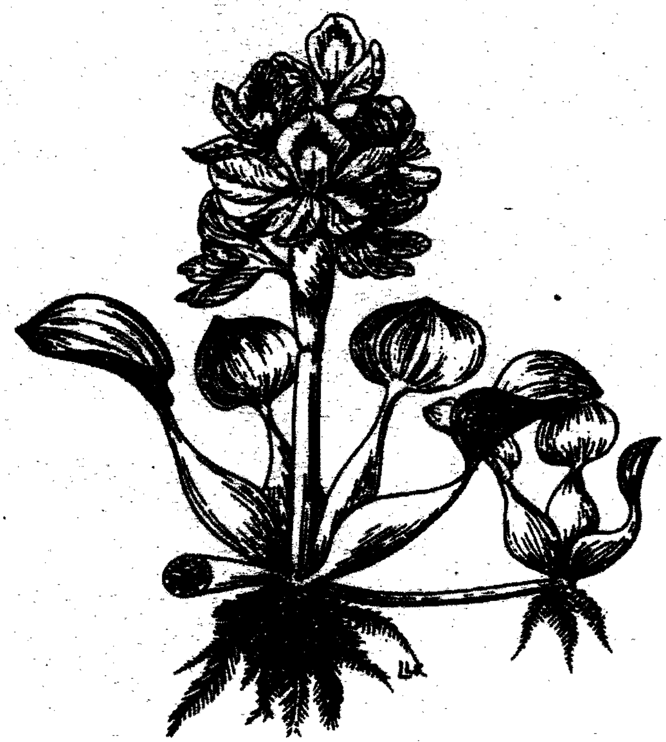
The Aquatic Plant Management Society, Inc.

42nd Annual Meeting

Improve Aquatic Resources with Educated Minds

PROGRAM



Keystone Resort and Conference Center
Keystone, Colorado
July 21-24, 2002

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Meeting Sponsors

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

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

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Greensboro, North Carolina

General Information

Meeting Registration Desk
On Sunday, July 21, the Meeting Registration Desk will be located in the Lobby of the Keystone Lodge and will be open from 2:00 p.m. to 5:00 p.m. Beginning Monday, July 22 at 7:30 a.m. the Meeting Registration Desk will be located in the Longs Peak Foyer of the Keystone Conference Center. For specific times, please see the daily agenda pages in this Program. Messages will be posted on the message board at the Meeting Registration Desk.

Presenter's Preview Room
Need to check your PowerPoint or slide presentation? The preview room will be located in the Board Room of the Keystone Conference Center and will be equipped with a notebook computer, LCD projector, external zip drive, external CD writer, and caramate projector. For specific times, please see the daily agenda pages in this Program.

Poster Session
The poster session will be open for viewing from 8:00 a.m. to 5:00 p.m. on Monday and Tuesday. The poster area is in the Longs Peak Room of the Keystone Conference Center. Presenters of posters will be in attendance during scheduled refreshment breaks.

Sustaining Members and Exhibitors
Exhibits will be open for viewing from 8:00 a.m. to 5:00 p.m. on Monday and Tuesday. The following will be exhibiting their products and services in the Longs Peak Room of the Keystone Conference Center.

Applied Biochemists
Milwaukee, Wisconsin

Aquarius Systems
North Prairie, Wisconsin

Aqua Solutions
Lawrence, Kansas

Aquatic Control, Inc.
Seymour, Indiana

BioSonics, Inc.
Seattle, Washington

Brewer International
Vero Beach, Florida

Cerexagri, Inc.
Philadelphia, Pennsylvania

Cygnet Enterprises, Inc.
Flint, Michigan

Dow AgroSciences
Indianapolis, Indiana

Electronic Data Solutions
Jerome, Idaho

Griffin LLC
Valdosta, Georgia

Pump Systems / Solar Bee
Westminster, Colorado

ReMetrix LLC
Carmel, Indiana

Syngenta Professional Products
Greensboro, North Carolina

SePRO Corporation
Carmel, Indiana

UAP Timberland LLC
Memphis, Tennessee

Special Events

- *President's Reception, Sunday, July 21, 7:00 p.m. – 9:00 p.m., Terrace, Keystone Lodge.* The APMS cordially invites all registered delegates, guests, and student paper competition participants 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 and regular students may purchase tickets at the Meeting Registration Desk.

- *Guest Tour and Luncheon, Monday, July 22, 9:00 a.m. – 2:00 p.m., meet in Lobby, Keystone Lodge.* The APMS cordially invites all registered guests to the Guest Tour and Luncheon, graciously sponsored by Applied Biochemists. Enjoy a historical tour of Montezuma (an old silver mine), rustic Ski Tip Lodge, and Old Keystone; as well as a cooking demonstration and luncheon at the Keystone Ranch Restaurant. Non-registered guests may purchase tickets at the Meeting Registration Desk.

- *APMS Regional Chapters Presidents' Breakfast, Tuesday, July 23, 6:30 a.m. – 8:00 a.m., Windwood Room, Keystone Lodge.* Two representatives from each APMS regional chapter are invited to attend this breakfast. Ken Manuel, APMS Vice President and Regional Chapters Committee Chair will be the moderator for discussions on aquatic plant management activities within each region.

- *APMS Banquet, Tuesday, July 23, 6:00 p.m. – 9:00 p.m., board shuttle buses at Keystone Lodge or Keystone Inn, buses will run from 5:30 p.m. to 7:00 p.m.* The APMS cordially invites all registered delegates, guests, and student paper competition participants to the APMS Banquet, graciously sponsored by Griffin LLC. Enjoy magnificent mountain views while riding the gondolas to the top of North Peak for a memorable evening at the Der Fondue Chessel for a fun alpine experience featuring a four-course dinner and Bavarian music. After an exceptional dinner, the evening will be highlighted by the Scholastic Endowment Grand Prize drawing, featuring a Gateway notebook computer graciously sponsored by Cygnet Enterprises, Inc., and a trip to Cancun, Mexico graciously sponsored by Professional Lake Management. Non-registered guests and regular students may purchase tickets at the Meeting Registration Desk

- *Awards and Installation of Officers Luncheon, Wednesday, July 24, 12:00 p.m. – 2:00 p.m., Shavano Peak Terrace.* The APMS cordially invites all registered delegates, guests, and student paper competition participants to the Awards and Installation of Officers Luncheon, graciously sponsored by Syngenta Professional Products. After an excellent lunch, we will recognize those who have served and contributed to the society, welcome new officers and directors, and present awards to the student paper participants. Non-registered guests and regular students may purchase tickets at the Meeting Registration Desk.

APMS Annual Business Meeting

The APMS Annual Business Meeting will be held in Quandary Peak Rooms 1-2 of the Keystone Conference Center on Monday, July 22 from 4:40 p.m. to 5:30 p.m. All APMS members are welcome to attend.

APMS 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.

APMS Board of Directors

David Tarver
President
SePRO Corporation
Tallahassee, Florida

Jim Schmidt
Immediate Past President
Applied Biochemists
Germantown, Wisconsin

Richard Hinterman
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U.S. Army Engineer R&D Center
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Robert Gunkel
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Joe Bondra
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Gerald Adrian
Director
Cerexagri, Inc.
Exton, Pennsylvania

John W. Barko
Director
U.S. Army Engineer R&D Center
Vicksburg, Mississippi

APMS Committee Chairs and Special Representatives

Bylaws and Resolutions	John Barko
Education and Outreach	Jeff Schardt
Exhibits	Joe Bondra
Finance	Richard Hinterman
Legislative	Tom McNabb
Local Arrangements	Robert Gunkel
Membership	Gerald Adrian
Nominating	Jim Schmidt
Past President's Advisory	Jim Schmidt
Program	Richard Hinterman
Publications	John Madsen
Regional Chapters	Ken Manuel
Scholastic Endowment	Tyler Koschnick
Site Selection	Robert Gunkel
Student Affairs	Mike Netherland
Strategic Planning (Ad Hoc)	J. Lewis Decell
Website (Ad Hoc)	Ken Manuel and Dave Petty
BASS Representative	Michael Masser
CAST Representative	Kurt Getsinger
NALMS Representative	R. Michael Smart
WSSA Representative	Greg MacDonald
RISE Representative	Terry McNabb

Past Meeting Sites and Presidents

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

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

Agenda Summary

Sunday, July 21, 2002

8:00 am - 5:00 pm	APMS Board of Directors Meeting *(Board Room)*
2:00 pm - 5:00 pm	Meeting Registration *(Lobby, Keystone Lodge)*
2:00 pm - 5:00 pm	Exhibit Set-up *(Longs Peak)*
2:00 pm - 5:00 pm	Poster Set-up *(Longs Peak)*
5:00 pm - 6:00 pm	Presenter's Preview Room *(Board Room)*
7:00 pm - 9:00 pm	President's Reception *(Terrace, Keystone Lodge)*

Monday, July 22, 2002

7:30 am - 8:00 am	Continental Breakfast *(Longs Peak)*
7:30 am - 5:00 pm	Meeting Registration *(Longs Peak Foyer)*
7:30 am - 5:00 pm	Presenter's Preview Room *(Board Room)*
8:00 am - 5:00 pm	Exhibits Open *(Longs Peak)*
8:00 am - 5:00 pm	Posters Open *(Longs Peak)*
8:00 am - 11:45 am	Session I: Plenary *(Quandary Peak 1-2)*
9:00 am - 2:00 pm	Guest Tour and Luncheon *(Meet in Lobby of Keystone Lodge)*
9:40 am - 10:05 am	Refreshment Break *(Longs Peak)*
11:45 am - 1:15 pm	Lunch
11:45 am - 1:15 pm	AERF Luncheon and Meeting - AERF Members and Invited Guests *(Quandary Peak 3)*
1:15 pm - 4:40 pm	Session II: Aquatic Plant Mapping/Remote Sensing, Aquatic Plant Invasions, and Herbicide-Fish Interactions *(Quandary Peak 1-2)*
2:55 pm - 3:20 pm	Refreshment Break *(Longs Peak)*
4:40 pm - 5:30 pm	APMS Annual Business Meeting *(Quandary Peak 1-2)*

Tuesday, July 23, 2002

6:30 am - 8:00 am	APMS Regional Chapters Presidents' Breakfast *(Windwood, Keystone Lodge)*
7:30 am - 8:00 am	Continental Breakfast *(Longs Peak)*
7:30 am - 5:00 pm	Meeting Registration *(Longs Peak Foyer)*
7:30 am - 5:00 pm	Presenter's Preview Room *(Board Room)*
8:00 am - 5:00 pm	Exhibits Open *(Longs Peak)*
8:00 am - 5:00 pm	Posters Open *(Longs Peak)*
8:00 am - 11:45 am	Session III: Aquatic Plant Biology, Ecology, and Restoration *(Quandary Peak 1-2)*
9:40 am - 10:05 am	Refreshment Break *(Longs Peak)*
11:45 am - 1:15 pm	Lunch
1:15 pm - 5:00 pm	Session IV: Aquatic Herbicides and Surfactants *(Quandary Peak 1-2)*
2:55 pm - 3:20 pm	Refreshment Break *(Longs Peak)*
6:00 pm - 9:00 pm	APMS Banquet *(Der Fondue Chessel, Timber Ridge)*

Wednesday, July 24, 2002

7:30 am - 8:00 am	Continental Breakfast *(Longs Peak)*
7:30 am - 12:00 pm	Meeting Registration *(Longs Peak Foyer)*
7:30 am - 12:00 pm	Presenter's Preview Room *(Board Room)*
8:00 am - 12:00 pm	Exhibit Tear-down *(Longs Peak)*
8:00 am - 12:00 pm	Poster Tear-down *(Longs Peak)*
8:00 am - 12:00 pm	Session V: Biocontrol, Mechanical Control, and Case Studies *(Quandary Peak 1-2)*
9:40 am - 10:05 am	Refreshment Break *(Longs Peak)*
12:00 pm - 2:00 pm	Awards and Installation of Officers Luncheon *(Shavano Peak Terrace)*
2:00 pm - 5:00 pm	APMS Board of Directors Meeting *(Castle Peak 1-2)*

Agenda

Summary for Sunday, July 21

8:00 am - 5:00 pm	APMS Board of Directors Meeting *(Board Room)*
2:00 pm - 5:00 pm	Meeting Registration *(Lobby, Keystone Lodge)*
2:00 pm - 5:00 pm	Exhibit Set-up *(Longs Peak)*
2:00 pm - 5:00 pm	Poster Set-up *(Longs Peak)*
5:00 pm - 6:00 pm	Presenter's Preview Room *(Board Room)*
7:00 pm - 9:00 pm	President's Reception *(Terrace, Keystone Lodge)* *Sponsor: SePRO Corporation*

Summary for Monday, July 22

7:30 am - 8:00 am	Continental Breakfast *(Longs Peak)* *Sponsor: Cerexagri, Inc.*
7:30 am - 5:00 pm	Meeting Registration *(Longs Peak Foyer)*
7:30 am - 5:00 pm	Presenter's Preview Room *(Board Room)*
8:00 am - 5:00 pm	Exhibits Open *(Longs Peak)*
8:00 am - 5:00 pm	Posters Open *(Longs Peak)*
8:00 am - 11:45 am	Session I: Plenary *(Quandary Peak 1-2)*
9:00 am - 2:00 pm	Guest Tour and Luncheon *(Meet in Lobby of Keystone Lodge)* *Sponsor: Applied Biochemists*
9:40 am - 10:05 am	Refreshment Break *(Longs Peak)* *Sponsor: Cerexagri, Inc.*
11:45 am - 1:15 pm	Lunch
11:45 am - 1:15 pm	AERF Luncheon and Meeting - AERF Members and Invited Guests *(Quandary Peak 3)*
1:15 pm - 4:40 pm	Session II: Aquatic Plant Mapping/Remote Sensing, Aquatic Plant Invasions, and Herbicide-Fish Interactions *(Quandary Peak 1-2)*
2:55 pm - 3:20 pm	Refreshment Break *(Longs Peak)* *Sponsor: Cerexagri, Inc.*
4:40 pm - 5:30 pm	APMS Annual Business Meeting *(Quandary Peak 1-2)*.

