesta! In our fiesta village decorated with strands of multi-colored fiesta lights, Mexican flower carts, and fiesta maypoles you will enjoy the music of a mariachi band. The full host bars will feature premium brand drinks, margaritas, domestic and imported beer, and wine. The dinner includes salad, sliced tenderloin of beef with zinfandel sauce, grilled boneless breast of chicken with roasted pepper sauce, oven roasted new potatoes, fresh vegetables, and desert. After dinner, we will recognize those who have served and contributed to the Society, welcome new officers and directors, and present awards to the student paper participants. Our evening will conclude with the reverse raffle drawing for the $1,000 Cabela's gift certificate, graciously sponsored by Cygnet Enterprises, Inc. Non-registered guests may purchase tickets at the meeting registration desk on Sunday afternoon.

Membership Information

The Aquatic Plant Management Society, Inc. is an international organization of scientists, educators, students, commercial pesticide applicators, administrators, and concerned individuals interested in the management and study of aquatic plants. The membership reflects a diversity of federal, state, and local agencies, universities and colleges around the world, corporations, and small businesses. Membership applications are available at the meeting registration desk.

Program

Sunday, July 10

Sunday's Program-at-a-Glance

7:30 am - 5:00 pm	Board of Directors Meeting *(Pecan)*
1:00 pm - 5:00 pm	Meeting Registration *(Regency Foyer)*
1:00 pm - 5:00 pm	Presenter's Preview Room *(Guadalupe)*
1:00 pm - 5:00 pm	Exhibits Setup *(Rio Grande Ballroom)*
1:00 pm - 5:00 pm	Posters Setup *(Rio Grande & Los Rios Foyers)*
7:00 pm - 9:00 pm	President's Reception *(Garden Terrace)*
	Sponsored by SePRO Corporation

Monday, July 11

Monday's Program-at-a-Glance

7:30 am - 8:00 am	Continental Breakfast *(Rio Grande Ballroom)* *Sponsored by Cerexagri, Inc.*
7:30 am - 5:00 pm	Meeting Registration *(Regency Foyer)*
7:30 am - 5:00 pm	Presenter's Preview Room *(Guadalupe)*
8:00 am - 5:00 pm	Exhibits Open *(Rio Grande Ballroom)*
8:00 am - 5:00 pm	Posters Open *(Rio Grande & Los Rios Foyers)*
8:00 am - 11:45 am	Session I: Presidential Address and Invasive Plant and Water-related Issues in Texas and the Southwest *(Regency Ballroom East)*
9:00 am - 3:00 pm	Guest Tour and Luncheon *(Meet in Lobby)* *Sponsored by Applied Biochemists*
9:30 am - 10:00 am	Refreshment Break *(Rio Grande Ballroom)* *Sponsored by Cerexagri, Inc.*
11:45 am - 1:15 pm	Lunch
11:45 am - 1:15 pm	AERF Luncheon and Meeting - AERF Members and Invited Guests *(Live Oak)*
1:15 pm - 4:30 pm	Session II: Evaluating Aquatic Plants and Integrating Control *(Regency Ballroom East)*
2:45 pm - 3:15 pm	Refreshment Break *(Rio Grande Ballroom)* *Sponsored by Cerexagri, Inc.*
4:30 pm - 5:00 pm	APMS Annual Business Meeting - APMS Members *(Regency Ballroom East)*
5:00 pm - 5:30 pm	TAPMS Annual Business Meeting - TAPMS Members *(Regency Ballroom East)*
5:30 pm - 7:00 pm	Poster Session and Reception *(Chula Vista & Boardroom)* *Sponsored by Syngenta Professional Products*

Session I: Presidential Address
Invasive Plant and Water-related Issues in Texas and the Southwest

8:00 am - 11:45 am
Regency Ballroom East
Moderator: Chetta Owens, *Analytical Services Inc., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*

8:00 am **Opening Remarks and Announcements**
Eric P. Barkemeyer
APMS President, Cygnet Enterprises, Inc., Statesville, NC

8:10 am **Presidential Address**
Eric P. Barkemeyer
APMS President, Cygnet Enterprises, Inc., Statesville, NC

8:30 am **Aquatic Vegetation Management in the Rio Grande: Downstream of McAllen, Texas**
Earl W. Chilton II
Texas Parks and Wildlife Department, Austin, TX

8:45 am **Overview of the Saltcedar Management Program in the Southwest with Emphasis on Biological Control**
Raymond I. Carruthers[1], C. Jack DeLoach[2], Daniel W. Bean[3], and Gerald L. Anderson[4]
[1]*U.S. Department of Agriculture, Agricultural Research Service, Albany, CA*
[2]*U.S. Department of Agriculture, Agricultural Research Service, Temple, TX*
[3]*Colorado Department of Agriculture, Biological Pest Control Section, Palisade, CO*
[4]*U.S. Department of Agriculture, Agricultural Research Service, Pest Management Research Unit, Sidney, MT*

9:00 am **Biological Control of Saltcedar (*Tamarix* spp.) in Texas** *(Student Presentation)*
Jeremy L. Hudgeons[1], Kevin M. Heinz[1], and Allen E. Knutson[2]
[1]*Texas A&M University, Department of Entomology, College Station, TX*
[2]*Texas A&M University, Texas Agricultural Experiment Station, Dallas, TX*

9:15 am **Revegetation Strategies and Technologies for Restoration of Native Shrub/Grass Communities on Riparian Saltcedar (*Tamarix* spp.) Infestation Sites**
Kenneth D. Lair
U.S. Department of Interior, Bureau of Reclamation, Ecological Research and Investigations Group, Denver, CO

9:30 am **Refreshment Break** *(Rio Grande Ballroom)*

10:00 am **Invasion of an Experimental Riparian Restoration Project by *Arundo donax*** *(Student Presentation)*
Lauren Quinn and Jodie Holt
Department of Botany and Plant Sciences, University of California, Riverside, CA

10:15 am **Response of Giant Reed (*Arundo donax* L.) to Intermittent Shading**
David F. Spencer, G. G. Ksander, and P. S. Liow
U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weeds Research Unit, University of California-Davis, Davis, CA

10:30 am **An Internet Survey of Private Pond Owners and Managers in Texas** (*Student Presentation*)
April Schonrock[1] and Michael Masser[2]
[1]*Texas A&M University, College Station, TX*
[2]*Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX*

10:45 am **The Impact of Invertebrate Herbivores on Aquatic Macrophyte Biomass** *(Student Presentation)*
Julie M. Graham[1], Michael J. Grodowitz[2], and R. Michael Smart[3]
[1]*University of North Texas, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisv ille, TX*
[2]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[3]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*

11:00 am **The Expansion of Giant Salvinia (*Salvinia molesta*) on Toledo Bend Reservoir, Texas**
Howard Elder
Inland Fisheries, Texas Parks & Wildlife Department, Jasper, TX

11:15 am ***Cyrtobagous salviniae* vs. *Salvinia molesta* on Toledo Bend Reservoir**
James M. Hyde[1] and Phillip W. Tipping[2]
[1]*Sabine River Authority, Many, LA*
[2]*U.S. Department of Agriculture, Agricultural Research Service, Invasive Plant Research Laboratory, Ft. Lauderdale, FL*

11:30 am **Eradication of Giant Salvinia (*Salvinia molesta* complex) from Inland Ponds and Rivers in California: 2005 Update**
Robert Leavitt and Ross O'Connell
California Department of Food and Agriculture, Sacramento, CA

11:45 am **Lunch**

Session II: Evaluating Aquatic Plants and Integrating Control
1:15 pm - 4:30 pm
Regency Ballroom East
Moderator: Mark Heilman, *SePRO Corporation, Research and Technology Campus, Whitakers, NC*

1:15 pm **Selective Control of Eurasian Watermilfoil and Curlyleaf Pondweed Using Low Application Rates of Endothall Combined with 2,4-D**
John G. Skogerboe[1] and Kurt D. Getsinger[2]
[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*

1:30 pm **Evaluation of an Herbicide Application on Vegetated Habitat and the Structure of a Fish and Macroinvertebrate Community in Minnesota Lakes** *(Student Presentation)*
Jeremy G. Slade and Eric D. Dibble
Department of Wildlife and Fisheries, Mississippi State University, Mississippi State, MS

1:45 pm **Evaluation of Aquashade Dye for Growth Inhibition of Submersed Aquatic Vegetation**
Lee Ann M. Glomski[1] and Michael D. Netherland[2]
[1]*Analytical Services Inc.,U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[2]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL*

2:00 pm **Experimental Evaluation of the Effects and Efficacy of Fluridone and Copper in Double-cropped Aquaculture Ponds** *(Student Presentation)*
Annie P. Jacob[1], R. P. Lanno[2], and D. A. Culver[1]
[1]*Department of Evolution, Ecology, and Organismal Biology, Ohio State University, Columbus, OH*
[2]*Department of Entomology, Ohio State University, Columbus, OH*

2:15 pm **Enhancement of Diquat Activity by Copper on a Biotype of Diquat-resistant Duckweed (*Landoltia punctata* (G. Meyer) D. H. Les and D. J. Crawford)**
Tyler J. Koschnick and W. T. Haller
University of Florida, Center for Aquatic and Invasive Plants, Gainesville, FL

2:30 pm **Evaluation of Herbicides for Controlling Alligator Weed (*Alternanthera philoxeroides*) and Restoring Native Wetland Plants at Eufaula National Wildlife Refuge** *(Student Presentation)*
Shannon L. Allen[1], Gary R. Hepp[1], and James H. Miller[2]
[1]*Auburn University, Auburn, AL*
[2]*U.S. Department of Agriculture, Forest Service, Auburn, AL*

2:45 pm **Refreshment Break** *(Rio Grande Ballroom)*

3:15 pm **Production and Growth Rates of *Egeria densa* in the Sacramento-San Joaquin Delta, California** *(Student Presentation)*
Toni G. Pennington and Mark D. Sytsma
Center for Lakes and Reservoirs, Portland State University, Portland, OR

3:30 pm **Environmental Factors Affecting Biomass and Distribution of *Stuckenia pectinata* in the Heron Lake System, Jackson County, Minnesota** *(Student Presentation)*
Ryan M. Wersal[1], John D. Madsen[1], and Brock R. McMillan[2]
[1]*GeoResources Institute, Mississippi State University, Mississippi State, MS*
[2]*Department of Biological Sciences, Minnesota State University, Mankato, MN*

3:45 pm **Evaluation of Methods for Establishing Native Aquatic Vegetation in Seven Texas Reservoirs**

Mark A. Webb[1], R. Michael Smart[2], and Rick A. Ott, Jr.[3]
[1]Texas Parks and Wildlife, Inland Fisheries District 3E, Bryan, TX
[2]U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX
[3]Texas Parks and Wildlife, Tyler, TX

4:00 pm **Hyperspectral Data to Differentiate Waterhyacinth from Common Rush**
(Student Presentation)

Wilfredo Robles, John D. Madsen, Abhinav Mathur, and Lori M. Bruce
GeoResources Institute, Mississippi State University, Mississippi State, MS

4:15 pm APMS Regional Chapters Reports: Brazil, Florida, MidSouth, Midwest, Nile Basin, Northeast, South Carolina, Texas, Western

4:30 pm **Annual Business Meeting**

5:00 pm **Adjourn**

Poster Session
5:30 pm - 7:00 pm
Chula Vista & Boardroom

Alligatorweed Biocontrol - Use of Biocontrol Insects to Reduce the Use of Herbicides to Control Invasive Aquatic Plants

Charles E. Ashton
U.S. Army Corps of Engineers, Jacksonville District, Aquatic Plant Control Operations Support Center, Jacksonville, FL

A Rapid, Quantitative Detection Assay of Cyanobacteria

Clay H. Britton, Robert E. Pruitt, and Carole A. Lembi
Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN

Native Aquatic Plant Founder Colony Establishment: Four Case Histories

Gary O. Dick[1], Joe R. Snow[1], Lynde D. Williams[1], and R. Michael Smart[2]
[1]University of North Texas, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX
[2]U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX

Using Spatial Information Technologies for Detecting and Mapping Eurasian Watermilfoil

J. H. Everitt, M. A. Alaniz, and M. R. Davis
U.S. Department of Agriculture, Agricultural Research Service, Weslaco, TX

Native and Naturalized Insect Herbivores of Invasive Aquatic and Wetland Plants

Jan E. Freedman[1], Michael J. Grodowitz[1], Robin Bare[2], and Julie Graham[3]
[1]U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS
[2]Baylor University, Waco, TX
[3]University of North Texas, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX

Overview of the Chemical Control and Physiological Processes Team

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

Evaluation of Three Candidates for Biocontrol of Water Hyacinth

M. Cristina Hernández, Alejandro J. Sosa, and Joaquín Sacco
South American Biological Control Laboratory, U.S. Department of Agriculture, Agricultural Research Service, Hurlingham, Argentina

Experimental Effects of Lime Application on Aquatic Macrophytes

William F. James[1], Harry L. Eakin[1], and John W. Barko[2]
[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*

Management of Eurasian Watermilfoil for Small-scale Restoration of Native Vegetation in Mobile Delta, Alabama

Joe Jernigan[1] and John D. Madsen[2]
[1]*Alabama Division of Wildlife and Freshwater Fisheries, Daphne, AL*
[2]*GeoResources Institute, Mississippi State University, Mississippi State, MS*

Effect of Cutting and Burning on the Growth Pattern of *Miscanthus sacchariflorus* in the Woopo Wetland, South Korea

Gu Yeon Kim, Chan Woo Lee[1], Hae Soon Yoon[2], and Gea Jae Joo[1]
[1]*Department of Biology, Pusan National University, Busan, South Korea*
[2]*Department of Biology, Dong-A University, Busan, South Korea*

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

Sonya F. Lewis[1], Jan E. Freedman[2], Michael J. Grodowitz[2], Lavon Jeffers[1], and Fred Nibling[3]
[1]*Computer Science Corporation, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[3]*U.S. Department of Interior, Bureau of Reclamation, Denver, CO*

Preliminary Results from a Study to Determine the Effects of Armored Shorelines on Processes within Submersed Aquatic Vegetation Beds in the Oligohaline to Mesohaline Potomac River, Maryland

Dwilette G. McFarland[1], N. B. Rybicki[2], R. Wardwell[3], and R. Murphy[4]
[1]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2]*U.S. Geological Survey, National Research Center, Reston, VA*
[3]*U.S. Army Adelphi Laboratory Center, Adelphi, MD*
[4]*Alliance for the Chesapeake Bay, Washington, DC*

Investigations of Torpedograss Seed Viability and the Seed Bank at Selected Sites in the Marsh at Lake Okeechobee, Florida

Dwilette G. McFarland[1], D. H. Smith[2], R. Michael Smart[3], and C. G. Hanlon[4]
[1]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2]*University of North Texas, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[3]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[4]*South Florida Water Management District, West Palm Beach, FL*

Water Nutrients, Plant Nutrients, and Indicators of Biological Control in Waterhyacinth at Texas Field Sites

Patrick J. Moran
U.S. Department of Agriculture, Agricultural Research Service, Beneficial Insects Research Unit, Weslaco, TX

Impact of Herbicides and Burning on Restoration of a Phragmites-dominated Wetland

Linda S. Nelson[1], Lee Ann M. Glomski[2], and Kurt D. Getsinger[1]
[1]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2]*Analytical Services Inc.,U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*

Integrated Weed Management Strategies for Improved Hydrilla Control

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

Benzene Degradation by Rhizospheric Microorganisms Isolated from *Limnobium laevigatum* in La Conejera Wetland (Bogota, Colombia)

G. Suescun-Otero, J. Bernal-Castillo, and P. Martinez-Nieto
Javeriana University, Chemistry Department, Pontificia, Bogota, Columbia

Regeneration of Giant Salvinia from Apical and Axillary Buds Following Desiccation or Physical Damage

Chetta S. Owens[1], R. Michael Smart[2], and Gary O. Dick[3]
[1]*Analytical Services Inc., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[2]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[3]*University of North Texas, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX*

Concentration/Exposure Time Study of Endothall Against Monoecious and Dioecious Hydrilla

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

Occurrence of Three Endophytes in Eurasian Watermilfoil

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

Ecological Attributes of Exotic and Native Aquatic Plant Communities

R. Michael Smart[1], Gary O. Dick[2], Joe Snow[2], Dian H. Smith[2], and David Honnell[2]
[1]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[2]*University of North Texas, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*

Establishment of Diverse Aquatic Plant Communities

R. Michael Smart[1], Gary O. Dick[2], and Joe R. Snow[2]
[1]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[2]*University of North Texas, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*

Spatial and Temporal Variation in the Composition of Filamentous Algae Present in California Rice Fields

David F. Spencer[1] and C. A. Lembi[2]
[1]*U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weeds Research Unit, University of California-Davis, Davis, CA*
[2]*Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN*

Waterhyacinth Survival and Growth Response to Cutting

David F. Spencer[1], G. G. Ksander[1], M. J. Donovan[1], P. S. Liow[1], W. K. Chan[1], B. K. Greenfield[2], S. B. Shonkoff[2], and S. Andrews[3]
[1]*U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weeds Research Unit, University of California-Davis, Davis, CA*
[2]*San Francisco Estuary Institute, Oakland, CA*
[3]*Environmental Sciences Teaching Program, University of California, Berkeley, CA*

Natural Enemies of Fanwort (*Cabomba caroliniana* Gray): First Report on Species Richness and Host Ranges

W. Cabrera Walsh[1] and Mic Julien[2]
[1]*U.S. Department of Agriculture, Agricultural Research Service, South American Biological Control Laboratory, Buenos Aires, Argentina*
[2]*Commonwealth Scientific and Industrial Research Organisation, Entomology, Indooroopilly, Brisbane, Australia*

Innovative Solutions for Invasive Species Information Transfer

Sherry G. Whitaker[1], Michael J. Grodowitz[1], and Lavon Jeffers[2]
[1]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2]*Computer Science Corporation, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*

Mass Production of *Cyrtobagous salviniae* and Transfer of Technology for Biological Control of S*alvinia molesta* in the U.S.

