31st Annual
Western Aquatic Plant Management Society
Annual Conference

April 2 – 4, 2012

The Westin Hotel ~ San Diego, California

WWW.WAPMS.ORG

Past WAPMS Meetings Sites and Presidents

2012	San Diego, CA	Toni Pennington
2011	Westminster, CO	Thomas Moorhouse
2010	Seattle, WA	Robert Leavitt
2009	Honolulu, HI	Tom McNabb
2008	Tahoe City, CA	Scott Shuler
2007	Coeur d'Alene, ID	Ross O'Connell/ Lars Anderson
2006	San Diego, CA (25th Meeting)	Jenifer Parsons
2005	Denver, CO	George Forni
2004	Bellevue, WA	Terry McNabb
2003	Sacramento, CA	Shaun Hyde
2002	Coeur d'Alene, ID	Mike Mizumoto
2001	Las Vegas, NV	Ron Crocket
2000	Bozeman, MT	Valerie Van-Way
1999	Reno, NV	Stuart Perry
1998	San Diego, CA	Kathy Hamel
1997	Seattle, WA	Mark Sytsma
1996	Portland, OR	Vanelle Peterson
1995	Sacramento, CA	Fred Ryan
1994	Coeur d'Alene, ID	Paul Beatty
1993	Tucson, AZ	Lars Anderson
1992	Salt Lake City, UT	David Spencer
1991	Seattle, WA	Richard Thiery
1990	Sparks, NV	Tom McNabb
1989	Honolulu, HI	Barbra H. Mullin
1988	Fresno, CA	Fred Nibling
1987	Boise, ID	Winn Winkyaw
1986	San Diego, CA	Randall Stocker
1985	Phoenix, AZ	Nate Dechoretz
1984	Spokane, WA	Les Sonder
1983	Las Vegas, NV	Terry McNabb
1982	Denver, CO	First Business Meeting Terry McNabb (President); Paul Beaty (VP)
1981	Formation Interest meeting, San Diego, CA - Floyd Colbert and Lars Anderson (Co-chairs)	

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The objectives of the Society shall be to:

1. Establish a forum for the exchange of information on aquatic vegetation management techniques, strategies, and research through periodic meetings and other appropriate means.
2. Cooperate with local, state, regional, and national agencies, both public and private, in the identification of and solution to aquatic vegetation problems.
3. Promote uniformity and coordination of activities among agencies concerned with the regulatory aspects of aquatic plant management.
4. Encourage scientific research and assist in promoting the control and management of aquatic plants through scientifically sound procedure.
5. Recognize and promote scientific advancement of the members and facilitate the education of aquatic plant scientists through scholarship and other assistance programs.
6. Extend and develop public interest in, and understanding of, aquatic plant management problems and solutions.
7. Cooperate with local chapters and other organizations with similar and related interests.

The Western Aquatic Plant Management Society geographic region includes the states of:
Alaska, Arizona, California, Colorado, Hawaii, Idaho, Oregon, Nevada, New Mexico, Montana, Utah, Washington, and Wyoming

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PROGRAM

Monday, April 2

2:00 - 6:00	Registration (Crystal Foyer)
2:00 - 6:00	Exhibitor Setup (Crystal Ballroom II)
4:00 - 5:00	Board Meeting (Boardroom - Third Floor)
6:00 - 8:00	President's Reception, hosted by Toni Pennington, President, WAPMS (Opal Room)

Tuesday, April 3

7:00 - 8:00	Coffee and Pastries (Crystal Ballroom II)
Session I (Crystal Ballroom I):	Moderator: Mark Sytsma (Vice-President, WAPMS), Portland State University
8:00 - 8:10	**Welcome**: Toni Pennington (President, WAPMS), Tetra Tech Inc.
8:10 – 8:40	**Keynote: Thinking Outside the Boat: Perspectives on Aquatic Invasive Species Management in the West** Lars Anderson, USDA/ARS, retired
	Special Session: Management in the Presence of Threatened and Endangered Species Sponsored by the Aquatic Ecosystem Restoration Foundation Moderator: Carlton Layne, Executive Director, Aquatic Ecosystem Restoration Foundation
8:40 – 9:00	**Regulatory Issues** Carlton Layne, Aquatic Ecosystem Restoration Foundation

9:00 – 9:20	**Pesticides and ESA-listed Species: Leaps of Faith and Pious Hopes** Chris Grue, University of Washington
9:20 – 9:40	**Sublethal Effects of the Aquatic Herbicide endothall on Salmon and Steelhead Smolts During Seawater Transition** Lauren A. Courter, Mt Hood Environmental; Ian Courter and Tommy Garrison, Cramer Fish Sciences
9:40 - 10:10	**Selective control of invasive plants using herbicides to improve aquatic habitat - and relevance to endangered species issues** Kurt Getsinger, US Army Corps of Engineers Environmental Laboratory
10:10 - 10:40	Break (Crystal Ballroom II)
Session II (Crystal Ballroom I):	Moderator: Joe Vassios, United Phosphorus, Inc.
10:40 - 11:00	**When Endangered Species Love the Weeds You Want to Eradicate: The Story of Invasive Spartina and California Clapper Rails in the San Francisco Estuary** Peggy Olofson, San Francisco Estuary Invasive Spartina Project
11:00 - 11:20	**The West Coast Governors' Agreement and Spartina Management in on the West Coast** Vanessa Morgan and Mark Sytsma, Portland State University
11:20 - 11:40	**An Update on Flowering Rush Control Demonstration Projects for Infestations Spanning Watersheds Between the Pacific Northwest and the Great Lakes** Thomas G. Moorhouse, Clean Lakes, Inc. et al (see abstract for complete list of co-authors
11:40 – 12:00	**Eradication of Eurasian Watermilfoil in Lake Tapps, WA** Toni Pennington, Harry Gibbons, Tetra Tech, Inc. and Jon Shimada, Cascade Water Alliance
12:00 - 1:30	Lunch on Your Own
Session III (Crystal Ballroom I):	Moderator: Scott Nissen, Colorado State University
1:30 - 1:50	**Invasive Aquatic and Riparian Weeds and Mosquitoes; Challenges, Successes, and Importance of On-going Studies** Charles Blair, Mosquito and Vector Management District of Santa Barbara County
1:50 - 2:10	**Phosphorus, Algae, and Water Quality: Interactions and Management Implications** Shaun Hyde, West Bishop, and Scott Shuler, SePRO Corporation
2:10 - 2:30	**How to Combat the Detrimental Effects of Turbidity and Eutrophication Caused by Runoff and Erosion: Plymer Enhanced Best Management Practices with a Focus on Nutrient Control** Kyla J. Iwinski, Applied Polymer Systems