Session I: Plenary *(Quandary Peak 1-2)*
Moderator: David Tarver, APMS President, SePRO Corporation, Tallahassee, FL

8:00 am	Opening Remarks **David P. Tarver**, APMS President, SePRO Corporation, Tallahassee, FL
8:05 am	Announcements **Richard Hinterman**, APMS President Elect and Program Chair, Cygnet Enterprises, Inc., Flint, MI
8:10 am	Presidential Address - APMS, Reflections of the Past Year, Current Opportunities, and Future Challenges **David P. Tarver**, APMS President, SePRO Corporation, Tallahassee, FL
8:40 am	Keynote Address - Managing Aquatic Issues: Benefits of Working with a National Association **Allen James**, Responsible Industry for a Sound Environment (RISE), Washington, DC
9:20 am	The Aquatic Ecosystem Restoration Foundation: An Innovative Approach to Research **Michael D. Moore**, Aquatic Ecosystem Restoration Foundation (AERF), Lansing, MI
9:40 am	**Refreshment Break** *(Longs Peak)*
10:05 am	Update on Federal Liaison Activities **Rob Hedberg**, National and Regional Weed Science Societies, Washington, DC

10:25 am Registering an Aquatic Herbicide
Donald Stubbs, U.S. Environmental Protection Agency, Washington, DC

10:45 am Commercialization of Submersed Aquatic Vegetation Mapping System Technology
Doug Henderson, ReMetrix, LLC, Carmel, IN, Robert McClure, BioSonics, Inc., Seattle, WA, and Bruce Sabol, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

11:05 am Invasive Aquatic Plant Mapping Using Airborne and Satellite Remotely Sensed Imagery: An Evaluation and Comparison of Methods
Mark E. Jakubauskas, Dana L. Peterson, Kansas Applied Remote Sensing Program, Lawrence, KS, Scott W. Campbell, Kansas Biological Survey, Lawrence, KS, Sam D. Campbell, TerraMetrics, Inc., Lawrence, KS, and David Penny, AquaSolutions LLC, Lawrence, KS

11:25 am Use of GPS, GIS, and Variable Rate Application Technologies for Maximum Application Precision of Sonar Herbicide
Mark A. Heilman, ReMetrix, LLC, Carmel, IN, Craig S. Smith, Slidell, LA, Michael D. Netherland, SePRO Corporation, Carmel, IN, and David P. Tarver, SePRO Corporation, Tallahassee, FL

11:45 am **Lunch**

Session II: Aquatic Plant Mapping/Remote Sensing, Aquatic Plant Invasions, and Herbicide-Fish Interactions
(Quandary Peak 1-2)
Moderator: Eric Barkemeyer, Cygnet Enterprises, Inc., Statesville, NC

1:15 pm Phyto-Benthic Observer: An Underwater Surveillance Technique ***(Student Presentation)***
Carolyn L. Link, Joseph Shannon, G. Allen Haden, and Emma P. Beneath, Northern Arizona University, Merriam Powell Research and Education Center, Biological Sciences, Flagstaff, AZ

1:35 pm The Abundance and Distribution of Water Hyacinth in Lake Victoria and the Kagera River Basin, 1988-2001
Thomas Albright, Raytheon, U.S. Geological Survey/EROS Data Center, Sioux Falls, SD, Thomas Moorhouse, Clean Lakes, Inc., Kampala, Uganda, and Thomas McNabb, Clean Lakes, Inc., Martinez, CA

1:55 pm Rates of Unintentional Plants in Aquatic Plant Orders ***(Student Presentation)***
Kristine Maki and Susan Galatowitsch, University of Minnesota, St. Paul, MN

2:15 pm *Cryptocoryne beckettii*: A "pretty" Aquarium Plant Threatens Endangered Aquatic Plant Species in the San Marcos River, TX
Robert Doyle, Baylor University, Department of Biology, Waco, TX

2:35 pm Riparian Vegetation Responses to Two Flow Regimes in Grand Canyon, AZ ***(Student Presentation)***
Marianne E. Porter and M. J. C. Kearsley, Northern Arizona University, Flagstaff, AZ

2:55 pm **Refreshment Break** *(Longs Peak)*

3:20 pm The Use of Herbicides to Replace Hydrilla with Native Submersed Plants and Impact on Juvenile Largemouth Bass in Lake Seminole
Michael J. Maceina and Jeffrey W. Slipke, Department of Fisheries, Aquacultures, and Aquatic Sciences, Auburn University, Auburn, AL

3:40 pm	A Fish and Macroinvertebrate Population Assessment Relative to a Herbicide Application in Perch Lake, Michigan ***(Student Presentation)*** **Christine L. Pedlow** and Eric D. Dibble, Department of Wildlife and Fisheries, Mississippi State University, Mississippi State, MS
4:00 pm	Toxicity of 19 Adjuvants to *Lepomis macrochirus* (Bluegill Sunfish) **Randall K. Stocker** and William T. Haller, Center for Aquatic and Invasive Plants, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL
4:20 pm	Diquat Dibromide: Toxic Pesticide or Medicine? A Real Case for Safety Margins and Perceptions Using an Aquatic Herbicide **Jim F. Petta**, Syngenta Professional Products, New Braunfels, TX
4:40 pm	**APMS Annual Business Meeting**
5:30 pm	**Adjourn**

Summary for Tuesday, July 23

6:30 am - 8:00 am	APMS Regional Chapters Presidents' Breakfast *(Windwood, Keystone Lodge)*
7:30 am - 8:00 am	Continental Breakfast *(Longs Peak)* *Sponsor: Cerexagri, Inc.*
7:30 am - 5:00 pm	Meeting Registration *(Longs Peak Foyer)*
7:30 am - 5:00 pm	Presenter's Preview Room *(Board Room)*
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8:00 am - 5:00 pm	Posters Open *(Longs Peak)*
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9:40 am - 10:05 am	Refreshment Break *(Longs Peak)* *Sponsor: Cerexagri, Inc.*
11:45 am - 1:15 pm	Lunch
1:15 pm - 5:00 pm	Session IV: Aquatic Herbicides and Surfactants *(Quandary Peak 1-2)*
2:55 pm - 3:20 pm	Refreshment Break *(Longs Peak)* *Sponsor: Cerexagri, Inc.*
6:00 pm - 9:00 pm	APMS Banquet *(Der Fondue Chessel, Timber Ridge)* *Sponsor: Griffin, LLC*

Session III: Aquatic Plant Biology, Ecology, and Restoration *(Quandary Peak 1-2)*
Moderator: Ken Manuel, Duke Power Company, Huntersville, NC

8:00 am — Hybridity in Invasive Milfoil Populations: Unveiling a Hidden Management Concern? ***(Student Presentation)***
Michael L. Moody and Donald H. Les, University of Connecticut, Department of Ecology and Evolutionary Biology, Storrs, CT

8:20 am — Biodiversity in Restoration
Katharina A. M. Engelhardt, University of Maryland Center for Environmental Science, Appalachian Laboratory, Frostburg, MD

8:40 am — Seasonal Biomass and Carbohydrate Allocation in Southern Minnesota Curlyleaf Pondweed Populations ***(Student Presentation)***
Thomas E. Woolf and John D. Madsen, Minnesota State University, Department of Biological Sciences, Mankato, MN

9:00 am — Effects of Macrophyte Colonization on Some Water Quality Characteristics Under Mesocosm Conditions
R. A. Pitelli and W. Spindola, Paulista State University, Jaboticabal, Sao Paulo, Brazil

9:20 am — Phytomass Dynamics and Distribution of *Egeria densa* in Neusa, a Tropical High Mountain Reservoir (Colombia) ***(Student Presentation)***
Yolima Carillo, Institute of Ecology, University of Georgia, Athens, GA, Alejandro Guarin, Department of Geography, Pennsylvania State University, University Park, PA, and Gabriel Guillot, Laboratorio de Ecologia Acuatica, Departamento de Biologia, Universidad Nacional de Colombia, Bogota, Colombia

9:40 am — **Refreshment Break** *(Longs Peak)*

10:05 am — Phenology and Impacts of *Egeria densa* in a Drinking Water Reservoir ***(Student Presentation)***
Toni G. Pennington and Mark D. Sytsma, Portland State University, Center for Lakes and Reservoirs, Portland, OR

10:25 am Cooperative Revegetation Projects in Central Florida Lakes - Getting Everybody Wet and Muddy
David R. Douglas, **Rue S. Hestand III**, Boyd Z. Thompson, Bruce V. Jaggers, Lowell L. Trent, Florida Fish and Wildlife Conservation Commission, Eustis Fisheries Research Lab, Eustis, FL, and Craig T. Mallison, Florida Fish and Wildlife Conservation Commission, Kissimmee Fisheries Field Office, Kissimmee, FL

10:45 am Quantification of the Aquatic Vegetation of Heron Lake, Jackson County, Minnesota ***(Student Presentation)***
Morgan L. Case and John D. Madsen, Minnesota State University, Department of Biological Sciences, Mankato, MN

11:05 am Organizing an Effort to Fight Purple Loosestrife Invading the Denver, Colorado Area
David Weber, Colorado Division of Wildlife, Denver, CO

11:25 am Restoration of Native Aquatic Vegetation and Largemouth Bass in Hydrilla-Infested Lake Bellwood, Texas
R. Michael Smart, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX, Richard Ott, Texas Parks and Wildlife Department, Tyler, TX, and Gary O. Dick, University of North Texas, Institute of Applied Science, Denton, TX

11:45 am **Lunch**

Session IV: Aquatic Herbicides and Surfactants *(Quandary Peak 1-2)*
Moderator: Jim F. Petta, Syngenta Professional Products, New Braunfels, TX

1:15 pm Evaluation of Fluridone for Selective Control of Eurasian Watermilfoil in Lake Hortonia, Vermont: I. Application Strategy and Herbicide Residues
Kurt D. Getsinger, Robert M. Stewart, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS, John D. Madsen, Minnesota State University, Mankato, MN, Adam Way, Dyntel Corporation, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS, Chetta S. Owens, Analytical Services, Inc., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX, Holly Crosson, Vermont Department of Environmental Conservation, Waterbury, VT, and Alan Bo Burns, SePRO Corporation, Carmel, IN

1:35 pm Evaluation of Fluridone for Selective Control of Eurasian Watermilfoil in Lake Hortonia, Vermont: II. Impacts on Plant Communities
Robert M. Stewart, Kurt D. Getsinger, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS, John D. Madsen, Minnesota State University, Mankato, MN, Adam Way, Dyntel Corporation, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS, Chetta S. Owens, Analytical Services, Inc., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX, Holly Crosson, Vermont Department of Environmental Conservation, Waterbury, VT, and Alan Bo Burns, SePRO Corporation, Carmel, IN

