37^{th} Annual
Western Aquatic Plant Management Society
Annual Conference

March 26 – March 28, 2018

Grand Sierra Resort ~ Reno, Nevada

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Past WAPMS Meetings Sites and Presidents

2017	Coeur d'Alene, ID (joint meeting w/ WSWS)	Scott Nissen
2016	San Diego, CA	Joseph Vassios
2015	Portland, OR	Patrick Akers
2014	Reno, NV	Cody Gray
2013	Coeur d'Alene, ID	Mark Sytsma
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, March 26

2:00 - 4:00	**Board of Directors Meeting** *(The Board Room, Spa Level)*
4:00 - 6:00	**Registration** *(Convention Registration Desk, Spa Level, across from Nevada Foyer)*
2:00 - 6:00	**Exhibitor Setup** *(Nevada Foyer, Spa Level)*
6:00 - 8:00	**President's Reception,** hosted by Amy Ferriter, President, WAPMS *(The Bunker Indoor Golf Center, Spa Level)*

Tuesday, March 27

All Sessions will be held in N8-N9-N10 on the Spa Level next to Nevada Foyer.

7:30 - 8:30	**BREAKFAST –** *Join us for a full breakfast in the Nevada Foyer.*
Session I	**Moderator:** Andrea Sealock (Vice-President, WAPMS), Cygnet Enterprises West, Inc.
8:30 – 8:40	**Welcome:** Amy Ferriter (President, WAPMS), CPS-Timberland, Boise, ID
8:40 – 9:00	**Aquatic Ecosystem Restoration Foundation Update** Carlton Layne; Executive Director, Aquatic Ecosystem Restoration Foundation, Marrieta, GA
9:00 – 9:15	**The Aquatic Plant Management Society Update** John D. Madsen; USDA ARS, UC Davis Plant Sciences, Davis, CA
9:15 – 9:30	**Women of Aquatics Update** Amy Kay; Clean Lakes, Inc., WI
9:30 – 9:50	**A Global Perspective on Aquatic Plant Management: Highlights from the 15^{th} International Aquatic Plants Symposium, Queenstown, NZ** S.J. Nissen; Colorado State University Fort Collins, CO

9:50 – 10:10	**BREAK** *(Nevada Foyer)*
Session II	**Moderator –** Amy Ferriter (President, WAPMS), CPS-Timberland
10:10 – 10:40	**Lake Tahoe: Waging War Against Aquatic Invasive Species While Trying to Protect a National Treasure** Julie Regan; APR Chief, External Affairs/Deputy Director, Tahoe Regional Planning Agency, Stateline, NV
10:40 – 11:10	**Using Ultra Violet Light to Control Aquatic Invasive Plants - Pilot Study** Dennis M. Zabaglo; APR Manager, Principal Environmental Specialist, Tahoe Regional Planning Agency, John J. Paoluccio; Inventive Resources, Inc., Salida, CA
11:10 – 11:40	**Response of Sprouting Lake Tahoe Curlyleaf Pondweed Turions to Endothall (K-salt), Penoxsulam or Procellacor** Lars W.J. Anderson; WaterweedSolutions, Davis, CA
11:40 – 1:00	**LUNCH** *(On Your Own)*
Session III	**Moderator –** John Madsen, USDA ARS, UC Davis Plant Sciences
1:00 – 1:20	**An Overview of the Delta Regional Areawide Aquatic Weed Program** Patrick J. Moran, Paul Pratt; USDA-ARS Exotic and Invasive Weeds Research Unit, Albany, CA, John D. Madsen, USDA ARS, UC Davis Plant Sciences, Davis, CA, David L. Bubenheim; NASA Ames Research Center, Earth Science Division, Biospheric Science Branch, Moffett Field, CA, Edward Hard; Division of Boating and Waterways, California Department of Parks and Recreation, Sacramento, CA
1:20 – 1:40	**Growth and Phenology of Weeds in the Delta** John D. Madsen; USDA ARS, UC Davis Plant Sciences, Davis, CA
1:40 – 2:00	**Biological Control of Weeds and the Delta Region Areawide Aquatic Weed Project** Paul D. Pratt, Patrick Moran; USDA-ARS, Exotic and Invasive Weeds Research Unit, Albany, CA
2:00 – 2:20	**Evaluation of Newly Registered Herbicides for Control of Waterhyacinth in the Sacramento / San Joaquin Delta** Guy B. Kyser; University of California, Davis, CA, John D. Madsen; USDA ARS, UC Davis Plant Sciences, Davis, CA
2:20 – 2:40	**Bio-economic Model of Delta Weed Management** Karen Jetter; University of California Agricultural Issues Center, Davis, CA, Kjersti Nes; UC Davis Department of Agricultural and Resource Economics, Davis, CA
2:40 – 3:00	**BREAK** *(Nevada Foyer)*

3:00 – 3:20	**Using Remote Sensing Mapping and Growth Response to Environmental Variability to Aide Aquatic Invasive Plant Management** David L Bubenheim; NASA Ames Research Center, Earth Science Division, Biospheric Science Branch, Moffett Field, CA
3:20 – 3:40	**TBD**
3:40 – 4:00	**Quantifying Pesticide and Nutrient Loading from the Sacramento and San Joaquin River Watersheds into the Sacramento-San Joaquin Delta using a Modeling Approach** Minghua Zhang, Huajin Chen, Ruoyu Wang; Department of Land, Air and Water Resources, University of California, Davis, CA
4:00 – 4:30	**Annual Business Meeting**
5:30 - 6:30	**Member Reception –** *N6, N7*
6:30 – 8:30	**Banquet & Scholarship Raffle –** *N6, N7*

Wednesday, March 28

All Sessions will be held in N8-N9-N10 on the Spa Level next to Nevada Foyer.