2:30 - 2:50	**On-line Interactive Aquatic Weed Identification Tool and Management Options** Joseph M. DiTomoso, UC Davis
2:50 - 3:20	Break (Crystal Ballroom II)
Session IV (Crystal Ballroom I):	Moderator: Cody Gray, United Phosphorus, Inc.
3:20 – 4:20	**Vendor Moment** – Vendors take approximately 5 minutes to highlight products and services
4:20 – 5:00	**Annual Business Meeting**
6:00 - 8:30	**WAPMS Annual Banquet** (Topaz)

Wednesday, April 4

7:00 - 8:00	Coffee and Pastries (Crystal Ballroom II)
Session V (Crystal Ballroom I):	Moderator: Toni Pennington, (President, WAPMS), Tetra Tech Inc.
8:00 - 8:20	**Balancing Emerging Threats with Strategic Goals** Tyler Koschnick, APMS President, SePRO Corporation
8:20 – 8:40	**Movement of Rhodamine WT in South Lake Tahoe Keys: Implications for Aquatic Weed Management** Lars Anderson, USDA/ARS, retired; Tom McNabb and Tom Moorhouse, Clean Lakes, Inc.
8:40 – 9:10	**Developing Use Patterns for New Aquatic Herbicides and Supporting Formulation Development** Mark Heilman, Tyler Koschnick, Todd Horton and Scott Shuler, SePRO Corporation.
9:10 – 9:30	**NPDES Permits: A Sharing Experience** Michael Blankinship, Blankinship and Associates, Inc.
9:30 – 9:50	**NPDES Permits for Aquatic Pesticides in California** Philip S. Isorena P.E., State Water Resources Control Board, California
9:50 - 10:20	Break (Crystal Ballroom II)
Session VI (Crystal Ballroom I):	Moderator: Mike Stephenson, Big Bear Municipal Water District
10:20 - 10:40	**Sago Pondweed Control in Irrigation Canals Using Endothall and Chelated Copper: Comparing Greenhouse and Field Results** Scott J. Nissen, Colorado State University; Joseph D. Vassios, United Phosphorus, Inc.; and William A. Ratajczyk and Brian Lind, Applied Biochemists
10:40 - 11:00	**A Case Study in Hydrilla Mangement Using Bispyribac-sodium in a Florida Lake** James Petta, Valent USA

11:00 – 11:20	**Absorption and Translocation of Granular and Liquid Triclopyr Formulations in Eurasian Watermilfoil** Scott J. Nissen, Colorado State University; Joseph D. Vassios, United Phosphorus, Inc.; and Tyler J. Koschnick and Mark A. Heliman, SePRO Corporation
11:20 - 11:40	**Field Trials Using Harpoon Granular Formulation for Control of Invasive and Nuisance Aquatic Plants** Paul Westcott, William Ratajczyk, and Harry Knight, Lonza Microbial Control
11:40 - 1:00	Lunch on Your Own
Session VII (Crystal Ballroom I):	Moderator: Thomas Moorhouse, Clean Lakes, Inc.
1:00 - 1:20	**Clipper Herbicide's Use in Aquatic Plant Management** Todd Mayhew, Valent Professional Products
1:20 - 1:40	**Endothall Concentration Exposure Time Evaluation for *Elodea canadensis* Control** Cody J. Gray, United Phosphorus, Inc.; Christopher R. Mudge and Kurt D. Getsinger, U.S. Army Engineer Research and Development Center; Joe Vassios, United Phosphorus, Inc.; and Scott Nissen, Colorado State University
1:40 - 2:00	**South American Spongeplant spread in California** Patrick Akers, California Department of Food and Agriculture
2:00 - 2:20	**Early Detection of Dreissenid Mussels in Western Waters: Discussion of Reclamation's Data** Denise M. Hosler, US Bureau of Reclamation
2:20 - 2:50	Break (Crystal Ballroom II)
Session VIII (Crystal Ballroom I):	Moderator: Vanessa Morgan, Portland State University
2:50 - 3:10	**A Review of a Mechanical Control Project for Emergent Aquatic Vegetation Control in Coastal Southern California** Tom Moorhouse, Clean Lakes, Inc.
3:10 - 3:30	**Update on Hydrilla in California** Patrick Akers, California Department of Food and Agriculture
3:30 - 3:50	**Pond lining to eradicate hydrilla: history of a long-infested pond** Jonathan Heintz and Patrick Akers, California Dept of Food and Agriculture
3:50 - 4:10	**Ludwigia Invasions: Update and Implications for Management and Restoration** Brenda J. Grewell and Raymond I. Carruthers, USDA-ARS Exotic and Invasive Weeds Research Unit
4:10 - 4:30	**Early Detection of Ludwigia in Portland, Oregon** Mitchell Bixby, City of Portland - Bureau of Environmental Services

4:30	MEETING ADJOURNED
2:50 - 5:30	Vendor and Exhibitor Breakdown
4:30 – 5:30	WAPMS Board meeting (Boardroom - Third Floor)

Poster Session (Crystal Foyer)

Invasive Aquatic Weeds - Implications for Mosquito Management
Charles Blair MD, Trustee Mosquito and Vector Management District of Santa Barbara County

Amphibian Exposure to Aquatic Herbicides
Amy E. Yahnke[1], Christian E. Grue[1], Marc P. Hayes[2], and Alexandra Troiano[1]. [1]University of Washington. [2]Washington Department of Fish and Wildlife.

Ca^{+} as a Limiting Factor for Growth and Survival of Quagga Mussels
Brian Adair and Mark Sytsma. Portland State University

Early Detection Monitoring for Zebra and Quagga Mussels in Western Contiguous USA
Steve Wells, Portland State University, et al (see abstract for complete list of co-authors

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ABSTRACTS
In Alphabetical Order by Presenting Author

ORAL PRESENTATIONS

South American Spongeplant Spread in California. Patrick Akers. California Department of Food and Agriculture, Integrated Pest Control Branch, 1220 N Street, Room 341, Sacramento, CA 95814. (pakers@cdfa.ca.gov)

Spongeplant, *Limnobium laevigatum*, produces abundant seeds, abundant seedlings, and seedlings and young plants are very small. As a result, the plant seems to spread more readily than water hyacinth, and it is more difficult to exclude from water infrastructure. Although spongeplant was slow to take off in California, it is now spreading alarmingly. There does seem to be some promise of containing or slowing it with consistent effort. This talk will explore the spread of the plant in California and some of the efforts to keep it contained.