1:55 pm Three and a Half-Years of Laboratory and Field Monitoring of Fluridone-Tolerant Hydrilla: What Have We Learned?
Michael D. Netherland, SePRO Corporation, Carmel, IN, Franck Dayan, Brian Scheffler, U.S. Department of Agriculture, Agricultural Research Service, National Center for Natural Products Research, Oxford, MS, and Steve Cockreham, SePRO Corporation, Carmel, IN

2:15 pm Management of Variable-Leaf Milfoil (*Myriophyllum heterophyllum*) with Fluridone
Stratford H. Kay, Department of Crop Science, North Carolina State University, Raleigh, NC

2:35 pm A New Herbicide for Aquatic Use: Arsenal 2NS
Jennifer Vollmer, BASF, Laramie, WY and Kathy Kalmowitz, BASF, Research Triangle Park, NC

2:55 pm **Refreshment Break** *(Longs Peak)*

3:20 pm California's $2 Million Aquatic Pesticide Monitoring Program or: Aquatic Pest Control Jousting in the Wild West
Lars W. J. Anderson, U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, CA and Geoff Siemering, Aquatic Pesticide Monitoring Program, San Francisco Estuary Institute, Oakland, CA

3:40 pm The Development and Performance Characteristics of a New Sonar Formulation: Interaction with Sediment Type
Michael D. Netherland, SePRO Corporation, Carmel, IN, William T. Haller, Tyler J. Koschnick, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL, and David P. Tarver, SePRO Corporation, Tallahassee, FL

4:00 pm Effects of Endothall in Irrigation Water on Selected Turf and Ornamental Species ***(Student Presentation)***
Tyler J. Koschnick and William T. Haller, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL

4:20 pm Use of the Aquatic Herbicide Renovate for Selective Management of Submersed and Emergent Vegetation
Shaun Hyde and Steve Cockreham, SePRO Corporation, Carmel, IN

4:40 pm Control of Wild Taro Using Rodeo in Combination with Cygnet Plus Adjuvant
Tyler J. Koschnick, William T. Haller, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL, and **Steve Brewer**, Brewer International, Vero Beach, FL

5:00 pm **Adjourn**

Summary for Wednesday, July 24

7:30 am - 8:00 am	Continental Breakfast *(Longs Peak)* *Sponsor: Cerexagri, Inc.*
7:30 am - 12:00 pm	Meeting Registration *(Longs Peak Foyer)*
7:30 am - 12:00 pm	Presenter's Preview Room *(Board Room)*
8:00 am - 12:00 pm	Exhibit Tear-down *(Longs Peak)*
8:00 am - 12:00 pm	Poster Tear-down *(Longs Peak)*
8:00 am - 12:00 pm	Session V: Biocontrol, Mechanical Control, and Case Studies *(Quandary Peak 1-2)*
9:40 am - 10:05 am	Refreshment Break *(Longs Peak)* *Sponsor: Cerexagri, Inc.*
12:00 pm - 2:00 pm	Awards and Installation of Officers Luncheon *(Shavano Peak Terrace)* *Sponsor: Syngenta Professional Products*
2:00 pm - 5:00 pm	APMS Board of Directors Meeting *(Castle Peak 1-2)*

Session V: Biocontrol, Mechanical Control, and Case Studies *(Quandary Peak 1-2)*
Moderator: Michael J. Grodowitz, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

8:00 am — Demonstration of Aquatic Weed Control by Tilapia in South Carolina Irrigation Ponds
Jack M. Whetstone, Department of Aquaculture, Fisheries, and Wildlife, Clemson University, Georgetown, SC

8:20 am — Potential Fecundity of the Milfoil Weevil on its Native and Exotic Host Plants ***(Student Presentation)***
Michelle D. Marko, Raymond M. Newman, and Julie Krueger, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota, St. Paul, MN

8:40 am — Bio-Control of a Marine Invasive Weed? Novel Use Against *Spartina alterniflora* in Willapa Bay, Washington
Miranda Wecker, Fritzi Grevstad, University of Washington, Olympic Natural Resources Center, Naselle, WA, Don Strong, Department of Evolution and Ecology, University of California, Davis, CA, and Dino Garcia-Rossi, Bodega Marine Laboratory, Bodega Bay, CA

9:00 am — Biological Carriers for Submerged and Emerged Weed Control
Lucia G. I. Marshall and Richard L. Lowe, Biosorb, Inc., St. Charles, MO

9:20 am — The Developing Mechanical Shredder Technology
David Penny, AquaSolutions, Lawrence, KS

9:40 am — **Refreshment Break** *(Longs Peak)*

10:05 am — Eradication of Hydrilla from the Eastman Lake/Chowchilla River Complex in California: 2002 Update
J. Robert Leavitt, Ross O'Connell, and Frank Zarate, California Department of Food and Agriculture, Plant Health and Pest Prevention Services, Integrated Pest Control Branch, Sacramento, CA

10:25 am — Costs of Applying an Aquatic Herbicide with the New West Coast Rules (Lake Oswego, Oregon)
Steve Lundt, Lake Oswego Corporation, Lake Oswego, OR, and Mark Sytsma, Center for Lakes and Reservoirs, Portland State University, Portland, OR

10:45 am	U.S. Eradication Program for *Caulerpa taxifolia*, an Exotic and Invasive Marine Alga **Lars W. J. Anderson**, U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, CA
11:05 am	Control of Eurasian Watermilfoil in Mesocosms at Lake Tahoe **Robert J. Duvall**, Division of Planning and Local Assistance, Department of Water Resources, Sacramento, CA, Lars W. J. Anderson, U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, CA, and Charles R. Goldman, Department of Environmental Science Policy, University of California, Davis, CA
11:25 am	APMS Regional Chapters Reports: Brazil, Florida, MidSouth, Midwest, Nile Basin, Northeast, South Carolina, Texas, Western **Chapter Officer or Delegate**
12:00 pm	**Adjourn 42nd Annual Meeting**

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

Posters

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

Technology Transfer for Invasive Species via Computer-Based Information Systems
Sherry G. Whitaker and Michael J. Grodowitz, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Substrate Selection for the Propagation of Submersed Aquatic Vegetation
Todd B. Chadwell and Katharina A. M. Engelhardt, University of Maryland Center for Environmental Science, Appalachian Laboratory, Frostburg, MD

Abstracts

Session I: Plenary

The Aquatic Ecosystem Restoration Foundation: An Innovative Approach to Research

Michael D. Moore[1]
[1] *Aquatic Ecosystem Restoration Foundation (AERF), Lansing, MI*

From its beginning in 1996 the Aquatic Ecosystem Restoration Foundation has fulfilled it's mission as a non-profit organization dedicated to the environmentally-sound restoration and management of aquatic and wetland systems via research and development, public education, regulatory interactions and public/private/academic partnerships. Virtually every aspect of human activity relies on adequate and high-quality water resources, and every day increased pressure is being placed on these unique and life-sustaining ecosystems. Unfortunately, invasive vegetation is causing significant ecological and economic impacts on critical aquatic, wetland, and riparian systems in the United States. These plant species degrade and/or diminish water quality, human health, fisheries, water-bird habitat, recreation, aesthetics, and property values. Although traditional plant management techniques and tools are available, there is a pressing need to develop new strategies and refine existing ones that can selectively control these aggressive weeds in an environmentally compatible fashion. The Aquatic Ecosystem Restoration Foundation (AERF) has sponsored numerous activities over its six years. A review of the successes of the organization in the areas of research, development, education and partnerships will be presented. In addition, a discussion of newly planned research and educational projects will be presented including an in-depth discussion of an underway Best Management Practices manual on aquatic plant management with an emphasis on fish and wildlife habitat.

Registering an Aquatic Herbicide

Donald Stubbs[1]
[1] *U.S. Environmental Protection Agency, Washington, DC*

A pesticide is anything that prevents, destroys, repels or mitigates any pest. Aquatic herbicides are pesticides. The Registration Division of the Office of Pesticide Programs, EPA is responsible for registering uses of pesticides to be applied to waters of the U.S. for control of weeds. Requests for aquatic herbicides must first be placed on the Registration Division's priority list. Data concerning a chemical's human toxicity, ecotoxicity, and fate in the environment must be submitted and reviewed by agency scientists. These data must be determined to support the chemical's use in accordance with the Federal Insecticide, Fungicide, and Rodenticide Act and the Federal Food Drug and Cosmetic Act. Aquatic herbicides generally require more data and will utilize more of the reference dose of a chemical than any other use. Due to the potential volume of material to be sold, aquatic herbicides are not high on the list of uses to be registered by industry.

Commercialization of Submersed Vegetation Mapping System Technology

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

Rapid and accurate measurement of the abundance and distribution of submersed vegetation has been achieved with the Submersed Aquatic Vegetation Early Warning System, developed at the U.S. Army ERDC. The system consists of off-the-shelf commercially available digital echo sounder, global positioning system, and PC components. Data are post processed with an ERDC-developed and patented digital signal processing code. The system has been tested on most commonly occurring freshwater and estuarine species of submersed vegetation in the U.S. The patent for the processor has been licensed to Biosonics, Inc., manufacturer of the echo sounder used, which distributes the package under the name EcoSAV as part of a suite of software for characterization of shallow water environments. Numerous organizations in this country and worldwide are currently using the system operationally for various resource and nuisance plant assessments. Remetrix, LLC, an environmental resource assessment firm, utilizes hydroacoustic detection as a preferred assessment technique and has

partnered with Biosonics to assist in the development of EcoSAV and related products. The status of this development is discussed and recent application examples are presented.

Invasive Aquatic Plant Mapping Using Airborne and Satellite Remotely Sensed Imagery: An Evaluation and Comparison of Methods

Mark E. Jakubauskas[1], Dana L. Peterson[1], Scott W. Campbell[2], Sam D. Campbell[3], and David Penny[4]
[1] *Kansas Applied Remote Sensing Program, Lawrence, KS*
[2] *Kansas Biological Survey, Lawrence, KS*
[3] *TerraMetrics, Inc., Lawrence, KS*
[4] *AquaSolutions LLC, Lawrence, KS*

Timely, accurate information on aquatic plant distribution and density is required both by public agencies charged with the management of navigable waterways, and by private companies engaged in aquatic plant control efforts. Traditional field-based mapping and monitoring of the extent and density of aquatic plant infestation present several challenges, including inaccessibility of areas for field sampling, rapid changes in aquatic plant location, extent, and density, and budget constraints on field sampling and monitoring. Remote sensing technology has significant potential to aid managers in detecting and prioritizing infested areas for control efforts, providing detailed information on plant extent and density for estimating control costs, and assessing the effectiveness of aquatic plant control operations. This project evaluated airborne and satellite remotely sensed imagery to map aquatic plant extent, quantify plant density, and assess the effectiveness of control efforts on water hyacinth and hydrilla infestations in the Rio Grande River, Texas. Several different types of remotely sensed imagery were used, including airborne color video, IKONOS satellite imagery, and ASTER image data. This presentation will evaluate and compare the different methods in terms of speed, accuracy, level of information, and cost-effectiveness, and provide recommendations for different applications of remote sensing technology.

Use of GPS, GIS, and Variable Rate Application Technologies for Maximum Application Precision of Sonar Herbicide

Mark A. Heilman[1], Craig S. Smith[2], Michael D. Netherland[3], David P. Tarver[3]
[1] *ReMetrix LLC, Carmel, IN*
[2] *Slidell, LA*
[3] *SePRO Corporation, Carmel, IN*

Precision methods have been used to apply various agricultural chemicals for many years. In precision agriculture, application rates are electronically controlled to account for ground speed of the application vehicle and within-field differences in soil properties and other growing conditions. The final result is the best possible control of applied product volumes with maximum environmental stewardship. Through combining GPS (Global Positioning Systems), GIS (Geographic Information Systems) and variable rate application technologies, the methods of precision agriculture have been applied to the planning and implementation of Sonar aquatic herbicide applications. Through pre-treatment GIS analysis of lake bathymetry, predicted boat speed, and swath layout, detailed bathymetric maps were translated into digital variable rate prescriptions. These prescriptions directed a variable-rate spray control system that performed automatic, real-time adjustment of Sonar application rates according to water depth. Differential GPS measurements were also input into the control system, allowing automatic corrections for boat speed that maintained the depth-specific application rate. Equipment design and detailed treatment planning allowed Sonar to be applied to shallow (2-3 feet) and deeper areas (up to 20 feet) at rates appropriate to yield an even 6 ppb concentration at reasonable boat speeds (6-8 mph). Overall, this advancement maximizes evenness of Sonar applications and permits more consistent targeted concentrations to be quickly achieved throughout a lake. This maximizes the impact to target species while minimizing impact to non-target vegetation and wildlife. While initially utilized for Sonar, this technology can also be used to improve precision in application of other aquatic herbicides.