7:00 – 8:40	**BREAKFAST –** *Join us for a full breakfast in the Nevada Foyer.*

Session IV

Moderator – Curt Cress, Marine Biochemists

8:40 – 9:00	**Gaining Control & Managing HAB's** Patrick Simmsgeiger; Diversified Waterscapes, Inc., Laguna Niguel, CA
9:00 – 9:20	**Cyanobacterial Management in California with Liquid Activated Peroxygen Algaecide/Cyanobacteriacide** Tom Warmuth; BioSafe Systems, LLC, Kure Beach, NC
9:20 – 9:40	**Prymnesium parvum (golden algae): Observations & Considerations in Managing Urban Lakes in Central Arizona.** Robert Revolinski; Water Resource Management, Inc., Glendale, AZ
9:40 – 10:00	**Evaluation of Pulse 'Slug' Application of a Chelated Copper Algaecide (Captain® XTR) and Formulation Comparisons** West M. Bishop, Ben E. Willis; SePRO Research & Technology Campus, Whitakers, NC, Mike Pearce; SePRO Corporation, Carmel, IN
10:00 – 10:20	**BREAK** *(Nevada Foyer)*

Session V

Moderator – Scott Nissen (WAPMS - Past President) Colorado State University

10:20 – 10:40 **Laboratory and Mesocosm Evaluation of Growth and Herbicide Response in Eurasian Watermilfoil and Four Accessions of Hybrid Watermilfoil**
Jens Beets; University of Florida- CAIP, Chetta Owens; U.S. Army Engineer Research Development Center, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX, Mark A. Heilman; SePRO Corporation, Carmel, IN

10:40 – 11:00 **Endothall Behavior in Several Aquatic Weeds**
Mirella F. Ortiz, Scott J. Nissen; Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO, Cody J. Gray; Field Development Representative, UPI, Peyton, CO

11:00 - 11:20 **Comparing Efficacy of Endothall+Diquat and Endothall+Copper Formulations for *Egeria densa* control**
Kristen Tanz, Mirella F. Ortiz, Scott J. Nissen; Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO Cody J. Gray; Field Development Representative, UPI, Peyton, CO

11:20 – 11:45 **WAPMS – where do we go from here?**
An open discussion with membership on the progress and future of the society.
Moderator - Amy Ferriter (WAPMS – Past President), CPS-Timberland

11:45 – 1:00 **LUNCH** *(On Your Own)*

Session VI

Moderator: Tom Warmuth (WAPMS – Director), BioSafe Systems LLC

1:00 – 1:20 **Affordable and Easy to Use Bathymetric Surveying Tools to Improve Aquatic Weed Management**
Stephen M. Metzger; Blankinship & Associates, Inc., Davis, CA

1:20 – 1:40 **Enhanced Herbicide Management Strategies for Selective Control of Invasive Watermilfoils**
Mark A. Heilman; SePRO Corporation, Carmel, IN

1:40 – 2:00 **The Science and Art of Renewing a Washington State NPDES Permit**
Elaine S. Brouillard; Sunnyside Valley Irrigation District, Sunnyside, WA

2:00 – 2:20 **BREAK** *(Nevada Foyer)*

2:20 – 2:40 **Short Duration Endothall (Teton) Injections in Irrigation Canals**
R. Cory Greer; South Columbia Basin Irrigation District, Pasco, WA

2:40 – 3:00 **The Science (and Art) of Controlling Aquatic Plants**
Craig Geyselink**;** Quincy – Columbia Basin Irrigation District, Quincy, WA

3:00 – 3:20 **Flowering Rush in the Columbia River Basin: Planning for Strategic Control**
Jenifer K. Parsons; Washington State Department of Ecology, Yakima WA, Justin Bush; Washington State Invasive Species Council, Olympia, WA, Jennifer Andreas; Washington State University, Puyallup, WA, Mark Sytsma, PhD; Portland State University, Portland, OR

3:20 – 3:30	**Closing Remarks**
1:00 – 3:30	**Vendor and Exhibitor Breakdown**
3:45 – 4:15	**Board of Directors Meeting** *(The Board Room, Spa Level)*

Please join us next year at the joint meeting of:

Aquatic Plant Management Society
And
Western Aquatic Plant Management Society

July 13 – 19, 2019

San Diego, CA

DoubleTree Hilton San Diego Mission Valley Hotel

37th Annual
Western Aquatic Plant Management Society
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ABSTRACTS
In Alphabetical Order by Presenting Author

Lars W.J. Anderson. **Response of Sprouting Lake Tahoe Curlyleaf Pondweed Turions to Endothall (K-salt), Penoxsulam or Procellacor.** WaterweedSolutions**,** Davis, CA

Turions from naturally growing Potamogeton crispus were collected during late summer 2017 at the Tahoe Keys lagoons adjacent to Lake Tahoe, and maintained at 7-8 C for five weeks. Turions were exposed in distilled water to "room temperature" (ca. 18-20 C) under natural light until sufficient number of turions began to sprout (10-14 days). Temperature was recorded hourly ("Onset Hobo" logger) during grow-out and exposures to herbicides. Four replicates per treatment were used. One replicate=1,000 ml Nalgene beaker containing 500 ml solution and 10 sprouting turions. Replicates were exposed either to distilled water alone (controls), or to 2.0 ppm endothall (K-salt) for 7days, or 2X -2 weeks to 20 ppb penoxsulam, or 7 days to 2.0 ppb procellacor. Conditions of turions and sprouting leaves and shoots were observed and photographed at 7, 15, 28 and 37 DAT. Number of leaves per turion was recorded 37 DAT. Endothall killed emerged leaves and shoots were killed within 7-15 DAT. Turions in endothall treatments did not recover and were partially decomposed by 28 DAT and 37 DAT. Penoxsulam and procellacor caused stunting and reduced shoot production by 15 DAT. By 37 DAT, procellacor completely killed most turions. At 37 DAT, number of leaves produced per turion were: controls: 11.6; endothall: 0.5; penoxsulam: 5.2; procellacor: 0.6. These results suggest that late summer applications of endothall (K- salt) or procellacor to newly sprouted turions may be very effective in reducing subsequent growth the following spring. Results also suggest potential systemic activity with endothall, although additional studies on uptake and responses are necessary to confirm this. Results suggest that early spring applications of both herbicides could further reduce the capacity of the turions generate mature plants and thus block the normal turion production phase. An optimal regime may include both a fall and spring applications of these herbicides to maximize efficacy and prevent recruitment from turions. (Note: Separate turions from the same collections, maintained in natural (short day) lighting at 20C in 500ml distilled water with 1 g "Osmocote" fertilizer ("Four month, 14N-14P-14K") produced new turions within 60 days after moving them from 8 C to 18-20 C.)