Leeda Wood, Dan Flores, and Jason Carlson
U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology, Pest Detection, Diagnostic, and Management Laboratory, Edinburg, TX

Tuesday, July 12

Tuesday's Program-at-a-Glance

6:30 am - 8:00 am	Regional Chapters Presidents' Breakfast *(Pecan)*
7:30 am - 8:00 am	Continental Breakfast *(Rio Grande Ballroom)* *Sponsored by Cerexagri, Inc.*
7:30 am - 5:00 pm	Meeting Registration *(Regency Foyer)*
7:30 am - 5:00 pm	Presenter's Preview Room *(Guadalupe)*
8:00 am - 5:00 pm	Exhibits Open *(Rio Grande Ballroom)*
8:00 am - 5:00 pm	Posters Open *(Rio Grande & Los Rios Foyers)*
8:00 am - 12:00 pm	Session III: A Special Session on Issues Pertaining to Harmful and Toxic Algae and Cyanobacteria *(Regency Ballroom East)*
9:30 am - 9:55 am	Refreshment Break *(Rio Grande Ballroom)* *Sponsored by Cerexagri, Inc.*
12:00 pm - 1:30 pm	Lunch
12:00 pm - 1:30 pm	Past Presidents' Luncheon *(Pecan)*
1:30 pm - 5:00 pm	Session IV: Investigating Algae and Cyanobacteria Impacts and Developing Aquatic Plant Control Strategies *(Regency Ballroom East)*
3:00 pm - 3:30 pm	Refreshment Break *(Rio Grande Ballroom)* *Sponsored by Cerexagri, Inc.*
6:00 pm - 10:00 pm	Banquet – Viva Fiesta! *(Regency Ballroom West)* *Sponsored by BASF Corporation*

Session III: A Special Session on Issues Pertaining to Harmful and Toxic Algae and Cyanobacteria

8:00 am - 12:00 pm
Regency Ballroom East
Moderator: Carole A. Lembi, *Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN*

8:00 am **Introductory Remarks and Linkage to Aquatic Plant Managers**

Jeffrey D. Schardt[1] and **Carole A. Lembi**[2]
[1]Department of Environmental Protection, Tallahassee, FL
[2]Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN

8:15 am **Ecotoxicological Impacts of the Invasive Marine Alga *Caulerpa taxifolia***

Lars W. J. Anderson
U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, CA

8:30 am **Update on Investigations into an Emerging Avian Disease and Links to Waterfowl, Fish, Invasive Aquatics, and Cyanobacteria**

Susan B. Wilde[1], Sarah E. Williams[1,2], Alan J. Lewitus[1], Thomas M. Murphy[3], Charlotte P. Hope[3], Faith Wiley[4,5], Rebecca Smith[4], William W. Bowerman[4], and John J. Hains[6]
[1]Baruch Institute, University of South Carolina and South Carolina Department of Natural Resources, Marine Resources Division, Charleston, SC
[2]College of Charleston, Charleston, SC
[3]South Carolina Department of Natural Resources, Wildlife and Freshwater Fisheries Division, Green Pond, SC
[4]Institute of Environmental Toxicology, Clemson University, Pendleton, SC
[5]National Oceanic and Atmospheric Administration, Charleston, SC
[6]U.S. Army Engineer Research and Development Center, Environmental Laboratory, Calhoun Falls, SC

8:45 am **_Lyngbya_ Growth and Control: We Are Working On It?**
John H. Rodgers, Jr.[1], Ryan Jones[1], Maurice Duke[1], Scott Lankford[2], and Wes Anderson[2]
[1]Clemson University, Department of Forestry and Natural Resources, Clemson, SC
[2]Alabama Power, Environmental Affairs Department, Birmingham, AL

9:00 am **An Overview of Harmful Algae Waterblooms (HABs)**
Wayne W. Carmichael
Department of Biological Sciences, Wright State University, Dayton, OH

9:30 am **Refreshment Break** *(Rio Grande Ballroom)*

9:55 am **Red Tides in the Gulf of Mexico: _Karenia brevis_ and Other Fish-killing Species**
Tracy A. Villareal
Marine Science Institute, University of Texas at Austin, Port Aransas, TX

10:25 am **_Cylindrospermopsis raciborskii_ in Florida's Freshwater Systems**
Christopher D. Williams, Andrew P. Chapman, Mark T. Aubel, and Peter Daiuto
GreenWater Laboratories/CyanoLab, Palatka, FL

10:40 am **Water Quality and Cyanobacterial Management in the Ocklawaha Chain-of-Lakes, Florida**
Rolland Fulton, Michael Coveney, and Walt Godwin
St. Johns River Water Management District, Palatka, FL

10:55 am **Spread of _Cylindrospermopsis raciborskii_ in the Midwest**
Carole A. Lembi
Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN

11:10 am **Review of Golden Alga _(Prymnesium parvum)_ Problems in Texas**
Joan Glass
Texas Parks & Wildlife Department, Waco, TX

11:25 am **Toxic Golden Alga Research Sponsored by the Texas Parks and Wildlife Department**
David Sager
Inland Fisheries, Texas Parks and Wildlife Department, Austin, TX

11:40 am **Harmful Algae Waterblooms (HABs): An Overview of the National Plan**
Wayne W. Carmichael
Department of Biological Sciences, Wright State University, Dayton, OH

12:00 pm **Lunch**

Session IV: Investigating Algae and Cyanobacteria Impacts and Developing Aquatic Plant Control Strategies
1:30 pm - 5:00 pm
Regency Ballroom East
Moderator: Gregory MacDonald, *University of Florida, Department of Agronomy, Gainesville, FL*

1:30 pm **Investigating Triploid Chinese Grass Carp (*Ctenopharyngodon idella*) as a Potential Vector of Avian Vacuolar Myelinopathy** *(Student Presentation)*
Rebecca M. Smith[1], William W. Bowerman[1], Susan B. Wilde[2], Sarah K. Williams[2], Charlotte P. Hope[3], Thomas M. Murphy[3], John J. Hains[4], R. Lawrence McCord[5], John R. Morrison[5], John Grizzle[6], and John R. Fischer[7]
[1]*Department of Forestry and Natural Resources, Institute of Environmental Toxicology, Clemson University, Pendleton, SC*
[2]*Baruch Institute, University of South Carolina and South Carolina Department of Natural Resources, Marine Resources Division, Charleston, SC*
[3]*Wildlife and Freshwater Fisheries, South Carolina Department of Natural Resources, Green Pond, SC*
[4]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Calhoun Falls, SC*
[5]*Environmental Services, Santee Cooper Power, Moncks Corner, SC*
[6]*Department of Fisheries and Allied Aquacultures, Auburn University, Auburn, AL*
[7]*Southeastern Cooperative Wildlife Disease Study, University of Georgia, Athens, GA*

1:45 pm **Investigation of Factors Regulating Toxin Production in an Epiphytic Cyanobacterial Species Associated with AVM Bird Deaths** *(Student Presentation)*
Sarah K. Williams[1], Faith Wiley[2], Susan B. Wilde[3], Alan J. Lewitus[3], and John J. Hains[4]
[1]*College of Charleston, and Belle W. Baruch Institute for Coastal Research, University of South Carolina, Charleston, SC*
[2]*Institute of Environmental Toxicology, Clemson University and National Oceanic and Atmospheric Administration, Charleston, SC*
[3]*Baruch Institute, University of South Carolina and South Carolina Department of Natural Resources, Marine Resources Division, Charleston, SC*
[4]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Calhoun Falls, SC*

2:00 pm **Bleb Formation and XTT Reduction in Channel Catfish Hepatocyte Primary Culture Exposed to Microcystin-LR**
J. E. Schneider, Jr., J. S. Terhune, and J. M. Grizzle
Department of Fisheries and Allied Aquacultures, Auburn University, Auburn, AL

2:15 pm **Site-specific Management of Problematic Algae Using a Copper-containing Algaecide** *(Student Presentation)*
B. Maurice Duke, O'Niell R. Tedrow, and John H. Rodgers, Jr.
Clemson University, Department of Forestry and Natural Resources, Clemson, SC

2:30 pm **MCB, Camp Pendleton Invasive Riparian Weed Program**
Todd Easley and Deborah Bieber
Land Management Branch, Camp Pendleton, CA

2:45 pm **Impacts from Military Activities on the Phytoplankton Composition and Water Quality of Headwater Streams in the Pascagoula River Basin** *(Student Presentation)*
Nestor Raul Anzola, George F. Pessoney, and Carmen L. Hernandez
Department of Biological Sciences, University of Southern Mississippi, Hattiesburg, MS

3:00 pm **Refreshment Break** *(Rio Grande Ballroom)*

3:30 pm **Breeding System and Seed Germination Between Common and Imperiled *Nuphar* Species of New England** *(Student Presentation)*
Paul A. Muller and Donald J. Padgett
Department of Biological Sciences, Bridgewater State College, Bridgewater, MA

3:45 pm **Effect of Salinity and Cutting on the Growth of *Phragmites australis* in Nakdong River Estuary, South Korea** *(Student Presentation)*

Gu Yeon Kim, Yuno DO, Myoung Chul Kim, and Gea Jae Joo
Department of Biology, Pusan National University, Busan, South Korea

4:00 pm **Registration of Aquatic Herbicides: A New Model**

Kurt D. Getsinger[1], Donald R. Stubbs[2], and Michael D. Netherland[3]
[1]U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS
[2]U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, DC
[3]U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL

4:15 pm **The IR-4 Project: New Opportunity – Aquatic Herbicide Registration**

M. Arsenovic[1], R. E. Holm[1], J. J. Baron[1], D. L. Kunkel[1], K. D. Getsinger[2], and W. T. Haller[3]
[1]IR-4 Project, Rutgers University, North Brunswick, NJ
[2]U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS
[3]University of Florida, Center for Aquatic and Invasive Plants, Gainesville, FL

4:30 pm **SP-1019: Status Report on Development of Potential New Aquatic Herbicide for Large-scale Aquatic Plant Management**

Mark A. Heilman
SePRO Corporation, Research and Technology Campus, Whitakers, NC

4:45 pm **An Overview of the Recent Hydrilla Management Issues Workshop in Florida**

Michael D. Netherland[1], Mark V. Hoyer[2], and Michael S. Allen[2]
[1]U.S. Army Engineer Research and Development Center, Environmental Laboratory, Gainesville, FL
[2]University of Florida, Institute of Food and Agricultural Sciences, Department of Fisheries and Aquatic Sciences, Gainesville, FL

5:00 pm **Adjourn**

Wednesday, July 13

Wednesday's Program-at-a-Glance

7:30 am - 8:00 am	Continental Breakfast *(Rio Grande Ballroom)* *Sponsored by Cerexagri, Inc.*
7:30 am - 12:00 pm	Meeting Registration *(Regency Foyer)*
7:30 am - 12:00 pm	Presenter's Preview Room *(Guadalupe)*
8:00 am - 12:00 pm	Exhibits Open *(Rio Grande Ballroom)*
8:00 am - 12:00 pm	Posters Open *(Rio Grande & Los Rios Foyers)*
8:00 am - 12:00 pm	Session V: Environmental, Chemical, and Biological Methods for Controlling Aquatic Plants *(Regency Ballroom East)*
10:00 am - 10:30 am	Refreshment Break *Sponsored by Cerexagri, Inc.*
12:00 pm - 5:00 pm	APMS Board of Directors Meeting *(Pecan)*
12:00 pm - 5:00 pm	Exhibits Teardown *(Rio Grande Ballroom)*
12:00 pm - 5:00 pm	Posters Teardown *(Rio Grande & Los Rios Foyers)*

Session V: Environmental, Chemical, and Biological Methods for Controlling Aquatic Plants

8:00 am - 12:00 pm
Regency Ballroom East
Moderator: Jeffrey D. Schardt, *Department of Environmental Protection, Tallahassee, FL*

8:00 am **Effect of Light Quality on Duckweed (*Lemna minor*)**
Laura Anderson and Dean F. Martin
Institute for Environmental Studies, Department of Chemistry, University of South Florida, Tampa, FL

8:15 am **Use of Native Macrophytes to Reduce Growth and Radial Spread of *Hydrilla verticillata* in Pond-scale Mesocosms**
Richard A. Ott[1], R. Michael Smart[2], Hans M. Williams[3]
[1]*Texas Parks and Wildlife Department, Inland Fisheries Division, Tyler, TX*
[2]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[3]*Stephen F. Austin State University, Arthur Temple College of Forestry, Nacogdoches, TX*

8:30 am **Manipulation of Environmental Conditions to Stress Nuisance Aquatic Plants**
William F. James[1] and John W. Barko[2]
[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*

8:45 am ***Ludwigia hexapetala* in the Russian River Basin, California: Ecology and Integrated Management for Restoration**
Brenda J. Grewell
U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weeds Research Unit, Department of Plant Sciences, Davis, CA

9:00 am **Hydrilla Management in Lake Austin, Texas: An Integrated Approach**
Mary P. Gilroy
City of Austin, Austin, TX

9:15 am **Long-term Post-treatment Vegetation Assessment and Restoration Evaluation of Houghton Lake**
Mark S. Mongin
SePRO Corporation, Aquatic Speciality Products, Carmel, IN

9:30 am **Peruvian Watergrass – A New Threat to Coastal Louisiana**
D. E. Sanders[1] and E. P. Webster[2]
[1]*Agricultural Center, Louisiana State University, Clinton, LA*
[2]*Agricultural Center, Louisiana State University, Baton Rouge, LA*

9:45 am **First Hydrilla Found in Brazil: Implications of Further Dispersal and Likely Impacts**
Lars W. J. Anderson[1], R. A. Pitelli[2], R. Carruthers[1], R. L. C. M. Pitelli[3], and W. L. B. Ferreira[4]
[1]*U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, CA*
[2]*São Paulo State University, Jaboticabal, SP, Brazil*
[3]*EcoSafe Agriculture and Environmental Sciences, Jaboticabal, SP, Brazil*
[4]*Syngenta, São Paulo, SP, Brazil*

10:00 am **Refreshment Break** *(Rio Grande Ballroom)*

10:30 am **When Does an Insect Biocontrol Agent Become Operational?**
Michael J. Grodowitz
U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

10:45 am ***Mycoleptodiscus terrestris*: Progress Report on Dry Formulation Development**
Judy F. Shearer[1] and Mark A. Jackson[2]
[1]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2]*U.S. Department of Agriculture, National Center for Agriculture Utilization Research, Peoria, IL*

11:00 am **Potential for Insect Vectoring of a Plant Pathogenic Fungus to Improve Biological Control of Waterhyacinth**
Patrick J. Moran and Connie J. Graham
U.S. Department of Agriculture, Agricultural Research Service, Beneficial Insects Research Unit, Weslaco, TX

11:15 am **Impact of Herbivory and Plant Competition on the Growth of Hydrilla in Small Ponds**
Michael J. Grodowitz[1], **Chetta S. Owens**[2], R. Michael Smart[3], and Julie M. Graham[4]
[1]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2]*Analytical Services Inc., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[3]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[4]*University of North Texas, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*

11:30 am **Influence of Nutritional Characteristics of *Hydrilla verticillata* on Two Biological Control Agents**
Judy F. Shearer, Michael J. Grodowitz, and Jan Freedman
U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

11:45 am **Large-scale Rearing of Insect Biological Control Agents for the Management of Aquatic Plants**
Brian D. Durham[1], Michael J. Grodowitz[2], Harvey L. Jones[2], Chetta S. Owens[3], Julie M. Graham[4], and R. Michael Smart[5]
[1]*JAYA Corporation, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[3]*Analytical Services Inc., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[4]*University of North Texas, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[5]*U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*

12:00 pm **Closing Remarks and Adjourn 45th Annual Meeting**
Eric Barkemeyer, *Cygnet Enterprises, Statesville, NC*

NEXT YEAR
46th Annual Meeting
July 16-19, 2006
Marriott Portland Downtown
Portland, Oregon

Abstracts

Session I: Invasive Plant and Water-related Issues in Texas and the Southwest

Aquatic Vegetation Management in the Rio Grande: Downstream of McAllen, Texas

Earl W. Chilton II
Texas Parks and Wildlife Department, Austin, TX

In 1998, water hyacinth and hydrilla began to inhibit the flow of water in the Rio Grande. The Rio Grande is an important conduit for both irrigation and for municipal water. The Texas Commission on Environmental Quality, the entity that controls the flow of water in the river, reported releasing as much as 30% more water from upstream reservoirs than demand called for in order to push it through dense hydrilla beds. Since the Rio Grande is international water, all management options had to be agreed upon jointly by Mexico and the United States. Due to differences in herbicide regulations, as well as questions about grass carp releases, initially, the only feasible management option was mechanical control of water hyacinth. However, the infestations continued to expand, and by 2001, water flowing in the lower reaches of the river had been reduced to a trickle and the mouth of the river closed. Most of the problems associated with various management options were resolved by 2003. In that year 150 acres of water hyacinth were treated with herbicide, 275 acres were mechanically shredded, and 26,595 triploid grass carp were stocked. Surveys conducted in June 2004 indicated water hyacinth and hydrilla had been effectively eliminated from the river for approximately 120 miles below Anzaduas Dam (approximately river mile 50 through 170).

Overview of the Saltcedar Management Program in the Southwest with Emphasis on Biological Control

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Biological control of saltcedar (*Tamarix* spp.) was initiated in 1987, using host-specific insect herbivores that are thought to regulate this plant in the Old World. With cooperators in France, Israel, Kazakhstan, China and Turkmenistan, 15 insect species were tested. After quarantine and regulatory approval, the leaf beetle *Diorhabda elongata* from China and Kazakhstan, was released into field cages at ten approved sites in six states in 1999 and into the open environment in 2001. These beetles have been tested at several locations where they have successfully overwintered, established reproductive populations and spread substantially within saltcedar infested areas. The beetles have caused extensive defoliation for multiple seasons and are severely impacting saltcedar growth and development. Ground sampling of beetle populations and their impact on target saltcedar and adjacent beneficial species was conducted at all of the release sites for several years. In support of these assessments, remote sensing was conducted both to characterize saltcedar infestations and to follow beetle establishment and spread. In some areas the beetles have spread over 100 miles and have defoliated over 5,000 acres of saltcedar. Additionally, beetles from Crete were released into the field in Texas, New Mexico, and California during late 2003 and 2004. They overwintered well and are increasing in numbers. This project is expected to allow recovery of native riparian plant communities, improve wildlife and fish habitat, reduce wildfires, and increase availability of water in many areas across the western United States.