Update on Hydrilla in California. Patrick Akers. California Department of Food and Agriculture, Integrated Pest Control Branch, 1220 N Street, Room 341, Sacramento, CA 95814. (pakers@cdfa.ca.gov)

Since 1976, hydrilla has infested approximately 31 distinct sites in California. The CDFA Hydrilla Program had eradicated the plant from 21 of those sites as of 2009. Progress has been good in the remaining sites since then. In 2010, we declared eradication in the Chowchilla River/Eastman Lake infestation after seven years of survey with no plants found. That infestation involved 26 miles of river and an 1800-acre reservoir. This year, we should declare eradication in three other, smaller, infestations, after seven years of survey with no plants. In three of the remaining active infestations, no plants have been seen for five years. Currently, only two infestations have produced plants in the last few years: Clear Lake, and Oregon House in the north Sierra foothills. In 2009, the Clear Lake infestation had undergone a recent resurgence and looked threatening: 196 plant sites were found in the lake in 2008, and 76 were found in 2009. In the last couple years, however, the situation has turned to the better. Only 12 plants appeared in 2010, six in 2011, and preparations are underway to use dredging instead of herbicides to control future straggler plants. Progress is also happening in the Oregon House

infestation, where over 1.5 miles of the most heavily infested part of the canal is now lined with concrete, and the most troublesome pond has been lined with a heavy pond liner.

Movement of Rhodamine WT in South Lake Tahoe Keys: Implications for aquatic weed management. Lars W.J. Anderson[1], Tom McNabb[2] and Tom Moorhouse[3]. [1]USDA-ARS Exotic and Invasive Weed Research. One Shields Ave. Mail Stop #4, Davis, CA. [2]Clean Lakes, Inc., PO Box 3186, Martinez, CA 94553. [3]Clean Lakes, Inc., 31320 Via Colinas, # 114, Westlake Village, CA 91362. (lwanderson@ucdavis.edu)

Lake Tahoe is a deep, alpine lake that spans California and Nevada in the Sierra Nevada and is designated as an Outstanding National Resources Water under the US Clean Water Act. Lake Tahoe's pristine environment has been increasingly impaired over the past 20 years by expanding populations of Eurasian watermilfoil and curlyleaf pondweed, particularly in the Tahoe Keys marina. Restrictions by the Lahontan Regional Water Quality Control Board (LRWQCB) preclude the use of aquatic herbicides. Current mechanical control operations create viable plant propagules that facilitate further spread within infested areas as well as un-infested sites in Lake Tahoe. Changes in LRWQCB policies approved in fall of 2011 may eventually allow herbicide use. To better understand the likely fate and movement of herbicides in the marinawe applied a water- soluble fluorescent dye, Rhodamine WT, at sites in the marina in the summer and fall of 2011. Rhodamine WT applied in "dead-end" coves the dye dispersed vertically within 24-48 hours, but remained primarily within the sites for over 30 days. In contrast, dye applied in sites having multiple channel connections moved westerly and southerly out of the site within a few hours. Since more than 75% of the infested surface area is comprised of "dead-end" coves, these results suggest that herbicides would most likely remain within "targeted" coves and that dispersal to off-target areas would be minimal. The results also indicate that within areas having rapid exchange rates, granular or pelleted formulations of herbicides may overcome the high wash-out rates.

Early Detection of Ludwigia in Portland, Oregon. Mitchell Bixby. Botanic Specialist, City of Portland, 1120 SW 5th Ave. #1000, Portland, OR 97204. (mitch.bixby@portlandoregon.gov)

The City of Portland, Oregon operates an Early Detection/Rapid Response program through its Bureau of Environmental Services [BES]. Like other early detection networks, Portland's ED/RR seeks to identify and manage newly-arrived invasive plant species through a combination of management, mapping and outreach. The collaborative nature of ED/RR creates opportunities and challenges in identification, outreach, and treatment, as evidenced by recent experience with a targeted aquatic species.

*Ludwigia peploide*s ssp. *montevidensis* is of particular concern because it has demonstrated strong invasive tendencies elsewhere. Beginning in 2009, BES began collaborating with residents, non-profits and other agencies in order to more effectively manage *L. peploides*, and possibly eradicate it. The species' novelty means little treatment information is available, leading to extensive conversations among stakeholders, researchers and environmental managers. These conversations have led in turn to limited, but targeted, herbicide applications. Preliminary results suggest the effectiveness of glyphosate; it is hoped that continuing research and more extensive

treatment will inform future treatment of *L. peploides*. A neighborhood monitoring network is also planned as a follow-up to treatment.

Invasive Aquatic and Riparian Weeds and Mosquitoes; Challenges, Successes, and Importance of On-going Studies. Charles E. Blair MD. Trustee, Mosquito and Vector Management District of Santa Barbara County and Member Southern California Vector Control Environmental taskforce. 176 Alcor Ave. Lopmoc, CA 93436-1206 USA. (blairce@verizon.net)

The adverse effects of invasive aquatic and riparian weeds on water quality; hydrology, native plant communities, and wildlife habitat and their consequences for mosquito control efforts, public health and nuisance problems, have been often implied, but could be better articulated. This presentation will present some of these relationships and highlight collaborative activities among vector and weed control agencies. Invasive aquatic and riparian weeds result in several adverse changes in these settings. Displacement of native flora degrades habitat for fauna that feed on mosquito larvae and pupae. The use of biorational larvicides, some derived from bacterial sources that do not harm this fauna supplements the effectiveness of their predation, which can reduce or eliminate the necessity of aerial adulticide application. There are situations where the density of invasive flora has been shown to interfere with application of these agents. Mosquito breed in standing water, which can include still-water natural areas, such as ponds, and small lakes and also moving water areas streams and tidal areas with changing levels which leave isolated standing water areas. Manmade sources include landscaping, irrigation canals, ponds, storm drain holding areas, and wastewater recharge basins. Examples of specific problems in particular settings will be described: for still-water, *Ludwigia spp* ; for estuarine; *Spartina spp*.; and riparian, *Arundo donax*. Successful projects that can be applied elsewhere; lessons that can be learned from unsuccessful activities; and the need for continuing investigations will be discussed.

NPDES Aquatic Permits: A Sharing Experience. Michael Blankinship. Blankinship & Associates, Inc. 322 C St. Davis, CA 95616. (mike@h2osci.com)

The NPDES aquatic pesticide permit has been in place in California since 2002. The pros and cons of forming regional groups to share resources to comply with the permit will be presented along with examples of various different approaches to cost-effective compliance.

