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## NALMS Southeastern Lakes and Watershed Management 22nd Annual Conference and the Florida Lake Management Society's 24th Annual Conference and Technical Symposium

# CONFERENCE PROGRAM

*** designates a student paper**
**You are encouraged to vote for the best presentation or poster**
**and the highest will receive monetary awards and registration to the North American Lake Management Society**

# NALMS Southeastern Lakes and Watershed Management 22nd Annual Conference and the Florida Lake Management Society's 24th Annual Technical Symposium

# *Integrating Lake and Watershed Management*

**June 17-20, 2013**

## Welcome!

**MONDAY - JUNE 17, 2013 – WORKSHOPS**

| | |
|---|---|
| 8:00 am – 4:00 pm | **Check-In and Registration** (Bill France Lobby) |
| 7:45 am – 10:00 | **MORNING BREAK (*Rooftop Foyer)*** |
| 8:15 – 12:15 am | **Workshop 1: The Algae in Your Lake**. Andrew Chapman, Phycologist, GreenWater Laboratories/CyanoLab |
| 8:15 – 12:15 am | **Workshop 2: Part I: DEP Measures of Floral Health: Procedures and Uses.** Russel Frydenborg and Nia Wellendorf, Florida Department of Environmental Protection |
| 12:00 – 1:00 pm | **LUNCH *(Rooftop Foyer - provided with full-day Workshop registration)*** |
| 2:45 – 3:00 pm | **AFTERNOON BREAK (*Rooftop Foyer)*** |
| 12:45 – 4:45 pm | **Workshop 3: Part II: DEP Measures of Floral Health: Procedures and Uses (Field).** Russel Frydenborg and Nia Wellendorf, Florida Department of Environmental Protection **(Leave for field immediately after morning session)** |
| 12:45 – 4:45 pm | **Workshop 4: Water Quality Monitoring, Data Analysis and Interpretation.** Harvey H. Harper, Ph.D., P.E. – President Environmental Research & Design, Inc. |
| 12:45 – 4:45 pm | **Workshop 5: How Watersheds Do (and don't) Dictate the Ecological Integrity of Florida Lakes.** Dr. David Kaplan, University of Florida, Assistant Professor of Environmental Engineering Sciences, Engineering School of Sustainable Infrastructure & Environment |

## TUESDAY - JUNE 18, 2013 MORNING

| | |
|---|---|
| 8:00 am – 4:00 pm | **Check-In and Registration** (Bill France Lobby) |
| 7:00 am – 8:30 am | **Breakfast** (Azure Room) |

**Opening Program** (Richard Petty Room)

8:45– 9:00 am **Opening Remarks:** **Sherry Brandt-Williams**, *Outgoing FLMS President*
**Lawrence Keenan**, *Conference and Program Chair*
**Ann Shortelle**, *NALMS President and Executive Director of the Suwannee River Water Management District*

9:00 – 9:45 am **Keynote Speaker** **William J. Mitch**, *Eminent Scholar and Director, Everglades Wetland Research Park and the Juliet C. Sproul Chair for Southwest Florida Habitat Restoration and Management*

**"Protecting the Gulf of Mexico and the Florida Everglades with Wetlands —A Tale of Two Watersheds and Two Nutrients"**

9:45-10:00 am **Question Period**

| | |
|---|---|
| 10:00 – 10:30 am | **MORNING BREAK** (Bill France Room) |

**Session 1: Springs: What do we know?** (Richard Petty Room)
Moderator: Erich Marzolf

10:30 – 10:35 am **Session Introduction - Moderator**

10:35 – 10:50 am **Relationships Between Discharge And Nutrient Concentrations In Florida Springs.**
Erich R. Marzolf and Ann B. Shortelle

10:50 – 11:05 am **Protecting The Dark By Shedding Some Light.**
Amy L. Giannotti, Rima B. Franklin, Aaron L. Mills, Terrence N. Tysall, and Marissa L. Williams

11:05 – 11:20 am **Solutions For Springs, Suwannee Style.**
Ann B. Shortelle and Erich R Marzolf

11:20 – 11:35 am **Evidence Of Spring Flow Declines Due To Regional Groundwater Extractions.**
Robert Knight