Biological Control of Saltcedar (*Tamarix* spp.) in Texas *(Student Presentation)*

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Like many riparian systems of the southwestern United States, the Colorado River of Texas has been severely infested with saltcedar (*Tamarix* spp.), an invasive species from the Old World. Saltcedar increases soil salinity, displaces native plant communities, degrades wildlife habitat and consumes significant quantities of groundwater. Biological control using exotic insect herbivores is proposed as a highly specific and inexpensive tactic to reduce saltcedar infestations. The leaf beetle *Diorhabda elongata* (Coleoptera: Chrysomelidae) has been released at locations along the Upper Colorado River watershed in

Texas. For the beetle to be an effective biological control agent, it must be able to establish in and disperse from release areas and have an adverse effect on the growth of the saltcedar trees. Transects have been created and a GIS is being employed to document beetle establishment and dispersal at each release site. To measure the effects of beetle feeding on saltcedar survivability, total non-structural carbohydrates from the root crown of the trees are being quantified using the enzymatic method of analysis. An understanding of the efficacy of this biological control agent in Texas is necessary for the coordinated management of saltcedar in the United States.

Revegetation Strategies and Technologies for Restoration of Native Shrub / Grass Communities on Riparian Saltcedar (*Tamarix* spp.) Infestation Sites

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Critical knowledge gaps exist regarding vegetative recovery in xeric, monotypic saltcedar (*Tamarix* spp.) stands with no (desirable) understory. Formulation of revegetation strategies that provide site stabilization, resistance to further saltcedar and secondary weed infestation, and acceptable habitat values for affected wildlife species becomes particularly problematic in monotypic saltcedar stands under biological, fire and herbicidal control scenarios. Amount and density of standing biomass (live and dead) remaining after control poses limitations in relation to seeding and planting techniques, seed interception in aerial (broadcast) applications, and seedbed preparation methods. Undisturbed soil surfaces impacted by saltcedar leaf litter accumulation, salinity, hummocky micro-relief, and nutrient limitations restrict potential for successful revegetation. Long duration of saltcedar occupation may deplete needed microbial communities, particularly mycorrhizae symbiotic with native revegetation species. Technical approaches include soil surface and rhizosphere manipulation methods to facilitate removal of standing dead biomass, increase precipitation capture and retention, and create micro-sites exhibiting lower salinity for improved seed germination; salinity remediation using HydraHume™; seeding methodologies, including use of seed coating techniques; and mycorrhizal inoculation methods. Preliminary results indicating positive response to mycorrhizal inoculation suggests that mycorrhizal colonization and association with seeded native species can occur on highly saline / sodic sites characteristic of mature, monotypic saltcedar infestations. This capability is particularly important for rapid establishment and spread of competitive, transitional ("eco-bridging") native species that will suppress encroachment of secondary invasive species following saltcedar control.

Invasion of an Experimental Riparian Restoration Project by *Arundo donax* *(Student Presentation)*

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Based on the hypothesis that plant community composition can influence a site's susceptibility to invasion by exotic plant species, small-scale experimental restoration plots were established. Three riparian species (a tree, a shrub, and a reed) were planted into experimental plots in all possible combinations in 2002. Half of the plots received *Arundo donax* rhizomes in the spring of 2003, and the other half received rhizomes in spring 2004. Both groups were followed for one year to determine sprouting timing, shoot height, and senescence date. Survival time for the 2003 planting group differed between the resident plant community types, with *A. donax* plants surviving for significantly shorter periods of time in shrub-only plots, shrub + reed plots, and shrub + tree plots. Shoot emergence time showed a similar, but only marginally significant, pattern. The 2004 planting group, however, did not differ in terms of shoot emergence time, shoot height, or shoot survival. By 2004, colonization of some of the experimental plots by surrounding riparian plants had begun to occur. Data for percent colonization and number and identity of colonizing species were taken. Both percent colonization and number of colonizing species were significantly decreased in shrub-only plots, shrub + reed plots, shrub + tree plots, and plots with all three species. Plots initially planted with reeds-only, trees-only, or reeds + trees were significantly colonized, primarily by shrubs. These results suggest that some restoration designs can be made more resistant to the colonization of certain species than others.

Response of Giant Reed (*Arundo donax* L.) to Intermittent Shading

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A species' successful invasion into a new site depends on its ability to persist in the context of local environmental conditions. Thus, knowledge of environmental limitations on growth and reproduction will provide a mechanistic understanding of the invasion process and lead to practical management solutions. We conducted an experiment to examine the response of giant reed (*Arundo donax* L.) to intermittent periods of shading for four years. Results indicate that giant reed tolerates significant shading (i.e., 90% reduction of full sun) and, that shading also causes changes in a number of plant characteristics, such as stem height, leaf number, and chlorophyll content. Giant reed's ability to persist and grow under intermittent low light conditions implies that plants would be poised to take advantage of disturbances that create gaps within the resident plant community.

An Internet Survey of Private Pond Owners and Managers in Texas *(Student Presentation)*

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The primary emphasis of this study was to determine what specific problems Texas pond owners face, how widely these problems occur, and where pond owners get the information they use to deal with pond management problems. A secondary emphasis of the project was to examine the potential presented by the Internet for use in this type of information gathering and distribution for Extension. A random sample was taken of 2,999 applicants for Triploid Grass Carp Permits from Texas Parks and Wildlife. Only private applicants were included in the study; no survey of public entities was included at this time. The Parks and Wildlife list contained records of complete names and mailing addresses, and was the only source used to generate the sample population information. A 49-question survey was constructed containing five sections: general pond characteristics, physical pond characteristics, aquatic vegetation, fish and other wildlife, and management goals. An overall response rate of 21.3% (excluding non-deliverables and unusable submitted surveys) was obtained. Summary statistics for each question were calculated and then compared to each other in order to gain a clearer picture of pond management practices employed by Texas pond owners. These results indicated some initial discrepancies between pond owners' management practices and preferences and current management recommendations, most dramatically where aquatic vegetation was concerned.

The Impact of Invertebrate Herbivores on Aquatic Macrophyte Biomass *(Student Presentation)*

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A study was conducted in two 0.75-acre ponds in Lewisville, Texas during the summer of 2004 to determine the impact invertebrate herbivores have on native macrophyte biomass. In June, five native macrophytes, including *Vallisneria americana*, *Potamogeton nodosus*, *P. illinoensis*, *Heteranthera dubia*, and *Nymphaea odorata*, were enclosed in cages and planted. Three species had significant quantities of floating leaves while two species were almost entirely submersed. Temephos (Abate), an insecticide used for the control of midge and mosquito larva, was applied in one pond to exclude all invertebrate herbivores. In October, dry biomass was compared between the insecticide and non-treated ponds. Plant tissue damage in the treated pond was rare, while plants within the non-treated pond exhibited significant levels of damage due to invertebrates, primarily insect feeding, ovipositioning, and case making. The mean biomass of the floating leaved species was two times greater in the herbivore free pond, while the mean biomass of the submersed species did not differ significantly. The three floating leaved species exhibited from 2.5 to 3 fold greater biomass when herbivores were eliminated, but only *P. nodosus* was significantly different. The two submersed species exhibited a 45- to 90-percent reduction in biomass when herbivores were eliminated, but only *V. americana* differed significantly. The decrease in submersed species biomass may be explained by the 11 times greater biomass of *Chara vulgaris* in the treated pond. This submersed macroalga possibly limited light penetration, thereby out-competing the submersed species.

The Expansion of Giant Salvinia (*Salvinia molesta*) on Toledo Bend Reservoir, Texas

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Mild winters and high water levels throughout the spring and summer of 2004 resulted in a record expansion of giant salvinia (*Salvinia molesta*) throughout Toledo Bend Reservoir. Since its discovery on the reservoir in 1998, isolated infestations had been held in check by aggressive herbicide treatments conducted by Texas Parks & Wildlife Department and the Louisiana Department of Wildlife and Fisheries. An extended drawdown of the reservoir by the Sabine River Authority in 2000 resulted in a marked reduction of infestations, but failed to eliminate the threat. The expansion of giant salvinia on Toledo Bend Reservoir in 2004 poses a serious threat to neighboring water bodies. Giant salvinia is easily transported overland to new locations by boat trailers and personal watercraft. Due to the plant's overwhelming rate of growth and magnitude of areas covered, herbicide treatments on Toledo Bend Reservoir proved ineffective in 2004. Large-scale introductions of a bio-control agent in the form of the giant salvinia weevil (*Cyrtobagous salviniae*) on the Texas portion of the reservoir began in July of 2004. It is hoped the establishment of the giant salvinia weevil will effectively reduce herbicide use and provide a long-term management tool for the control of giant salvinia in the future.

***Cyrtobagous salviniae* vs. *Salvinia molesta* on Toledo Bend Reservoir**

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The water fern, *Salvinia molesta,* was found in Toledo Bend Reservoir in September 1998. Dr. David Mitchell, who named it, refers to giant salvinia as the most dangerous plant in the world because of its extremely rapid growth rate. An integrated, multifaceted approach to controlling the noxious weed was recommended by the newly formed Salvinia Task Force. Herbicides have limited effectiveness because of the weed's growth rate and its shifting location with water currents and wind. A ray of hope was offered by a biological control organism, the weevil, *Cyrtobagous salviniae,* which is effective in other parts of the world. The first weevils were put out on the Louisiana side of Toledo Bend at Salter Creek on June 30, 1999, where the salvinia infestation appeared to be centered. This and other efforts were frustrated by fluctuating water level, but suitable areas were eventually found, such as the pond adjoining the reservoir at Cypress Bend Resort, where the weevils multiplied slowly, but were an effective countermeasure. This pond also provided a nursery, from which weevil-infested salvinia was transplanted to other problem areas on Toledo Bend. An estimated 12,000 weevils on salvinia, obtained from the USDA in McAllen, TX, were also relocated to various sites on the 70-mile-long reservoir. A recent survey of weevil distribution shows them to be widespread and present in great numbers on Toledo Bend. Their positive effects are now visible in numerous places.

Eradication of Giant Salvinia (*Salvinia molesta* complex) from Inland Ponds and Rivers in California: 2005 Update

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The California Department of Food and Agriculture (CDFA) operates a project to detect and eradicate giant salvinia from the inland waterways of California. This project is complementary to the Lower Colorado River Task Force, which is controlling giant salvinia along the lower Colorado River. Since year 2000, the CDFA has controlled giant salvinia in San Diego, San Luis Obispo, and Mendocino Counties. In each county, the county Department of Agriculture has been a partner in this project. In San Diego County, giant salvinia was removed from 1) a small pool along the San Diego River, 2) three small ponds near a private residence near Fallbrook, 3) three small ponds at an aquatic nursery near Rainbow, and 4) a small pond at a high school in San Diego. In San Luis Obispo County, giant salvinia was controlled in a 1-acre pond used as a fire control pond at an oil field. In Mendocino County, giant salvinia was removed from a small pond at a private residence. Control measures include hand removal using nets and aquatic herbicides. At all sites, eradication is the goal, and is close to being achieved.

Session II: Evaluating Aquatic Plants and Integrating Control

Selective Control of Eurasian Watermilfoil and Curlyleaf Pondweed Using Low Application Rates of Endothall Combined with 2,4-D

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Curlyleaf pondweed (*Potamogeton crispus* L.) and Eurasian watermilfoil (*Myriophyllum spicatum* L.) have become widespread problems in many northern U.S. lakes. Both plants begin growing in very early spring (March and April) following ice-out, forming dense canopies before many native aquatic plants begin to grow later in spring (May and June). Outdoor mesocosm studies demonstrated that endothall applied at 1 mg/L active ingredient [ai] to curlyleaf pondweed in cool water temperatures provided improved control of that plant, with significantly less growth recovery than found in warm temperature applications. Greenhouse studies showed that combining endothall (1 mg/L ai) with a low rate of 2,4-D (0.5 mg/L ai) provided excellent control (99 %) of Eurasian watermilfoil. Based on these results, a 3-year field study was initiated to evaluate long-term control of curlyleaf pondweed and Eurasian watermilfoil using early spring applications of endothall combined with 2,4-D. Four lakes infested with these invasive plants were selected in the Minneapolis, MN area. Pretreatment plant surveys were conducted in June and August of 2003, and all of the curlyleaf pondweed and Eurasian watermilfoil stands in two lakes were treated with the herbicide combination in April 2004. Two lakes served as untreated references. Post-treatment plant evaluations occurred in June and August 2004. Herbicide treatments were successful at controlling 95% of the curlyleaf pondweed and Eurasian watermilfoil for at least one growing season. The herbicide treatments resulted in no significant changes in native plant abundance or diversity. Follow-up spot treatments with endothall and 2,4-D, along with efficacy evaluations, will continue through 2006.

Evaluation of an Herbicide Application on Vegetated Habitat and the Structure of a Fish and Macroinvertebrate Community in Minnesota Lakes *(Student Presentation)*

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Macrophytes provide important habitat complexity mediating structure of aquatic communities in lakes. We investigated the hypothesis that removal of invasive macrophytes and subsequent change in plant complexity will alter fish and macroinvertebrate populations. A four-lake experiment was conducted in the Minneapolis, MN metropolitan area (June 2003-September 2004) to measure herbicide effects on the structure of the aquatic community. A BACI (before–after/control–impact) sampling design was used to evaluate change in structural habitat (stem frequency) by removing two invasive plant species (*Myriophyllum spicatum* and *Potamogeton crispus*) and its effect on the abundance and richness of fish and macroinvertebrates. As an experimental treatment, a low-dose, species-specific herbicide application was made using 2,4-D and endothall in two of the lakes. Pre- and post-treatment fish and macroinvertebrate population data were collected, and the treatment effect was evaluated using repeated measures two-way ANOVA. A multi-sampling approach using popnets, boat-mounted electrofishing, and seining was deployed to ensure accuracy in fish data. Our data documented significant loss of the two invasive plant species; however, no treatment effect was noted on overall stem frequency, or abundance and richness of the fish and macroinvertebrate community. Lack of change in stem frequency was due to immediate replacement by native macrophytes. Temporal (seasonal) effects in the abundance and richness of macrophyte, fish, and macroinvertebrate communities were noted. In our study we measured no immediate effect on the fish and macroinvertebrate community by using a herbicide to remove invasive macrophytes.

Evaluation of Aquashade Dye for Growth Inhibition of Submersed Aquatic Vegetation

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Despite the widespread use of shading dyes for the past four decades in the field of aquatic plant management, little information has been published regarding the quantitative impact of dye treatments on plant growth reduction. Therefore, an outdoor mesocosm study was conducted in the summer of 2004 to determine the impact of Aquashade dye on the growth of two

submersed plants, hydrilla (*Hydrilla verticillata* L.f. Royle) and sago pondweed (*Stuckenia pectinatus* (L.) Boerner). The study was conducted in two mesocosm systems, one with tanks 1.4 m deep (shallow tanks) and one with tanks 3.0 m deep (deep tanks). Three replicate shallow tanks were treated at rates of 0, 0.5, 1.0 and 1.5 ppm Aquashade, whereas the deep tanks were only treated at rates of 0 and 1.0 ppm. A secchi disk could be seen at the bottom of the shallow tanks. Water samples were collected weekly to monitor dye concentrations throughout the study. Plants were harvested at 6 and 9 weeks after treatment (WAT). Shoot biomass was collected and tubers were counted at each harvest. Results indicated that 0.5 to 1.5 ppm Aquashade could reduce hydrilla biomass by 30 to 56 percent and sago pondweed biomass by 59 to 73 percent 9 WAT in the shallow tanks. Both hydrilla and sago pondweed exposed to 1.5-ppm Aquashade for nine weeks produced significantly more tubers than untreated controls. Biomass of both hydrilla and sago pondweed was reduced by 84 percent in the deep tanks 9 WAT; however, there were no significant differences in the number of tubers produced. Aquashade dye residues decreased by 46 to 65 percent through 6 WAT and then stabilized for the remainder of the study. Results of this study demonstrate that shading dyes can significantly reduce growth of submersed plants over a broad range of concentrations.

Experimental Evaluation of the Effects and Efficacy of Fluridone and Copper in Double-cropped Aquaculture Ponds *(Student Presentation)*

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Multiple herbicides applied to aquaculture ponds can interact to control plants and /or accumulate in the sediment, affecting subsequent fish production directly or indirectly. Our previous studies at the Hebron State Fish Hatchery, Ohio, revealed that applications of copper sulfate to control algae during the summer catfish rearing season can have a negative impact on the survival of larval saugeye raised in the same ponds the following spring. Starting in 2001, fluridone (the active ingredient of AVAST) was applied to catfish ponds to control vascular plants. We tested the effect of fluridone and copper on plant biomass, phyto/zooplankton abundance and community structure and fish production across three different treatments (AVAST alone, Copper alone, AVAST plus copper) and controls. Fluridone concentration in the pond water declined rapidly from an initial concentration of 0.17 ppm to 0.005 ppm at the end of the fish production season as revealed by high performance liquid chromatography analyses. Preliminary results show that combined treatment with AVAST and copper showed the best results: decreasing plant biomass by 86% and providing the highest fish survival (93%). Further analysis of plankton abundance and community structure across treatments, and analysis of residual effects of fluridone and copper on this spring's saugeye production in the same ponds will allow examination of indirect effects of copper and fluridone. Our finding of potentially toxic *Cylindrospermopsis* in the hatchery water samples indicates that any chemical addition to fish ponds requires caution.