Jens Beets*, Chetta Owens, Mark A. Heilman. **Laboratory and Mesocosm Evaluation of Growth and Herbicide Response in Eurasian Watermilfoil and Four Accessions of Hybrid Watermilfoil.** University of Florida- CAIP, U.S. Army Engineer Research Development Center, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX, SePRO Corporation, Carmel, IN

Eurasian watermilfoil (EWM) and Hybrid watermilfoil (HWM) are problematic submerged aquatic invasive plants in many waterways of the Pacific Northwest. Auxin-mimic herbicides, such as 2,4-D and triclopyr, are commonly used herbicides for management to control invasive populations of EWM and HWM. The development of the novel arylpicolinate herbicide, florpyrauxifen-benzyl provides a new tool to augment control options of problematic aquatic weedy species including EWM and HWM. To better understand the efficacy of florpyrauxifen-benzyl on EWM and HWM and differences between HWM accessions we performed experiments in growth chambers as well as large-scale experiments in mesocosms. Objectives of these studies were to: 1) evaluate HWM and EWM response to several auxin mimic herbicides under static, environmentally controlled conditions, using EC50 values derived from length and weight of treated plants, 2) Investigate potential for increased herbicide tolerance of HWM, 3) evaluate a wide range of contact exposure time (CET) conditions to determine the effect of florpyrauxifen-benzyl on well-established EWM, HWM, and several native species under large-scale mesocosm condition, and 4) Document differences in growth and response of three herbicides between populations of EWM and HWM under large-scale mesocosm conditions. Growth chamber results indicate strong response to florpyrauxifen-benzyl in both EWM and HWM, with differences in response between EWM and HWM for all of the auxin-mimic herbicides based on EC50 values. This complemented our results in large-scale mesocosm trials, with significant reduction in EWM across all CET scenarios and significant reduction of HWM in all but one CET scenario. In addition to growth differences between HWM accessions, there were differences in herbicide response between accessions. The results of native species herbicide response will also be discussed.

West M. Bishop*, Ben E. Willis, Mike Pearce. **Evaluation of Pulse 'slug' Application of a Chelated Copper Algaecide (Captain® XTR) and Formulation Comparisons.** SePRO Research & Technology Campus, SePRO Corporation, Carmel, IN

Nuisance algal growths greatly impact the function of irrigation canals for water conveyance and flood control. Copper algaecides are routinely used to control algae in moving water with no irrigation restrictions though formulations can significantly differ. Understanding copper formulation efficiency and dissipation following application is critical in attaining desired control while complying with regulated discharge levels. In this research, we monitored a field application to a Western US canal system to evaluate a new use pattern of a chelated copper algaecide in flowing water and compared results to predictions of control utilizing associated laboratory exposures. This study documented 1) dissipation of copper, 2) copper exposures realized by the algae, and 3) relation to target algal control. The highest peak copper concentration (3.17 ppm) was measured 0.80 km (0.5 miles) from the application point though decreased significantly at each sampling interval to the 9.66 km (6 mile) sampling point and remained at or below 0.2 ppm at 9.66-19.31 km (6-10 miles) from the application site. Dissipation of copper mass followed an exponential degradation curve (R2=0.9558) and less than 10 % of applied copper was recovered at or beyond 9.66 km (6 miles) from application. Peak concentration dissipation also was modeled by exponential decay (R2=0.9922) and was predicted to achieve background concentrations by 20.9km (13 miles) from application. Exposure factors (ppm Cu times duration in minutes) ranged from 0.866 at the 0.80 km (0.5 mile) sampling point to 0.043, 12.87 km (8 miles) from application. Scaled

laboratory experimentation showed control at exposure factors achieved through 6.44 km (4 miles) from application though sub-lethal impacts from 9.66-19.31 km (6-12 miles). This research demonstrates a method to improve operational efficiency of copper use in flowing water to achieve desired algal control, while decreasing overall copper use and complying with applicable discharge levels.

Elaine S. Brouillard. **The Science and Art of Renewing a Washington State NPDES Permit.** Sunnyside Valley Irrigation District, Sunnyside, WA

The Irrigation System Aquatic Weed Control permit issued by the State of Washington, Department of Ecology (Ecology) states irrigation districts that have properly obtained permit coverage are authorized to treat irrigation water with acrolein, copper, endothall, fluridone, imazapyr, sodium carbonate peroxyhydrate, and xylene and then discharge, within the permit conditions, to waters of the state. The permit has three components and entities involved: The National Pollutant Discharge Elimination System (NPDES), authorized by the Environmental Protection Agency (EPA); the State Waste Discharge General Permit, Ecology; and a Washington Department of Agriculture, Special Local Needs (SLN) requirement for acrolein. The 2012 – 2017 general permit was set to expire in June. Multiple meetings between the irrigation districts and Ecology's water quality department occurred several years before the expiration date. The meetings were proceeding well and both parties were grateful for the assistance of the Washington State Water Resources Association (WSWRA). Simultaneously, Ecology adopted a rule in August 2016 that updated surface water quality standards to include human health criteria. This resulted in Ecology issuing a determination of significance in April 2017 for the irrigation permit, requiring an environmental impact statement (EIS) prior to issuing the next permit. The EIS public comment period has closed and Ecology is researching and writing the EIS, due in approximately 9-18 months. The irrigation districts are operating under the 2012 – 2017 permit, now referred to as the amended permit. Ecology's general permit department will write the new permit, unlike the three previous permits. Several irrigation districts have hosted Ecology permit writers for facility tours. The tours foster energetic question and answer discussions on general district operation and specifically on aquatic treatments. Ecology hosted the irrigation districts to an introductory meeting. Ecology asked how the districts would write their ideal general permit and went down their agenda and filled in the answers. While the discussion between the groups started hesitantly, it finished with robust conversation. Ecology then requested each district fill out a description of their facilities. This mutual approach has gained trust and bolstered collaboration between the Washington irrigation districts and the Washington Department of Ecology. Face to face tours and agenda specific meetings are a highly recommended permit writing model.