11:35 – 11:50 am **The Research Component Of The Springs Protection Initiative Of The St. Johns River Water Management District.**
Edgar F. Lowe

11:50 – 12:00pm **Question Period**

## TUESDAY – JUNE 18, 2013 AFTERNOON

| | | |
|---|---|---|
| 12:00 – 1:00 pm | **LUNCH** (Atlantic Room) | |
| 1:00 – 1:45 pm | **Special Lunch Speaker** (Richard Petty Room) | **Mark Brenner,** *Director, Univ. of Florida Land Use and Environmental Change Institute* |

**"Long-Term Interactions Among Climate, Environment and Humans in the Neotropics: Insights from Lake Sediment Cores."**

**Session 2: FDEP Standards and Stuff** (Richard Petty Room)
Moderator: Shannon Carter Wetzel

| | |
|---|---|
| 1:45 – 1:50 pm | **Session Introduction - Moderator** |
| 1:50 – 2:10 pm | **Revised Dissolved Oxygen (DO) Criteria For Florida's Fresh And Marine Waters.**<br>Russ Frydenborg and Garry Payne |
| 2:10 – 2:30 pm | **Use Of The Stream Condition Index To Assess Biological Health In Florida Streams And Rivers.**<br>Nia Wellendorf and Russ Frydenborg |
| 2:30 am– 3:00 pm | **Question Period** |
| 3:00-3:30 pm | **AFTERNOON BREAK** (Bill France Room) |

**Session 3: Lake Apopka and Other Applied Research** (Richard Petty Room)
Moderator: Mike Perry

| | |
|---|---|
| 3:30 – 3:35 pm | **Session Introduction - Moderator** |
| 3:35 – 3:50 pm | **History and Monitoring of Submersed Aquatic Vegetation in Lake Apopka.**<br>Jim Peterson, Paul Ek, and Roxanne Conrow |
| 3:50 – 4:05 pm | **SAV Monitoring on Lake Apopka in 2011 and 2012: A Statistical Approach to Quantifying SAV Recovery.**<br>Pam Bowen, Roxanne Conrow, Mike Coveney, and Jim Peterson |
| 4:05 – 4:20 pm | **Effects of Sediments on the growth of *Vallisneria americana* in Lake Apopka.**<br>Ellen Bailey and Patrick Inglett |
| 4:20 – 4:35 pm | **Evaluation of Bacterial Water Quality Changes around the Coastal Town of Suwannee, Florida after Septic Tank Phase Out.**<br>Larry J. Danek and Gary P. Dalbec |
| 4:35 – 5:00 pm | **Question Period** |
| 5:00 – 5:30 pm | **FLMS Chapter Meetings** (Richard Petty Room) |

## TUESDAY – JUNE 18, 2013 EVENING POSTERS

| | |
|---|---|
| 5:30 – 7:00 pm | **EXHIBITORS' SOCIAL** (Bill France Room) |

5:30 – 6:30 pm **Session 4: Poster Session** (Bill France Room)

1. **EFFECTS OF MOTORIZED BOATING ON THE AQUATIC PLANT COMMUNITY OF THE RAINBOW RIVER, FLORIDA.**
   *Amanda C. Croteau, Charles E. Cichra, and Jesse Stephens

2. **ASSESSMENT METHODS FOR HILLSBOROUGH COUNTY LAKES AND STREAMS.**
   David Eilers

3. **IMPACTS OF RECLAIMED WASTEWATER ON BENTHIC FAUNAL DIVERSITY AND DECOMPOSITION RATES: PRELIMINARY FIELD STUDY.**
   *Patrick Goodwin and Kelly Smith

4. **AERIAL APPLICATION OF GRANULAR ALUM IN BLUE CYPRESS WATER MANAGEMENT AREA-WEST,UPPER ST. JOHNS RIVER BASIN .**
   Victoria R. Hoge, Dianne Hall, Dean Dobberfuhl, Lawrence Keenan, Steven J. Miller, and Angelique Bochnak

5. **SUCCESSION PATTERNS OF ZOOPLANKTON DURING SPRING CYANOBACTERIAL BLOOM IN A SHALLOW, SUBTROPICAL LAKE.**
   *****Akeapot Srifa, Linghan Dong, Mary F. Cichra and Edward J. Phlips