Session II: Aquatic Plant Mapping/Remote Sensing, Aquatic Plant Invasions, and Herbicide-Fish Interactions

Phyto-Benthic Observer: An Underwater Surveillance Technique

Carolyn L. Link[1], Joseph Shannon[1], G. Allen Haden[1], and Emma P. Beneath[1]
[1] *Northern Arizona University, Merriam Powell Research and Education Center, Biological Sciences, Flagstaff, AZ*

Monitoring inaccessible and turbulent habitats is an obstacle in aquatic ecology. Characterizing temporal variability in lotic phyto-benthic communities is also problematic. In order to address these sampling barriers we constructed a Phyto-Benthic Observer (PBO) or 110 kg sled with various attached instruments. The PBO allows collection and storage of aquatic data including; temperature, light intensity, water velocity, depth, and digital video through remote interval data-logging. We tested the PBO in the Colorado River below Glen Canyon Dam while determining the impact of daily peaking hydro-power and subsequent change in river velocity on the phyto-benthic community. By comparing high versus low fluctuating flow periods we documented a 16% increase in phyto-benthic biomass after the reduction in flow fluctuations. To estimate drifting aquatic plant biomass over 28 days we used digitized video collected with the PBO. Using National Institute of Health Image1.62 software we estimated the number of pixels, in 30 frames of a two min. video, comprised of drifting tufts of algae and aquatic macrophytes. After comparison to a known scale we estimated the area of aquatic plants photographed in a frame (mm^2). We then determined ash free dry mass for known areas (10-100 mm^2) of common algal and aquatic macrophyte taxa. These data were then regressed (n=127; R^2>0.86; P<0.001) so we could predict the mass of the drifting plants during the collection period with known current velocities. Our PBO drifting aquatic plant biomass estimates were within 25% of traditional estimates. The PBO shows promise for underwater surveillance in aquatic environments.

The Abundance and Distribution of Water Hyacinth in Lake Victoria and the Kagera River Basin, 1988-2001

Thomas Albright[1], Thomas Moorhouse[2], and Thomas McNabb[3]
[1] *Raytheon, U.S. Geological Survey/EROS Data Center, Sioux Falls, SD*
[2] *Clean Lakes, Inc., Kampala, Uganda*
[3] *Clean Lakes, Inc., Martinez, CA*

Water hyacinth (*Eichhornia crassipes* (Mart.) Solms) is an invasive aquatic macrophyte associated with major economic and ecological damage in the Lake Victoria region since the weed's establishment in the 1980s. In order to assist the management and mitigation of this problem, Clean Lakes, Inc. and the US Geological Survey's EROS Data Center have acquired and analyzed remotely sensed imagery, conducted field work, and compiled reports to document the abundance and distribution of this weed, from it's establishment to the present day. For Lake Victoria, the invasion can be characterized by four phases. In the lag phase (1989-1994), water hyacinth was present in relatively low quantities in various parts of the lake. This was followed by a period of rapid growth (1994-1999) during which, water hyacinth attained maximum coverage and problems associated with it were most acute. While reported values very widely, our analysis suggests a maximum coverage between 17,000 and 20,000 ha in 1998. Between 1998 and 2000, a combination of factors, including management practices and changes in environment conditions, contributed to a major decline in water hyacinth in the most affected portions of the lake. Currently, relatively low levels of water hyacinth are present in most portions of the lake suitable for growth. Water hyacinth may remain approximately at these levels indefinitely if active management continues and environmental conditions are maintained. In addition to our analysis of Lake Victoria, we also document water hyacinth abundance and distribution in the Kagera River system, which is infested into its headwaters and constitutes the principal source of surface water for Lake Victoria.

Rates of Unintentional Plants in Aquatic Plant Orders

Kristine Maki[1] and Susan Galatowitsch[1]
[1] *University of Minnesota, St. Paul, MN*

Horticulture trade is presumed to be a pathway for the introduction and spread of invasive species. Invasive species may be included in plant orders accidentally or when prohibited plants are purchased. We developed a study to determine risks involved when ordering aquatic plants through commercial vendors. To determine the rate of unintentional receipts associated with aquatic plant orders, 40 orders, totaling 96 taxa and 697 individual plants, were placed to 34 vendors across the U.S. between May and September 2001 to determine receipts of plants not ordered, presence of seeds in an order, receipt

of Federal or Minnesota state noxious plants, and mis-identification of aquatic plants. Orders were inspected for receipts beyond specified plants and soil and water were incubated to detect seeds. We found 92.5% of orders received from aquatic plant vendors contained a plant or animal species not specifically requested; 8% of these purchases contained Federal or Minnesota State noxious weeds. *Lemna minor* was the most common incidental receipt found per taxa and per purchase, however *Hydrilla verticillata, Lythrum salicaria,* and *Salvinia molesta* were also found. The presence of unordered seeds was minimal. Federal or Minnesota State noxious weeds that we acquired were *Hygrophila polysperma, Butomus umbellata, Hydrocharis morsus-ranae,* and *Lythrum salicaria.* Mis-identified plants were found in 20% of the orders. This study showed intentional movement of plants is linked to inadvertent movement of plants. While transferring an invasive plant inadvertently is relatively uncommon, these events potentially increase their rate and geographic spread.

Cryptocoryne beckettii: A "pretty" Aquarium Plant Threatens Endangered Aquatic Plant Species in the San Marcos River, TX

Robert Doyle[1]
[1] *Baylor University, Department of Biology, Waco, TX*

Cryptocoryne beckettii Thw. ex R. Trim. is an exotic aquatic plant recently found in the San Marcos River, TX. The species is currently expanding rapidly within the lower portions of the upper San Marcos River. The distribution and areal extent of the species was quantified on three occasions between April 1998 and August 2000. During this 28-month period, the number of individual colonies increased from 11 to 63, and the total areal coverage increased from 171 to 646 m^2. The average rate of areal expansion during this period was 80% per year. Most colonies of *C. beckettii* were found to be small (< 5 m^2), although in August 2000 three colonies were greater than 50 m^2 in size. All colonies were found at water depths between 30 and 120 cm and appeared to favor more rapidly flowing water. This preference for shallow, rapidly flowing areas of the river makes *C. beckettii* a potentially serious threat to *Zizania texana* Hitchc., an endangered plant endemic to the San Marcos River, that occupies a similar river zone. All known colonies of *C. beckettii* are currently downstream from the remaining stands of *Z. texana*. Efforts are now underway to control the exotic species.

Riparian Vegetation Responses to Two Flow Regimes in Grand Canyon, AZ

Marianne E. Porter[1] and M. J. C. Kearlsey[1]
[1] *Northern Arizona University, Flagstaff, AZ*

Most large rivers in the world are regulated and 60% are fragmented for irrigation. In the American southwest riparian areas make up only 3% of the total landscape and are migration corridors known for having high biodiversity. In this study we examined the responses of near-shore native and exotic vegetation to two flow regimes (experimental steady flows in 2000 and a summer of low fluctuating flows in 2001) on the Colorado River through Grand Canyon. The 2000 experimental low steady flows were designed to create habitat and increase the food base for native endangered fishes such as humpback chub (*Gila cypha*). In 2001 low fluctuating flows occurred due to a low water year. Native plant colonization of newly exposed beach area increased throughout the duration of these two flow regimes, but significant mortality of extant *Equisetum* occurs early in the experimental flows. In addition to increased native vegetation, *Tamarix* seedling establishment also increased significantly. However, a four-day spike flow resulted in 60% mortality of *Tamarix* seedlings while having no negative effect on the densities of the newly established native vegetation. Throughout the low steady 2000 flows *Tamarix* established prolifically, while the low fluctuating flows of 2001 showed a reversal in dominance between *Tamarix* and the native vegetation. We suggest the need to manage regulated ecosystems for multiple years rather than the shorter time spans often utilized in management regimes.

The Use of Herbicides to Replace Hydrilla with Native Submersed Plants and Impact on Juvenile Largemouth Bass in Lake Seminole

Michael J. Maceina[1] and Jeffery W. Slipke[1]
[1] *Department of Fisheries, Aquacultures, and Aquatic Sciences, Auburn University, Auburn, AL*

Shortly after impoundment in 1957, many native submersed plant species became established in Lake Seminole, Georgia (13,800 ha). In the early 1980's, the exotic plant hydrilla Hydrilla verticillata was discovered and by 1992, covered nearly 70% of this reservoir eliminating nearly the entire native submersed plant community. From 1997 to 2001, fluridone and endothall based herbicides were used to control hydrilla in treatment plots (< 10 ha). This also resulted in the partial reestablishment of native submersed plants, but at times, hydrilla was not completely eliminated. Typically, the dominant plants that became reestablished included Illinois pondweed Potomogeton illinoensis and stonewort Nitella sp., but coontail Ceratophyllum demersum, southern naiad Najas guadalupensis, and fanwort Cabomba caroliniana, were also found in treatment areas. Herbicide treatments only temporally reduced hydrilla, native plants were displaced by hydrilla unless additional applications were made. Catch-per-unit of effort for both number and weight of age-0 and age-1 largemouth bass sampled for the 1997 to 2000 year-classes were similar or higher in herbicide treated mixed plant areas compared to untreated dense hydrilla infested areas. Aquatic herbicides applied to hydrilla infested regions where a native seedbank existed temporally promoted the growth of native plants and at times, improved juvenile largemouth bass population characteristics. In one cove that has been utilized by adult largemouth bass for spawning, treatments with Aquathol K over three years reestablishment fanwort, and abundance of adult fish nearly doubled over over time

A Fish and Macroinvertebrate Population Assessment Relative to a Herbicide Application in Perch Lake, Michigan

Christine L. Pedlow[1] and Eric D. Dibble[1]
[1] *Department of Wildlife and Fisheries, Mississippi State University, Mississippi State, MS*

Aquatic plants provide important habitat to fish and their macroinvertebrate prey. Changes in plant communities can alter trophic interactions among these populations. We investigated the indirect effects of a whole-lake herbicide treatment on macroinvertebrates and fish in Perch Lake, Michigan. Trophic relationships among juvenile Centrarchidae (*Lepomis gibbosus, L. macrochirus*) and their macroinvertebrate prey were assessed relative to changes in aquatic plants. A low dosage (8mg/l) of fluridone was applied to the entire lake in October 2000 to selectively eradicate Eurasian watermilfoil (*Myriophyllum spicatum*). As predicted, overall plant density and biomass significantly decreased after the treatment ($p<0.001$). Fish and macroinvertebrate samples were collected within aquatic plants, and forage items from fish stomachs were identified. Exotic plant decomposition facilitated increases in abundance of detritivores (i.e., Gastropoda, Mollusca, Ceratopogonidae, and Leptoceridae) and significant decreases were noted in the abundance of Crustacea (Cladocera, Amphipoda, Ostracoda, Copepoda) and Chironomidae ($p<0.001$). An increase of Crustacea in juvenile centrarchid stomachs suggested that changes in the plant community may have led to increased predation by the young fish in Perch Lake.

Toxicity of 19 Adjuvants to *Lepomis macrochirus* (Bluegill Sunfish)

Randall K. Stocker[1] and William T. Haller[1]
[1] *Center for Aquatic and Invasive Plants, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL*

Nineteen adjuvants, many used as surfactants for aquatic herbicide application, were applied in static bioassay to bluegill (*Lepomis macrochiurs*) sunfish for 96 hr to determine LC_{50} concentrations. MON 0818 and Entry II, containing ethoxylated tallow amine, were most toxic having LC_{50} values of 1.6 and 2.9 ppm (all values V/V) respectively. Seven alcohol/glycol based surfactants had 96 hr LC_{50} values of 4.0 to 11.6 ppm (mean = 7.9 ppm). The polysiloxane or silicone based surfactants had toxicities of 18.1 to 29.7 ppm (mean =24.7). Two limonene based products had LC_{50} values of 10.2 (Cide-Kick) and 30.2 ppm (Cygnet Plus). A methylated seed oil with emulsifier (Sunwet) had a LC_{50} of 53.1 ppm. Two acid/buffer utility adjuvants had LC_{50} values of 60.8 (LI 700) and 220.9 ppm (Quest). Assuming adjuvant use at maximum label rate in 1 m of uniformity mixed water, the most toxic labeled adjuvant tested (Big Sur 90) had a safety margin of 5.5X. When used according to label recommendations under normal use conditions, these adjuvants should not be present in acutely toxic concentrations. The most toxic adjuvants in very shallow water (<10 cm) would be toxic to bluegill that did not move to deeper water to avoid lethal concentrations.