Enhancement of Diquat Activity by Copper on a Biotype of Diquat-resistant Duckweed (*Landoltia punctata* (G. Meyer) D. H. Les and D. J. Crawford)

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Observations in Lake Co., FL suggested reduced activity of diquat on a duckweed population that historically was effectively managed using diquat. Trials conducted with an accession of landoltia (*Landoltia punctata*) from this site showed that it developed resistance to diquat [resistance factor (Rf) of 50] and was cross resistant to paraquat (Rf 29). Discrepancies in the literature regarding the exact mechanism of resistance to the bipyridylium herbicides exist, and it is unclear whether multiple mechanisms have evolved. One involves elevated levels of antioxidant enzymes, and the other an exclusionary or sequestration mechanism that prevents the herbicide from reaching the site of action. Copper applied in combination with diquat overcame the 50-fold resistance in landoltia. Experiments were conducted with multiple sources of copper and in combinations with diuron to ensure Cu^{2+} enhanced diquat toxicity. Copper probably increased permeability of the cell membrane to diquat by causing the formation of non-specific ion pores, as electrolyte leakage from copper exposure was rapid (< 1 hr). Therefore, copper may alter the transport mechanism for diquat across the plasmalemma. Diquat transport across the plasmalemma is likely reduced in resistant accessions of landoltia due to a modification at the site of transport.

Evaluation of Herbicides for Controlling Alligator Weed (*Alternanthera philoxeroides*) and Restoring Native Wetland Plants at Eufaula National Wildlife Refuge *(Student Presentation)*

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Alligator weed dominates many wetlands managed to provide food and habitat for migratory waterfowl at Eufaula National Wildlife Refuge (ENWR). In this study, we experimentally tested two herbicides (triclopyr amine and imazapyr) applied at three application rates (high, medium, and low) and two application dates (April and July) for alligator weed control and native plant restoration to managed wetlands at ENWR. We used a randomized block design and treatments consisting of different herbicides, application rates, and application dates were assigned randomly to experimental plots (5 x 5 m) within each block ($n = 4$). Control plots also were established. Two quadrats (0.5 m^2) per experimental plot were used to measure alligator weed height, stem number, and percent cover of all plants before treatment and 1, 2, and 3 weeks and 1, 2, and 3 months after treatment. In October 2004, two quadrats (0.25 m^2) were randomly placed in experimental plots to sample plant biomass. Our results showed that July application of either triclopyr amine or imazapyr resulted in greater control of alligator weed than April application. Imazapyr resulted in greater control of alligator weed than triclopyr amine when applied in April and high application rate resulted in greater control than low application rate. April application of medium or high application rates resulted in greater biomass of native plants available for waterfowl later in the year than April application of low rate or July application of any application rate. Triclopyr amine application resulted in greater native plant biomass than imazapyr application.

Production and Growth Rates of *Egeria densa* in the Sacramento-San Joaquin Delta, California *(Student Presentation)*

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Egeria densa is one of the most problematic aquatic plants west of the Cascade Mountains in Oregon and Washington, and in the Sacramento-San Joaquin Delta of California. Life history characteristics of the plant were studied to inform management. Growth and photosynthetic response to light was measured monthly in the Delta beginning December 2003. Photosynthetic response to light was determined by incubating plant tips in 300-ml bottles at five light levels. Photosynthetic rate was estimated from changes in pH and dissolved oxygen concentration after 4-h incubations at ambient surface water temperature. Photosynthetic efficiency was determined from the initial, light-limited portion of the photosynthetic response curve. Growth rates were determined by tagging plants and measuring changes in apical growth and stem elongation after approximately three weeks. Photosynthetic rates were positively related to degree day ($p = 0.07$) and the maximum photosynthetic rate (8 mg $O_2 \cdot$ mg $DW^{-1} \cdot h^{-1}$) was observed during summer 2004 when surface water temperature was 25 ºC. Minimum photosynthetic rate (1.2 mg $O_2 \cdot$ mg $DW^{-1} \cdot h^{-1}$) was observed in January 2004 when surface water temperature was 9.2 ºC. Photosynthetic efficiency was positively associated with percent nitrogen in plant tips ($p = 0.02$) and negatively associated with surface irradiance ($p=0.008$) and temperature ($p = 0.09$). Maximum nitrogen content of plant tips was observed in January for both years (ca. 5.4%) and declined significantly in the spring and into summer (3.4%). Maximum apical growth of 0.7 (± 0.09 SE) cm d^{-1} and stem elongation of 0.25 (± 0.04 SE) cm d^{-1} was observed in April 2004 when water temperature was 23 ºC.

Environmental Factors Affecting Biomass and Distribution of *Stuckenia pectinata* in the Heron Lake System, Jackson County, Minnesota *(Student Presentation)*

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Sago pondweed (*Stuckenia pectinata* (L.) Börner) is an important food for waterfowl in which all plant parts are consumed. Lush growth of sago pondweed in Heron Lake attracted waterfowl for many decades, supporting nesting, feeding, and staging waterfowl. In recent years, Heron Lake water quality has declined, resulting in a sago pondweed population decline. We studied Heron Lake during 2002 and 2003 to determine the effects of environmental factors on the biomass and distribution of sago pondweed. Biomass of sago pondweed and environmental parameters were collected every three weeks from May through September of each year. Sago pondweed plant and tuber distribution was assessed using a point intercept survey method during July and October, respectively, during both years. We predicted that increased spring and early summer light transparencies would increase plant distribution and biomass. Conversely, greater water depths in the spring would result in lower whole-lake sago pondweed distribution and biomass. Differences in biomass were correlated to environmental factors (water depth, water transparency, and water temperature) early in the season. Variation in water depth and water transparency during May (time of early growth) was negatively correlated with maximum biomass at each site in each year. Decreased light availability may be the primary factor negatively affecting sago pondweed biomass and distribution in Heron Lake. The primary management action that would result in improved sago pondweed growth would be to reduce nutrient loading, resulting in reduced algal growth and improved light conditions.

Evaluation of Methods for Establishing Native Aquatic Vegetation in Seven Texas Reservoirs

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Aquatic vegetation plays an important role in freshwater systems, providing quality habitat for fish, sequestering nutrients from the water, stabilizing sediments, and improving water clarity. Because many Texas reservoirs are either sparsely vegetated or contain an overabundance of non-native species such as hydrilla (*Hydrilla verticillata)*, Texas Parks and Wildlife Department's Inland Fisheries Division began a new initiative to develop procedures for establishing diverse native aquatic plant communities. Establishment techniques have been tested in seven reservoirs representing diverse geographical areas from 1998 through 2003. Aquatic plant species native to Texas and representing three growth forms (submersed, floating-leaved, and emergent plants) were used. Plant survival and spread were documented using GIS technology. Results were variable; however, founder colonies capable of long-term propagule production and spread were established in all seven reservoirs.

Hyperspectral Data to Differentiate Waterhyacinth from Common Rush *(Student Presentation)*

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Waterhyacinth [*Eichhornia crassipes* (Mart.) Solms] is a nuisance aquatic weed worldwide that causes economic losses and impacts the aquatic environment. Successful control of this aquatic weed requires accurate monitoring. Remote sensing is an alternative to monitoring plant populations and predicting future invaded areas in aquatic habitats. Hyperspectral remote sensing covers more spectral bands compared to multispectral methods. Pertinent features can be extracted from this higher dimensional feature space, allowing high accuracy on species differentiation. Studies were conducted in Lake Columbus, Columbus, MS between April 4, 2004 and February 11, 2005 to differentiate waterhyacinth and common rush (*Juncus effusus* L.) in natural areas by means of hyperspectral data. Hyperspectral data were collected monthly using a spectroradiometer, Analytical Spectral Device (ASD), Field Spec Pro®, model FR. The data were collected in 2151 spectral channels between 350 and 2500 nm with a 1.4-nm band width. The best spectral band used to distinguish waterhyacinth from common rush was selected using a spectro-temporal greedy search approach. Fisher's linear discriminant analysis was used to determine the best combination of the selected spectral bands. The best bands selected were 1347, 1348, 1349, and 1350 nm and the combination of features resulted in an accuracy of 100%. These spectral bands clearly differentiated waterhyacinth from common rush for all sample dates.

MCB, Camp Pendleton Invasive Riparian Weed Program

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MCB, Camp Pendleton (Base), in coordination with the U.S. Fish and Wildlife Service, developed the Programmatic Activities and Conservation Plans in Riparian and Estuarine/Beach Ecosystems Biological Opinion for Camp Pendleton. These plans allow for military training while sustaining riparian ecosystems. The invasive riparian weed program created a weed treatment bank to offset impacts to riparian habitat from military activities (e.g., infrastructural maintenance, construction projects). This involves an acreage deduction from the bank using a previously agreed upon mitigation ratio. The bank began with weed treatments in the uppermost portions of the Camp Pendleton watersheds and proceeded downstream. The primary targeted species are, but are not limited to: *Arundo donax, Tamarix* spp., *Lepidium latifolium,* and various palms. This presentation is an overview of the program goals, treatment and data management strategies.

Poster Session

Alligatorweed Biocontrol - Use of Biocontrol Insects to Reduce the Use of Herbicides to Control Invasive Aquatic Plants

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After an extensive research and quarantine process, three insect species were introduced into the United States from South America in the 1960's to control alligatorweed (*Alternathera philoxeroides*). These insects, the alligatorweed flea beetle (*Agasicles hygrophila*), the alligatorweed stem-borer (*Arcola malloi*), and the alligatorweed thrip (*Amynothrips andersoni*), have become established and successfully control alligatorweed in much of the southeastern United States. Since introduction of the insects, the Jacksonville District has eliminated the spraying of herbicides to control alligatorweed. Unfortunately the insects are not as tolerant to cold as alligatorweed. Through funding from the U.S. Army Engineer Research and Development Center in Vicksburg, Mississippi, the Jacksonville District's Aquatic Plant Control Operations Support Center (APCOSC) field-collects and ships flea beetles to public agencies where the insects do not overwinter. This biocontrol project began in the 1980's and continues today. The APCOSC provides this yearly service to participants in Alabama, Mississippi, Georgia, Louisiana, North and South Carolina, Texas, and Puerto Rico. Permits from the U.S. Department of Agriculture are required to ship biocontrol insects between states. Photographs of the insect species, collections and shipping methods, and results will be provided in the poster.

A Rapid, Quantitative Detection Assay of Cyanobacteria

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A number of invasive cyanobacterial species form harmful algal blooms (HABs) and have the potential to cause health problems. *Cylindrospermopsis raciborskii* and *Pseudanabaena limnetica* are two species that have proven problematic through the production of toxins and compounds that lead to taste and odor problems, respectively. Due to these two species' ability to produce blooms as well as their respective deleterious compounds, it is vital to detect these organisms at low concentrations in an accurate and efficient manner. However, current methods of detection have proven difficult with light microscopy, especially when concentrations are low. Furthermore, when people with the technical capability and training are able to make a positive identification, the process has been time-consuming and the population has already reached "bloom" levels. Also, these methods are expensive, adding to the cost of the cyanobacterial treatment. Although real-time PCR is not a novel tool, it has had limited use in the environmental analysis of cyanobacteria. Therefore, we are developing a quantitative, molecular detection assay using 5'-exonuclease PCR (*Taq*man) specific for *C. raciborskii* and *P. limnetica*. By doing so we will have a quantitative method for detecting these cyanobacteria at lower cell concentrations. The successful development of this technology will provide a rapid, relatively inexpensive method of detecting low concentrations of cyanobacteria, potentially leading to improved management of the organisms and facilitating the study of the effects that ecological parameters have on cyanobacteria.

Native Aquatic Plant Founder Colony Establishment: Four Case Histories

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Vegetation plays a vital role in aquatic ecosystem health, and can be especially important to fisheries and waterfowl populations. Aquatic plants also improve water clarity and quality, reduce rates of shoreline erosion and sediment resuspension, and help prevent spread of nuisance exotic plants: this last role has been of primary interest to the Aquatic Plant Control Research Program (APCRP). Research on aquatic plant establishment conducted under the APCRP has caught the attention of resource managers; subsequently, numerous entities have solicited our involvement in planning and implementing native aquatic plant establishment in lakes and reservoirs that support poor aquatic plant communities. Our usual approach has been to establish founder colonies, which once well-established, serve to provide propagules for natural spread to unvegetated areas. This presentation provides four case histories in which aquatic plant establishment efforts have been made, including Cooper Lake (Texas), Drakes Creek (Tennessee), Arcadia Lake (Oklahoma), and Bull Shoals Lake (Arkansas).

Using Spatial Information Technologies for Detecting and Mapping Eurasian Watermilfoil

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This paper describes the spectral light reflectance characteristics of Eurasian watermilfoil (*Myriophyllum spicatum* L.) and the application of aerial color-infrared photography and videography for distinguishing infestations of this invasive, exotic, submersed aquatic weed in Texas waterways. Airborne videography was integrated with global positioning system (GPS) and geographic information system (GIS) technologies for mapping the distribution of Eurasian watermilfoil. Field reflectance measurements showed that Eurasian watermilfoil could be spectrally distinguished from other associated plant species in either the visible green, visible red, or near-infrared regions of the electromagnetic spectrum. Eurasian watermilfoil submerged at depths greater than 5 cm below the water surface had similar visible reflectance to water. Surfaced Eurasian watermilfoil could be distinguished on color-infrared (CIR) aerial photography and videography where it had a grayish-pink or faint pink image response. Integrating the GPS with the video imagery permitted latitude-longitude coordinates of Eurasian watermilfoil infestations to be recorded on each image. A stretch of the Rio Grande River in southwest Texas was flown with the photographic and video systems to detect giant reed infestations. The GPS coordinates on the color-infrared video scenes depicting Eurasian watermilfoil infestations were entered into a GIS to map the distribution of this invasive weed in the Rio Grande.

Native and Naturalized Insect Herbivores of Invasive Aquatic and Wetland Plants

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In the United States, several species of native and naturalized insect species have exhibited potential to severely impact and possibly manage both introduced and native aquatic plant species. However, little, if any information is available on the operational use of these agents. A coherent plan for the implementation of native/naturalized agents needs to be developed, initiated, and evaluated. Toward this goal, research is being conducted by ERDC scientists to identify naturalized and/or native insect herbivores of aquatic plants in an effort to develop viable alternative management strategies through an understanding of the agents' biology and ecology. Native species examples include *Altica* spp. for water primrose, *Donacia* spp. for American lotus, and *Euhrychiopsis lecontei* for Eurasian watermilfoil control. Naturalized species with possibility include *Cyrtobagous salviniae* for common and giant salvinia and *Parapoynx diminutalis* for hydrilla. In addition, recent experiments have indicated that management of submersed aquatic plant species using introduced insect agents may be strengthened by increasing native plant competition. Unfortunately, in most cases, native plants do not compete effectively with the introduced species partially because of a large and diverse assemblage of herbivores that feed, damage, and hence reduce the production of the native plants; a herbivore assemblage that is typically missing for the introduced plant species. Before these methods can be used effectively, information on herbivores that impact native plant species must be obtained. Research toward this understanding has been initiated in small pond situations.

Overview of the Chemical Control and Physiological Processes Team

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Invasive aquatic plants have become problematic in lakes, reservoirs, rivers and wetlands across the United States. Once introduced, they rapidly expand in coverage, spread into nearby water bodies, and form dense monocultures in littoral zones and along shorelines. Existing infestations should be aggressively controlled to prevent degradation of water quality, fish and wildlife habitat, and the reduction of biodiversity. Operating under the purview of the U.S. Army Corps of Engineers Aquatic Plant Control Research Program, the Chemical Control and Physiological Processes Team develops and evaluates environmentally sound strategies for managing invasive aquatic and wetland plants using herbicides. Evaluations are conducted using a multi-tiered approach in controlled-environment chambers, greenhouses, and outdoor mesocosm/pond facilities located in key water-resource regions of the country, e.g., Florida, the Gulf Coast, and the Great Lakes. Results from small-scale studies are verified in a variety of field sites. Research focus areas include selective control of invasive species to restore native plant communities, integration of non-chemical control techniques, and prevention of herbicide resistance. Work is conducted on a cost-reimbursable basis with sponsors and cooperators including Federal and state agencies, non-profit groups, and the private sector. Coordination with the U.S. Environmental Protection Agency and state regulatory agencies is undertaken to support the

review and registration of new aquatic herbicides and amendments to established labels. Information and technology developed via research efforts are transferred to natural resource managers, the private sector, and the general public through workshops and symposia, and the publication of technical reports, popular articles, and peer-reviewed scientific literature.

Evaluation of Three Candidates for Biocontrol of Water Hyacinth

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The following candidates are being studied at SABCL for biocontrol of Water Hyacinth (WH), *Eichhornia crassipes* (Mart. Solms-Laub.): the dolichopodid fly *Thrypticus truncatus* Bickel & Hernández, the planthopper *Megamelus scutellaris* Berg, and the planthopper *Taosa inexacta* (Walker). Multiple-choice oviposition tests, field interspersions of test plants and field surveys were conducted with *T. truncatus.* Results confirmed its high specificity for WH. No larvae developed in any of the ten Pontederiaceae species and three subspecies tested. Oviposition multiple-choice tests with Commelinaceae species, a family related to Pontederiaceae, are being carried out. Preliminary results indicate that larvae developed only WH controls. The petiole miner larvae of *T. truncatus* feed on the sap that exudes from small holes scraped on the vascular bundles. This particular way of feeding limits its host range to those plants with aerenchyma. Studies on *M. scutellaris* were focused on its host specificity, the ovipositional-plant selection and the damage caused to the plant. Multiple-choice tests and paired-choice tests (WH-pickerelweed) confirmed its high specificity on WH. Recently, studies to evaluate the potential of the dictyopharid *Taosa inexacta* were started. Six replications of feeding non-choice test with whole test plants of five species of Pontederiaceae were carried out. *Taosa paraherbida* completed its development only on the WH control. The damage produced is being studied by rearing different numbers of nymphs on an equivalent number of WH plants. Nymphal temperature-dependent developmental rates were estimated. These results warrant further studies on the biology and specificity of this species.