## WEDNESDAY - JUNE 19, 2013 MORNING

| | |
|---|---|
| 8:00 am – 4:00 pm | **Check-In and Registration** (Bill France Lobby) |
| 7:00 – 8:30 am | **Breakfast** (Azure Room) |

**Morning Program** (Richard Petty Room)

8:45– 9:00 am **Announcements:** **Lawrence Keenan**, *Conference and Program Chair*

9:00 – 9:45 am **Keynote Speaker** **Wendy Graham**, *Carl S. Swisher Chair in Water Resources and Director, University of Florida Water Institute*

**"Geologic, vegetative, and climatic controls on surface water–groundwater interactions in the Santa Fe River Basin: Lessons learned from an integrated hydrologic model."**

9:45-10:00 am **Question Period**

| | |
|---|---|
| 10:00-10:30 am | **MORNING BREAK** (Bill France Room) |

## WEDNESDAY - JUNE 19, 2013 MORNING

**Session 5-A: Lake Okeechobee Research** (Richard Petty Room)
Moderator: Jennifer Sagan

| | |
|---|---|
| 10:30 – 10:35 am | **Session Introduction - Moderator** |
| 10:35 – 10:50 am | **Lake Okeechobee's Dynamic Marsh – Ecological Responses To Natural And Human Impacts.**<br>Chuck Hanlon |
| 10:50 – 11:05 am | **Submerged Aquatic Vegetation (SAV) Monitoring In Lake Okeechobee, 2000-Present.**<br>Amy L. Peters and Chuck Hanlon |
| 11:05 – 11:20 am | **An Update Of The Lake Okeechobee Water Quality Model (LOWQM): Callibrating To Extreme Events.**<br>R. Thomas James |
| 11:20 – 11:35 am | **Monitoring Organic Sediment Removal Projects On Lake Okeechobee For Changes In Fish, Plant And Avian Communities.**<br>Alyssa Jordan, Brent Bachelder, Tyler Beck, and Donald Fox |
| 11:35 – 12:00 pm | **Question Period** |

**Session 5-B: A Systems Approach to Freshwater Management I** (River Room)
Moderator: H Kenneth Hudnell

| | |
|---|---|
| 10:30 – 10:35 am | **Session Introduction - Moderator** |
| 10:35 – 10:50 am | **Waterbody Management, The Unimplemented Pillar Of The Clean Water Act, Is Essential: Water Circulation Benefits.**<br>H Kenneth Hudnell |
| 10:50 – 11:05 am | **Water Quality Management Practices Using Treatment Technology Within The Waterbody.**<br>Eddie Snell |
| 11:05 – 11:20 am | **Biological Augmentation of Water Bodies.**<br>Peter G. Kalogridis |
| 11:20 – 11:35 am | **Floating Wetlands As A Tool For Nutrient Pollution Remediation.**<br>Steve Beeman, M.S. |
| 11:35 – 12:00 pm | **Question Period** |

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|---|---|
| 12:00 – 1:30 pm | **BANQUET LUNCH/FLMS ANNUAL MEETING** (Atlantic Room) |

## WEDNESDAY - JUNE 19, 2013 AFTERNOON

**Session 6-A: Lake Jesup I plus - the Watershed** (Richard Petty Room)
Moderator: Sherry Brandt-Williams

| | |
|---|---|
| 1:30 – 1:35 pm | **Session Introduction - Moderator** |
| 1:35 – 1:50 pm | **Water Quality Before And After Lake Jesup TMDL.**<br>Sherry Brandt-Williams, Ph.D. |
| 1:50 – 2:05 pm | **Stormwater Treatment Retrofits: Baffle Boxes With Media Filtration For The Lake Jesup Watershed.**<br>Kelly H. Brock |
| 2:05 – 2:20 pm | **Lake Jesup Nutrient Reduction Facility-Soldiers Creek Regional Stormwater Facility At County Road 427.**<br>Mark Flomerfelt, Kim Ornberg, Harvey H. Harper III, and Greg Teague |
| 2:20 – 2:35 pm | **Update On The Nutrient Removal Efficiency Of Stormwater Catch Basin Insert (Cbi) Filter Baskets Within Urban Residential Areas In Orange County - Florida.**<br>Sergio Duarte |
| 2:35 – 3:00 pm | **Question Period** |