Diquat Dibromide: Toxic Pesticide or Medicine? A Real Case for Safety Margins and Perceptions Using an Aquatic Herbicide

Jim F. Petta[1]
[1] *Syngenta Professional Products, New Braunfels, TX*

Diquat dibromide has been used for aquatic weed management for over 35 years in the United States. As part of the registration and re-registration process under FIFRA, numerous studies have been submitted to the Environmental Protection Agency to substantiate the safety margins as required by law to submit any negative claims made against the product concerning any potential problems such as fish kills or other off-target effects. To date, no negative effects have been reported to either Syngenta or to the EPA from Syngenta as no reports have been received. At the same time as these questions are raised on herbicidal use, fish hatcheries have been using diquat dibromide under an Experimental Permit system

since 1992 as a fish protectant/medicine at rates up to 20x of the herbicidal use rates. Diquat dibromide is applied in fish hatcheries for the control of two very serious disease of fish, Columnaris disease (*Cytophaga columnaris*) and fungal disease (*Saprolegnia*). The treated fish include musky, small and large mouth bass, trout, salmon, and several other species at predominantly fingerling growth stage. This paper attempts to bridge the apparent gap in perceived toxicity by some ecologists as an aquatic herbicide and the use in fish hatcheries.

Session III: Aquatic Plant Biology, Ecology, and Restoration

Hybridity in Invasive Milfoil Populations: Unveiling a Hidden Management Concern?

Michael L. Moody[1] and Donald H. Les[1]
[1] *University of Connecticut, Department of Ecology and Evolutionary Biology, Storrs, CT*

Invasive water milfoil (*Myriophyllum*) populations in North America have been believed to represent nonindigenous species that have become ecologically aggressive outside their native range. Morphological characterization of Eurasian water milfoil (*M. spicatum*; throughout North America) and variable leaf milfoil (*M. heterophyllum*; in New England) invasive populations have often been ambiguous relative to closely related native North American milfoil species. Molecular studies of presumed "*M. heterophyllum*" and "*M. spicatum*" invasive populations have revealed widespread polymorphisms in the biparentally inherited nuclear ribosomal (nrDNA) internal transcribed spacer (ITS) region. Subclones of these polymorphic regions revealed the occurrence of distinct sequences matching those acquired from both native and nonindigenous species. Molecular markers have subsequently been developed from this molecular data that make it possible to efficiently identify each of the parent species as well as the hybrids. These data clearly demonstrate that these invasive water milfoil populations in North America have resulted from hybridization. Invasive population of *M. "heterophyllum"* in New England typically represents hybrids between *M. heterophyllum* (native to eastern USA) and *M. pinnatum* (native to southeastern USA). Morphologically aberrant invasive populations of *M. "spicatum"* in North America have been found to represent hybrids between *M. spicatum* (Eurasian) and *M. sibiricum* (native North American). These observations indicate that invasivity in these aggressive aquatic weeds may be linked to heterosis maintained by vegetative propagation. In addition, preliminary data suggest *M. spicatum* × *M. sibiricum* hybrids may be resistant to the milfoil weevil (*Euhrychiopsis lecontei*), an effective biocontrol agent for *M. spicatum*. These findings may have serious implications for management of these invasive aquatic plants.

Biodiversity in Restoration

Katharina A. M. Engelhardt[1]
[1] *University of Maryland Center for Environmental Science, Appalachian Laboratory, Frostburg, MD*

Demand is increasing for identifying strategies that enhance the success of restoration efforts of impaired aquatic systems. One such strategy may be restoration and management for plant diversity, which could enhance restoration success and the sustainability of restoration outcomes. Here, I review alternative hypotheses that explain how diversity may influence long-term restoration success of submersed aquatic vegetation (SAV), using the Chesapeake Bay estuary (CBE) as the study system. Diversity may enhance restoration success by ensuring a variety of species traits within an assemblage, thereby increasing the chance that a species adapted to certain environmental conditions will be present in the community ("buffering hypothesis"), or increasing facilitative interactions among species ("facilitation hypothesis"). Alternatively, diversity of SAV may affect restoration success when species are so similar in their traits that they all respond similarly to environmental conditions ("redundancy hypothesis"), or when competition among species is too strong to allow facilitative or complementary interactions ("competition hypothesis"). I explored these hyptheses using simulation experiments and found that diversity may indeed increase restoration success, especially in spatially and temporally variable environments. These results will be applied in the restoration of SAV in the Chesapeake Bay.

Seasonal Biomass and Carbohydrate Allocation in Southern Minnesota Curlyleaf Pondweed Populations

Thomas E. Woolf[1] and John D. Madsen[1]
[1] *Minnesota State University, Department of Biological Sciences, Mankato, MN*

Four populations of curlyleaf pondweed (*Potamogeton crispus* L.) were sampled to determine seasonal phonological, biomass, and carbohydrate allocation patterns. Low points of carbohydrate storage in the seasonal phonological cycle

indicate vulnerable points in the plant's life cycle and may indicate ideal times to initiate management and control effects. Curlyleaf pondweed was sampled from four southern Minnesota lakes starting in June 2001 and continuing through June 2002. Samples were collected monthly with biweekly samples taken at times of peak growth (May and June). Samples were separated by plant structure (shoots, roots, inforescence, and turions) and were dried, weighed, and biomass determined (g/m2). Each plant component was then extracted and analyzed for total nonstructural carbohydrates (TNC). The biomass data illustrates the characteristic rapid growth in May and June followed by senescence in early July. Turion formation and flowering were observed to coincide with peak biomass. Shoot carbohydrate concentrations averaged from 3-105 TNC and roots from 4-10%. Turion TNC concentrations were found to be as high as 60%. Concentrations of TNC in turions were found to drop 40% in late November, following sprouting. The improved knowledge of phenology and carbohydrate allocation may be utilized to improve the management of curlyleaf pondweed.

Effects of Macrophyte Colonization on Some Water Quality Characteristics, Under Mesocosm Conditions

R.A. Pitelli[1] and W. Spindola[1]
[1] *Paulista State University, Jaboticabal, Sao Paulo, Brazil*

Under antropic conditions, it is common to occur dense colonizations of waterbodies by aquatic weeds, usually under mono-specific infestations. In this research, the effects of different species colonization on some water quality characteristics were evaluated in mesocosms 0.9 m deep, surface area of 1.0 m^2 and 900 L water volume. Twenty mesocosms were colonized by four aquatic weeds and a control mesocosm (no plant), providing five conditions of macrophyte colonization and four replications arranged in a completely randomized plots statistical design. The aquatic weeds were *Eichhornia crassipes*, *Pistia stratiotes*, *Salvinia auriculata*, and *Egeria densa*. The evaluations were made at 7:30h, 13:30h, and 18:30h in four periods of five days. In general, the floating weeds reduced the oxygen concentration and saturation, temperature and amplitude of temperature variation, and pH of the water, but increase the electric conductivity. The differences are more pronounced at noon and early evening evaluations. *Egeria densa* promoted expressive reduction of water electric conductivity.

Phytomass Dynamics and Distribution of *Egeria densa* in Neusa, A Tropical High Mountain Reservoir (Colombia)

Yolima Carrillo[1], Alejandro Guarín[2], and Gabriel Guillot[3]
[1] *Institute of Ecology, University of Georgia, Athens, GA*
[2] *Department of Geography, Pennsylvania State University, University Park, PA*
[3] *Laboratorio de Ecologia Acuatica, Departamento de Biologia, Universidad Nacional de Colombia, Bogota, Colombia*

Neusa Reservoir, a tropical high mountain impoundment located on the eastern Andes of Colombia is extensively occupied by the submersed macrophyte *Egeria densa* Planch. (Hydrocharitaceae). Such prolific growth of aquatic plants has often raised ecological and economic concerns, but has seldom been studied in tropical inland waters. This paper addresses the spatial and temporal dynamics of the phytomass of *E. densa* in this reservoir. Macrophyte stands occupy a band that runs parallel to the littoral, whose width is mainly determined by littoral slope. Significant growth of rooted vegetation was recorded only up to 7 m of depth. A total of 279.3 Ha (29.4% of total reservoir surface area) are currently occupied by *E. densa*. Macrophyte phytomass and percent biomass were estimated with direct sampling and geostatistical analysis. Over 700 kriged interpolations provided by a mean value of 521.84 g/m2 (phytomass, dry weight), with 86% biomass and 14% dead mass. Degree of vegetation development was found to be influenced by littoral slope and sediment characteristics. Growth was determined both for free-living and rooted (planted and *in situ*) shoots. Depth was found to be an important factor in controlling growth, possibly due to depth-related irradiation differences. Decay was estimated as an exponential curve with $k = 0.0146$, and was found to be little affected by depth.

Phenology and Impacts of *Egeria densa* in a Drinking Water Reservoir

Toni G. Pennington[1] and Mark D. Sytsma[1]
[1] *Portland State University, Center for Lakes and Reservoirs, Portland, OR*

An examination of the seasonal phenological changes in *Egeria densa* (Brazilian elodea) and its potential impact to a drinking water reservoir in Oregon began in 2001. To determine seasonal phenological changes in *E. densa*, plants were sampled monthly, separated into various plant parts and analyzed for carbon, nitrogen, and total nonstructural carbohydrates. Preliminary data indicate relatively high percent N (up to 5 percent) in apical meristems of *E. densa* compared to other plant parts considered in this study and other aquatic angiosperms. Seasonal changes in percent N were minimal, as plants did not senesce during the winter of 2001. Nitrogen content in double node regions and root crowns varied little by seasonal (2.3 to 4.0 percent and 2.4 to 3.2 percent, respectively). To investigate the potential impacts of *E. densa* infestation in a drinking water reservoir, monthly water samples were collected and analyzed for dissolved organic carbon and for total trihalomethanes (TTHMs) after 0 and 7d incubation. Due to increased contact time between chlorine and water, TTHM levels generally increased two-fold over the 7d incubation period, suggesting significant THM formation potential in the sourcewater.

Cooperative Revegetation Projects in Central Florida Lakes – Getting Everybody Wet and Muddy

David R. Douglas[1], Rue S. Hestand III[1], Boyd Z. Thompson[1], Bruce V. Jaggers[1], Lowell L Trent and[1], and Craig T. Mallison[2]
[1] *Florida Fish and Wildlife Conservation Commission, Eustis Fisheries Research Lab, Eustis, FL*
[2] *Florida Fish and Wildlife Conservation Commission, Kissimmee Fisheries Field Office, Kissimmee, FL*

Many central Florida public lakes have experienced a loss or degradation of fish and wildlife habitat as a result of urbanization, agricultural impacts and water level stabilization. Many of these lakes currently support only limited submersed aquatic plant communities and/or littoral communities characterized by monotypic stands of exotic and undesirable plant species. Other lakes have no submersed plants and a very narrow, sparse littoral plant band due to shoreline development and eutrophication. In 1997 the Florida Fish and Wildlife Conservation Commission (FWC) Aquatic Plant Section began a cooperative program with local and state governmental agencies as well as homeowners associations, environmental clubs and school groups to initiate revegetation projects on many of these public water bodies. These projects begin by eliminating or minimizing existing stands of undesirable aquatic species using herbicides and then allowing desirable native species to recolonize. If the native plant response is less than desired revegetation with desirable native species is initiated. In some instances the scale of the project requires the use of a contractor to facilitate timely completion. An important component of these efforts is to educate resource users and lake front residents about which species are desirable from both a habitat and aesthetic standpoint. A large effort is made to get as many individuals from various user groups out in the water assisting with the project so they have a "stake " in their lake. As of fall 2001 cooperative revegetation projects have been conducted on 12 water bodies throughout central Florida with over 350,000 aquatic plants of 13 species being planted. These species include *Scirpus californicus, S. validus, Eleocharis interstincta, Fuirena scirpoidea, Pontederia cordata, Sagitaria latifolia, Panicum hemitomon, Paspalidium geminatum, Vallisneria americana, Nuphar luteum, Nymphaea mexicana,* and *Taxodium distichum.* An additional 6 water bodies are scheduled for revegetation projects in 2001 - 2002. Other groups in the FWC Aquatic Plant Section are conducting similar revegetation efforts in other parts of the state.