Experimental Effects of Lime Application on Aquatic Macrophytes

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

Management of Eurasian Watermilfoil for Small-scale Restoration of Native Vegetation in Mobile Delta, Alabama

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Exotic aquatic plants such as Eurasian watermilfoil (*Myriophyllum spicatum*) and Hydrilla (*Hydrilla verticillata*) often create dense beds at the water's surface that can interfere with public water uses. Eurasian watermilfoil has been present in Alabama waterways since the 1970's. This species as well as some notable others have had a detrimental impact on native submersed aquatic vegetation (SAV) distributions in several parts of the state, including the Mobile Delta. Without any natural control measures, the rampant growth of Eurasian watermilfoil can reduce overall species diversity and adversely affect the diversity and abundance of aquatic invertebrates and fishes. Two treatment plot sizes (1 and 2 acres) and a no-treatment reference (2 acres) were replicated six times each, for a total of 18 plots. Granular 2,4-D ester herbicide (Navigate) was applied in mid-June, 2002 and again in late May 2004. Herbicides were not applied during 2003 due to a lack of Eurasian watermilfoil in the treatment plots. The treatments were evaluated periodically throughout the growing season to determine the effectiveness of the treatments to control Eurasian watermilfoil and evaluate the response of native submersed plant species. Evaluations were performed using a point-intercept technique on 30 points per plot. Data analysis indicated that the highest diversity and native plant frequencies were found in the 1-acre treatments with 2,4-D. While the 2-acre treatments with Navigate did improve the effectiveness of Eurasian watermilfoil control, it also decreased species diversity and potentially reduced the frequency of some desirable native plants. Fine-tuning of small plot applications may be possible based on concentration-exposure time information. Changes in plant communities were also occurring due to the variability of water levels and weather patterns in the Delta.

Effect of Cutting and Burning on the Growth Pattern of *Miscanthus sacchariflorus* in the Woopo Wetland, South Korea

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Growth patterns after the cutting and burning of a *Miscanthus sacchariflorus* community were analyzed in the Woopo Wetland. Three replicates of 5- by 5-m plots of control, burning, and cutting treatments were established in April 2003 and growth pattern changes were monitored by August 2003. In the control, burning, and cutting plots, a total of 7 families and 8 species, 14 families and 18 species, 6 families and 8 species were observed, respectively. Burning plots showed a high diversity of flora. However, high diversity declined after July and all plots showed a similar species diversity. A vine plant, *Humulus japonicus*, dominated in the burning plots. Change of shoot density was highest in the early period in the burning plots (176/m²) and shoot density in early May was almost double that of the control and cutting plots. Toward the end of the active growth period (August), shoot density in cutting plots (170 ± 7/m²) was higher than that of burning plots (141 ± 9/m²). Shoot length of the cutting, burning, and control plots was 205 ± 15 cm, 196 ± 17 cm, and 187 ± 6 cm (n > 100), respectively. Above-ground biomass of the cutting plots was higher than that of the burning and control plots. Above-ground biomass of the cutting plots was 1.6 times higher than the control, while burning plots showed 1.4 times. This study indicted that cutting of *M. sacchariflorus* community increases shoot density development, length growth, and above-ground biomass.

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

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A joint project was initiated in September 1999 to determine if the use of biocontrol would aid in hydrilla/waterhyacinth management in the Lower Rio Grande. Two species of leaf-mining flies, in the genus *Hydrellia*, were released on the Rio Grande at Falcon and Anzulduas in 2001. In 2003, additional flies were introduced at the Roma and Lonesome Dove sites. Waterhyacinth weevils (*Neochetina* spp.) were released at Cameron No. 6 Canal located adjacent to the Rio Grande River in 2000, and in 2001 they were released at four sites on the river at Delta Lake, LaFeria, T-192, and T-241. Establishment of the hydrilla control agents was confirmed at all release locations and hydrilla significantly declined in 2003 while nearby infestations remained intact. In 2004, an increase in hydrilla below Falcon Reservoir necessitated the release of 900,000 flies. A point sampling technique was instituted in 2003 and will continue throughout 2005 allowing for more intensive monitoring. Establishment and impact of the waterhyacinth agents was complicated by high water levels due to increased rain activity in late summer 2003. Increased water flow flushed the river clean of waterhyacinth and associated insect agents. However, one site (Cameron # 6 Canal) still contains waterhyacinth and has exhibited a five-fold increase in weevil numbers with a corresponding decrease in plant height of over 60%. Plant surveys continue.

Preliminary Results from a Study to Determine the Effects of Armored Shorelines on Processes within Submersed Aquatic Vegetation Beds in the Oligohaline to Mesohaline Potomac River, Maryland

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The U.S. Army has proposed installation of a shoreline erosion minimization system consisting of 12 offshore breakwaters and 250 m of stone revetment at the Blossom Point Research Facility in Charles County, Maryland. This project, when completed, will protect approximately 800 m of shoreline that was eroding at a rate of 0.3 m year^{-1} along the Nanjemoy Creek, a tributary in the oligohaline to mesohaline portion of the Potomac River. The revetment portion of the project was completed in March 2005. (Funding for the breakwater portion of the project has been requested but not yet authorized.) Shoreline armoring could affect local SAV (submersed aquatic vegetation) communities through impacts on light availability and nutrient cycling. In a cooperative effort with other agencies, we are conducting research to determine SAV habitat conditions before and after installation of revetment at the Blossom Point shoreline. Under natural, pre-revetment conditions (2000-2004), we found sediment nitrogen concentration within the plant bed has decreased each year between spring and fall and that nitrogen in plant tissues was near the critical concentration for SAV growth by 2002. A decline in SAV coverage in 2002 and 2003 corresponded with a decrease in water clarity, sediment nitrogen, and plant tissue nutrient concentration. We also documented pre-revetment overwintering propagule density and biomass and found that overwintering propagules corresponded with previous year's SAV aerial coverage. This study represents a unique opportunity to study the effects of armored shorelines on ecological processes within established SAV beds.

Investigations of Torpedograss Seed Viability and the Seed Bank at Selected Sites in the Marsh at Lake Okeechobee, Florida

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Proliferation of the exotic perennial *Panicum repens* (torpedograss) has caused the loss of thousands of hectares of wildlife habitat in the marsh at Lake Okeechobee, Florida. Uncontrolled, torpedograss forms dense, monospecific stands that spread asexually by stem fragments and rhizomes with "torpedo-shaped" tips. Viable seeds have been reported in few torpedograss populations (e.g., in Portugal and Mexico) and little is known regarding *in situ* seed germination of this species in the United States. Studies were conducted to determine whether torpedograss was among species most likely to emerge from the seed bank in the Lake Okeechobee marsh. Substrate samples (5 cm deep) were collected from six sites supporting torpedograss—three sites each at two elevations (lower = 13.2-13.3' msl; upper = 13.6-13.7' msl) differing in hydrologic pattern. Upon removal of vegetative propagules, the substrates were placed in a growth chamber and examined for seedling emergence for 8 weeks under 14-hr photoperiod and alternating temperature (22/32°C, 12/12 hrs). By the end of the study period, 14 native plant species had emerged; however, no torpedograss seedlings were present. Collectively, the upper elevation sites accounted for 63% of the total number of seedlings (n = 266), while lower elevation sites showed greater species diversity (H). The lack of torpedograss seedlings was verified in a related secondary study in which torpedograss seeds (n = 1,000) from Lake Okeechobee showed only trace (0.3%) germination. These results suggest that areas impacted by torpedograss in the marsh, if managed to control vegetative spread of this species, could potentially develop native plant communities from seed banks.

Water Nutrients, Plant Nutrients, and Indicators of Biological Control in Waterhyacinth at Texas Field Sites

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Interactions occur under controlled conditions between the nutrient content of floating waterhyacinth plants (*Eichhornia crassipes*) and reproduction of waterhyacinth weevils (*Neochetina bruchi* and *N. eichhorniae*) introduced for biocontrol. Few studies have linked water nutrition, plant nutrition and biocontrol measures in waterhyacinth under variable field conditions. Fifteen sites in coastal Texas were sampled repeatedly in 2003 and 2004. Water samples were analyzed for total nitrogen and reactive phosphorous. Plant biomass, damage by waterhyacinth weevils, symptoms of a fungal plant pathogen (*Cercospora*

piaropi), and leaf nitrogen (N) and phosphorous (P) contents were determined. Total water nitrogen concentration was strongly, positively correlated to leaf N and P. Water phosphorous concentrations were more modestly associated with leaf N and P. Water collected from five sites on the Lower Rio Grande had higher nitrogen and phosphorous levels than did water from four South Texas sites off of the river. Chemical and mechanical removal of waterhyacinth from the Rio Grande in 2003 did not substantially alter water nutrient differences between on- and off-river sites. In 2004, sites with flowing water (the Rio Grande and irrigation canals) had near-significantly more water and plant tissue nitrogen than did sites with relatively low-flowing water (ponds, reservoirs), and plants growing in flowing water had more biomass. Damage by waterhyacinth weevils and leaf coverage by *C. piaropi* necrotic spots were higher at low-flow sites, and necrosis was negatively correlated to water and plant N levels. Water nutrients could alter biological control efficacy by influencing plant nutrient levels and plant biomass.

Impact of Herbicides and Burning on Restoration of a Phragmites-dominated Wetland

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Phragmites australis (Cav.) Trin. ex Steud., is a robust perennial grass often associated with wetlands. Once established, this invasive weed produces dense monotypic stands which displace native plant communities and degrade wildlife habitat. A 2-year field study was conducted to evaluate and compare the effectiveness of herbicide treatments applied with and without prescribed burning for control of *P. australis* populations at St. John's Marsh, Michigan. 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, followed by burning 7 months later. Changes in percent cover of *P. australis* and the subsequent recovery of non-target plants were determined 1 and 2 years after treatment (YAT) using quadrat sampling along permanently marked transects. Control of *P. australis* averaged 93% for all herbicides 1 YAT; there were no statistical differences among herbicides. There was a significant effect of burning. Treatments followed by burning showed higher *P. australis* cover than those without burning. By 2 YAT, regrowth of *P. australis* was evident; however, all herbicides still showed significantly lower *P. australis* cover compared with untreated controls. Imazapyr and glyphosate + imazapyr performed similarly, maintaining 76% control of *P. australis*, whereas glyphosate sustained only 67% control. Recovery of non-target plants was not impacted by herbicide application or burning. Results of this 2-year study indicated that both imazapyr and glyphosate + imazapyr provided superior long-term control of *P. australis* over glyphosate applied alone. The data also demonstrated that prescribed burning following herbicide application did not improve herbicide efficacy or enhance recovery of the non-target plant community.

Integrated Weed Management Strategies for Improved Hydrilla Control

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While herbicides often provide a quick and effective means for controlling nuisance submersed vegetation, over-reliance on chemical methods alone can lead to weed resistance to herbicides, unfavorable shifts in weed populations, and impacts to non-target organisms. The ability of plant communities to change in response to repeated control practices suggests the need to identify more diverse weed management strategies for future use. Previous studies have shown that integrating the indigenous fungal pathogen, *Mycoleptodiscus terrestris* (Gerd.) Ostazeski, with fluridone can provide effective control of hydrilla (*Hydrilla verticillata* (L.f.) Royle). The rapid biomass reduction exhibited by *M. terrestris* and the long-term suppression of plant re-growth characteristic of fluridone use, resulted in better hydrilla control than either agent applied singly. In addition, utilizing reduced rates of each product improved treatment selectivity. Recent advances in the fermentation process of this pathogen have resulted in the production of a dry formulation prototype. The results of ongoing growth chamber experiments designed to evaluate the effectiveness of combining this new formulation prototype with fluridone for controlling both resistant and susceptible hydrilla biotypes will be discussed. The effect of contact time on treatment efficacy will also be reported.

Benzene Degradation by Rhizospheric Microorganisms Isolated from *Limnobium laevigatum* in La Conejera Wetland (Bogota, Colombia)

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In this research, 51 bacterial strains were isolated from beds of *Limnobium laevigatum*, and 21 of these strains were positively identified. In the first transect the following bacterial composition was noted: *Bacillus* (33.33%), *Enterobacter* (22.22%),

Aeromonas, *Flavobacterium*, *Sphingobacterium* and yeast (11.11%). A second transect *Bacillus*, *Acinetobacter*, *Shewanella*, *Stenotrophomonas*, and yeast (12.50%). A third transect contained *Bacillus* (35.56%), *Pseudomonas*, *Alcaligene*, and *Actinomycetes* (11.11%). The capacity for benzene degradation was evaluated *in vitro* for 49 bacterial strains. Studies indicated that benzene degradation was observed after 96 hours following exposure to the bacterial strains *Sphingobacterium spiritivorum* (92.35%), *Bacillus mycoides* (89.88%), *Pseudomona aureofaciens* (89.79%), *Actinomycetes* (88.37%), and the number 9 strain (83.00%). It was established *in vivo* that benzene degradation was more effective in the third transect due to a synergistic relation between the *Limnobium laevigatum*-bacterial mixture, the number 25 strain (*Pseudomonas* sp. and *Bacillus mycoides*) with a resultant 39.36% reduction of benzene in the wetland water at 12 hours.

Regeneration of Giant Salvinia from Apical and Axillary Buds following Desiccation or Physical Damage

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Giant salvinia *(Salvinia molesta)* is an aggressive floating aquatic fern native to Brazil and currently found in tropical and temperate regions around the world. Dense mats of giant salvinia can impede water-based transportation, irrigation, hydroelectric production, and flood and mosquito control. These mats can destroy fish and wildlife habitats, degrade water quality, and hinder rice farming and fishing. Giant salvinia survival during periods of stress such as might occur during a freeze, drawdown or contact herbicide application depends on protection of buds on the rhizome. If sufficient portions of the buds are protected, the population can regenerate when favorable environmental conditions ensue. Because buds are protected by their location and are thus most likely to survive stress, this study focused on the effects of 1) drying of buds, and 2) effects of bud size on survival of existing buds. Moisture content of exposed, excised salvinia steadily decreased over the desiccation period. Effects on viability were not observed until the salvinia had dried for 2.5 hours. Viability of giant salvinia was unaffected by desiccation until tissue moisture content was below 30%. Additionally, giant salvinia buds that measure 2 mm or less did not produce new growth. Sixty-seven percent of giant salvinia buds that measured 3 mm in length produced new growth and all buds that measured 4 mm and greater produced new growth.

Concentration/Exposure Time Study of Endothall Against Monoecious and Dioecious Hydrilla

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The monoecious biotype of the exotic macrophyte hydrilla (*Hydrilla verticillata* (L.f.) Royle) has expanded its coverage in lakes and reservoirs of the mid-Atlantic United States. Monoecious hydrilla has been present in the region for 25 years, yet there is little published information on herbicide rates and contact times required to control this biotype in the field. A small-scale concentration and exposure time (CET) evaluation was conducted in a controlled-environmental growth chamber using the aquatic herbicide endothall as a first step to develop control strategies for this plant. Dioecious hydrilla was also included as a check for herbicide efficacy. Shoots from each biotype were field collected, propagated, and grown in vertical aquaria (50-L) filled with aqueous medium. After an establishment period, plants were dosed with endothall rates ranging from 1 to 4 mg ai (active ingredient) L^{-1} and exposure times ranging from 24 to 96 hours. Control of endothall treatments dosed with rates of 2 to 4 mg ai L^{-1} ranged from 60 to 100% for monoecious hydrilla and 90 to 100% for dioecious hydrilla. Although control of both biotypes with 1 mg ai L^{-1} for a 48-hour exposure period was <40%, a 96-hour exposure time increased control to 60% for monoecious hydrilla and 86% for dioecious hydrilla. Lower herbicide concentrations with longer exposure times were as effective as higher doses with short exposure times in stopping shoot biomass accumulation for both hydrilla biotypes. Results from this study match CET curves generated from other small-scale studies.

Occurrence of Three Endophytes in Eurasian Watermilfoil

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Healthy Eurasian watermilfoil (EWM) plants were examined for the presence of endophytes in roots, root crowns, stems, leaves and inflorescences. The most commonly isolated fungal species in order of frequency of occurrence were *Plectosphaerella cucumerina*, *Mycoleptodiscus terrestris*, and *Colletotrichum gloeosporioides*. Every plant examined harbored one or more of the aforementioned species. The presence of one endophyte in tissues did not exclude another. Distribution of the endophytes in the roots occurred almost exclusively within the 2-cm section adjacent to the root crown. Mean density of root crown colonization was 24, 58, and 18% for *M. terrestris*, *P. cucumerina*, and *C. gloeosporioides*, respectively. This may have important survival implications for the fungi when EWM plants die back to the propagating root crown during adverse conditions and then resume growth as water temperatures moderate. *Plectosphaerella cucumerina* was consistently found in high frequencies (> 60%) in every stem section from the base of the plant to the apex. It frequently co-occurred with both *M. terrestris* and *C. gloeosporioides* in stem and leaf tissues. Only *M. terrestris* was absent from inflorescences. In healthy Eurasian watermilfoil plants *M. terrestris*, *P. cucumerina*, and *C. gloeosporioides* exist benignly and asymptomatically and their role in plant tissues is poorly understood. However, EWM plants that become stressed by biotic or abiotic factors may induce them to become pathogenic.

Ecological Attributes of Exotic and Native Aquatic Plant Communities

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Despite public perception, such as bass angler resistance to hydrilla management, resource managers realize that monospecific populations of hydrilla and other nonindigenous species may provide poor or even harmful aquatic habitat. Information on habitat quality of ecosystems comprised of monospecific populations of nonindigenous aquatic plant species or diverse communities dominated by native species is needed in order to help justify both management of exotic plant species and restoration of native plant communities. An earlier study by the authors demonstrated poor growth and/or survival of largemouth bass and bluegill in newly planted, shallow ponds dominated by hydrilla or Eurasian watermilfoil when compared with ponds vegetated with native species. These same ponds were restocked and monitored for two additional years (2001-2002) for evaluation of water quality and fish populations in mature plant communities. Several water quality parameters, particularly DO and pH, diverged greatly between pond types. Fish in native vegetation ponds grew and reproduced, but no bass and few bluegills survived in hydrilla and Eurasian watermilfoil ponds. Fish mortality in exotic species ponds was attributed to long periods of low DO that occurred during the second summer, when surface canopy development peaked.