**Session 6-B: Fundamentals and Techniques** (River Room)
Moderator: Sergio Duarte

| | |
|---|---|
| 1:30 – 1:35 pm | **Session Introduction - Moderator** |
| 1:35 – 1:50 pm | **Assessing Total Phosphorus Variability In Florida's Nutrient Zones.**<br>*Christopher C. Anderson, Daniel E. Canfield Jr., Mark T. Brenner, and Charles E. Cichra |
| 1:50 – 2:05 pm | **Evaluation Of Soil Enhancement Retrofits In Stormwater Ponds To Reduce Nitrogen Loading Within The Wekiva Springshed.**<br>Lance M. Lumbard, Sam Arden, William Tucker, Timothy Kelly, Mikhal Moberg, Terry Dykehouse, Vineela Griddaluru, Mark Flomerfelt, and Kim Ornberg |
| 2:05 – 2:20 pm | **Shoreline Restoration Within A Transition Zone.**<br>John Slupecki |
| 2:20 – 2:35 pm | **Significance Of Internal Recycling As A Nutrient Source To Central Florida Lakes.**<br>Harvey Harper |
| 2:35 – 3:00 pm | **Question Period** |

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| 3:00 – 3:30 pm | **AFTERNOON BREAK** (Bill France Room) |

## WEDNESDAY - JUNE 19, 2013 AFTERNOON

**Session 7-A: Lake Jesup II - The Lake** (Richard Petty Room)
Moderator: Sherry Brandt-Williams

| | |
|---|---|
| 3:30 – 3:35pm | **Session Introduction - Moderator** |
| 3:35 – 3:50 pm | **Assessment Of The Cycling And Compartmentalization Of Nitrogen And Phosphorus In Saturated Soils, Sediments And The Water Column In Lake Jesup, Florida**.<br>Serge Thomas, William Anderson, Leonard Scinto, Shauna Nielsen, David Fugate, and Reide Corbett |
| 3:50 – 4:05 pm | **Evaluation Of Hydrologic And Nutrient Loadings From Groundwater Seepage To Lake Jesup.**<br>Harvey Harper and Kim Ornberg |
| 4:05 – 4:20 pm | **Aqualutions™ Performance Results At Lake Jesup, Florida: A Commercial-Scale, Dual-Nutrient Removal Technology With Implications For Numeric Nutrient Criteria Compliance.**<br>Duane E. De Freese and William A. Eggers |
| 4:20 – 4:35 pm | **Lake Jesup Cooperative Efforts: Vegetation Restoration.**<br>Gloria Eby and Ed Hayes |
| 4:35 – 5:00 pm | **Question Period** |

**Session 7-B: Applied Research** (River Room)
Moderator: Shannon Carter Wetzel

| | |
|---|---|
| 3:30 – 3:35pm | **Session Introduction - Moderator** |
| 3:35 – 3:50 pm | **Effects Of Irrigating Five Common Landscape Species With Water Treated With Bispyribac And Penoxsulam**.<br>Amy L. Giannotti, Michael D. Netherland, Timothy J. Egan, Marissa L. Williams, and Alicia K. Knecht |
| 3:50 – 4:05 pm | **Vegetation Community Driven Changes In Potential Evapotranspiration.**<br>Dean R. Dobberfuhl, Dianne Hall, and Kimberli Ponzio |
| 4:05 – 4:20 pm | **Algae Scrubbers For Phosphorus Removal In Impaired Waters.**<br>Hugo R. Sindelar*, Mark T. Brown, and Treavor H. Boyer |
| 4:20 – 4:35 pm | **Lake Restoration Using Aeration And Alum: A Florida Case Study.**<br>Josette M. La Hée |
| 4:35 – 5:00 pm | **Question Period** |

| | |
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| 5:00 – 6:00 pm | **FLMS BOARD MEETING** (will be announced at last Sessions) |

## THURSDAY – JUNE 20, 2013 MORNING

| | |
|---|---|
| 8:00 am – 4:00 pm | **Check-In and Registration** (Bill France Lobby) |
| 7:00 – 8:30 am | **Breakfast** (Azure Room) |