Quantification of the Aquatic Vegetation of Heron Lake, Jackson County, Minnesota

Morgan L. Case[1] and John D. Madsen[1]
[1] *Minnesota State University, Department of Biological Sciences, Mankato, MN*

We conducted a study in 2001 to document the aquatic vegetation of Heron Lake and evaluate the seasonal growth and tuber production of *Stuckenia pectinata* (sago pondweed) with the goal of identifying factors limiting the success of *S. pectinata.* Methods employed in the study were: 1) point-intercept surveys to determine percent frequency of occurrence of individual plant species for Heron Lake, 2) biomass samples at three sites in North and South Heron Lake to document the life history of *S. pectinata* throughout the growing season, and 3) a tuber and sediment survey after plant senescence to show distribution and production of tubers along with possible areas of stress. Six species of aquatic plants were found in Heron Lake, five emergent and one submersed. The *S. pectinata* in North Heron Lake followed a typical life history with peak biomass of 56 g/m^2 in July and senescence in August. The South Heron Lake sites had lower biomass peaks of 16 g/m^2 and 20 g/m^2. Seasonal environmental data showed a great decrease in water transparency in late June and early July. Water temperatures were greater than 28 °C at all sites in early July. Light availability was shown to be the primary factor restricting the growth of *S. pectinata* in Heron Lake, due to the growth of phytoplankton. Early senescence of *S. pectinata* may be caused by thermal stress. Wave action limits the distribution of *S. pectinata* in Heron Lake.

Organizing an Effort to Fight Purple Loosestrife Invading the Denver, Colorado Area

David Weber[1]
[1] *Colorado Division of Wildlife, Denver, CO*

Purple loosestrife (*Lythrum salicaria*) is an invasive wetland plant introduced to North America from Europe in the early 1800's. It has become a widespread problem in many parts of the United States. Loosestrife was discovered growing in Colorado in 1990 in the City of Boulder, and two years later in the nearby Denver metropolitan area. Since then it was found at many other locations in the vicinity - growing in ditches, on lake margins, in marshes, and stream banks. It invaded from landscape or garden plantings. Twenty-seven agencies and organizations, under the leadership of the Colorado Division of Wildlife, have been cooperatively battling purple loosestrife in the metro area since 1992. The strategy has been for public agencies to control loosestrife on their lands, with the Division of Wildlife doing control on private lands. Most control has been by backpack spraying with the herbicide Rodeo, but some hand pulling and 2,4-D herbicide have been used. This strategy has been effective and good headway has been made in stopping the spread of purple loosestrife and reducing its density. Numbers of loosestrife plants have been drastically reduced at the vast majority of infestation sites. All sites are monitored each summer and control work done yearly. Total eradication from the entire metro area is probably not possible, but we are confident that further spread will be stopped and the plant can be eradicated at many individual sites. We believe that this is one of the more successful cooperative weed management efforts ever attempted in North America. Purple loosestrife is controllable if detected early!

Session IV: Aquatic Herbicides and Surfactants

Evaluation of Fluridone for Selective Control of Eurasian Watermilfoil in Lake Hortonia, Vermont: I. Application Strategy and Herbicide Residues

Kurt D. Getsinger[1], Robert M. Stewart[1], John D. Madsen[2], Adam Way[3], Chetta S. Owens[4], Holly Crosson[5], and Alan Bo Burns[6]
[1] *U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2] *Minnesota State University, Mankato, MN*
[3] *Dyntel Corporation, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[4] *Analytial Services, Inc., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[5] *Vermont Department of Environmental Conservation, Waterbury, VT*
[6] *SePRO Corporation, Carmel, IN*

In an effort to document the effects of a whole-lake herbicide treatment, a multi-year study was conducted on Lake Hortonia, Vermont. The objective of this portion of the overall study was to develop and implement a low-dose application strategy using fluridone. Lake bathymetry and pretreatment thermocline data were used to determine the amount of herbicide required to achieve the target dose. On June 4, 2000, the lake was treated to achieve a nominal rate of 6 $\mu g\ L^{-1}$ fluridone using Sonar® AS. The lake was subsequently treated with a booster application of Sonar® AS at 35 days after the initial treatment to re-set the whole-lake concentration to 6 $\mu g\ L^{-1}$ fluridone, thereby extending the exposure time of the herbicide to the target plant. Water samples were collected at various locations from 0 through 116 days after treatment (DAT), and analyzed for fluridone residues. Aqueous residues at 1 DAT indicated that the whole-lake concentration was 6.3 $\mu g\ L^{-1}$ fluridone and had declined to 3.8 $\mu g\ L^{-1}$ by 29 DAT. Following the booster application, whole-lake residues recovered to 6.1 $\mu g\ L^{-1}$, and slowly declined to a level of 2.8 $\mu g\ L^{-1}$ by 116 DAT. In order to provide consistent, precise, and selective control of Eurasian watermilfoil (*Myriophyllum spicatum* L.) using low-doses of fluridone on a whole lake basis, it is recommended that factors such as accurate lake bathymetry, pretreatment thermocline information, rapid water residue analysis, and plant injury assessments be coupled with established fluridone concentration and exposure time relationships.

Evaluation of Fluridone for Selective Control of Eurasian watermilfoil in Lake Hortonia, Vermont: II. Impacts on Plant Communities

Robert M. Stewart[1], Kurt D. Getsinger[1], John D. Madsen[2], Adam Way[3], Chetta S. Owens[4], Holly Crosson[5], and Alan Bo Burns[6]
[1] *U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[2] *Minnesota State University, Mankato, MN*
[3] *Dyntel Corporation, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*
[4] *Analytial Services, Inc., U.S. Army Engineer Research and Development Center, Environmental Laboratory, Lewisville, TX*
[5] *Vermont Department of Environmental Conservation, Waterbury, VT*
[6] *SePRO Corporation, Carmel, IN*

A three-year study of the aquatic plant community of Lake Hortonia, Vermont, was conducted to evaluate the effectiveness of a whole-lake fluridone treatment for selective control of Eurasian watermilfoil (*Myriophyllum spicatum* L.). The lake was treated with SONAR® AS on June 4, 2000 at a target rate of 6 $\mu g\ L^{-1}$. The plant communities were sampled in June and August 1999, 2000, and 2001 using point-intercept, biomass, and line-intercept sampling techniques. Pre-treatment point-intercept surveys documented 22 plant species in the open-lake zone. Common native submersed species included

Potamogeton amplifolius, P. illinoensis, P. robbinsii, Chara spp., *Elodea canadensis*, and *Vallisneria americana*. In August 1999, native plants occurred at ~55 % of whole-lake sample points. At that time, Eurasian watermilfoil occurred in over 54 % of whole-lake sample points and accounted for over 76 % of total plant biomass. Eurasian watermilfoil occurrences had been reduced by ~17 % of pre-treatment levels at 2 months post-treatment, and by ~85 % at 14 months post-treatment (August 2001). Eurasian watermilfoil biomass levels were reduced by ~80 % at 2 months post-treatment (August 2000) and by ~96 % at 14 months post-treatment (August 2001). Over 51 % of the sample points remained vegetated by native plants in August 2000 and August 2001, though reductions in occurrences were detected for several native species in both years. Summed total biomass of all native species was reduced below pre-treatment levels during August 2000, but returned to pre-treatment levels by August 2001. No impacts from the fluridone treatment were detected to the aquatic plant community in the adjacent wetland area.

Three and a Half-Years of Laboratory and Field Monitoring of Fluridone-Tolerant Hydrilla: What Have We Learned?

Michael D. Netherland[1], Franck Dayan[2], Brian Scheffler[2], and Steve Cockreham[1]
[1] *SePRO Corporation, Carmel, IN*
[2] *U.S. Department of Agriculture, Agricultural Research Service, Natural Product Utilization Research Unit, National Center for Natural Products Research, Oxford, MS*

While herbicide resistance is a well known phenomenon in terrestrial agriculture, the issue is not well understood in aquatics. The development of tolerance to fluridone by hydrilla (*Hydrilla verticillata* (L.f.) Royle) was unexpected due to the clonal nature of the plant and the fact that no terrestrial plants have developed resistance to phytoene desaturase inhibitors. The onset of this problem has led to the development of PlanTEST and EffecTEST plant assays for tolerance screening and field monitoring as well as the development of a new Sonar formulation. Plant assays and monitoring have expanded to include numerous species other than hydrilla, and results indicate an application of these technologies for target plant control, prediction of selectivity, and proving that the target population has not become more tolerant. In addition to use of plant assays, genetic testing conducted on hydrilla at the USDA Natural Product Utilization Research Unit in Oxford, MS has confirmed the genetic basis for the tolerance to fluridone. This work will be discussed and it has confirmed plant assay results that show varying levels of hydrilla tolerance exist between different water bodies. In addition to documenting the basis for the tolerance, techniques have been developed to determine potential for increased tolerance to develop over time. Intense field monitoring over the past 3.5 years suggests that environmental factors can play a significant role in the response of tolerant plants to a fluridone application. Integration of plant assay, plant monitoring, and data collection on environmental conditions will be discussed as they relate to control of hydrilla.

Management of Variable-Leaf Milfoil (*Myriophyllum heterophyllum*) with Fluridone

Stratford H. Kay[1]
[1] *Department of Crop Science, North Carolina State University, Raleigh, NC*

Testing was initiated in the spring of 2001 in farm ponds in North Carolina to evaluate the importance of treatment timing for control of variable-leaf milfoil, *Myriophyllum heterophyllum*, with fluridone. Two fluridone treatment rates, 60 and 90 ppb, also were examined. Fluridone symptoms began to appear on young growing points as early as 3 days after treatment in both the early (early May) and mid-season (mid-July) ponds, but symptoms did not become pronounced at any site until 7 to 14 days after application. Early-season treatment with fluridone prior to the appearance of any significant number of emergent floral spikes provided good control of variable-leaf milfoil, in comparison with poor control in ponds treated during mid-summer when the emergent floral spikes already were well formed. At the end of the 2001 growing season, the milfoil was gone in ponds treated the spring, but dense growths of milfoil still were present rooted on the bottom and appeared green and quite healthy in ponds treated in mid-summer. There were no discernible differences in response of the milfoil to application rate at either treatment timing. These observations at the end of the 2001 growing seasons suggested that the treatment rate was more than adequate to provide control and that the timing of the treatment was the more important factor. When evaluated in April of 2002, however, two of the mid-season ponds were clean, whereas the milfoil in the other two mid-season ponds was robust and growing. The two mid-season ponds in which the milfoil did not drop out had substantial flow during the growing season, compared with little outflow in the other two ponds in which the milfoil dropped out over the winter. This study is being repeated in 2002 using lower application rates. Progress of the current growing season's testing will be discussed.

A New Herbicide for Aquatic Use: Arsenal 2NS

Jennifer Vollmer[1] and Kathy Kalmowitz[2]
[1] *BASF, Laramie, WY*
[2] *BASF, Research Triangle Park, NC*

Arsenal 2NS (imazapyr) herbicide is currently under review by the Environmental Protection Agency for an aquatic use label. Arsenal has been registered and used successfully over the past 15 years for weed control in non-crop areas. An experimental use permit (EUP) has allowed BASF to utilize Arsenal in aquatic weed control operations since 1996. These EUPs have shown Arsenal herbicide to give excellent control of terrestrial and emersed aquatic weed species. Riparian area invasive species have been successfully controlled and the land restored including saltcedar *(Tamarix* spp.), Melaleuca (*Melaleuca quinquenervia*), cattail (*Typha* spp.), phragmites (*Phragmites australis*), sedge species (*Cyperus* spp.), torpedograss (*Panicum repens*), giant cutgrass (*Zizaniopsis miliacea*), and Chinese tallowtree (*Sapium sebiferum*). Emersed species controlled with Arsenal include alligator weed (*Alternanthera philoxeroides*), water hyacinth (*Eichhornia crassipes*), parrots feather (*Myriophyllum aquaticum*), Frog's-bit (*Limnobium spongia*) and duckweed (*Lemna minor* and *Spirodela polyrhiza*). Arsenal 2NS is in the imidazolinone family and is the first acetolactate synthase (ALS) inhibitor to be considered as an aquatic herbicide. Imidazolinones exhibit excellent characteristics for aquatic use due to low toxicity, quickly broken down in water and basic metabolites. Arsenal has low toxicity to mammals, birds, fish and reptiles partially because it acts by inhibiting a biosynthetic process that occurs only in plants. The half-life of Arsenal in water is 75 hours. Break down occurs through aqueous photolysis and microbial action, breaking the active ingredient down to carbon, hydrogen, oxygen and nitrogen. Restrictions on the aquatic label are expected to be limited to irrigation water in regard to dilution and time.