David L Bubenheim. **Using Remote Sensing Mapping and Growth Response to Environmental Variability to Aide Aquatic Invasive Plant Management.** NASA Ames Research Center, Earth Science Division, Biospheric Science Branch, Moffett Field, CA

Management of aquatic weeds in complex watersheds and river systems present many challenges to assessment, planning and implementation of management practices for floating and submerged aquatic invasive plants. The Delta Region Areawide Aquatic Weed Project (DRAAWP), a USDA sponsored area-wide project, is working to enhance planning, decision-making and operational efficiency in the California Sacramento-San Joaquin Delta. Satellite and airborne remote sensing are used map (area coverage and biomass density), direct operations, and assess management impacts on plant communities. Archived satellite records enable review of results following previous climate and management events and aide in developing long-term strategies. Examples of remote sensing aiding effectiveness of aquatic weed management will be discussed as well as areas for potential technological improvement. Modeling at local and watershed scales using the SWAT modeling tool provides insight into land-use effects on water quality (described by Zhang in same Symposium). Controlled environment growth studies have been conducted to quantify the growth response of invasive aquatic plants to water quality and other environmental factors. Environmental variability occurs across a range of time scales from long-term climate and seasonal trends to short-term water flow mediated variations. Response time for invasive species response are examined at time scales of weeks, day, and hours using a combination of study duration and growth assessment techniques to assess water quality, temperature (air and water), nitrogen, phosphorus, and light effects. These provide response parameters for plant growth models in response to the variation and interact with management and economic models associated with aquatic weed management. Plant growth models are to be informed by remote sensing and applied spatially across the Delta to balance location and type of aquatic plant, growth response to altered environments and phenology. Initial utilization of remote sensing tools developed for mapping of aquatic invasive plants improved operational efficiency in management practices. These assessment methods provide a comprehensive and quantitative view of aquatic invasive plants communities in the California Delta.

Craig Geyselink**. The Science (and Art) of Controlling Aquatic Plants.** Quincy – Columbia Basin Irrigation District, Quincy, WA

The use of aquatic herbicides and algaecides is widely employed by irrigation district managers and is a critical component of vegetation management programs.
With only a limited number of available chemistries for use in irrigation canals; differences in scale, scope, timing, management objectives, and regulations between districts create profound aquatic weed management challenges. In the face of these challenges, water quality experts have employed new methods to maximize the efficacy of chemical control options, while complying with complex and dynamic regulatory restrictions.

Water quality experts will discuss new and innovative methods of using aquatic herbicides in irrigation canals. The results of these findings include better control and reduced costs while successfully conforming to regulatory requirements.

R. Cory Greer. **Short Duration Endothall (Teton) Injections in Irrigation Canals.** South Columbia Basin Irrigation District, Pasco, WA

Aquatic Vegetative Management has become increasingly difficult, in the Pacific Northwest, over the past decade due to the pervasiveness of invasive aquatic plants and the goal of overall reduction in aquatic chemical usage. A goal of managers of irrigation systems is to find new and useful methods of application with the existing chemicals we have at our disposal. Recent studies with Teton (Mono(N,N-dimethylalkylamine) salt of Endothall) have led to attempting shorter durations (2 hours or less)of treatments at the medium to high rates of Teton. The South Columbia Basin Irrigation District has experimented with short duration applications as a replacement of an Acrolein (Magnecide-H) application and/or Copper Sulfate. Results show that the efficacy of shorter duration treatments can be optimized with Teton, over other chemicals, and additionally achieve a longer control of the target aquatic submerged species.

Mark Heilman. **Enhanced Herbicide Management Strategies for Selective Control of Invasive Watermilfoils.** Mark A. Heilman; SePRO Corporation, Carmel, IN

Invasive watermilfoils (IWM) including Eurasian (Myriophyllum spicatum), parrotfeather (M. aquaticum), and variable watermilfoil (M. heterophyllum - invasive in some US states) have challenged aquatic resource managers for many decades. These species are aggressive invaders that displace native aquatic plants, compromise fisheries, reduce shoreline property values, and challenge recreation and other uses. In infested aquatic sites with high diversity, the selective control of IWM---control of the invader with little or no impact to the native aquatic plant community--is a major criteria defining successful management. Past research and operational efforts have demonstrated improvements in selective control over the last several decades. However, changing climatic conditions, spread into more diverse or more hydrodynamic systems, permitting requirements, and evolution of hybrid watermilfoil varieties with tolerance to past management strategies all pose risk to sustained success in selective IWM control. Recent research and field development are introducing new technologies and methods for selective control. This paper will review two enhanced methods for selective control versus older strategies: use of Sonar pellet formulations (a.i., fluridone) in diverse northern lake systems particularly for hybrid Eurasian watermilfoil control and the introduction of the recently registered ProcellaCOR™ Aquatic Herbicide (a.i., florpyrauxifen-benzyl). Several recent case studies from the Midwest using Sonar pellet formulations will be reviewed including dissipation profiles, IWM control, and improved selectivity outcomes. Finally, USEPA recently registered ProcellaCOR, and past mesocosm and field trial results will be highlighted to set the stage for the novel herbicide's early operational adoption for IWM and other problem weed management in the Western US.

Karen Jetter*, Kjersti Nes. **Bio-economic Model of Delta Weed Management.** University of California Agricultural Issues Center, Davis, CA, UC Davis Dept. of Agricultural and Resource Economics.

Between 2013 and 2016 over $46 million was spent by different businesses and agencies to manage invasive aquatic weeds in California's Bay Delta region. Management of invasive weeds in this region is challenging. Timing, environmental constraints, methods and costs all need to be taken into consideration when determining where and how to treat.

The public agency primarily charged with management of aquatic weeds is the California Division of Boating and Waterways (DBW), and it is also the only agency licensed to apply herbicides on aquatic weeds in this area. In addition to herbicides, mechanical harvesting has been used when herbicides are not a practical option. For example, mechanical harvesters can be an option early in the year when floating aquatic weeds, such as water hyacinth, begin to spread, but before DBW can legally use herbicides.

A comparative analysis of the costs to management floating aquatic vegetation will be presented. The economic model will be run jointly with the weed growth model to simulate different control strategies and to estimate the total cost of each strategy across the relevant DBW treatment sites in the Delta. The economic model contains equations that estimate the time that it will take to treat an infestation, given the size of the infestations and the site characteristics. The demand for labor is then modeled as a function of the complete time needed to treat an infestation. This includes travel time to a site, time at the launch site to launch the boats and pack up the boats at the end of the day, travel from the launch site to the treatment site, and time at the treatment site to control the infestation. The model also includes equations, by DBW treatment site, to estimate the cost of fuel, labor and materials for each treatment option.

The analysis will consist of comparing the total costs of alternative methods to manage floating aquatic weeds, and the timing of those techniques. For example, the costs to use mechanical harvesting on water hyacinth in key sites, and possible herbicides applications later in the season, will be compared to the cost of weeds being left to grow until herbicide applications can be legally applied.