**Session 8-A: A Systems Approach to Freshwater Management II** (Richard Petty Room)
Moderator: H Kenneth Hudnell

| | |
|---|---|
| 8:30 – 8:35 am | **Session Introduction - Moderator** |
| 8:35 – 8:50 am | **Satellite Measurements Of Phosphorus On Land And In Waterbodies.**<br>Milt Baker |
| 8:50 – 9:05 am | **APB Alert: Using Nanotechnology For Non-Point Source Nutrient Pollutant Control.**<br>Edward Weinberg |
| 9:05 – 9:20 am | **Pond And Lake Clarification During Dredging And When Nutrients Are An Issue.**<br>Seva Iwinski |
| 9:20 – 9:35 am | **Old School Alum Treatment For Little Lake Jackson – How It Looks Ten Years Later.**<br>Clell J. Ford |
| 9:35 – 10:00 am | **Question Period** |

**Session 8-B: Sustainable Water Resources at the Local Level** (River Room)
Moderator: Mike Britt

| | |
|---|---|
| 8:30 – 8:35 am | **Session Introduction - Moderator** |
| 8:35 – 8:50 am | **Sustainable Water Resource Management: Linking Environmental, Social, And Economic Demands.**<br>Thomas L. Singleton |
| 8:50 – 9:05 am | **The Need For Holistic Water Management: An Example From Winter Haven, Florida.**<br>David Tomasko |
| 9:05 – 9:20 am | **Valuing Ecosystem Services.**<br>Valerie Seidel |
| 9:20 – 9:35 am | **Decision-Making For Sustainability Begins At The Local Level.**<br>Mike Britt |
| 9:35 – 10:00 am | **Question Period** |

| | |
|---|---|
| 10:00 – 10:20 am | **MORNING BREAK** (Bill France Room) |

## THURSDAY – JUNE 20, 2013 MORNING

**Session 9-A: Saved The Best For Last I** (Richard Petty Room)
Moderator: Mike Perry

| | |
|---|---|
| 10:20 – 10:25 am | **Session Introduction - Moderator** |
| 10:25 – 10:40 am | **Drawdowns Of Florida Lakes And Trophic State Assessment.**<br>Bradley L. Jones |
| 10:40 – 10:55 am | **Effects Of User Interactions, River Morphology, And Plant Community On Prop Scars In The Rainbow River, Florida.**<br>*Amanda C. Croteau, Charles E. Cichra, and Jesse Stephens |
| 10:55 – 11:10 am | **Potential Impacts Of Seagulls On Nutrient Loading And Water Quality In Lake Weir.**<br>Rolland Fulton |
| 11:10 – 11:25 am | **Lake Eulalia Water Quality Improvement Project.**<br>Marissa Williams |
| 11:25 – 11:40 am | **Question Period** |

**Session 9-B: Saved The Best For Last II** (River Room)
Moderator: Sergio Duarte

| | |
|---|---|
| 10:20 – 10:25 am | **Session Introduction - Moderator** |
| 10:25 – 10:40 am | **Invasive Species Mapping In Hillsborough County Lakes And Streams.**<br>David Eilers |
| 10:40 – 10:55 am | **Developing A Public Education Program For Aquatic Plant Mangement Activities That Include The Use Of Systemic Herbicides (Bispyribac And Penoxsulam) In Residential Lakes.**<br>Timothy J. Egan |
| 10:55 – 11:10 am | **Empirical Evidence For Water Level Recovery In Isolated Natural Systems Following Reduced Groundwater Production In The Northern Tampa Bay Area.**<br>Dan Schmutz |
| 11:10 – 11:40 am | **Question Period** |

| | | |
|---|---|---|
| **11:40 am – Noon** | **Student Awards and Closing Remarks.** | **2013- 2014 FLMS President** |