Establishment of Diverse Aquatic Plant Communities

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Establishment of diverse aquatic plant communities can be used to enhance aquatic habitat for fish and wildlife, improve water quality, stabilize shorelines, and deter invasion or regrowth of harmful nonindigenous species. In order for managers to effectively promote the development of these diverse aquatic plant communities, several objectives must be accomplished. First, a reliable source of container-grown, weed-free, planting stock must be identified. Appropriate planting sites must then be located, and finally, protection from herbivory/biotic disturbance must be provided. After planting, it is critical that progress be monitored on a regular basis so that corrective action can be taken, if necessary. This e-poster provides information on plant propagation and production of a variety of submersed and emergent species. Guidance on site selection and herbivore protection is also provided. Examples of successful (and not so successful) revegetation projects are also shown.

Spatial and Temporal Variation in the Composition of Filamentous Algae Present in California Rice Fields

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Algae pose major problems in California rice fields. Algal mats envelop seedlings, dislodging them when the mats begin to float to the surface. Although copper sulfate is relatively effective in controlling most algae, some fields have species that appear to be tolerant to copper. Our purposes were to 1) identify algae in rice fields, and 2) characterize the water quality and nutrient conditions in these fields with the goal of developing capabilities for predicting which fields might be at greatest risk of algal problems. We sampled 8 fields at 2-day intervals from May 1 to June 1, 2004. Algal abundance shifted from dominance by green algae (*Sphaeroplea, Tribonema, Ankistrodesmus, Tetraspora*) and diatoms (*Navicula*) early in May to dominance by blue-green algae (almost totally *Nostoc,* with *Anabaena* and *Phormidium* also present) in late May/early June. The same species occurred in all the fields at around the same time. The most abundant blue-green algal species was *Nostoc*. This species may be able to tolerate relatively high levels of copper due to its production of mucilage. There was considerable variation in the 22 water quality parameters measured among the 8 fields. Results from multiple regression analysis showed that total algal biomass was negatively related to total alkalinity and sulfate concentration, but was positively related to the concentration of ammonium and sodium in the water and also to the concentration of calcium divided by 0.25 mg/L of copper. These variables explained 49% of the variance associated with algal biomass.

Waterhyacinth Survival and Growth Response to Cutting

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Waterhyacinth (*Eichhornia crassipes* (Mart.) Solms), is a serious problem in the Sacramento Delta. This study tests the hypothesis that waterhyacinth would not survive treatments made by three types of cutting machines mounted on boats and thus result in open-water areas. Waterhyacinth mats were treated by machines 1 and 2 during September 2003 at Lambert Slough, south of Sacramento, California and at the Dow Wetlands, near Antioch, California. In June 2004, machine 3 cut plants in the Dow Wetlands. Machine 1 sheared off the leaves, resulting in many plant fragments and plants that consisted of floating stem bases with intact root systems. Plants collected immediately after the treatments and grown either *in situ* or in tubs began to produce new leaves within one week of treatment. Leaf production rates were higher for cut than for uncut plants. Similarly, plant dry weight increased over the course of the experiments. All of the plants survived in the tub experiments and 65% of them survived in field enclosures for at least six weeks. At Lambert Slough, > 50% of the surface was covered by floating plant debris (2446 g dry weight m^{-2} and 1589 g dry weight m^{-2}) after four and six weeks. Cutting waterhyacinth with the three machines evaluated in this study did not immediately (i.e., within six months) produce large weed-free areas of open water in habitats typical of those found in the Sacramento / San Joaquin Delta.

Natural Enemies of Fanwort (*Cabomba caroliniana* Gray): First Report on Species Richness and Host Ranges

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Cabomba caroliniana Gray is a submerged, rooted weed in the Cabombaceae that is considered noxious in Australia, Japan, Southeast Asia, New Guinea and India. It is supposed to be native both to southern South America and North America, although its disjunct distribution, that of other members in the genus, the apparent lack of specific natural enemies in the United States, and the fact that it is invasive in several areas, suggest it may be naturalized here. The SABCL has an agreement with the CSIRO Australia to survey and evaluate natural enemies of fanwort in South America. The most interesting insects discovered so far are an aquatic weevil, *Hydrotimetes natans* Kolbe (Curculionidae: Bagoini), that has stem-mining larvae, and an aquatic arctiid moth that can cause heavy defoliation. Field host range studies suggest the weevil is specific to fanwort. Laboratory tests indicate that the arctiid moth, however, can also develop on the rooted water hyacinth, *Eichhornia azurea* Kunth, and will feed, but not complete development, on at least four other aquatic plant species. We have also found several generalist plant feeders such as snails and limpets, shore flies (Ephydridae), midge larvae (Chironomidae), caddisfly larvae, seed shrimp (Ostracoda), and aphids, in all chances of little interest for biocontrol, and the rice weevil *Oryzophagus oryzae* Lima.

Innovative Solutions for Invasive Species Information Transfer

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Invasive plants create many problems throughout the entire United States. Because of the sheer number of plants and strategies available for control, one must have the ability to readily and efficiently obtain pertinent information enabling the development of viable management procedures. For this reason, researchers at the U.S. Army Engineer Research and Development Center (ERDC) have created several computer-based information systems including the Aquatic Plant Information System (APIS) and the Noxious and Nuisance Plant Management Information System (PMIS). Information covered includes plant biology, ecology, identification, and management options and all operate using sophisticated programming algorithms that allow for easy identification of invasive species or available management options. The systems contain in-depth textual information as well as numerous photographic-quality diagrams and images. With the ever-growing amount of new information, revisions to these systems are needed in order to provide the most up-to-date information. For this reason, the research team at ERDC is in the process of adding content and images for six new plant species in APIS and more than 40 new plant species in PMIS, as well as updating the herbicide, ecology and biocontrol sections in both systems. Version 3.0 of the APIS will be available this summer, with the updated version of the PMIS expected in the fall. Copies of each system are available free of charge on a first-come, first-serve basis by contacting Sherry Whitaker (601-634-2990, Sherry.L.Whitaker@erdc.usace.army.mil).

Mass Production of *Cyrtobagous salviniae* and Transfer of Technology for Biological Control of S*alvinia molesta* in the United States

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The USDA APHIS PPQ CPHST Pest Detection, Diagnostic, and Management Laboratory (PDDML) in Edinburg, TX, mass produces a culture of *Cyrtobagous salviniae*, the salvinia weevil, for biological control of *Salvinia molesta*, giant salvinia (GS). The *C. salviniae* culture was established in 2000 from collections in Australian sites where introductions of Brazilian weevils led to a successful GS biological control in Australia during the 1980's. Following completion of the required host specificity testing and receipt of an approved U.S. field release permit, *C. salviniae* releases were initiated in October 2001 in six evaluation sites in east Texas. Additional releases and monitoring continued throughout the next two years that led to weevil establishment and successful control of giant salvinia in five of the six sites. The GS biological control program expanded to include establishment of field insectary sites (FIS) in other states from which within-state redistribution of *C. salviniae* could occur. Nine FIS were successfully established in Louisiana, North Carolina, and north Texas. Transfer of the GS biological control program technology continues in 2005 with survey, site identification and/or releases of *C. salviniae* in Alabama, Florida, Georgia, Mississippi, South Carolina, and Virginia. In addition, PDDML continues to supply *C. salviniae* for a similar release program in Arizona and California conducted by another CPHST laboratory located in Brawley, CA, and for support of the Hawaiian host specificity testing program.

Session III: A Special Session on Issues Pertaining to Harmful and Toxic Algae and Cyanobacteria

Ecotoxicological Impacts of the Invasive Marine Alga *Caulerpa taxifolia*

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Widespread sub-tidal invasions of *Caulerpa taxifolia* have blanketed over 40,000 acres in the Mediterranean from 1984 until the present. The rapid growth rate (>1 to 3 cm/day; 1 to 3 new fronds per day), coupled with its ability to photosynthesize in low light only partially account for its successful dominance. The production in *C. taxifolia* of the sequiterpene compound caulerpenyne at high concentrations (ca. 1-2% of dry wt.) can also deter feeding of some invertebrates such as mollusks. Other mollusks, which have developed mechanisms to cope with this toxin at lower levels in other *Caulerpa* species, may also utilize it in their own defense against herbivorous fish. Caulerpenyne, which was first isolated from *C. prolifera*, is a neurotoxin that affects Na^+/K^+-ATPase in the "touch" neurons of the leech *Hirudo.* It also can interfere with cell division in sea urchins and has been reported to affect behavior of urchins that ingest *C. taxifolia*. Variations in content in other species of *Caulerpa* as well as the ability of their associated grazers (primarily sacoglossan opisthobranchs such as *Lobiger serradifalci* and *Oxynoe olivacea, Elysia viridis)* affect their relative distribution and abundance. Both the uniqueness of the caulerpenyne (and derivatives), as well as their conversions and utilization of these products by grazers for their own protection ("kleptoplasty"), make these toxins interesting as mediators of species interactions.

Update on Investigations into an Emerging Avian Disease and Links to Waterfowl, Fish, Invasive Aquatics, and Cyanobacteria

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Avian vacuolar myelinopathy (AVM), first reported in 1994, was the cause of death for at least 100 bald eagles (*Haliaeetus leucocephalus*) and thousands of American coots (*Fulica americana*) at 11 sites from Texas to North Carolina by December 2003. During the past year (Jan-Dec 2004), additional bald eagle, coot, mallard duck and Canada geese deaths in Georgia, South Carolina and North Carolina were attributed to AVM. These birds were recovered at two established sites (GA/SC and NC) and at two additional sites (GA and NC) during the 2004-5 field season. All of the sites where active disease occurred were dominated by hydrilla (*Hydrilla verticillata*) and an unknown species of cyanobacteria. Genetic analysis of the cultures developed from the disease sites established these colonies as a new species within the order Stigonematales. Our current working hypothesis is that the disease agent for AVM is an uncharacterized neurotoxin produced by this novel Stigonematales epiphyte. Laboratory feeding trials and a sentinel bird study using naturally occurring blooms of this species on hydrilla leaves and farm-raised mallard ducks (*Anas platyrhynchos*) induced the disease experimentally. Fractions of extracts developed from hydrilla collected at positive and control locations are being evaluated for general toxicity. Work is underway to develop a cell line bioassay that will allow researchers to detect the putative AVM toxin. Additionally, we are investigating whether triploid grass carp (*Ctenopharyngodon idella*) are sensitive to AVM or if they have the capacity to transfer the disease through the food chain. Our research investigations have expanded into new locations where AVM status is unknown, but it is probable that occurrences of this disease will increase with the introduction of hydrilla and associated cyanobacteria species into additional ponds, lakes, and reservoirs.

Lyngbya Growth and Control: We Are Working On It?

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Cyanobacteria "blooms" may achieve densities that are problematic and can produce toxins that are harmful to invertebrates and fish inhabiting infested water resources. *Lyngbya* sp. has spread to a number of new sites (i.e., lakes and reservoirs) in the United States, and in some cases, produced a toxin causing mortality to invertebrates and fish. We have been studying growth and control of these *Lyngbya* sp. dominated algal mats in southern reservoirs. Physical control (drawdown) has been unsuccessful for controlling growths of these cyanobacteria. Recent studies indicate that, of the algaecides and adjuvants registered for use in aquatic systems, a weakly chelated copper formulation applied in conjunction with an adjuvant and a peroxide-based algaecide, will likely be efficacious approaches for controlling growths of these *Lyngbya* sp. However, periodic maintenance is required. Risk assessment indicated that this is the most environmentally sound strategy for potentially controlling growths of this noxious alga.

An Overview of Harmful Algae Waterblooms

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While harmful algal blooms (HABs), in a strict sense, are a completely natural phenomena that have occurred throughout recorded history, in the past two decades the public health and ecomonic impacts of such events appear to have increased in frequency, intensity and geographic distribution. Harmful algal blooms are being reported worldwide due to several factors, primarily eutrophication, climate change, and more scientific investigation. Harmful algal bloom organisms include those causing: PSP (paralytic shellfish poisoning), DSP (diarrhetic shellfish poisoning), NSP (neurotoxic shellfish poisoning), ASP (amnesic shellfish poisoning), EAS (estuary-associated syndrome) and CTP (cyanobacteria toxin poisoning). All but CTP organisms are mainly a marine occurrence. Cyanobacteria toxin poisoning's occur in freshwater lakes, ponds, rivers and reservoirs, as well as brackish waters and estuaries throughout the world. Issues with golden algae waterblooms, belonging to certain haptophytes in the Prymnesiophyceae, have reoccurred in Northern Europe and the South-central United States. Hemolytic cytotoxins, from *Chrysochromulina* blooms in the North Sea have led to fish losses, especially net-pen-reared Atlantic salmon. *Prymnesium* blooms also have led to fish losses, especially striped bass and catfish, in certain rivers and estuaries in Texas. New discoveries that Cyanobacteria produce a neurodegenerative amino acid toxin (BMAA) and its link to *Amyotropic lateral sclerosis/Parkinson dimentia (ALS/PDC)* extend the health risk possibilities from the cyanobacteria harmful algae blooms.

Red Tides in the Gulf of Mexico: *Karenia brevis* and Other Fish-Killing Species

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The Gulf of Mexico is a sub-tropical sea that is home to a great diversity of toxic and inimical phytoplankton. The most common red tide dinoflagellate is *Karenia brevis*, an unarmored species that produces a series of polyether toxins collectively known as brevetoxins. These toxins are highly ichthyotoxic and can result in fish kills of tens to hundreds of millions of fish. In addition, the toxins can accumulate in shellfish and cause a significant human health illness (Neurotoxic Shellfish Poisoning). Curiously, *K. brevis* is rarely found outside the Gulf of Mexico, although it can be transported into the coastal waters of the eastern seaboard by the Florida Current. Florida is affected by these blooms almost annually, while Texas has only sporadic blooms. *Karenia brevis* is the subject of intense study in the Gulf, with emphasis on understanding bloom origins and developing means of detecting cells before blooms occur, as well as development of satellite remote sensing capability for advance warning. The scale of the blooms (10^4+ km^2) makes mitigation and control impractical, although advance warning is useful to shellfish managers to prevent contaminated product from reaching the market. The historical record notes *Karenia* blooms from the 19th century, and probably much earlier than that. There is little evidence that humans are directly affecting the frequency or intensity of blooms. However, recent work indicating linkages between African dust inputs and *Karenia* blooms suggest that climate modification due to global warming could be an area of concern.

Cylindrospermopsis raciborskii in Florida's Freshwater Systems

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Cyanobacteria (blue-green algae) are common components of Florida's eutrophic and hypereutrophic freshwater systems. *Cylindrospermopsis raciborskii*, a potentially toxigenic blue-green algae, was first identified in Florida lakes in the mid 1990s. Subsequent to its identification, these algae began to dominate (> 90% of total species present by biovolume) the phytoplankton community and were reported to produce extremely high biomass levels (200-500 µg/m^3). *Cylindrospermopsis raciborskii* are relatively small (1-2 µm by 15-20 µm), heterocystous, filamentous algae that can maintain dense population levels (> 100,000 trichomes/ml) throughout the year. The population dynamics of these algae, however, appear to be lake specific. In general, lakes typically exhibit late summer and early fall maxima. Certain lakes will maintain dense populations throughout the year while others will experience significantly reduced populations or "crashes" in abundance levels to where these algae are not present or are relatively rare. Several smaller lakes have been observed to maintain low levels of these algae throughout the year as well. One of the unique traits of *C. raciborskii* is its ability to flourish throughout the water column, producing extremely high total biomasses. Data from our laboratory indicate that these algae can maintain significant populations, as indicated by chlorophyll-a concentrations, down to 90-95% of the total water column (for lakes 3-4 m in depth) and can be found distributed throughout the entire lake system, not just in localized bloom areas. These high biomass lakes can exhibit relatively high pH levels (9.0-9.9), saturated dissolved oxygen concentrations and limited light penetration (SD $\leq$ 0.3 m). Production of the water-soluble hepatotoxin cylindrospermopsin is common but can vary dramatically. Between 1999 and 2000, cylindrospermopsin was reported in concentrations that ranged from 0 – 200 µg/L and was reported in 100% (n=34, 1999) and 88% (n=113, 2000) of all samples analyzed during this time. Recently (2002-2004), however, environmental concentrations have ranged from only 0–0.2 µg/L (14%, n=132). The major environmental difference between the two sampling periods was the termination of severe drought conditions. The effects of cylindrospermopsin on the flora and biota of Florida lakes has not been studied.

Water Quality and Cyanobacterial Management in the Ocklawaha Chain-of-Lakes, Florida

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The Ocklawaha Chain-of-Lakes consists of large, shallow water bodies located in central Florida. Surface waters in the Ocklawaha Chain-of-Lakes are naturally productive. However, water quality has been severely degraded by nutrient loading, primarily from large agricultural operations. Water quality in the lakes ranges from mesotrophic to hypereutrophic, and the lakes have experienced prolonged severe cyanobacterial blooms. The program to manage water quality and cyanobacteria in the lakes includes purchase and restoration of wetland habitat in former agricultural areas to reduce external phosphorus loading, operation of a marsh flow-way to remove particulate phosphorus from lake water, harvesting of gizzard shad, and re-establishment of desirable aquatic vegetation. Following external phosphorus load reduction and shad harvesting, Lake Griffin has seen substantial improvements in water quality, including decreases in phosphorus and chlorophyll concentrations, and increases in transparency. Cyanobacterial biovolume has also decreased, and there have been changes in the composition, including a decrease in dominance by *Cylindrospermopsis*. The phytoplankton community has shifted from year-round cyanobacterial dominance to cyanobacterial dominance only during the warm season. Data from Lake Yale, a less-impacted lake in the chain, indicate that meeting phosphorus targets for the lakes will significantly improve water quality, but cyanobacteria will still be a prominent part of the phytoplankton community.