Guy B. Kyser*, John D. Madsen. **Evaluation of Newly Registered Rerbicides for Control of Waterhyacinth in the Sacramento / San Joaquin Delta.** University of California, Davis, California, USDA ARS, UC Davis Plant Sciences, Davis, CA

Waterhyacinth (Eichhornia crassipes (Mart.) Solms) is a worldwide aquatic weed that has become a significant nuisance in the Sacramento/San Joaquin River Delta (hereafter the Delta). Glyphosate and 2,4-D have been the predominant herbicides used for management. While these chemicals have been effective for control, additional herbicides need to be evaluated to address concerns over herbicide resistance management, environmental restrictions, and reduction in total active ingredient applied. We performed three trials in floating quadrats in the Delta. In the first (2016), we applied two rates each of 2,4-D, glyphosate, imazamox and penoxsulam in four replicate quadrats. In this trial, the highest rates of all four herbicides provided satisfactory control (2,4-D, 82%; glyphosate, 87%; imazamox, 93%; and penoxsulam, 94%). In the second trial (2016), we compared the lower rate of glyphosate (1681 g ae ha-1) to four rates each of imazamox (187 to 1494 g ai ha-1) and penoxsulam (12 to 98 g ai ha-1). The highest rates of imazamox and penoxsulam provided excellent control (96% and 95%, respectively). In the third trial (2017), we applied other low-rate chemicals, carfentrazone and flumioxazin, alone and in tank mixes with imazamox or glyphosate. We also applied glyphosate (1681 g ae ha-1) in three spray volumes (25 GPA, 50 GPA, and the standard volume of GPA). The tank mix of flumioxazin + imazamox (316 + 280 g ai ha-1) and the 50 GPA application of glyphosate each produced better than 95% control. Imazamox and penoxsulam appear to be effective alternatives to 2,4-D and glyphosate for controlling waterhyacinth with reduced rates of active ingredient. Their availability also will facilitate management for herbicide resistance.

John D. Madsen. **Growth and Phenology of Weeds in the Delta.** USDA ARS, UC Davis Plant Sciences, Davis, CA

The Sacramento / San Joaquin River Delta (hereafter the “Delta”) is a 65,000 acre network of waterways that constitute the transition of the free-flowing Sacramento River and San Joaquin River to the brackish Suisun Bay. A freshwater tidal estuary, the Delta is a critical habitat for numerous freshwater and migratory species. The Delta has a diverse assemblage of native aquatic plant species, as well as several invasive aquatic plants. As part of ongoing aquatic plant management in the Delta, the seasonal growth of waterhyacinth (Eichhornia crassipes (Mart.) Solms), Brazilian elodea (Egeria densa Planch.), and curlyleaf pondweed (Potamogeton crispus L.) were studied. For each species, three separate sites were sampled monthly from May 2015 through December 2017. At each site, twelve biomass samples were taken with either a 0.1 m2 quadrat (floating plants) or a 0.023 m2 Eckman dredge (submersed plants). Air and water temperature were recorded continuously at 15 minute intervals using a Hobo temperature sonde. Samples were sorted to relevant plant parts, dried at 70C, and weighed to determine plant biomass. Growth data was analyzed by calculating plant relative growth rate (RGR) from biomass, and relative growth rate of either stembases (waterhyacinth) or turions (curlyleaf pondweed) from density data. Growth and abundance will be related to air or water temperature. Preliminary data suggests that water temperature is an important driver for plant growth of all three species. Low flow years tend to have more plant growth in part because of the earlier onset of adequate temperature for growth, and higher water temperatures throughout the growing season. Future work may include analysis of waterhyacinth stembases for starch content, and analysis of tissues for nitrogen content.

Patrick J. Moran, Paul Pratt, John D. Madsen, David L. Bubenheim, Edward Hard. **An Overview of the Delta Regional Areawide Aquatic Weed Program.** USDA-ARS Exotic and Invasive Weeds Research Unit, Albany, CA, USDA ARS, UC Davis Plant Sciences, Davis, CA, NASA Ames Research Center, Earth Science Division, Biospheric Science Branch, Moffett Field, CA, Division of Boating and Waterways, California Department of Parks and Recreation, Sacramento, CA

The 68,000-acre San Joaquin-Sacramento Delta, also known as "the Delta", is the largest freshwater estuary on the U.S. West Coast. The Delta is of great value environmentally and economically. Inflows from the upstream watersheds irrigate over $2 billion in Delta-based crops and over $33 billion in the vast Central Valley of California. The Delta also provides drinking water for 25 million people. Recreational boating, fishing, hunting, and tourism support local industries with a value of $300 million, including 100 marinas and two million boat trips per year, and the Delta is home to 600,000 people. The ports of Stockton and Sacramento handle four million tons of cargo per year. The Delta's tidally-influenced sloughs, coves, wetlands and riparian habitats are home to at least 56 endangered, threatened or rare species. The Delta faces major environmental challenges, including saltwater intrusion, loss of habitat, and invasions by non-native species. Invasive aquatic plants, including floating water hyacinth (Eichhornia crassipes), submersed Brazilian waterweed (Egeria densa), and the riparian giant grass arundo (Arundo donax), consume water, block water conveyance, hinder navigation, degrade habitats, and may harbor pathogen-vectoring mosquitos. Until recently, control was addressed in a funding-dependent manner by single agencies. The U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS) Areawide Pest Management Program focuses on integrated, adaptive control of pests that are causing major economic and environmental damage over large areas by coordinating Federal, state, and local public agencies, university researchers, and private stakeholders to implement science-based control solutions. In 2014, an Areawide project was funded to improve control of aquatic weeds in the Delta. The Delta Region Areawide Aquatic Weed Project, or DRAAWP, now covers control of eight aquatic weeds and arundo, and has achieved major improvements in management using chemical, mechanical, and in some cases biological methods. Development of decision support tools to inform the lead control agency (Division of Boating and Waterways, CA Department of Parks and Recreation) have produced new knowledge on aquatic weed phenology in the Delta, models of weed growth based on watershed modeling and controlled environment studies, new remote sensing data and processing methods, efficacy information for six herbicides new to the Delta, and new biological control agents. Project benefits have been measured through a bioeconomic model as decreased weed coverage, decreased control costs, leveraging of new funding, improved awareness of the connection between invasive aquatic weeds and habitat quality, and improved dialogue among agencies and stakeholders.