Sublethal Effects of the Aquatic Herbicide Endothall on Salmon and Steelhead Smolts during Seawater Transition. Lauren A. Courter[1], Ian Courter[2] and Tommy Garrison[2]. [1]Toxicologist, Mount Hood Environmental, PO Box 66253 Portland OR 97266. [2] Fish Biologist and Quantitative Fish Biologist, Cramer Fish Sciences, 600 NW Fariss Rd Gresham OR 97030. (lauren.courter@gmail.com)

Pacific Northwest salmon and steelhead recovery efforts have led to careful consideration of potential effects of chemical exposure on sensitive life-stages. Delayed effects of pesticide exposure on anadromous species as they transition from freshwater to seawater is a concern previously overlooked by standardized toxicity testing for chemical labeling. For example, the widely used aquatic herbicide endothall has relatively low toxicity to salmonids following initial exposure (LC50 of 230-450 ppm a.e.); however, it is unclear whether endothall exposure affects the survival of seagoing juveniles. Previous studies relied on small sample sizes and inappropriate life-stages, generating contradicting results. To resolve uncertainty about endothall effects on anadromous salmonids, Coho (*Oncorhynchus kisutch*), Chinook (O. *tshawytscha*), and steelhead (O. *mykiss*) were subjected to a ten-day seawater challenge following acute exposure to Cascade® (endothall dipotassium salt). Acute exposure ranged from 0 to 12 ppm acid equivalent (a.e.) endothall for 96 h. The seawater challenge yielded mean survival rates of 82% (n=225), 84% (n=133), 90% (n=73) and 59% (n=147) for 0, 3-5, 6-8, and 9-12 ppm a.e. exposure groups, respectively. Steelhead experienced the lowest survival relative to Coho and Chinook at 9-12 ppm a.e. Osmoregulation was not impaired, as indicated by plasma sodium analysis. Results suggest that the lowest observable effect concentration (LOEC) during seawater transition between 8 and 12 ppm a.e., higher than previously reported levels for which regulations are based. This study emphasizes the importance of well-designed seawater challenge experiments incorporating appropriate life-stages of salmonids before defining chemical toxicity levels in areas with anadromous fish.

On-line interactive aquatic weed identification tool and management options. Joseph M. DiTomaso. University of California, One Shields Ave., Davis, CA 95616. (jmditomaso@ucdavis.edu)

Through the UC Weed Research and Information Center (WeedRIC), we developed an online interactive weed identification tools that allow the user to enter a wide variety of weed characteristics present on the plant of interest. The tool narrows the field of choices to either one or a few possibilities, which can then be verified by comparing with several photographs per species. The online program has 450 of the most common weed species found in California, including all of the most common aquatic plants of the state and the western US. The final aspect of this long term project is to link the identification of specific weeds, including all aquatic weeds, to their management options. The online identification tool offers the perfect opportunity to provide that linkage. While UC guidelines are available for various crops within California, this is the first time this type of information has been developed for such a large number of non-crop weeds (weeds of natural areas, forests, rangelands, aquatic, and riparian areas). The novel aspect of the study is that the control information on non-crop weeds is linked to the identification of the weed. Therefore, the tool for weed identification, information on the biology and ecology of the species, and management options are all in one locations. There is no other website that provides this type of information for non-crop weeds.

Endothall Concentration Exposure Time Evaluation for *Elodea canadensis* Control. Cody J. Gray[1], Christopher R. Mudge[2], Kurt D. Getsinger[2], Joe Vassios[1] and Scott Nissen[3]. [1]United Phosphorus, Inc., [2]U.S. Army Engineer Research and Development Center, [3]Colorado State University. (Cody.GRAY@uniphos.com)

Elodea (*Elodea canadensis* Rich. in Michx.) is a submersed, perennial, aquatic species native to the U.S. Although native to the U.S., elodea infestations can reach levels where management strategies must be implemented especially in western U.S. irrigation systems. With flowing irrigation systems, an herbicide concentration must be maintained for a pre-determined length of time to achieve the desired level of control. Therefore, a concentration and exposure time (CET) experiment was conducted to evaluate the dimethylalkylamine salt formulation of endothall to determine the CET relationship needed to achieve control of two elodea populations. Both the Wisconsin and Montana elodea populations were subjected to 0.5, 1.0, 2.0, and 3.0 parts per million (ppm) of endothall for 6, 8, and 12 hr. Both populations responded similarly to the herbicide treatments. Endothall applied at 0.5 and 1.0 ppm, regardless of exposure time, provided unacceptable elodea control. All treatments containing endothall at concentrations > 2 ppm, significantly reduced elodea biomass compared to the untreated control, with greater efficacy occurring with longer exposure times. These data suggest elodea control can be achieved using the dimethylalkylamine salt formulation of endothall.

Ludwigia Invasions: Update and Implications for Management and Restoration. Brenda J. Grewell[1] and Raymond I. Carruthers[2]. [1]Research Ecologist, USDA-ARS Exotic and Invasive Weeds Research Unit, Dept. of Plant Sciences MS-4, University of California-Davis, 1 Shields Ave. Davis, CA 95616. [2]Research Leader/Entomologist, USDA-ARS Exotic and Invasive Weeds Research Unit, Western Regional Research Center, 800 Buchanan Street, Albany, CA 94710. (bjgrewell@ucdavis.edu)

Five invasive Ludwigia taxa are now problematic in western states: Uruguayan primrose-willow (*L. hexapetala*), Large-flowered primrose-willow (*L. grandiflora*), Winged primrose-willow (*L. decurrens*) and creeping water primroses (*L. peploides subsp. montevidensis* and *L. p. subsp. peploides*). Hydrochorous dispersal of buoyant fruits and fragments promotes rapid spread throughout watersheds. Potential for seed bank formation is high, prompting the need for long term management and restoration efforts. Integrated management methods including manipulation of hydrology, mechanical removal and herbicide applications show promise for control in canals. Integrated tillage and grazing methods are useful for management in seasonal wetlands. Natural enemies present in California, and in the native South American range have been identified and may be useful for integrated management in the future.

Developing Use Patterns for New Aquatic Herbicides and Supporting Formulation Development. Mark Heilman, Tyler Koschnick, Todd Horton and Scott Shuler. Aquatics Technology Leader, SePRO Corporation, 11550 N. Meridian St. #600, Carmel, IN 46032. (markh@sepro.com)

Several new aquatic herbicides and formulations have been developed in recent years to improve efficacy and potential selectivity of invasive aquatic plant management. The acetolactate synthase (ALS) inhibitor herbicide Clearcast™ (a.i. imazamox) has been federally registered since 2008 and should receive its California registration in the spring of 2012. Research has documented that rates of 12-16 fl oz/acre (0.1 – 0.14 kg ai / ha) provide excellent control of water hyacinth (*Eichhornia crassipes*) while providing selectivity to native species such bulrush (*Scirpus* spp.). For treatment of conveyances, Clearcast effects range from sustained growth regulation of desirable, ditchbank grasses at rates of 16 oz/acre up to sustained, post-flood, broad-spectrum control of submersed weeds at use rates of 64-128 oz/acre (0.64 – 1.28 kg ai / ha) with dewatered applications. Further research and development has also led to new formulations of Sonar™ (a.i., fluridone) and Renovate™ (a.i. triclopyr) herbicides. The latest formulation improvement for Sonar is the newly registered Sonar Genesis™ liquid formulation, which shows potential in ^{14}C translocation studies for up to 30% greater herbicide uptake by target submersed plants and enhanced action on floating weed target plants while maintaining overall selectivity. The introduction of Renovate OTF and MAX G (auxin combination) granules has improved delivery and performance of auxin herbicides for targeted selective management. ^{14}C studies indicate that these granular formulations can increase herbicide absorption by milfoil root crowns by as much as 10X versus liquid formulations, and on-going studies will be reviewed that expand on these findings for future formulation refinement.