Spread of *Cylindrospermopsis raciborskii* in the Midwest

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Midwestern waters, historically, have been populated by "toxic" blue-green algae such as *Microcystis*, *Anabaena*, and *Aphanizomenon*. With the exception of some dog deaths and one purported human death in Wisconsin, these algae have not caused serious health problems. In 2001, a bloom of the toxic blue-green alga *Cylindrospermopsis raciborskii* was reported for the first time in the Midwest in a northeastern Indiana lake by Ann St. Amand (PhycoTech, Inc.). My subsequent analysis of water samples from Eagle Creek Reservoir, which provides drinking water for Indianapolis, also showed the presence of *C. raciborskii* in 2001. Bill Jones (Indiana University) conducted a survey funded through the Indiana Clean Lakes Program between 2002-2004 and reported the presence of *C. raciborskii* in 19 lakes in Indiana, with populations in two lakes greater than the limit of 100,000 cells/ml established by the World Health Organization. Since the original finding in 2001, a Blue-green Algae Task Force, consisting of government, university, and environmental personnel, has been convened to develop an action plan. The development of a viable plan, however, has been hampered by the perception that the risk is not great enough to justify large expenditures for further surveys and management. There is also controversy as to how to publicize these findings without causing undue, and possibly unjustified, concern among members of the public. The state is already being pressured not to close lakes when algal populations are high because of the potential loss in revenue to marinas, campgrounds, etc. *Cylindrospermopsis raciborskii* has also been reported at high levels in Wisconsin, so it is likely present in most Midwestern states.

Review of Golden Alga *(Prymnesium parvum)* Problems in Texas

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Since 1985, blooms of the golden alga, *Prymnesium parvum*, have been documented as a major cause of fish kills in Texas river basins. Over 17.5 x 10^6 fish with an estimated value of $6.5 million have been killed by *P. parvum*. The majority of the golden alga kills occur during the winter months, with the number and magnitude increasing. In 2003 the fish kills within five river basins (19 lakes) culminated in over 6.4 x 10^6 fish killed with a value in excess of $2 million. The Texas river basins with confirmed golden alga fish kills are Canadian, Wichita (Red), Brazos, Pecos (Rio Grande) and Colorado. This presentation focuses on how to identify blooms, symptoms of toxins, and affects to the aquatic communities.

Toxic Golden Alga Research Sponsored by the Texas Parks and Wildlife Department

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Toxic golden alga (*Prymnesium parvum*) blooms have impacted five river systems in Texas (Pecos, Colorado, Brazos, Red, and Canadian Rivers). In recent years major reservoirs and state fish hatcheries have been impacted resulting in significant losses to fisheries resources and recreational economies. To address this problem the Texas Parks and Wildlife Department (TPWD) has expanded efforts to monitor the algal blooms, conduct research on the alga, and develop management options. TPWD obtained federal funds and the Texas Legislature directed funds to help in these efforts. An international scientific workshop on the golden alga was held in 2003 to help determine the state of knowledge on the alga and to determine information gaps and research needs. The TPWD Golden Alga Task Force used the results of this workshop, and other meetings, to approve research proposals submitted to TPWD for funding. An overview is given of the projects undertaken. Projects involve many agencies and universities in efforts to provide the information needed to develop management options for golden alga problems in fish hatcheries and public waters of Texas.

Harmful Algae Waterblooms (HABs): An Overview of the National Plan

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Worldwide increases in HABs led to the U.S. National Plan for Marine Biotoxins and Harmful Algae in 1993. Its purpose was to acknowledge the mounting numbers of algal bloom outbreaks and to develop a program to address the areas most affected by their occurrence. Because the problems of harmful algal blooms (HABs) have multiplied since that time, the Second National HABs Symposium met ten years later, in December of 2003 at Woods Hole, Massachusetts. Their purpose statement was as follows: "In the last decade, harmful algae and their toxins have continued to threaten public and natural resources health and to impact local economies. In recognition that there are newly immerging (sic) problem species and that algal blooms encompass a much broader diversity of habitats and issues than were (sic) originally discussed, it is time to revisit, expand and update the National Plan. Future financial, personnel and intellectual resources should be directed toward priority topics that reflect the changing nature of the HAB problem in the U.S. and summarize the progress that has been achieved thus far." (National HABs Symposium, 2003). In March 2004 a workshop on a National Plan for Algal Toxins and Harmful Algal Blooms was held at the NOAA Center, Charleston, S.C. The final report for a national plan entitled "Harmful Algal Research and Response: a National Environmental Science Strategy (HARNESS)," 2005-2015 will be available in late 2005.

Session IV: Investigating Algae and Cyanobacteria Impacts and Developing Aquatic Plant Control Strategies

Investigating Triploid Chinese Grass Carp (*Ctenopharyngodon idella*) as a Potential Vector of Avian Vacuolar Myelinopathy *(Student Presentation)*

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Avian Vacuolar Myelinopathy (AVM) is a lethal disease of birds resulting in lesions within brain and spinal cord tissues. These lesions were first observed in bald eagles (*Haliaeetus leucocephalus*) and coots (*Fulica americana*) in western Arkansas in 1994. Since then, AVM has been diagnosed in several avian species that frequent surface water impoundments in the southeastern United States. Previous investigations have found no association with likely toxins, infectious agents, pesticides, herbicides, or heavy metals. Feeding studies performed at Clemson University established a link between lake vegetation and AVM. Our working hypothesis is that an epiphytic toxin-producing *Stigonematalen* cyanobacteria, growing primarily on *Hydrilla verticillata,* is the etiologic agent. Our current research involves investigation of triploid Chinese grass carp (*Ctenopharyngodon idella*) as a potential biological control agent of the nuisance aquatic plants that provide a substrate for the suspect epiphytic cyanobacteria. Two feeding trial experiments were conducted to determine if carp are susceptible to AVM, and if carp fed AVM-causing vegetation can act as a potential disease vector. If carp are a disease vector, Chinese grass carp availability to avian predators during AVM season will be assessed. Because grass carp are a widely used and effective nuisance aquatic vegetation control strategy, it is important to determine if they can be affected by or confer AVM. The results of this study will allow for the development of potential control mechanisms for nuisance aquatic plants that are associated with AVM. These studies further our knowledge of the disease transfer pathway and possible preventative measures.

Investigation of Factors Regulating Toxin Production in an Epiphytic Cyanobacterial Species Associated with AVM Bird Deaths *(Student Presentation)*

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Reservoir surveys were conducted to investigate 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). While the specific cause of the disease has not been confirmed, the most probable hypothesis is that birds ingest a neurotoxin associated with epiphytic cyanobacteria. A strong relationship exists between the field abundance of a specific undescribed epiphytic blue-green species and the incidence of disease. 16S rRNA sequence identity has determined this environmental isolates is an undescribed Stigonematalan species. Bird fatalities peak during late fall and early winter when temperatures are rapidly declining in the reservoir. This decline in temperature initiates lake mixing, bringing a pulse of nutrients into the upper water column. Additionally, hydrilla and other aquatic macrophytes senesce and release additional nutrients to the epiphytic algal assemblage. We hypothesized that the declining temperatures and increase in nutrients may stimulate toxin production in the suspect Stigonematales species. Cultures of the Stigonematales species were grown at various media and temperature concentrations to test this hypothesis. Culture material was then evaluated on experimental cell-line bioassays under development to detect the putative AVM toxin. Understanding the factors regulating toxin production will provide researchers and managers with critical information needed to predict disease occurrence and to plan potential mitigation strategies.

Bleb Formation and XTT Reduction in Channel Catfish Hepatocyte Primary Culture Exposed to Microcystin-LR

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Cyanobacteria (blue green algae) are a major source of the problems attributed to toxin-producing algae in fresh water. They are responsible for a diversity of toxins that can be classified into the following functional groups: hepatotoxins, neurotoxins, cytotoxins, dermatotoxins, and irritant toxins. Certain strains of the cyanobacterium *Microcystis aeruginosa* produce hepatotoxins termed microcystins. More than 60 variants of these cyclic heptapeptide toxins have been described. Microcystin-LR (MC-LR) is perhaps the most studied of these variants due to its relative abundance and potency. We report here preliminary results for a bioassay under development for the presence of hepatotoxins by the use of channel catfish (*Ictalurus punctatus*) primary hepatocyte culture. Exposure of hepatocytes to microcystin-LR resulted in blebbing of the cell membrane, and reduction of the tetrazolium compound XTT (2,3-bis[2-methoxy-4-nitro-5-sulfophenyl]-2H-tetrazolium-5-carboxyanilide) in a dose-dependent manner. Since blebbing is one of the earliest biomarkers of microcystin-induced hepatotoxicity, we are currently exploring the use of this phenomenon as a sensitive assay for the presence of microcystins. The ability to detect the biological activity of microcystin toxins and a better understanding of the sensitivity of target organisms will aid in the management of intoxication by harmful cyanobacterial blooms.

Site-specific Management of Problematic Algae Using a Copper-containing Algaecide *(Student Presentation)*

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Management of problematic species of cyanobacteria that produce taste and odor compounds (e.g. *Oscillatoria* sp. and *Anabaena* sp.) and toxin-producing algae (e.g., *Prymnesium parvum*) is indicated when thresholds for drinking water and fish mortality and other adverse consequences are exceeded. Site-specific management strategies can be developed using algal challenge experiments evaluating responses of problem algae species in site-specific waters to algaecide exposures. Efficacious treatments using copper-containing algaecides are identified in laboratory experiments using site waters and field densities of the specific algae. These experiments guide selection of the requisite concentration, duration of exposure, and form of algaecide (copper-containing) that maximizes control, while minimizing potential effects on non-target species. Algal control (loss of algae from the water column) was obtained, in these cases, at 0.2, 0.6, and 1.0 mg Cu / L for *Prymnesium parvum*, *Oscillatoria* sp., and *Anabaena* sp., respectively. Strategies for management of problematic algal species that are site-specific, efficient, and effective, can be developed using this approach.

Impacts from Military Activities on the Phytoplankton Composition and Water Quality of Headwater Streams in the Pascagoula River Basin *(Student Presentation)*

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Military installations across the country require continuous evaluation of their natural resources and examination of the impact of military activities on the environment. Water monitoring in Camp Shelby, the largest National Guard and Reserve training facility in the continental United States, has been conducted seasonally, beginning in 1998 at designed sites in 28 creeks. The measurements are designed to detect acute changes in water quality or aquatic organism composition. Such monitoring includes the identification of the algal community and the assessment of temporal and spatial variation in the phytoplankton structure and density in relation to their interactions with the environmental conditions. A total of 147 taxa belonging to six divisions were registered. Pennate diatoms were the most abundant and frequent types of algae found in the streams. The Chlorophyta were more diverse that Chrysophyta, in terms of genera, but their presence was not as constant as the diatoms. The diatoms *Eunotia*, *Navicula*, *Nitzchia*, and *Tabellaria*, and the green algae *Closterium*, *Mougeotia*, and *Ankistrodesmus* were recurrent members of the algal community. When other algal genera that have been related to harmful algal blooms and water quality problems in freshwater systems were reported, they accounted for a low proportion of the total phytoplankton. The statistically significant environmental factors that produced shifts in algae numbers over time were water temperature, phosphate concentrations, and storm events. Phytoplankton genera richness was driven by water temperature and flow. The investigation has shown that the land uses at Camp Shelby have not caused environmental deterioration.

Breeding System and Seed Germination between Common and Imperiled *Nuphar* Species of New England
(Student Presentation)

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The yellow pond-lilies (*Nuphar* sp.) inhabit freshwater ponds and streams of the Northern hemisphere. In northeastern North America *N. microphylla* is rare and disappearing throughout much of its natural range, while *N. variegata* remains common. To investigate a potential cause of rarity in *N. microphylla*, we compared the breeding system and seed germination potential of each species. Flowers and mature fruits were collected from six populations from New England to examine pollen-ovule ratios and seed germination capacity under varying environmental conditions. Our findings indicate that *N. variegata* is an obligate out-crossing species (xenogamous) while in *N. microphylla* inbreeding is also likely, in addition to out-crossing (facultative xenogamous). *Nuphar variegata* produces over three times as many seeds per fruit as *N. microphylla*. There is a marked difference in seed germination rates also between the two species, whereby *N. microphylla* seeds germinate earlier and at a much higher capacity compared to those of *N. variegata*.

Effect of Salinity and Cutting on the Growth of *Phragmites australis* in Nakdong River Estuary, South Korea
(Student Presentation)

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Expansion of *Phragmites australis* often causes problems in management practice. The effects of salinity and cutting the above-ground biomass on the growth of *P. australis* were evaluated by investigating two reedbeds grown in Nakdong River Estuary, South Korea. Reedbed stands were identified in tidal brackish and non-tidal freshwater; one stand of each treatment was cut during the growing season. Length and biomass of shoots emerged from the freshwater reedbed were higher than those of the tidal brackish reedbed. The number of shoots emerged from uncut plant stands was markedly lower than cut stands in freshwater. However, the number, length, and above-ground biomass of shoots emerged from uncut reedbeds were significantly higher than those of cut stands in the tidal brackish area. Toward the end of the growing season (September), shoot density in uncut reedbeds ($202 \pm 13/m^2$) was higher than that of cut reedbeds ($50 \pm 6/m^2$) in tidal brackish areas. Shoot length of the cut-brackish and uncut-brackish stands was 68 ± 17 cm, 212 ± 25 cm ($n>100$) respectively. Above-ground biomass of uncut brackish stands was 17 times higher than the cut brackish stands. This study showed that salinity reduced the growth of *P. australis*. The growth was severely retarded by cutting combined with salinity. For a better management of *P. australis* stands in Nakdong River Estuary, further detailed study should address the effects of timing and tidal range.

Registration of Aquatic Herbicides: A New Model

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Only nine herbicides have national (Section 3) labels for aquatic sites in the United States, and from 1971 (the year the USEPA was established) until 2002 only two, glyphosate (1977) and fluridone (1986), received aquatic registrations. Yet, during this same period, invasive aquatic weeds increased dramatically, and the awareness and need to control these weeds has never been greater. The cause for this conundrum was driven by a number of factors. Cost of registration was estimated at $10-40 million and total annual sales in the aquatic market were estimated at $100-150 million, a minor share of the overall pesticide market. Major changes in regulatory requirements, such as re-registration and the Food Quality Protection Act, have complicated and slowed the entire process. State regulatory and permitting processes, National Pollution Discharge Elimination System permits, risk cup issues, and public perception of pesticides have placed added complexity and burdens on registrations. Also, patent life of a molecule, combined with the specter of generics, discouraged development of proprietary products. The combination of these factors resulted in an increased risk of a low potential return on investment for registrants. In addition, critical interactions among the research community, the registrants, and the regulatory community, were greatly diminished. All three groups had lost in-house technical expertise, been downsized due to reduced budgets/resources, and had lost the interactive communication required to secure an aquatic label. Recently, a public-private-academic partnership has emerged that is changing the aquatic registration landscape. Cooperators include Federal and state agencies, selected research institutions, and non-profit research

organizations. Through this partnership, three new aquatic registrations have been secured since 2002: triclopyr, imazapyr, and carfentrazone-ethyl. Operational success of this partnership will be discussed and this collaboration may well represent the future of aquatic herbicide registrations.

The IR-4 Project: New Opportunity – Aquatic Herbicide Registration

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The IR-4 Project is a publicly funded effort to support the registration of pest control products on minor or specialty crops. Its historic mission has been to provide pest management solutions to the growers of vegetables, fruits, ornamentals, and herbs. The IR-4 Program develops data for submission to the U.S. Environmental Protection Agency (USEPA) to support the regulatory clearance of new crop protection chemicals on specialty crops and assists in the maintenance of existing product registrations. The IR-4 also provides aid in the development and registration of biopesticides and expedites new pest control technology, such as seed technology and methyl bromide alternatives. Concerned about increasing invasive aquatic weed problems, experts from the USEPA, the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, land grant universities, scientific groups and IR-4 joined together to form the Aquatic Herbicide Working Group. A white paper entitled "New Missions for the IR-4 Project-Weed Control in Aquatic Sites and Irrigation Canals" was completed and approved by the IR-4 Project Management Committee. Stakeholder support for the concept was obtained in February 2005 at the IR-4 Strategic Planning Conference. If resources are made available from sources outside current program funding, IR-4 will work with stakeholders to obtain registration of herbicides for use in irrigation canals and water bodies that supply irrigation water for production agriculture.

SP-1019: Status Report on Development of Potential New Aquatic Herbicide for Large-scale Aquatic Plant Management

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SP-1019 is a new chemistry under study as a potential herbicide for large-scale management of a variety of nuisance aquatic plant species. The active ingredient in SP-1019 is penoxsulam. This active ingredient recently received full Section 3 registration for use as a reduced-risk herbicide in rice agriculture. With activity on a variety of broadleaf weed species and select monocots, SP-1019 has demonstrated excellent activity on *Hydrilla verticillata*, a major problem exotic plant in various areas of the United States. At low ppb rates, SP-1019 can completely shut down hydrilla growth and produce slow death of existing tissues—characteristics that allow for use of the product at large scales with minimal risk of dissolved oxygen drops and other water quality issues. Timing of application has been shown to be important, with a direct correlation between starting hydrilla biomass and necessary contact time. Field dissipation patterns will be discussed along with preliminary information on hydrilla efficacy and treatment selectivity from current trials being conducted under an expanded EUP program.

An Overview of the Recent Hydrilla Management Issues Workshop in Florida

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Hydrilla (*Hydrilla verticillata* L.f. Royle), now in its sixth decade in Florida, has been devastating in its ability to overwhelm the abundant clear and relatively shallow water bodies throughout the state. In December 2004, professional resource and aquatic plant managers representing federal, state, and county agencies gathered in Gainesville, Florida for a two-day meeting to discuss issues related to hydrilla management. One impetus for organizing this meeting was related to information disseminated during the APMS Symposium on Herbicide Resistance in July 2004. The recognition of increased fluridone resistance and the increasing complexity of managing hydrilla in large flood control project waters that serve multiple other uses brought together aquatic plant managers, researchers, water managers, engineers, and fishery and plant biologists. The discussions resulted in the generation of a summary document that identified five key issues related to hydrilla management: the status of integrating management techniques, the potential use and removal of grass carp for selective plant management, the current use of fluridone and future of new herbicide development, the impact of water regulation schedules and deviation requests on large-scale hydrilla management efforts, and the impacts of hydrilla and hydrilla management on fish and wildlife. Supporting information for the document and recommendations came from peer-reviewed literature and recent practical experience. The issues addressed must be balanced with Florida law that directs the Florida Department of Environmental Protection to manage hydrilla at the lowest feasible level given current technology and funding. Follow-up stakeholder meetings are planned to address the unique challenges in maintaining selective control of this invasive plant.