S.J. Nissen. **A Global Perspective on Aquatic Plant Management: Highlights from the 15th International Aquatic Plants Symposium, Queenstown, NZ.** Colorado State University, Fort Collins, CO

The International Aquatic Plant Symposium was held in the Southern Hemisphere for the first time when the meeting convened in Queenstown, NZ. The meeting was held on the shores of Lake Wakatipu at the south end of New Zealand's South Island. Like many island nations, New Zealand has a long history with intentional and unintentional, non-native species introductions. Many have resulted in significant harm to native species and New Zealand's many unique ecosystems. New Zealand was an island of birds. So you can imagine the impacts from the introduction of rabbits, weasels, foxes, cats, red deer, grouse, etc. New Zealand is also a land of massive lakes and pristine rivers known for fishing, boating, and water sports of all kinds. New Zealand in many ways represents, on a limited scale, what is happening around the world in terms of managing invasive terrestrial and aquatic species. Climate change, agricultural intensification, urbanization, and loss of riparian ecosystems are contributing to the increasing scale of aquatic plant invasions. The 15th International Aquatic Plant Symposium brought together experts from around the world, presenting their unique perspectives and challenges in aquatic ecosystem management. Meeting participants came away from the symposium realizing that we have many more shared experiences than we had anticipated and this meeting provided an opportunity to exchange ideas and map a way forward.

Mirella F. Ortiz*, Scott J. Nissen, Cody J. Gray. **Endothall Behavior in Several Aquatic Weeds.** Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO, Field Development Representative, UPI, Peyton, CO

Endothall was first labeled for aquatic weed control in 1960, and the endothall label was expanded to include aquatic weed control in flowing water in 2010. Endothall is generally considered a contact herbicide; however, many field observations suggest that it could have systemic activity. The objective of this experiment was to determine maximum absorption, absorption rate, translocation and desorption of endothall in Eurasian watermilfoil (Myriophyllum spicatum) (EWM), curlyleaf pondweed (Potamogeton crispus) (CLP), sago pondweed (Stuckenia pectinata) and two hydrilla biotypes (Hydrilla verticillata). Each weed was clonally propagated from apical shoot cutting or turions/tubers when present. For herbicide absorption and translocation, plants of each species with developed roots and 10 cm of shoot growth were transferred to test tubes containing fine, unwashed sand and sealed at the top with eicosane was to isolate the root system from the water column. Mesocosms were treated with 3 g mL-1 endothall as the potassium salt plus 14C-endothall. Plants were exposed to the herbicide over a time course of 192 hours. At predetermined time points three plants of each species were harvested, divided into shoot and root tissue, dried at 60C for 48 h, and oxidized. Radioactivity was determined by liquid scintillation spectroscopy. Herbicide desorption was evaluated over a time course of 72 hours using the same treatment as described before, but with higher concentration of radiolabeled endothall and 10 cm apical meristems shoots of EWM, hydrilla and hybrid watermilfoil. Hydrilla showed a linear increase in herbicide absorption, while herbicide absorption in EWM, CLP and sago pondweed best fit a hyperbolic function. Translocation to EWM, CLP and sago pondweed roots was limited, reaching a maximum translocation of 11%, 8% and 2% of total absorbed radioactivity, respectively. Monoecious and dioecious hydrilla showed a linear increase without reaching maximum absorption or translocation 192 HAT. The distribution of radioactivity was 72% shoot:28% root for monoecious hydrilla and 78% shoot:22% root for dioecious hydrilla. Herbicide desorption was 59% for hybrid watermilfoil and less than 31% for all the other three species. These data provide strong evidence that endothall is systemic.

Jenifer K. Parsons*, Justin Bush, Jennifer Andreas, Mark Sytsma, PhD. **Flowering Rush in the Columbia River Basin: Planning for Strategic Control.** Washington State Department of Ecology, Yakima WA, Washington State Invasive Species Council, Olympia, WA, Washington State University, Puyallup, WA, Portland State University, Portland, OR

Flowering rush (Butomus umbellatus), an invasive plant in North America, grows in a wide range of depths, habitats and flow regimes. In the Columbia River watershed it is well established and dominates the littoral zone in some areas such as Flathead Lake, MT. In other areas it is in the pioneering stages of invasion, and in still others it has yet to be found. This makes management a challenge, especially given that the area where flowering rush is most well established is high in the watershed and the plant spreads vegetatively on water currents down river. In 2017 the Washington Invasive Species Council obtained a grant to bring the various entities conducting flowering rush research, management, and surveys together to prioritize control efforts and identify additional research needs. Part of the process included a flowering rush summit, held at the end of February, 2018. An overview of the summit results, and identified needs for flowering rush research will be provided.

Paul D. Pratt*, Patrick Moran. **Biological Control of Weeds and the Delta Region Areawide Aquatic Weed Project.** USDA-ARS, Exotic and Invasive Weeds Research Unit, Albany, CA

The Sacramento-San Joaquin Delta provides critical water resources to drought-stricken northern California and agriculture in the Central Valley. Water resources are threatened as a result of invasive aquatic weeds, including floating water hyacinth, Eichhornia crassipes, and a shoreline giant grass, Arundo donax. The overall objective of biological control research and implementation on the USDA-ARS Delta Region Areawide Aquatic Weed Project (DRAAWP) is to improve biocontrol agent establishment, dispersal and impact while integrating with chemical and mechanical control. Three water hyacinth biocontrol agents were released in the Delta in 1983 and a fourth was released near the Delta in 2012. Monthly surveys of 16 locations revealed that only a single biological control agent was uniformly established throughout the Delta: the leaf-chewing/boring weevil Neochetina bruchi. Highest population densities were observed in the fall (September), reaching nearly 6 individuals (adults and larvae) per plant across all sites. Another weevil, Neochetina eichhorniae, was absent from the Delta, but present in isolated populations on the Tuolumne River in the San Joaquin River watershed. The third agent released in 1983, the leaf and crown-boring moth Niphograpta albiguttalis, was not observed. The more recent agent, the leaf-piercing planthopper Megamelus scutallaris, was established at one site in the Sacramento River watershed and possibly one site in the San Joaquin watershed. Current research focuses on introducing a new biotype of N. eichhorniae that is better-adapted to cold winter Delta conditions, and reintroducing N. albiguttalis from field sites in the temperate southeastern US. Future efforts will focus on mass-rearing and release of these two insects and M. scutellaris in the Delta to augment water hyacinth control. Biological control of arundo has included release of the shoot tip-galling arundo wasp Tetramesa romana and the root- and stem-feeding arundo armored scale Rhizaspidiotus donacis. Releases of about 5,500 arundo wasps in the western and central Delta were guided by satellite mapping to prioritize sites. Current research focuses on integrated control. In 2017, arundo in research plots at three sites in the western Delta were mowed at 1 m height, allowed to regrow, and then inoculated with 150 wasps each. Areas around the plots were sprayed with glyphosate + imazapyr. Armored scales will be added to the biocontrol plots in 2018, by rearing scales on arundo ‘microplants’ in a greenhouse, then planting microplants at field sites. Arundo wasps will be released onto regrowth in chemically-treated arundo stands.