Pond lining to eradicate hydrilla: history of a long-infested pond. Jonathan Heintz and Patrick Akers. Agricultural Biologist, California Department of Food and Agriculture, Integrated Pest Control Branch, 1220 N Street, Room 341, Sacramento, CA 95814. (jonathan.heintz@cdfa.ca.gov)

This talk will compare the costs and effectiveness of a limited herbicide program to eradicate hydrilla in a small pond, as opposed to lining the pond. The talk centers on the history of the most problematic pond (Citron) in the Oregon House Hydrilla Eradication Project. The Project began in 1997 with the discovery of hydrilla in the lowest three miles of an irrigation canal and in 13 ponds connected to it, including Citron. Most ponds responded well within a few years of the start of treatment, with few or no plants every year. Treatments were almost always with herbicides. By contrast, progress in Citron was sporadic and often reversed. Partly this was due to a cautious treatment approach used in the pond. The pond is a yard feature, surrounded with specimen plants and heavily stocked with fish, and the Project personnel cooperated with the owners to try to spare these assets. The major treatment was contact herbicides, which were applied gingerly. Fluridone was generally avoided. However, other ponds with similar treatment responded better.

In 2006, Citron was a lawn of hydrilla. Stepped up treatments thereafter reduced the density and vigor of plants, but numbers remained high. In 2010, the Project and owners agreed to line the pond with heavy butyl rubber pond liner. Since then, no plants have been found.

Early Detection of Dreissenid Mussels in Western Waters: Discussion of Reclamation's Data. Denise M. Hosler. Environmental Application and Research, US Bureau of Reclamation; Denver Federal Center, Bldg 56, Rm 2010; PO Box 25007 (86-68220); Denver, CO 80226. (Dhosler@USBR.gov)

Reclamation has been conducting an intensive monitoring program of western waters since 2008. Early detection of dreissenid species in water systems is critically important to maintaining structure and function of dam related structures. If detected early, facility operators may have approximately three to five years to adjust systems before the populations of mussels are large enough to restrict the flow of water, clog pipes, restrict water intakes, affect cooling systems, and impede power generation. However, early detection of dreissenids in water with current methods has some inherent issues with variability in sampling and reliability with analytical methods which creates management decision dilemmas. Since current control methods of these mussels are very limited in regulated water systems, Reclamation has developed an analytical strategy that has been used on water samples collected using a plankton tow net from reservoirs and also from water flow within facilities, usually from a tap or pipe. The programs methods and data will be discussed.

Phosphorus, Algae, and Water Quality: Interrelationships and Management Implications.
Shaun Hyde, West Bishop, and Scott Shuler. SePRO Corporation. 11550 North Meridian Street Suite 600, Carmel, IN 46032. (shaunh@sepro.com)

Increased demand on our freshwaters and factors that threaten water quality can elicit harmful ecological and economic consequences. Nutrient enrichment of water resources can impact aquatic diversity, drinking water supplies, recreation and compliance of water quality standards. Phosphorus is highly correlative to algae productivity, algal assemblage composition, and is typically the primary component governing eutrophication. Years of phosphorus accumulation has resulted in the need for innovative in situ management strategies that effectively remove bio-available phosphorus and restore water quality. The objectives of this presentation are 1) to correlate phosphorus levels to algae densities and classification; 2) to illustrate water quality impacts of increased phosphorus levels; 3) to highlight new solutions for management of algae, phosphorus and/or water quality; and 4) to discuss water quality impacts following field applications. Laboratory and field research data on the efficiency of these new solutions at mitigating nuisance algae and undesirable phosphorus levels will be reviewed. SeClear* is an algaecide and water quality enhancer that can control toxin and taste/odor compound producing cyanobacteria and decrease phosphorus levels. Experimental results showed significant decreases in algae response parameters (i.e. chlorophyll, cell densities) following one treatment and significant decreases in phosphorus concentrations throughout a treatment program. Phoslock® is a lanthanum-based phosphorus locking technology that provides an effective approach to combat the eutrophication process and restore water quality. Laboratory and field research studies documented significant decreases in both total and free reactive phosphorus at all treatment sites within 24 hours and continually decreased throughout the studies.

NPDES Permits for Aquatic Pesticides in California. Philip S. Isorena, P.E.. State Water Resources Control Board, Sacramento, CA. (pisorena@waterboards.ca.gov)

California has required an NPDES permit for the application of pesticides to water since 2002. The talk will cover the history and background for the development of the permit, the general goals, strategy, and tactics embodied in the permits, and some specific requirements of the different kinds of permits, with an emphasis on the aquatic plants statewide general permit. The upcoming renewal and possible changes to the aquatic plants permit will also be permitted, with attention given to changes in the data collection requirements.

How to combat the detrimental effects of turbidity and eutrophication caused by runoff and erosion: Polymer Enhanced Best Management Practices with a focus on nutrient control. Kyla J Iwinski. Biology masters candidate at Northern Michigan University. R&D, Applied Polymer Systems, 30189. (kylaiwinski@aol.com)

Sedimentation and excess nutrients such as phosphorous enter our water bodies from erosion, fertilizers, manures, and crop runoff. Fine particulates are a point of attachment for contaminants such as nutrients, phosphorous, bacteria, heavy metals, pesticides, and endocrine disruptors. These particulates make up turbidity, measured in units called Nephelometric Turbidity Units

(NTU's). Various studies have shown that as low as 10-100 NTU's will start to affect aquatic life and fish will begin to show signs of stress. Turbidity impacts aquatic life through decreased light, food, and oxygen, as well as mechanical effects and temperature increases.

In addition to high levels of turbidity, excess nutrients entering into waterbodies can lead to harmful algal blooms. Phosphorous and nitrogen are the leading food source for algae and aquatic vegetation. Algal blooms not only cause aesthetic, odor, and, taste problems, but many species of algae are capable of producing dangerous toxins that affect the liver or nervous system.

Using anionic water soluble polymer technologies to enhance our current best management practices (BMPs) we are able to greatly reduce sediment and nutrients (both organic and inorganic turbidity) from leaving a site as well as reduce the amount of sediment and nutrients in a given water body. Through various tests and case studies, using polymer enhancement in conjunction with other BMPs a 75-85 percent reduction in phosphorous has been found as well as a 95+ percent reduction in total suspended solids (TSS) and NTU's.

We will be looking at Polymer Enhanced Best Management Practices (PEBMPs) that have been quantified and are currently being used across various geographical locations to control sedimentation and eutrophication. Such Polymer Enhanced systems will include: soil stabilization (polymer enhanced soft armoring), de-watering systems, pond and lake clarification including nutrient reductions, de-mucking, and SRBs (Sediment Retention Barriers).