California's $2 Million Aquatic Pesticide Monitoring Program or: Aquatic Pest Control Jousting in the Wild West

Lars W. J. Anderson[1] and Geoff Siemering[2]
[1] *U.S. Department of Agricultural, Agricultural Research Service, Exotic and Invasive Weed Research, Weed Science Program, Davis, CA*
[2] *Aquatic Pesticide Monitoring Program, San Francisco Estuary Institute, Oakland, CA*

As a result of a 2002 legal settlement between the California State Water Quality Control Board and WaterKeepers, $1.95 million from the State Water Pollution Abatement Account will be allocated for specific monitoring of selected aquatic pesticides/uses over the next two years. An additional $600 thousand will be used for a "pilot grogram to explore less toxic alternatives to aquatic pesticides". The lawsuit came on the heals of the first issuance of NPDES permits in the US for labeled aquatic pesticides in CA, which resulted from a 9th Circuit Court's decision in March, 2001 which defined these uses as waste-discharges. The studies are aimed at obtaining data upon which to develop revised NPDES permits in 2004 when the current permits expire. A Steering Committee and Technical Advisory Committee were formed to facilitate development of the monitoring protocols, priority products (active ingredients) and use patterns to be included. The program is being directed by the San Francisco Estuary Institute (SFEI) and will initially focus on existing aquatic plant control programs that have some level of monitoring and that include the high priority active ingredients. The rationale and strategies for selecting uses, as well as components of the monitoring program will be discussed.

The Development and Performance Characteristics of a New Sonar Formulation: Interaction with Sediment Type

Michael D. Netherland[1], William T. Haller[2], Tyler J. Koschnick[2], and David P. Tarver[3]
[1] *SePRO Corporation, Carmel, IN*
[2] *Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL*
[3] *SePRO Corporation, Tallahassee, FL*

The performance characteristics of Sonar SRP have remained an enigma to both the research and applicator community despite several years of use. Nonetheless, intensive sampling following a variety of treatment scenarios over the last several years has provided new insights into SRP performance. The use of the FasTEST immunoassay in conjunction with the EffecTEST plant assay has also greatly increased understanding of the *in situ* response following an SRP application. The release and efficacy information collected on the SRP formulation has also been used to drive the development and USEPA registration of a new formulation of Sonar. Laboratory, mesocosm and field testing results indicate the new Sonar Precision Release (PR) pellet provides significantly different fluridone profiles in the water column compared to the current Sonar SRP and AS formulations. Data collected for Sonar SRP and PR release in a variety of sediment types indicates that sediments have a strong influence on the release of fluridone from both formulations. In all cases, Sonar PR provided consistently higher release of fluridone into the water column over a period of 70 days. Field development tests have characterized release and efficacy profiles in a variety of water bodies to determine the best fit for the product. Initial test sites included systems with moderate flow, sites with plant species that have a higher threshold tolerance to fluridone, ponds, drainage canals, and other aquatic sites. Development of Sonar PR was based on an improved understanding of the SRP formulation and the knowledge that formulation can impact fluridone efficacy under a variety of treatment scenarios.

Effects of Endothall in Irrigation Water on Selected Turf and Ornamental Species

Tyler J. Koschnick[1] and William T. Haller[1]
[1] *Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL*

The effects of two endothall (7-oxabicyclo [2.2.1] heptane-2,3-dicarboxylic acid) formulations in irrigation water were evaluated on selected turf (annual bluegrass, annual ryegrass, centipede grass, and St. Augustine grass) and ornamental species (begonias and impatiens). Two studies were conducted to determine endothall concentrations resulting in 50% growth reduction (LC50) and a second simulating irrigation from a pond or lake containing endothall considering a theoretical 8-day half-life. Overhead irrigations were conducted with a sprinkle can with 1.27 cm water containing various concentration of endothall. Turf species, grown in pure sand, were treated twice a week for 2 weeks to determine a LC50 and treated twice a week for 4 weeks with decreasing concentrations of endothall simulating irrigation from a pond. Plant biomass was harvested every 7-21 days during treatments, depending on growth rate, and up to 4 weeks following treatments to determine the impact on growth. Ornamental species were irrigated every other day for 6 days with constant endothall concentrations to determine an LC50, and every other day for 8 days when simulating an 8-day half-life. Biomass was harvested approximately one week after the last irrigation. The LC50 for St. Augustine grass was 381 ppm for the dipotassium formulation of endothall and 338 ppm for the amine formulation. The LC50 for impatiens was 45 ppm for the dipotassium salt and 29 ppm for the amine salt formulation (all calculations based on acid equivalent). Observable impacts on growth were observed between 10-20 ppm on impatiens and at concentrations >50 ppm for St. Augustine grass. Additional date will presented for the various species, but data suggest there is a wide range of safety when irrigating these species with endothall containing water at label rates and that the amine salt of endothall is slightly more toxic than the dipotassium salt.

Use of the Aquatic Herbicide Renovate for Selective Management of Submersed and Emergent Vegetation

Shaun Hyde[1] and Steve Cockhreham[1]
[1] *SePRO Corporation, Carmel, IN*

Renovate (active ingredient triclopyr) is in the final stages of review to receive a full aquatic registration from the US Environmental Protection Agency. Use restrictions, use patterns, and separation of the aquatic and terrestrial labels will be discussed. From a field development and research perspective, Renovate has not been used in the aquatics market in the past 2 years due to the cancellation of the Experimental Use Permit by the USEPA. Nonetheless, Renovate continues to hold promise as an integrated management tool for Purple loosestrife (*Lythrum salicaria* L.) due to its selectivity and compatibility with biological control organisms. Field development work shows that Renovate can be used at a broad range of concentrations when used to control the submersed plant Eurasian watermilfoil (*Myriophyllum spicatum* L.). Efficacy in the range of 0.5 mg/L (tolerance level for potable water) may allow for use of Renovate in areas where potable water intakes or wells are of concern. While the lower use rates are suggested for large treatment areas or in sites with a long water retention period, use rates of up to 2.5 mg/L continue to provide selective control of Eurasian watermilfoil. The higher rates can help to offset dilution and increase efficacy in smaller treatment plots. Field trials on the exotic plant Parrotfeather (*Myriophyllum aquaticum*) in California suggest that sequential low rate treatments may enhance control due to increased translocation of the herbicide. Research on Renovate will focus on correlating use rates and translocation in Eurasian milfoil and parrotfeather, and comparing Renovate efficacy and selectivity for control of emergent vegetation with other active ingredients currently registered in aquatics.

Control of Wild Taro Using Rodeo in Combination with Cygnet Plus Surfactant

Tyler J. Koschnick[1], William T. Haller[1], and Steve Brewer[2]
[1] *Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL*
[2] *Brewer International, Vero Beach, FL*

Cygnet Plus is a nonionic surfactant made from limonene and special emulsifiers. Cygnet Plus aids in wetting and penetration of the waxy cuticle of certain weed species. Rodeo is a non-selective herbicide used for control of emergent aquatic plants and some floating plants. A study was conducted by the University of Florida aquatic Research Center to determine efficacy with Cygnet Plus and Rodeo, and Rodeo alone. Treatments were compared using wild taro as aquatic weed with waxy cuticles. Cygnet plus was found to increase efficacy of Rodeo by 28 to 60% when used with Rodeo at label rates.

Session V: Biocontrol, Mechanical Control, and Case Studies

Demonstration of Aquatic Weed Control by Tilapia in South Carolina Irrigation Ponds

Jack M. Whetstone[1]
[1] *Department of Aquaculture, Fisheries and Wildlife, Clemson University, Georgetown, SC*

With more intensive management of golf courses and agricultural and nursery crops through the use of irrigation, concerns over aquatic herbicide use and restrictions on irrigation after herbicide applications have become more acute. Filamentous algae, duckweed and watermeal are major problem aquatic weeds in irrigation ponds in South Carolina. This project was designed to demonstrate the use of tilapia for the control of major aquatic weeds in irrigation ponds and evaluate tilapia as a control method for duckweed and watermeal. Fourteen ponds in four coastal counties were stocked with tilapia. The duckweed and watermeal ponds were stocked with a 1:1 ratio of blue tilapia, *Oreochromis aureus*, and red-bellied tilapia, *Oreochromis zillii*. The filamentous algae ponds were stocked with blue tilapia, *Oreochromis aureus*, only. At stocking, aquatic weed species and coverage as a percentage of total pond area was established. Monthly sampling visits were conducted to establish aquatic weed percent coverage and change in aquatic plant populations. All filamentous algae ponds were controlled with tilapia. The high stocking rate (400 fish/acre) required a one-two month period for complete control while the low stocking rate (200 fish per acre) required three months for control. Duckweed was not effectively controlled. Watermeal was controlled after three months, but only one pond was stocked. If pond managers are willing to wait a longer period before control, tilapia control of filamentous algae and possibly watermeal is an alternative to chemical control.

Potential Fecundity of the Milfoil Weevil on its Native and Exotic Host Plants

Michelle D. Marko[1], Raymond M. Newman[1], and Julie Krueger[1]
[1] *Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota, St. Paul, MN*

Euhrychiopsis lecontei (Curculionidae) is a fully aquatic native weevil that specializes on watermilfoils. The milfoil weevil has undergone a host range expansion from the native Northern watermilfoil, *Myriophyllum sibiricum* (Haloragaceae) to the invasive exotic Eurasian watermilfoil, *Myriophyllum spicatum*, and in fact prefers the chemically and morphologically similar Eurasian watermilfoil to its native host. We measured the potential fecundity of northern and Eurasian-reared weevils in 15-day no-choice and choice oviposition experiments. Eurasian-reared weevils had significantly higher potential fecundity on Eurasian than on Northern watermilfoil (repeated measures ANOVA, $F=1.82$, $p=0.0005$). Number of eggs oviposited per female per day was, from greatest to least (weevil rearing species:watermilfoil treatment species): Eurasian:Eurasian (mean $\pm$ SE; 4.6 ± 0.27) > northern:Eurasian (3.0 ± 0.24) > Eurasian:northern (2.4 ± 0.26) > northern:northern (2.2 ± 0.23 eggs/female/day). These means indicate that the milfoil species weevils were located on as adults is more important than rearing plant for potential fecundity. In choice tests, both rearing types preferred to oviposit on the exotic rather than the native host plant (chi-square, $p<0.0001$). Euraisan-and northern-reared weevils had similar ovipositions patterns throughout the experiment (4:1 Eurasian:Northern). Previous one-day oviposition studies have not shown that native-reared weevils prefer Eurasian to northern watermilfoil. By extending this study over a two-week period we have shown that there is in fact a strong preference by native-reared weevils for the exotic host plant. Furthermore, both northern and Eurasian-reared weevils have an increased potential fecundity on the exotic host plant.

Bio-Control of a Marine Invasive Weed? Novel use against *Spartina alterniflora* in Willapa Bay, Washington

Miranda Wecker[1], Fritzi Grevstad[1], Don Strong[2], and Dino Garcia-Rossi[3]
[1] *University of Washington, Olympic Natural Resources Center, Naselle, WA*
[2] *Department of Evolution and Ecology, University of California, Davis, CA*
[3] *Bodega Marine Laboratory, Bodega Bay, CA*

The Washington Legislature unanimously declared the infestation of smooth cordgrass-- *Spartina alterniflora*-- an environmental emergency in 1995. After seven years of work, the weed's spread continues to far outpace control efforts. Spartina threatens the most productive oyster growing grounds in the nation. It already has altered thousands of prime acres that feed migratory wildfowl along the Pacific Flyway. Endangered and threatened salmon use the estuarine habitat it has invaded. With severe limits on available funding, state and federal managers have been reluctant or unable to support "r&d" to explore new tools. With stimulus from the Coastal Resources Alliance, a grass roots citizen group, researchers from the University of Washington, Olympic Natural Resource Center (UW-ONRC) and the University of California at Davis launched studies to evaluate for the first time, the feasibility of using biological control to fight an exotic invasive plant in a marine setting. Risk studies focused on the safety of using the planthopper *Prokelisia marginata* after UC-Davis Professor Don Strong demonstrated its unusual potency in killing Willapa Bay Spartina. Following successful completion of host range and other risk studies, federal and state permits were issued in 2000. CRA, UW-ONRC and its local partners immediately began release activities. Rigorous scientific research, extensive monitoring, regular public education and involvement are all central elements of this partnership's approach. UW-ONRC staff has developed a dynamic model of spread which is embedded in a GIS application. The model will allow integration of bio-control into the overall integrated weed management program.