Julie Regan. **Lake Tahoe: Waging War Against Aquatic Invasive Species While Trying to Protect a National Treasure.** APR Chief, External Affairs/Deputy Director, Tahoe Regional Planning Agency, Stateline, NV

Lake Tahoe is one of the clearest large lakes in the world. Situated on the border of California and Nevada, its majestic mountains surround sparkling azure waters that run more than 1,600 feet deep. Mark Twain once said “at last the Lake burst upon us—a noble sheet of blue water lifted six thousand three hundred feet above the level of the sea … I thought it must surely be the fairest picture the whole earth affords.”

While it’s possible today to see more than 70 feet below the lake’s surface, clarity in the 1960s was more than 100 feet. The watershed has been forever altered by human activity and new threats exist from invasive species. Warming air and water temperatures are making the high-alpine cold waters of the lake more vulnerable to warm water fish, invasive aquatic plants, and other invaders like quagga mussels.

The battle came to us. Ten years ago, after quagga mussels migrated to the Western United States, a partnership of 40 agencies and organizations instituted the Lake Tahoe Aquatic Invasive Species Program, which included the creation of one of the most rigorous watercraft inspection programs in the United States. The Tahoe Regional Planning Agency and the Tahoe Resource Conservation District lead the program which has successfully prevented new introductions of invasive species, despite constant threats from water bodies in the West. In addition to prevention, the program focuses on controlling existing species that have already taken up residence in the lake. A national model for how to effectively keep invasives from entering a water body, the Lake Tahoe AIS Program is widely supported by the boating community, the general public, and elected officials.

On the management control side, the goal is to reduce populations of invasive plants, clams, and warm water fish through a science-based, prioritized plan. The plan uses an integrated approach with numerous techniques such as rubber mat barriers, diver weed pulling, new methods like UV light, and extensive public education. With science guiding the way, innovative policies have taken shape that rely on collaboration, public-private partnerships, and a commitment to protecting a national treasure. Waging war on invasive species at Lake Tahoe takes a major commitment, but as the program’s first outreach campaign said, “we’re all in this boat together.”

Robert Revolinski. **Prymnesium parvum (golden algae): Observations & Considerations in Managing Urban Lakes in Central Arizona.** Water Resource Management, Inc., Glendale, AZ

Golden alga was first identified in Arizona in 2004. Water Resource Management, Inc. has been on the front line since and manages hundreds of acres of lakes that have tested positive. Can we predict where golden algae will establish and when it will appear?

Observations on how various lake management strategies affect Prymnesium parvum recurrence will be shared.

Patrick Simmsgeiger. **Gaining Control & Managing HAB's.** Diversified Waterscapes, Inc., Laguna Niguel, CA

The topic of focus in this presentation will be Harmful Algae Blooms (HAB) and how they can be monitored and sustainably treated with a double chelated copper algaecide. HABs are a potential problem in any body of water, but it can be hard to judge when a regular algae bloom becomes one worthy of concern. The seasonal flux in algae density can be unpredictable, and various factors (nutrient loading, rainfall, human activity) can dictate the possibility and severity of algal population booms.

In response to this, professional lake management has become an increasingly important tool for the prevention and treatment of algae problems in freshwater systems, such as; lakes, ponds, and reservoirs. This presentation will cover how DWI approaches algae, what can be done to prevent populations becoming unsustainable, and what to do when treatment becomes necessary.

This presentation will be supported primarily by data from a recent case study in which DWI evaluated and treated multiple lakes on the HAB watch list in California using F-30 Algae Control, a naturally double chelated Algaecide and Bactericide. Working within the confines of an NPDES Permit, DWI brought their algal toxin levels down to non-detectable levels with a low copper concentration. Before, during, and after treatment we collected water samples that were then sent to EPA certified labs for algae and water chemistry analysis. With these results we were provided with a clear picture of the lakes' recovery and the reduction in algae populations, allowing the lakes to be successfully removed from the HAB watch list.

With this presentation, the goal is for the audience to leave with a broad understanding of how to evaluate when a bloom is a problem, what can be done to treat, and how we can reduce the chances of reoccurring blooms. There will be some background on common algae types, and the dangers associated with them blooming. Some common causes of HABs will also be briefly covered.

Tom Warmuth. **Cyanobacterial Management in California with Liquid Activated Peroxygen Algaecide/Cyanobacteriacide.** BioSafe Systems, LLC, Kure Beach, NC

Effective copper alternative treatments for cyanobacterial management are emerging as a needed option as the threat to our waters by these organisms becomes more realized and understood. The development of effective treatments for the "Bad Players", or what are identified as cyanobacteria that are known to produce harmful toxins or even taste and odor compounds, has never been more imperative. Both San Francisco Public Utilities and Santa Cruz Water, through their programs of monitoring, sampling and algal enumeration, developed an algaecide treatment regime with Clean Lakes, Inc. (contracted California Certified Pest Control Advisor and licensed aquatic applicator) and delivered effective control of various cyanobacteria throughout the season using Liquid Activated Peroxygen Algaecide, a NSF/ANSI 60 Certified, liquid activated peroxygen algaecide, in their reservoirs. Peroxide based algaecides have been identified as effective in selective treatments for cyanobacteria, where it is not greatly effecting the population of beneficial green algae/phytoplankton. The use and delivery of "granular peroxide", SCP – Sodium Carbonate Peroxyhydrate, can have challenges not only in the delivery of the treatment to the water, but also in effectively controlling the target organism depending on where it may be in the water strata. The chemistry of Liquid Activated Peroxygen Algaecide has shown to be effective, while also being easier to apply than SCP and having the ability to be more effectively applied. This all leading to a better potable water source through better control of target cyanobacteria while preserving most of the green phytoplankton; an overall healthier and productive algal population while limiting the input of copper based algaecides to the system.