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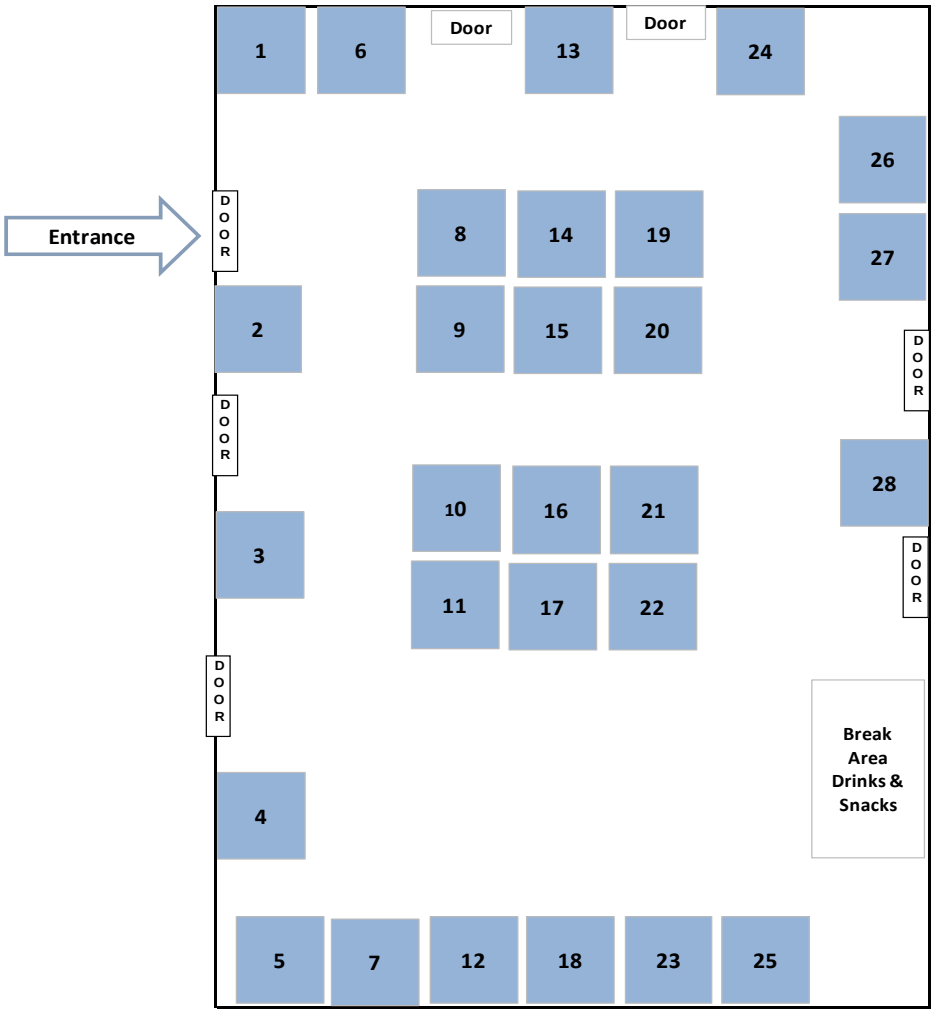


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## THE MARJORIE CARR AWARD
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***The Marjorie Carr Award*** *- is the Society's highest award and is given for life time work on behalf of Florida's aquatic resources. This award is named in honor of Marjorie Carr who, among other things, organized citizens and brought to an end the proposed Cross Florida Barge Canal.*

## THE EDWARD DEEVEY, JR. AWARD
**Mark Brenner**

***The Edward Deevey, Jr. Award*** *- is given to an individual for contributing to our scientific understanding of Florida's water bodies. Edward Deevey was an internationally recognized limnologist and affiliated with the State Museum of Florida at the time of his death.*

## THE SCOTT DRIVER AWARD
**Jill Heinerth**

***The Scott Driver Award*** *- is given to an "activist" who has promoted the restoration, protection and/or appreciation of Florida's aquatic resources. Scott was a well know activist on behalf of Lake Okeechobee and a member of the steering committee that founded the FLMS at the time of his death.*

## THE RICHARD COLEMAN AQUATIC RESOURCES AWARD
**John Hendrickson**

***The Richard Coleman Aquatic Resources Award*** *- is given to a professional who has worked to restore, protect and/or advance our understanding of Florida's aquatic resources.*

## THE MARJORY STONEMAN DOUGLAS AWARD
**Jeff Klinkenberg**

***The Marjory Stoneman Douglas Award*** *- is given to individuals in the media who report on aquatic resource issues. This award is named in honor of Marjory Stoneman Douglas who authored the book "Everglades: River of Grass", founded the Friends of the Everglades and who has been environmentally active in south Florida.*