Balancing Emerging Threats with Strategic Goals. Tyler Koschnick. President, APMS; SePRO Corporation, 11550 N. Meridian St., Ste 600, Carmel, IN 46032. (tylerk@sepro.com)

The Aquatic Plant Management Society held its 51st Annual Meeting in Baltimore, MD in July 2011. The theme of the meeting was "Emerging Threats". There were many special sessions. This presentation will highlight some of those "Threats" and opportunities, including the status of NPDES permitting for application of pesticides in, over, or near water and actions APMS has taken. In addition, the strategic goals of APMS will be reviewed and potential challenges will be described that may affect those goals. The 2012 APMS Annual meeting will be held in Salt Lake City, UT from July 22 to 25th, 2012.

Clipper Herbicide's use in Aquatic Plant Management. Todd Mayhew. Valent Professional Products, Gilbert AZ. (Todd.mayhew@valent.com)

Valent's Professional Products has introduced Clipper Herbicide with a new active ingredient, flumioxazin for use in the aquatic plant management. Clipper was evaluated for control of hydrilla (*Hydrilla verticillata*) , duckweed (*Spirodela* species), watermeal (*Wolffia columbiana*), giant salvina (*Salvina molesta*), Eurasian Watermilfoil (*Myriophyllum spicatum*), and fanwort (*Cabomba caroliniana*). Results from field and laboratory studies show rapid control of these important aquatic weed plants. Clipper Herbicide's rapid activity and rapid breakdown rate mean there are no restrictions on water use (other than for irrigation purposes) following application. A review of Clipper Herbicide's ecological effects is also included.

An Update on Flowering Rush Control Demonstration Projects for Infestations Spanning Watersheds Between the Pacific Northwest and a Great Lakes State. Thomas G. Moorhouse[1], Thomas J. McNabb[1], Peter Rice [2], Virgil Dupuis[3], Alvin Mitchell[3], Jenifer Parsons[4], Thomas Woolf[5], Steve Fleming[6], John Madsen[7]. [1]Clean Lakes, Inc., Coeur d'Alene, ID. [2]Division of Biological Sciences, University of Montana, Missoula, MT. [3]Salish Kootenai College, Pablo, MT. [4]Washington Department of Ecology, Yakima, WA. [5]Idaho State Department of Agriculture, Coeur d'Alene, ID. [6] SigMaxSolutions, Brookfield, WI. [7] Geosystems Research Institute, Mississippi State University. (tmoorhouse@cleanlake.com)

Flowering Rush (*Butomus umbellatus)* is now present and expanding in the majority of North American states between the Pacific Northwest and the New England states, as well as many Canadian provinces. An update will review herbicide control research and development projects that have been completed or are in progress in Washington, Idaho, Montana and Wisconsin.

A Review of a Mechanical Control Project for Emergent Aquatic Vegetation Control in Coastal Southern California. Thomas G. Moorhouse. Clean Lakes, Inc., 31320 Via Colinas, # 114, Westlake Village, CA 91362 (tmoorhouse@cleanlake.com)

Bulrush (*Scirpus californicus*) and Cattail (*Typha domingensis*) can develop into nuisance populations in southern California causing impacts to water flow and conveyance, increased mosquito breeding habitat, and causing the loss of open water area. Clean Lakes, Inc. implemented a mechanical and manual control project on the 29 acre shallow brackish water lagoon at the Andree Clark Bird Refuge (City of Santa Barbara) utilizing a Tiger Cut (cookie cutter), harvester, trailer conveyor and other supporting equipment. The presence of the federally endangered Tidewater Goby (*Eucyclogobius newberryi*) and the state species of special concern Southwestern Pond Turtle (*Emysmarmorata pallida*), as well as other wildlife species had to be considered during the project. A review of the permits, regulations, and operations will be discussed.

The West Coast Governors' Agreement and *Spartina* Management in on the West Coast. Vanessa Morgan and Mark Sytsma. Center for Lakes and Reservoirs, Portland State University, Portland, OR 97207-0751. (vhoward@pdx.edu)

The West Coast Governors' Agreement on Ocean Health calls for the eradication of all non-native *Spartina* from the West Coast by 2018. We will discuss the strategies of the WCGA's *Spartina* Eradication Action Coordination Team and progress towards this goal. We will provide updates on eradication, monitoring and rapid response efforts in Humboldt Bay, California, Oregon, Washington and British Columbia.

Sago Pondweed Control in Irrigation Canals Using Endothall and Chelated Copper: Comparing Greenhouse and Field Results. Scott J. Nissen[1], Joseph D. Vassios[2], William A. Ratajczyk[3] and Brian Lind[3]. [1]Professor Weed Science, Colorado State University, Fort Collins, CO 80525. [2]United Phosphorus, Inc. [3]Applied Biochemists. (snissen@lamar.colostate.edu)

Sago pondweed (*Stuckinea pectinata*) is a native species and is generally considered desirable, except when it infests irrigation canals. It thrives in flowing water, reducing efficient water delivery. Two herbicides commonly used for sago pondweed management in canals are endothall (Cascade®, UPI) and chelated copper formulations. There are some indications from previous research that these herbicides can interact synergistically. The goal of this research was to evaluate sago pondweed control using combinations of endothall and chelated copper under greenhouse conditions. These results were then used to guide two field applications. For greenhouse studies, a single tuber was planted in a 3-inch diameter pot and grown for 14 days prior to herbicide treatment. Herbicide treatments included endothall (1 and 2 ppm), ethanolamine chelated copper (Cutrine Ultra) (0.75 and 1 ppm), ethanolamine chelated copper (Clearigate) (0.5 and 1 ppm), and combination treatments. Herbicide exposure times were 4, 8, and 12 hours. Reductions in sago biomass indicated that 1 ppm endothall + 0.5 ppm Clearigate resulted in the greatest control at all exposure times. Based on these results the first field site was treated with 0.75 ppm Clearigate + 1 ppm Cascade for 6 hours, which did not result in commercially acceptable control. Adjustments were made and the second field site was treated with 0.5 ppm Clearigate + 1 ppm Cascade with a bump treatment of 0.25 ppm Clearigate for 8 hours. Excellent sago pondweed control was achieved with this combination. Sago pondweed biomass was reduced by 90% 21 DAT.