Dennis M. Zabaglo*, John J. Paoluccio. **Using Ultra Violet Light to Control Aquatic Invasive Plants - Pilot Study.** APR Manager, Principal Environmental Specialist, Tahoe Regional Planning Agency, Inventive Resources, Inc., Salida, CA

Aquatic invasive species, specifically Eurasian watermilfoil, have been introduced into our lakes and other waterways by boats, trailers, aquariums and by other means. They are fast growing and can easily overgrow an area causing a problem to boaters, native aquatic life and recreational economy of an area.

This past summer in Lake Tahoe, permitting, funding and support from local regulating agencies such as California Tahoe Conservancy (CTC), Tahoe Resources Conservation District (TRCD), Tahoe Regional Planning Agency (TRPA), Lahontan Water Board, Tahoe Water Suppliers Association and private supporter Tahoe Fund stood next to Inventive Resources Inc. (IRI) as they conducted a non-chemical UV treatment pilot study at Lakeside Beach and Marina in Lake Tahoe. Residents are hopeful that this new method would prove effective and offer more treatment options that in the long term can help eradicate aquatic invasive weeds.

The pilot study treatment phase was completed in September 2017. At the conclusion of the treatment phase it was visibly evident that the densities of the invasive plant population were reduced. All agencies have been positive thus far with the preliminary results. Treatment results show that after a specific exposure, all the treated AIP were impacted such that it did not continue to grow. The next phase of the pilot study is to monitor regrowth.

About Inventive Resources Inc.

John J. Paoluccio, President of Inventive Resources, Inc. (IRI) has been working on this approach to eliminate the AIP problem in Lake Tahoe. His patented treatment vessel and method involves the use of a unit towed underwater that emits a high frequency light wave which damages the Deoxyribonucleic acid (DNA) and cell structure of invasive aquatic weeds. This stops reproduction and within a few days plant decomposition is visible.

About the Lake Tahoe Aquatic Invasive Species Program

The Lake Tahoe Aquatic Invasive Species Program is implemented by 40 public and private partner organizations including federal, state and local jurisdictions, research partners, public utility districts, and private marinas. The Tahoe Regional Planning Agency is responsible for leading the implementation of a federally approved AIS Management plan through the collaborative framework of the Lake Tahoe Aquatic Invasive Species Coordinating Committee. The Committee is chaired by TRPA and the Tahoe Resource Conservation District and provides the leadership, direction, and resources to fulfill this program's mission of prevention, detection, and control of aquatic invasive species in the Lake Tahoe Region.

Minghua Zhang*, Huajin Chen, Ruoyu Wang. **Quantifying Pesticide and Nutrient Loading from the Sacramento and San Joaquin River Watersheds into the Sacramento-San Joaquin Delta using a Modeling Approach.** Department of Land, Air and Water Resources, University of California, Davis, CA

The Sacramento-San Joaquin Delta is an ecologically rich, hydrologically complex area that serves as the hub of California's water supply. However, pesticides have been routinely detected in the Delta waterways, with concentrations exceeding the benchmark for the protection of aquatic life. Pesticide loading into the Delta mainly comes from the agriculturally dominated Sacramento and San Joaquin River watersheds located upstream. In addition, agricultural activity has dramatically increased nitrogen loading to the Delta waterways, which could partially contribute to the invasion of aquatic weeds in the Delta region. Therefore, this study aims to simulate pesticide and nitrate loading to the Delta by applying the Soil and Water Assessment Tool (SWAT) model to both upstream watersheds, under the support of the

USDA-ARS Delta Region Area-Wide Aquatic Weed Project (DRAAWP). Pesticide use data were extracted from the California Pesticide Use Reporting (PUR) database as model input for pesticide simulation. Model performance on streamflow, sediment, nitrogen and pesticide was evaluated using a combination of graphic and quantitative measures. Our results show that the calibrated SWAT is able to successfully simulate monthly streamflow, sediment, nitrate loads and pesticide diuron in both the Sacramento and San Joaquin River watersheds. Model output (nitrate, temperature) could be used to feed the downstream plant growth model that simulates the growth of floating and submerged aquatic vegetation.

POSTERS
In Alphabetical Order by Presenting Author

West M. Bishop*, Ben E. Willis, Mike Pearce. **Importance of Phosphorus Mitigation in Managing Nuisance Algae.** SePRO Research & Technology Campus, SePRO Corporation, Carmel, IN

Phosphorus pollution can significantly impair freshwater resources due to correlations with nuisance algae, densities and degraded water quality parameters (i.e. pH, biological oxygen demand, turbidity, total suspended solids). Strategies to address external inputs of phosphorus (e.g. best management practices) are important for source control, although there are still numerous inputs unable to be controlled. Managing nutrient ratios (N:P; Si:P) by specifically removing in situ P can positively shift nutrient ratios and govern algal types/densities. Understanding sediment P sources is also important in management as exploitation of legacy P is a critical aspect of nuisance algal ecology. This research measured the impact of a specific P mitigation technology (Phoslock) at removing water column P and immobilizing sediment associated P. The shift in N:P ratios and algal assemblage composition were also analyzed. Multiple sites throughout the United States (CA, NC, VA) will be presented where Phoslock was applied. Objectives of field case studies included: 1) to measure the change phosphorus levels post-treatment, 2) to measure impacts of Phoslock on water quality, and 3) to evaluate algae types and densities through time. Phoslock significantly ($p<0.005$) decreased total (>80 %) and free reactive (>95 %) phosphorus in the water column and significantly shift potentially releasable sediment phosphorus fractions to residual forms after treatment in field applications. This shift in P availability altered the subsequent N:P ratio as well as the availability of sediment P stores. Algal assemblages either maintained beneficial types (i.e. offset nuisance cyanobacteria from arising) or shifted away from cyanobacterial dominance. Specific targeting of in situ P sources is important to consider in algal management programs especially with increased regulatory scrutiny and restrictions on pesticide use. Phoslock can provide an effective and ecologically friendly approach to combat the eutrophication process and restore water quality.

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