Biological Carriers for Submerged and Emerged Weed Control

Lucia G. I. Marshall[1] and Richard L. Lowe[1]
[1] *Biosorb, Inc., St. Charles, MO*

Biological carriers derived from grain and oil-seed materials are used for formulation and delivery of chemical and biological active ingredients (agents). This patented technology is demonstrated for use with agents in aquatic weed control as well as terrestrial weed control. The coating properties of the biological carrier system, Biocar®, enhances coverage and herbicidal activity. Plant pathogens, such as *Mycoleptodiscus terrestris* (Mt), need the coating and adherence properties of the biological carriers in order to attach the pathogen to the target under water plant species (hydrilla and Eurasian watermilfoil). (Studies have been previously published and the technology has been patented.) Using the same biocarrier technology, new field studies demonstrate the enhancement of herbicidal activity through the coating properties of Biocar® in terrestrial weed control. A new adjuvant was developed using the natural grain derived biocarriers, called TopFilm™. The natural adjuvant is not surfactant based and has excellent crop safety properties which allows the adjuvant's use in aquatics, turf and ornamentals, as well as in standard agricultural use. This presentation will review the coating properties of the Biocar® system, the new field data recorded in Illinois and in Wisconsin, and compare the herbicidal activity enhancement with commercially available synthetic surfactants/adjuvants.

The Developing Mechanical Shredder Technology

David Penny[1]
[1] *AquaSolutions LLC, Lawrence, KS*

Aquatic plant control uses a three-pronged approach of chemical, mechanical, and biological methods. Historically, large mechanical harvesters primarily destroyed or removed the invasive plants such a water hyacinth from channels and rivers. These mechanical behemoths were largely replaced by cheaper chemicals, some of a very toxic nature like arsenic. Since World War II more sophisticated, species-specific chemicals have dominated the control of non-native plants. In recent years, species-specific biological agents have been added to the arsenal of aquatic plant controls. Facing rising environmental resistance to chemicals on one hand and a proliferation of new invasive infestations on the other, managers need more cost-effective weapons in their biological and mechanical arsenal. In the last decade the new mechanical shredder technology has dramatically reduced the cost of mechanical controls in particularly difficult situations. Two case studies illustrate this technology on severely impacted sections of the St. Johns River in Florida and on the lower Rio Grande River between Texas and Mexico. A more recent variant of this technology manages tidal and semi-terrestrial infestations of high-density vegetation.

Eradication of Hydrilla from the Eastman Lake/Chowchill River Complex in California: 2002 Update

J. Robert Leavitt[1], Ross O'Connell[1], and Frank Zarate[1]
[1] *California Department of Food and Agriculture, Plant Health and Pest Prevention Services, Integrated Pest Control Branch, Sacramento, CA*

The California Department of Food and Agriculture (CDFA) first detected hydrilla (*Hydrilla verticillata*) in Eastman Lake and the first 26 miles of Chowchilla River upstream from the lake on June 20, 1989. CDFA, in cooperation with the U.S. Army Corps of Engineers, the Chowchilla Water District, and the Madera and Mariposa County Agricultural Commissioners, immediately started an eradication project. This project started with drawdown of Eastman Lake to minimum pool in 1989 followed by manual removal of exposed plants and soil fumigation with metam-sodium to control the tubers. Normal water management was restored in 1990. Also starting in 1989, the lake and river have been surveyed for hydrilla several times annually. Where hydrilla plants have been found they have been manually removed and the hydrosoil dredged for tubers. Infested areas have been treated with copper-ethylenediamine complex and fluridone (since 1994). The lake was also quarantined from all recreational use from 1989 until 1992 when limited fishing was allowed. Today, there are more recreational opportunities available than prior to closure. This eradication project has been successful in dramatically decreasing the level of infestation in the Eastman Lake and the Chowchilla River. No hydrilla plants have been detected in the lake since 1992. In the Chowchilla River, the number of hydrilla plants has decreased from uncountable in 1992 to 6,500 in 1993 to 562 in 1997 and to 5 in 2001. The number of dredged tubers has decreased from 35,451 in 1991 to 1,400 in 2000 and 21 in 2001.

Costs of Applying an Aquatic Herbicide with the New West Cost Rules. (Lake Oswego, Oregon)

Steve Lundt[1] and Mark Sytsma[2]
[1] *Lake Oswego Corporation, Lake Oswego, OR*
[2] *Center for Lakes and Reservoirs, Portland State University, Portland, OR*

Oswego Lake is a 403-acre lake located 10 miles south of downtown Portland. Oswego Lake is a classic victim of "cultural eutrophication" with high nutrient loading and low water clarity. The recent management of the Lake has included some significant rehabilitation projects resulting in an increase in water clarity. As a result, more aquatic plants are getting established, including exotics. To address these new plant concerns, the Lake Oswego Corporation (LOC) has developed an *Integrated Aquatic Plant Management Plan* for 2002 that involved prevention/protection, mechanical, and chemical techniques. Boat decontamination procedures, harvesting, hand pulling, and herbicides are the main tools for Oswego Lake. Aquatic herbicides, the most recent tool added to the integrated plan, was especially difficult to obtain due to the recent lawsuit in southern Oregon, *Headwaters v. Talent Irrigation District*. After three months of legal fees, permit fees, and a public hearing, LOC received an agreement from Oregon Department of Environmental Quality to apply three specific herbicides, Sonar®, Reward®, and Aquathol®. This Mutual Agreement and Order (MAO) is first of its kind for Northwest lakes. The MAO specifically spells out what chemicals can be used, how to manage the hydrology, and how stakeholders must be informed. In conclusion, the management of aquatic plants in Oswego Lake was a challenge and very expensive in 2002. Every tool possible was used on Oswego Lake. Exotics still remain in the Lake and this type of intense plant management will continue for the unforeseeable future.

U.S. Eradication Program for *Caulerpa taxifolia*, an Exotic and Invasive Marine Alga

Lars W. J. Anderson[1]
[1] *U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, CA*

Four weeks following the June 12, 2000 discovery the first known introduction in the northern hemisphere of *Caulerpa taxifolia* in Agua Hedionda lagoon near Carlsbad, California, eradication began. This alga has spread to over 30,000 ha in the Mediterranean over the past 15 years, and is encroaching in NSW Australia waters. Absence of a clear US federal or state lead agency necessitated the formation of the Southern California Caulerpa Action Team (SCCAT). The SCCAT Steering Committee includes representatives from California Dept. of Food and Agriculture, California Dept. of Fish and Game, San Diego Regional Water Quality Control Board, US Dept. of Agriculture-Agricultural Research Service, and the National Marine Fisheries Service. This "rapid response" was possible due to: (1) Quick confirmation of species ID; (2) Communication to appropriate state and federal resource and research agencies; (3) Short institutional "learning curve"; (4) Early consensus to eradicate (rather than "manage"); (5) Resolution of regulatory and "permitting" issues; (6) Field crews were in place with funds and other resources sufficient to act (Merkel and Associates); (7) Cooperative, dedicated and committed people. Annual program costs are approximately $1.1 million support monitoring, surveillance and eradication.

To date, funding has come from a variety of public agencies, and some private sources. In December 2001 sediment cores were taken to assess eradication efforts. Placed in controlled, "grow-out" conditions, cores from treated areas have not produced any *C. taxifolia* up to 76 days post-sampling; however, native eelgrass seedling did merge in some cores from treated sites.

Control of Eurasian Watermilfoil in Mesocosms at Lake Tahoe

Robert J. Duvall[1], Lars W. J. Anderson[2], and Charles R. Goldman[3]
[1] *Division of Planning and Local Assistance, Department of Water Resources, Sacramento, CA*
[2] *U.S. Department of Agricultural, Agricultural Research Service, Exotic and Invasive Weed Research, Davis, CA*
[3] *Department of Environmental Science Policy, University of California, Davis, CA*

The objective of this study was to provide and discuss efficacy and dissipation data for EPA-registered aquatic herbicides used to manage Eurasian watermilfoil (*Myriophyllum spicatum*) and to facilitate discussion of an integrated strategy to effectively manage and stop the spread of Eurasian watermilfoil in Lake Tahoe. Efficacy and dissipation of different rates and different formulations of the aquatic herbicides endothall, fluridone, and triclopyr were quantified using mesocosms located at Lake Tahoe, CA-NV. The mesocosms contained Eurasian watermilfoil, water and sediment collected from Lake Tahoe. Herbicide-treated lake water in the mesocosms was isolated from the lake by a circulating water bath system because a basin-wide water quality control plan established a zero tolerance for the addition of any pesticide to the lake, including EPA-registered aquatic herbicides. Efficacy was determined by comparing fresh weight and dry weight of herbicide-treated plants with non-treated controls. Herbicide dissipation in the water was measured using enzyme-linked immunosorbent assay. All rates and formulations were effective in reducing or eliminating Eurasian watermilfoil growth compared to the non-treated controls. Dissipation patterns varied among herbicides and formulations. Following these studies, small-scale replicated plots will be treated using fluridone, endothal and possibly triclopyr in the Tahoe Keys Marina pending approval by the Lahontan Regional Water Quality Control Board.

Posters

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

Robert C. Gunkel, Jr.[1] and John W. Barko[1]
[1] *U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS*

The U.S. Army Corps of Engineers (CE) Aquatic Plant Control Research Program (APCRP) is the Nation's only federally authorized research program directed to develop technology for the management of invasive aquatic plant species. The APCRP is designed to provide effective, economical, and environmentally compatible techniques for identifying, assessing, and managing invasive aquatic plant problems that interfere with the valued uses of our nation's water resources. Research is conducted on the biology, ecology, and management of invasive aquatic plants, developing biological, chemical, ecological, and integrated control methods. The APCRP provides water resources managers with the tools needed to restore aquatic ecosystems to achieve sustainable benefits provided by a healthy and diverse aquatic plant community dominated by native aquatic plant species. The CE APCRP is committed to the development, transfer, and implementation of aquatic plant management technologies, and will continue to lead the Nation in the future.

Technology Transfer For Invasive Species Via Computer-Based Information Systems

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

A large number of invasive species (noxious and nuisance plants, zebra mussel, etc.) cause serious problems in many areas of the United States. Since there are a tremendous number of management options available for the control of these species, one must have the ability to readily and efficiently obtain pertinent information on the various control methods. This information is essential to operational personnel in determining the most effective strategy for controlling a certain species in a given environment. For this purpose, several computer-based information/expert systems have been developed that provide rapid and easy access to up-to-date information on various management and control methods available for particular species. The systems are PC-based and operate under Windows® ensuring a high degree of portability for a wide variety of different computer configurations. The systems contain large amounts of textual information as well as numerous photographic quality diagrams and images. Information covered is system dependent but all operate using sophisticated programming algorithms that allow for easy identification of invasive species or available management options. The systems include the Noxious and Nuisance Plant Management Information System (PMIS), the Aquatic Plant Information System (APIS), the Zebra Mussel Information System (ZMIS) and the Ecosystem Management and Restoration Information System (EMRRP). Of the following, the ZMIS is currently being distributed. The others are being updated and are scheduled for release in the near future.

Substrate Selection for the Propagation of Submersed Aquatic Vegetation

Todd B. Chadwell[1] and Katharina A. M. Engelhardt[1]
[1] *University of Maryland Center for Environmental Science, Appalachian Laboratory, Frostburg, MD*

Proper selection of the appropriate substrate for submersed aquatic vegetation propagation must take into consideration such properties as texture, nutrient availability, nutrient diffusion rates, substrate uniformity, local availability, and cost. The ideal substrate for submersed macrophytes is one that has adequate nutrient availability for the plant roots, as well as a slow nutrient release rate to the water column. Two commonly employed substrates are fine-textured pond sediments and topsoil. Pond sediment, though an excellent medium for SAV propagation, may be difficult to acquire in large quantities. Topsoil may contain foreign material and differ chemically depending on its source. Kitty litter, with no perfumes or additives, was chosen as a potential substrate for SAV propagation. Kitty litter has potential advantages over other substrates due to its high cation exchange capacity, putative low nutrient content, local availability, and low cost. 24 mesocosms were filled 15 cm deep with kitty litter, topsoil/sand mixture, or locally acquired pond sediment. 4 mesocosms of each substrate were planted with sago pondweed (*Stuckenia pectinata* (L.) Börner). Water samples were drawn from the mesocosms 5 times during a period of 48 days. Water samples are currently being analyzed for total nitrogen, nitrate plus nitrite, ammonia, and total phosphorus. Data will be analyzed to assess the rate of nutrient diffusion from substrate to water column.