Absorption and Translocation of Granular and Liquid Triclopyr Formulations in Eurasian Watermilfoil. Scott J. Nissen[1], Joseph D. Vassios[2], Tyler J. Koschnick[3] and Mark A. Heliman[3]. Professor Weed Science, Colorado State University, Fort Collins, CO 80525. [2]United Phosphorus, Inc. [3]SePRO Corporation. (snissen@lamar.colostate.edu)

Eurasian watermilfoil (*Myriophyllum spicatum*) (EWM) is a submersed, invasive species that occurs across much of the United States. One of the more common control strategies for EWM is the use of systemic herbicides like triclopyr (Renovate®). Ongoing research has focused on evaluating triclopyr absorption and translocation in EWM using ^{14}C-triclopyr. Rooted plants were treated with 1 ppm triclopyr plus radiolabeled herbicide and triclopyr absorption and shoot to root translocation were determined. Additional experiments evaluated translocation from roots to shoots following root exposure. For both studies, plants were harvested over a 192-hour time course. EWM absorbed more triclopyr then would have been predicted based on parameters like log Kow; however, translocation to roots following shoot exposure was limited to only 2.6% of the absorbed herbicide. Triclopyr absorption by EWM roots was low, but there was accumulation 1.6 times the external concentration. Approximately 25% of absorbed triclopyr translocated to shoots 192 HAT. This information provided the bases for evaluating triclopyr absorption and translocation following a granular triclopyr application. Granules were formulated with cold and radiolabelled triclopyr in a manner similar to Renovate OTF and applied to large, well-established, multi-stemmed EWM plants in 11 L cylindrical tanks. There was no significant difference in foliar accumulation between the two formulations; however, the amount of radiolabel accumulating in plant roots increased 6-fold with the granular formulation.

For long-term control or for applications in areas with high water exchange, increasing root accumulation could improve control.

When Endangered Species Love the Weeds You Want to Eradicate: The Story of Invasive Spartina and California Clapper Rails in the San Francisco Estuary. Peggy Olofson, P.E., Director, San Francisco Estuary Invasive Spartina Project. 2612-A 8th St., Berkeley, CA 94710. (prolofson@spartina.org)

Non-native *Spartina* was identified by environmental and public interests as a threat to the San Francisco Estuary in the 1990s. In 2000, State and Federal agencies responded with a coordinated, estuary-wide program to control and eradicate it. At the peak of the invasion in 2006-2007, four non-native *Spartina* species and the extremely invasive hybrids formed between the native grass (*S. foliosa*) and one of the introduced species, covered 800+ net acres, disbursed throughout 40,000 acres of intertidal marsh and mudflat. Over the past 12 years, and at a cost of about $20,000,000, the Invasive Spartina Project has nearly eliminated the non-native species' from the Estuary. A qualified "eradication," considering complications related to the hybridization, could conceivably be achieved within a matter of 5-6 more years of work.
However, early in the planning for *Spartina* eradication, biologists recognized that a state and federally-listed endangered bird, the California clapper rail (*Rallus longirostris obsoletus*) used and seemed preferentially attracted to the tall, dense cover provided particularly by the invasive hybrid *Spartina*. In fact, as hybrid *Spartina* spread prior to initiation of effective treatment, the California clapper rail population flourished, particularly in areas the densest *Spartina* cover. The successful removal of more than 750 acres of non-native *Spartina* since 2007 has been accompanied by a distinct decline in the clapper rail population, which at many specific marshes can be clearly linked with the *Spartina* removal. Alarmed by the clapper rail decline, the federal regulating agency has required a number of immediate actions, including cancellation of treatment at 25 key locations, initiation of a multi-million dollar California clapper rail habitat enhancement program, and requirement for several years of documented increasing clapper rail numbers before treatment will be allowed to continue at several sites. Some of the requirements are at odds with the objective of eradication of *Spartina*, and cause "artificial" support and inflation of clapper rail numbers. The state and federal agencies and restoration interests are working diligently to better assess program's impact and threat to California clapper rails, and develop a treatment and restoration strategy that will protect the clapper rails and allow eradication of invasive *Spartina*.

Eradication of Eurasian Watermilfoil from Lake Tapps, WA. Toni Pennington[1], Harry Gibbons[1] and Jon Shimada[2]. [1]Tetra Tech, 1020 SW Taylor St., Suite 530, Portland, OR 97202. [2] Cascade Water Alliance, Bellevue, WA. (toni.pennington@tetratech.com)

Lake Tapps Reservoir, located east of Tacoma in Pierce County, Washington, was created in 1911 for hydropower generation by diverting water from the nearby White River and inundating four existing lakes (Tapps, Kirtley, Crawford, and Church Lakes). In 1986, changes to minimum instream flow requirements resulted in operational changes at the reservoir that increased water clarity in Lake Tapps, and subsequently more prolific growth of Eurasian watermilfoil (*Myriophyllum spicatum*). In 2009, the White River Project, including Lake Tapps was acquired by Cascade Water Alliance (Cascade) who intends to use Lake Tapps as a source of drinking water. Reservoir operations now include an increased recreational water level from April 15 to October 31 followed by a winter drawdown, largely for maintenance activities but also to control Eurasian watermilfoil. Despite this, milfoil has continued to be a nuisance. The purpose of the Lake Tapps Integrated Aquatic Vegetation Management Plan (IAVMP) is to develop a long-term strategy for Cascade to eradicate milfoil from Lake Tapps Reservoir to continue to improve existing beneficial and recreational uses, and ensure water quality to meet future water demands. The five-year plan includes early season surveys followed by an aggressive treatment plan in the early years, and later diver-assisted hand-pulling for small (< 1 acre) sites. Preliminary pre-treatment plant surveys conducted July 2010 found approximately 400 acres of milfoil which were treated in August and September with fluridone (Sonar Q or Sonar PR). Approximately 80 acres were again treated with fluridone (Sonar PR) and triclopyr (Renovate OTF) in August and September 2011. Post-treatment surveys conducted fall 2011 found roughly 25 acres of milfoil with patches large enough for chemical approaches. The remaining areas will be rechecked in 2012 and likely recommended for hand-pulling.

A Case Study in Hydrilla Management using Bispyribac-sodium in a Florida Lake. James Petta. Territory Manager, Valent USA. 5221 River Oaks Drive, Corpus Christi, TX 78413. (jim.petta@valent.com)

Hydrilla verticillata is an invasive species of significant proportions in the State of Florida and many of parts if the USA. Management of this species to protect native ecosystems including native plant species is one of the primary challenges facing biologists throughout the USA. The use of EPA-approved aquatic herbicides is one of the main tools used to manage this species. However, native plant tolerance to the herbicide is a key component in when selecting a herbicide for this use. The newly registered herbicide, bispyribac-sodium, marketed under the tradename of Tradewind, has demonstrated excellent plant selectivity when used in a *Hydrilla* management program. A moderate sized lake was treated in 2011 in the State of Florida and monitored for its control of *Hydrilla* as well as the tolerance of native desirable species to its effects. These results will be presented and discussed.

Field trials using Harpoon granular formulation for control of Invasive and Nuisance Aquatic Plants. Paul Westcott, William Ratajczyk, and Harry Knight. Lonza Microbial Control Southwest. Phoenix, AZ.

Harpoon granular is currently the only EDA copper granular formulation currently registered for aquatic use. This product has potential for control of invasive and nuisance aquatic plants where water use cannot be restricted for use due to irrigation and potable sites. In 2011, field trails were conducted on multiple target invasive and exotic plants including *Myriophyllum spicatum* and *Hydrilla verticillata*. Multiple parameters were recorded including visual observations vis digital photograph. Results show control of multiple species and potential for Harpoon Granular to control problem aquatic macrophytes in areas where extened contact time (via granule) is needed without restriction of irrigation and/or potable water uses.