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# Meet the Guest Speakers

## 1st Keynote Speaker

**William J. Mitch**
*Director, Everglades Research Park*

Dr. Mitsch is an ecosystem ecologist and ecological engineer who was co-laureate of the 2004 Stockholm Water Prize in August 2004 as a result of a career in wetland ecology and restoration, ecological engineering, and ecological modeling. His most significant contributions are development of the field of ecological engineering as an author of the first book on this subject and the founder (in 1992) and editor-in-chief of the scientific journal *Ecological Engineering*, creation of the Olentangy River Wetland Research Park, a unique 20-hectare (50-acre) wetland research laboratory and now Ramsar Wetland of International Importance at The Ohio State University, and major contributions toward the development of the field of wetland ecology, particularly as first author of four editions of the standard textbook *Wetlands*, a book used around the world to teach wetland ecology. That book has educated several generations of wetland scientists since it was first introduced in 1986. Dr. Mitsch's recent wetland research has emphasized wetlands for nutrient removal in the agricultural Mississippi-Ohio-Missouri (MOM) River Basin (Mitsch et al. 2001) and the importance of wetlands in climate change (Mitsch et al. 2009, 2012).

Mitsch is currently Eminent Scholar and Director, Everglades Wetland Research Park, Florida Gulf Coast University, Naples, Florida. Before October 2012 he was Distinguished Professor of Environment and Natural Resources at The Ohio State University and Director of the University's Wilma H. Schiermeier Olentangy River Wetland Research Park. His research and teaching has focused on wetland biogeochemistry, wetland creation and restoration, ecological engineering, and ecosystem modeling. Dr. Mitsch has authored or co-authored over 400 papers, books, and other publications in ecological and environmental science. He is co-author of 16 books including senior author of *Ecological Engineering* (1989), *Ecological Engineering and Ecosystem Restoration* (2004), four editions of *Wetlands* (1986–2007), and *Wetland Ecosystems* (2009).

## 2nd Keynote Speaker

**Wendy Graham**
*Director, University of Florida Water Institute*

Professor Wendy Graham is the Carl S. Swisher Eminent Scholar in Water Resources in the Department of Agricultural and Biological Engineering at the University of Florida and Director of the University of Florida Water Institute. She graduated from the University of Florida with a Bachelor's degree in Environmental Engineering. Her PhD is in Civil Engineering from the Massachusetts Institute of Technology. She conducts research in the areas of coupled hydrologic-water quality-ecosystem modeling; water resources evaluation and remediation; evaluation of impacts of agricultural production on surface and groundwater quality; and evaluation of impacts of climate variability and climate change on water resources. She has served as PI or co-PI on over $13 million in grants and contracts, has supervised 30 doctoral and master's thesis committees and has served on more than 50 additional graduate student committees. She served on the National Academy of Sciences Committee that reviewed EPA's Economic Analysis of Final Water Quality Standards for Nutrients for Lakes and Flowing Waters in Florida, and the National Academy of Sciences Committee that conducts an Independent Scientific Review of Everglades Restoration Progress.

## Special Lunch Speaker

**Mark T. Brenner**
*Director, Univ. of Florida Land Use and Environmental Change Institute*

Dr. Brenner is a limnologist/paleolimnologist with special interests in tropical and subtropical lakes and watersheds. He received his undergraduate degree in Biology from Grinnell College and his MS and PhD degrees in Zoology at the University of Florida (UF). Mark is a Professor in UF's Department of Geological Sciences and serves as Director of the Land Use and Environmental Change Institute (LUECI). He teaches courses in Paleolimnology, Limnology, Florida Lake Management, and TropicalField Ecology, the latter in Yucatan, Mexico. Mark is Co-Editor-in-Chief of the *Journal of Paleolimnology*.
Mark's research addresses interactions among climate, environment, and humans. He has worked on: 1) recent human-mediated changes in Florida lakes, 2) the historical ecology of the lowland Maya region, 3) Pleistocene/Holocene paleoclimate of the circum-Caribbean, 4) environmental history of the Bolivian Altiplano, 5) paleoecology of Yunnan Province, China, 5) the history of El Niño events, 6) 210Pb dating, and 7) biological accumulation of 226Ra. He has conducted fieldwork in Mexico, Guatemala, Panama, Venezuela, Bolivia, Ecuador and theGalapagos Islands, Haiti, Dominican Republic, China, Cambodia, and Florida.