Session V: Environmental, Chemical, and Biological Methods for Controlling Aquatic Plants

Effect of Light Quality on Duckweed (*Lemna minor*)

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This study measured the growth of *Lemna minor* using light from three different colored plastic panels (red, blue, and green). Temperature and light intensities for the test and control samples were nearly the same. Growth, as change in the number of fronds as a function of time, was measured over a 15-day period (in duplicate). Test rates were statistically less for blue and green light relative to control values, but greater for the red-light rates. *Lemna minor* has proven to be useful as biomass for a fuel cell (Carvalho-Knighton, 2004), so that being able to achieve enhanced growth is desirable for this application. The effect of the red light/far-red light ratio is considered as a means of explaining these observations.

Use of Native Macrophytes to Reduce Growth and Radial Spread of *Hydrilla verticillata* in Pond-scale Mesocosms

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This study assessed the ability of three native macrophyte species to resist invasion, expansion, and biomass accumulation of exotic hydrilla *(Hydrilla verticillata)*. Experiments were conducted in four 0.25-ha research ponds over 3 years at the LAERF (Lewisville Aquatic Ecosystem Research Facility) facility in Lewisville, TX. Native species were planted in protective exclosures and given 13 months of preemption prior to introduction of hydrilla. During the growing season, plant coverage was recorded by cover class. At the end of the experiment, biomass samples were collected and the pond-scale macrophyte community was mapped. Sediment nitrogen samples were collected by treatment twice a year and water quality parameters were collected on approximately 2-week intervals during the second and third years. Comparison of treatments was based on cover class through time and biomass accumulation at the end of the experiment. In one pond out of four, water star-grass *(Heteranthera dubia),* and eelgrass *(Vallisneria americana),* significantly resisted radial expansion of hydrilla compared to controls, but no difference was detected in biomass accumulation between hydrilla in treatments or controls. Hydrilla did not appear to limit expansion or biomass accumulation of treatment species compared to controls. No consistent change in sediment nutrient was detected and sediment nutrient content appeared to be influenced more by the action of aquatic animals than aquatic plants. Differences in environmental conditions between ponds and unexpected invasion by red swamp crayfish *(Procambarus clarkii)* confounded results. Eelgrass appeared to be more resistant than other species tested to adverse environmental conditions including herbivory by crayfish and grass carp *(Ctenopharyngodon idella)*, and rooting by common carp *(Cyprinus carpio)* and may be a better candidate for restoration than was previously recognized.

Manipulation of Environmental Conditions to Stress Nuisance Aquatic Plants

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What has not been considered adequately in aquatic plant management is the manipulation of environmental factors that may be combined with direct biomass control to successfully curtail invasions, promote decline, and encourage native plant re-establishment. Technologies and management strategies that change sediment nutrient chemistry and nutritional quality, alter the light regime, or create unfavorable environmental conditions for persistence of exotic and nuisance plants need to be integrated with other emerging technologies that directly target biomass. This will achieve more cost-effective, long-term control of an aggressive plant population and shift niche conditions toward native plant dominance. Two important factors affecting growth are inorganic carbon availability and sediment nutrition (primarily as nitrogen). Recent research in this work unit has determined that lime additions to aquatic systems may be very effective in suppressing growth and propagation by temporarily reducing inorganic carbon availability. Other research in this work unit has found that temporarily dewatering sediment via drawdown or natural pool level fluctuations results in decreases in sediment N concentrations due to nitrification-denitrification processes that translate into suppressed aquatic plant growth. Thus, manipulation technologies such as lime

additions and sediment dewatering may be effective in discouraging nuisance aquatic plants by providing environmental stressors to growth and persistence.

Ludwigia hexapetala in the Russian River Basin, California: Ecology and Integrated Management for Restoration

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Ludwigia hexapetala (Uruguayan primrose-willow, Uruguay seedbox, Uruguay water primrose) is a recent, aggressive invader of California's freshwater wetlands that degrades natural communities, reduces floodwater retention, harbors high densities of West Nile Virus mosquito vectors, and potentially threatens California rice production. This robust emergent aquatic plant has a creeping growth habitat, and can form dense mats over nutrient-rich pools, sloughs and canals. Population data (biomass, stem density and height) and site characteristics are presented from the invaded Russian River Basin of California. We have initiated ecological studies in California and Argentina to evaluate *Ludwigia* growth responses to herbivore pressure and environmental factors, and will experimentally evaluate integrated management strategies for native plant restoration.

Hydrilla Management in Lake Austin, Texas: An Integrated Approach

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Lake Austin, a 1600-acre reservoir on the Texas Colorado River, is used for drinking water, flood and irrigation water conveyance and recreation. In July 1999, 23 acres of hydrilla (*Hydrilla verticillata*) were documented in the lake by Texas Parks and Wildlife Department (TPWD). By May 2002, despite two winter drawdowns, the infestation grew to 320 acres. The reservoir presented unique challenges to hydrilla control, including drinking water and flow restrictions on herbicides, concerns regarding grass carp (potential escapement downstream and loss of non-target vegetation) and economic impacts from winter lake drawdowns. An integrated plan was developed and implemented by a partnership of jurisdictional agencies and citizens (City of Austin, Lower Colorado River Authority, TPWD and Friends of Lake Austin, a citizen group). The plan included incremental triploid grass carp stocking based on increases in hydrilla growth, harvesting and/or herbicide application on dense mats, and annual lake drawdowns. Begun in February 2003 with an initial stocking of 1600 fish, the plan resulted in over 8000 fish stocked, 3 consecutive winter drawdowns and two harvesting events. In spite of these efforts, hydrilla coverage peaked around 240 acres in both 2003 and 2004. The fish were initially less effective than first hoped, possibly due to cold water temperatures. Then a November 2004 stocking of 2400 fish was followed by a major flood and a winter drawdown. Subsequently, coverage has decreased significantly, with less than two acres of hydrilla documented in late February 2005.

Long-term Post-treatment Vegetation Assessment and Restoration Evaluation of Houghton Lake

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Since 1999, large-scale whole-lake restoration efforts have been underway on North Central Michigan's largest inland water body, Houghton Lake. This presentation is part of a series of ongoing studies regarding the long-term health of aquatic vegetation in Houghton Lake, Michigan. The primary focus of the report is to monitor the characteristics of aquatic vegetation following a lake-wide low-dose Sonar aquatic herbicide treatment in May and June of 2002. A secondary objective will be to evaluate and incorporate findings from personal interviews, public records, and fishery reports, particularly from the angler's point of view. Existing case studies will be referenced to illustrate changes in the plant community, fishery, and local economy over a number of years since the restoration process began. This presentation will attempt to explain the documented, long-term impact of the 2002 aquatic plant management effort on the exotic aquatic plant infestation of Houghton Lake, as well as provide other information relevant to understanding the changes resulting from this restoration effort. Qualitative as well as quantitative analysis of data gathered will be discussed.

Peruvian Watergrass – A New Threat to Coastal Louisiana

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In March of 2004, several south Louisiana rice growers complained that an unrecognized grass had infested a main irrigation canal in lower Vermilion Parish and was posing a serious problem by blocking irrigation equipment. Vegetative samples as well as digital images were circulated among various federal and state agencies for identification purposes. In May a specimen in flower was identified as *Luziola peruviana* (Peruvian watergrass). Samples of the grass were transplanted into microplots in containment areas at the Idlewild Research Station. Once established, both salinity and herbicide trials were conducted. The grass was able to withstand salinity levels of up to 5 ppt for 60 days. Of the herbicides screened only imazapyr at 1.0 lb ai/A provided greater than 90% control 58 DAT. Field trials with various herbicides or herbicide combinations indicated that only imazapyr at 1.0 lb. ai/A alone or in combination with glyphosate at 4.0 lb ai/A provided greater than 90 % control 60 DAT. A study was also conducted in 2004 on fallow ground in Vermilion Parish. The area was in rice production in 2003. Several herbicides used in rice production were applied at labeled field rates to Peruvian watergrass. The herbicides evaluated were bispyribac sodium, cyhalofop, fenoxyprop, imazethapyr, penoxsulam, propanil, and quinclorac. The grass had 1- to 3-ft stolons at the time of application. Control of Peruvian watergrass was less that 50% for any herbicide evaluated.

First Hydrilla Found in Brazil: Implications of Further Dispersal and Likely Impacts

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During initial field sampling of aquatic macrophytes for the presence of potential biological control agents for *Egeria densa*, populations of *Hydrilla* sp. were discovered in Porto Primavera Reservoir, Brazil (Lat.-22.5000, Long. –53.0167) on March 26, 2005. This constructed reservoir was filled in 2000 upon completion of the Porto Primavera Dam, which inundated large sections of the Rio Parana (Sao Paulo and Mato Grosso do Sul states). Porto Primavera area is approximately 2,200 sq. km (ca. 554,880 acres). Populations of native *Egeria najas* currently occupy several areas in the resulting lake, presumably derived from plants that were in São Paulo Lake before flooding and plant pieces from Jupiá Reservoir located upstream. Female flowers and mid-rib spines typical of *Hydrilla* spp. were present in a relatively small number of plants growing at a depth of approximately 3 to 4 meters among some of the *E. najas.* Subsequent microscopic examination of the leaf-stem insertion revealed the presence of pigmented axial scales called squamulae intravaginales, another characteristic found in hydrilla but not present in *Egeria* spp. or *Elodea* spp. The site will be sampled for presence of tubers during the fall/winter season of 2005. Since this is a hydroelectric project, continued spread and dispersal of hydrilla could have severe impacts on power generation as well as overall hydraulic characteristics of the impoundment. We recommend that additional surveillance be done to fully delineate the extent of the hydrilla infestation so that management options can be evaluated.

When Does an Insect Biocontrol Agent Become Operational?

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Within the aquatic plant management community, the question of when an insect biocontrol agent becomes operational is often discussed. As one would expect, this discussion is centered on the definition of "operational." Classical definitions frequently refer to something that is "…in proper working order and able to be used…" However, other definitions are often applied – most notably for an agent to be operational its impact must be "…consistent and quantifiable..." Consider the leaf-mining flies introduced for control of hydrilla. In most cases, they are still viewed as experimental even with ample, published evidence demonstrating effectiveness using controlled and field experimentation. Cost-effective distribution is available with the development of mass-rearing facilities and release procedures that can provide large numbers of insects at reasonable cost. Quantification is also defined allowing for relatively efficient counts and damage estimates usable at the operational level. Yet large-scale, operational application of the agents has yet to be accomplished across broad geographical ranges. The primary reluctance to operational use may be related to the current manner in which biocontrol is perceived and applied. First, the slow impact caused by the flies is often seen as a non-effect but in reality can be quite devastating. Also, biocontrol is often perceived as a passive technology, where little or no effort is put forth by operational personnel. A perceptional change is needed to view biocontrol as an active technology where knowledge, surveys, augmentation, and integration are utilized to allow for the most efficient application and impact.

Mycoleptodiscus terrestris: Progress Report on Dry Formulation Development

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As a result of a cooperative research agreement between the U.S. Army Corps of Engineers and the USDA, liquid fermentation methods have been developed and patented that yield stable, effective bioherbicidal propagules of *Mycoleptodiscus terrestris* (Mt). Under appropriate nutritional conditions, aerated Mt cultures produce high concentrations of vegetative biomass that differentiate to form compact hyphal aggregates or microsclerotia. The addition of new equipment at the USDA fermentation facility in Peoria, IL now allows rapid collection and drying of the microsclerotia following fermentation. Dried microsclerotia, collected after a 4-day fermentation, germinate vegetatively within 24 hours and sporogenically within 72 hours. This has important implications for a successful microbial agent because initial infection can rapidly ensue from hyphal germination of the microsclerotia followed several days later by secondary infection resulting from the development and release of spores from the surface of the microsclerotia. Initial aquarium studies indicate that dry inoculum applied at a rate of 40 mg/L can reduce hydrilla shoot biomass by more than 93% and up to 100% by 4 weeks post-inoculation, compared to untreated control plants. Current research efforts by formulators at the USDA are focused on characterizing the hydrophobicity of plant and microsclerotia surfaces to better select sticking agents that will improve adherence of the microsclerotia to plant surfaces.

Potential for Insect Vectoring of a Plant Pathogenic Fungus to Improve Biological Control of Waterhyacinth

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Biological control of floating waterhyacinth (*Eichhornia crassipes*) worldwide has been aided by the introduction of two weevils, *Neochetina eichhorniae* and *N. bruchi*. In the United States, several native plant pathogens have developed host associations with waterhyacinth, including the fungus *Cercospora piaropi*, which causes necrotic spotting on leaves. Applications of small amounts of spores of *C. piaropi* to weevils, followed by field releases of inoculated weevils, could lead to additive or synergistic biological control and avoid the need for costly large-scale foliar applications of fungi. Field site sampling in 2004 confirmed earlier reports of a positive correlation between leaf scarring by waterhyacinth weevils and leaf coverage with spots indicative of *C. piaropi* infection. In laboratory trials, *Neochetina* spp. weevils readily transferred inoculum to culture plates by walking on inoculated plates, or by being sprayed with spore suspensions and allowed to dry. Weevils remained capable of infecting plates for at least two weeks after spray inoculation. Plants in greenhouse tanks and field tanks infested with pre-inoculated weevils developed *C. piaropi* symptom levels equal to the levels produced by simultaneous infestation with non-inoculated weevils and foliar application of the fungal suspension. Plants in tanks receiving inoculated weevils had lower numbers of leaves and reduced biomass than did plants receiving non-inoculated weevils. Formulation technology and another pathogenic fungus (*Acremonium zonatum*) will be used to further improve weevil-fungus vectoring relationships, and to increase their role in biocontrol of waterhyacinth.

Impact of Herbivory and Plant Competition on the Growth of Hydrilla in Small Ponds

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Previous research has shown that sustained levels of insect herbivory by the hydrilla leaf-mining flies (*Hydrellia pakistanae* Deonier and *H. balciunasi* Bock) and native plant competition can reduce hydrilla biomass by 30%, increase branching, reduce tuber/turion production, and impact the ability of hydrilla to photosynthesize. This 2-year study further evaluates insect herbivory in combination with native plant competition using 21 small earthen ponds. The experiment utilized two levels (presence or absence) of plant competition and insect herbivory. Leaf-mining flies were excluded in some ponds using the insecticide ABATE 4E. Both insect herbivory and plant competition significantly impacted hydrilla growth parameters. Significant reductions of about 40% in aboveground biomass were observed when herbivores were present when compared to ponds without insect herbivores. No reductions in biomass were noted for plant competition. Both insect herbivory and native plant competition significantly reduced the production of tubers. A 50% reduction in tuber numbers occurred when herbivores were present, while a 70% reduction was noted in those ponds containing native plants. However, when hydrilla was exposed to a combination of insect herbivory and native plant competition, tuber production was reduced by more than 90%. More than 50% lower turion numbers occurred when herbivores were present, although significant differences could not be detected.

Influence of Nutritional Characteristics of *Hydrilla verticillata* on Two Biological Control Agents

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A complex of abiotic and biotic factors is known to impact the establishment and success of biological control agents. Experiments using the ephydrid fly *Hydrellia pakistanae* have demonstrated that hydrilla containing low and more typical nitrogen content appear to impact not only larval development time but the number of eggs oviposited per female. Eggs per female were over 2-fold higher for larvae reared on hydrilla containing 2.4-fold more protein (as estimated from nitrogen content). However, nitrogen content is only part of the story, since higher weight females occurred in samples containing higher protein and less crowding as indicated by lower fly emergence. The hydrilla biocontrol pathogen, *Mycoleptodiscus terrestris*, also responds to plant nutritional condition. Laboratory studies have demonstrated that the nutritional status of hydrilla shoots affects *M. terrestris* vegetative growth, disease development, production of secondary inoculum in the form of disseminative spores or conidia, and production of survival structures called microsclerotia. High nitrogen content in shoot tissues was associated with increased production of conidia providing secondary inoculum and higher disease severity. In contrast, low nitrogen content in shoot tissues stimulated the fungus to enter a survival mode as evidenced by an approximate 3.5-fold increase in melanized survival propagules called microsclerotia. These studies suggest that the nutritional condition of target plants cannot be excluded as an important factor in efficacy of biological control agents. Both agents respond to favorable conditions by switching to a reproductive mode that ultimately results in increased host damage.

Large-scale Rearing of Insect Biological Control Agents for the Management of Aquatic Plants

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The ability to mass produce large numbers of high-quality insect biocontrol agents has been shown to enhance the utility of insect biocontrol for the management of aquatic plants. This is especially true for the agents currently in use for the management of hydrilla and salvinia. However, until recently, mass-rearing procedures were nonexistent or highly expensive for these species. Using man-made pond systems in Vicksburg, MS and Lewisville, TX, innovative procedures have now been developed for mass-rearing insect agents. These procedures require a certain degree of manipulation in respect to water levels and fertilization. For example, the manipulation of fertilization levels and seasonal growth habits of hydrilla has enabled the production of large numbers of the leaf-mining flies, *Hydrellia pakistane* and *H. balciunasi*. Nitrogen-rich hydrilla has been shown to increase reproduction by the leaf-miners, thereby enhancing insect numbers and quality. Pond water levels can be manipulated to stagger plant and insect interactions. These procedures result in the availability of insects for colonization throughout the hydrilla growing season. Last year, over 3 million flies were collected and released at the minimal cost of < $0.01 per fly by the ERDC. Fertilization techniques have had similar results in boosting *Cyrtobagous salaviniae* weevil numbers and quality for use against salvinia. The higher-quality insects produced by these procedures may enhance the establishment, and increase population numbers, thereby allowing for better control of invasive aquatic plants.