POSTER PRESENTATIONS

Invasive Aquatic Weeds: Implications for Mosquito Management. Charles E. Blair, MD. Trustee Mosquito and Vector Management District of Santa Barbara County, 176 Alcor Ave. Lompoc, CA. (blairce@verizon.net)

Healthy natural wetlands are far less likely to be breeding areas for disease-carrying mosquitoes than degraded ones. Degradation of these bodies of water by invasive aquatic weeds and other influences can result in their being potential habitat for mosquitoes that can carry the West Nile Virus, encephalitis, and other diseases. Control of these invasive plants can be an important part of the Integrated Weed/Pest Management efforts of both Weed Management Areas and Mosquito and Vector Control Agencies. Adverse effects of Water Hyacinth (*Eichhnorina crassipes*), hydrilla (Hydrilla verticillata), Water Evening-primrose (*Ludwigia* spp.), cordgrass (*Spartina* spp./*S. densiflora* x *foliosa*), and other species on water quality and facilitating mosquito breeding will be shown. Presentations on the importance of *S.* spp. in San Francisco Bay were made at recent statewide Cal-IPC and Mosquito and Vector Control Conferences. Demonstration of these relationships can enhance both agency and public awareness of their importance.

Amphibian Exposure to Aquatic Herbicides. Amy E. Yahnke[1], Christian E. Grue[1], Marc P. Hayes[1], and Alexandra Troiano[1]. [1] Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA. [2] Habitat Program, Washington Department of Fish and Wildlife, Olympia, WA. aey@u.washington.edu

Conflict between native amphibians and aquatic weed management in the Pacific Northwest is rarely recognized because most native stillwater-breeding amphibian species move into upland habitats during the summer, when application of herbicides to control weeds in aquatic habitats typically occurs. However, for aquatic species present in wetland habitats through the summer, such as the Washington State Endangered Oregon Spotted Frog (*Rana pretiosa*) and the larvae of selected salamanders, aquatic weed management may pose a risk. Acute toxicity of herbicides used to control aquatic weeds tends to be low, but the direct effects of herbicide tank mixes (active ingredient, surfactant, and dye) on Oregon Spotted Frogs has remained unexamined. To address this gap, we exposed juvenile Oregon Spotted Frogs to mixtures of the herbicide Imazapyr (Polaris AQ, 28.7% active ingredient), Agri-Dex surfactant, and Hi-Light dye in a 96-hour static-renewal test. The imazapyr-Agri-Dex combination was chosen because of its low toxicity to fishes and its preference by state land managers for aquatic weed control. Concentrations were those associated with low (3.5 liters/hectare) and high (7.0 liters/hectare) volume applications of Polaris AQ to control Reed Canarygrass (*Phalaris arundinacea*), and a clean-water control. Following exposure, frogs were reared for 2 months in clean water to identify potential latent effects on growth. Endpoints evaluated included feeding behavior during the exposure and grow-out, growth, and liver condition index. We recorded no mortalities. We also found no significant differences for any endpoint between the herbicide-exposed and clean-water control frogs.

Ca+ as a Limiting Factor for Growth and Survival of Quagga Mussels. Brian Adair and Mark Sytsma. Center for Lakes and Reservoirs, Portland State University, POB 751, Portland OR 97207. sytsmam@pdx.edu

Dreissenid mussels are fouling organisms that grow on solid surfaces and clog screens and pipes in aquatic environments. In January of 2007, a population of quagga mussels (*Dreissena bugensis*) was discovered in Lake Meade, Nevada; the first occurrence of dreissenid mussels west of the 100th Meridian. This population is significant in that it is the first concrete evidence of long distance overland dispersal of dreissenid mussels. Studies have indicate that concentration of dissolved calcium in surface waters may impact ability of dreissenid mussels to establish themselves once the mussels have been introduced to a given water body. It is likely that there is a suite of sub-lethal effects caused by low dissolved calcium concentrations that collectively inhibit dreissenid mussel establishment in the presence of other stressors such as elevated water temperatures. This project will conduct feeding experiments to optimize culture of quagga mussels and growth experiments using water from various sites in the Columbia River Basin at Lake Mead Fish Hatchery to assess the interactive effect of calcium and temperature on quagga mussel growth rate. In-situ growth studies will be conducted at 3 sites in Lake Mead so that we may compare natural growth rates to laboratory growth rates. Preliminary results from the Willamette River indicate that there is a liner relationship between calcium concentration and weight gain in quagga mussels. The slope and intercept of the regression do not change significantly with increasing temperature; however, the regression coefficient (r^2) does increase with increasing temperature (at 12C $r^2 = 0.14$; at 16C $r^2 = 0.17$; at 24C, $r^2 = 0.22$). The results will permit development of a mussel growth model that will be used to predict impacts of quagga mussels on hydropower and other infrastructure in the Columbia River and to develop proactive management strategies that will maintain system reliability and minimize environmental impact.

Early Detection Monitoring for Zebra and Quagga Mussels in Western Contiguous USA

Steve Wells[1], Mark Sytsma[1], Stephen Phillips[2], Rick Boatner[3], Jesse Schultz[4], Matthias Herborg[5], Martha Volkoff[6], Rod Jung[7], Amy Ferriter[8], Karen Vargas[9], Larry Dalton[10], Elizabeth Brown[11], Denise Hosler[12], Tim Counihan[13], Rebecca Weiss[14], Angela Pletka[14], Lynn Schlueter[15], Steve Schainost[16], and Jason Goeckler[17].

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Many agencies, organizations and industries were involved with early detection monitoring for zebra and quagga mussels (*Dreissena polymorpha* and *D. rostriformis bugenis,* respectively) in the Western USA in 2010 and 2011. Zebra and quagga mussels are problematic, e.g. freshwater macro-fouling, and populations are spreading in Western USA waters. Effective rapid response and containment are dependent on accurate and timely early detection monitoring. Early detection is difficult, and there is a high likelihood of false negative results, i.e. present but not detected. Early detection monitoring, however, has been effective at detecting incipient populations, e.g. Cheney Reservoir, KS. There is no best method for early detection monitoring for zebra and quagga mussels, and all available tools should be employed including outreach/ education to both general public and agencies, artificial settlement substrates, plankton sampling, and inspecting existing submerged surfaces. Many agencies and organizations have responded to the threat posed by zebra and quagga mussels to uninfested water bodies, and these efforts have been relatively coordinated. In 2010-2011, efforts were focused on the highest priority areas regarding likelihood of introduction and establishment, but temporal and spatial gaps still exist; these efforts are not sufficient. The likelihood of false negative results can be reduced with increased coordination and effort, but it is difficult to collect data from multiple sources and keep current. Online databases such as the online mussel map maintained by Portland State University are promising tools to help coordination.

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