# Session Abstracts

# Session 1: Springs: What do we know?

(Richard Petty Room)

**Tuesday, June 18, 10:30 am to 12:00 am**

## RELATIONSHIPS BETWEEN DISCHARGE AND NUTRIENT CONCENTATIONS IN FLORIDA SPRINGS

*Erich R. Marzolf, Ph.D. and Ann B. Shortelle, Ph.D.*
Suwannee River Water Management District, Live Oak, Florida

The health of Florida springs are challenged by nutrient enrichment, primarily nitrate, and declining discharge. Elevated nitrate levels have been implicated in ecological changes in springs, primarily proliferation of filamentous and epiphytic algae. In addition, many Florida springs are experiencing declining discharge with some ceasing to flow completely. Impairment determinations are based upon specific nutrient (nitrate > 0.35 mg N-NOx/L) and discharge (flow < site-specific minimum flow or level). The existence of long-term temporal trends in nitrate concentrations and discharge in some springs are well established, however less is known about potential interactions between time, nitrate and discharge. Here we present evidence that Florida springs exhibit a variety of relationships between time, discharge and nitrate concentration. Springs within the Suwannee River Water Management District exhibited positive, negative and no trend in nitrate while also showing a positive correlation between nitrate concentration and discharge. Similarly, there were springs which showed positive, negative and no trend in nitrate concentration while exhibiting no correlation with discharge. One spring had a weak negative correlation between discharge and nitrate concentration. In some springs, the interaction of these relationships may obscure temporal trends and landscape loading issues. Cost-effective nutrient and/or flow impairment remediation will be more easily implemented when proximal causes of declining health are accurately determined.

## PROTECTING THE DARK BY SHEDDING SOME LIGHT

*Amy L. Giannotti[1], Rima B. Franklin, Ph.D.[2], Aaron L. Mills, Ph.D.[3], Terrence N. Tysall[1], Marissa L. Williams[1]*
[1]Cambrian Foundation, Winter Park, Florida
[2]Virginia Commonwealth University, Richmond, Virginia
[3]University of Virginia, Charlottesville, Virginia

While it is becoming increasingly evident that bacteria play a vital role in facilitating the geochemical reactions that have helped shape many environments here on Earth, this interplay of biological and geological process and product is at the center of this study, which investigates the diversity and activity of microorganisms in karst environments and submerged caves. Over the past 15 years, interest in cave geomicrobiology has grown; however, most prior research in cave microbiology has been restricted to subaerial ('dry') caves and sites that are relatively easy to access. Little research has been conducted in submerged caves, which represent unique windows into deeper groundwater environments. This project employs a variety of molecular genetic approaches to characterize microbial diversity from

several submerged freshwater caves in central Florida. Primary questions of interest include: How similar are the microorganisms in these systems to those typically found in dry caves? Do these habitats represent reservoirs of new microbial diversity? We are currently focusing on sites that are dominated by chemosynthetic bacteria with metabolism based on sulfur oxidation.

Just as the activities of farming, industrial production, municipal, and hazardous waste disposal have had deleterious effects on the quality of surface water, groundwater and cave water have also been negatively impacted. Though the mounting environmental threat to these systems has led to increased research into subterranean systems, including aquifers, caves, and karst windows, to most of us, these habitats still remain "out of sight, out of mind." This has consequences for humans, in terms of contamination of drinking water supplies, and for the unique and fragile ecosystems that thrive within karst systems. This research fills a fundamental gap in our understanding of the microbiology and geochemistry of karst aquifers, and lays the foundation for: (1) increased understanding of the role microbial communities may have in the formation of karst features (speleogenesis) and in the functioning of cave ecosystems, (2) a better understanding of groundwater biogeochemistry, and (3) exploration of the role that microbial chemolitho(auto)trophic production may play in subterranean food webs.

## SOLUTIONS FOR SPRINGS, SUWANNEE STYLE

*Ann B. Shortelle, Ph.D. and Erich R. Marzolf, Ph.D.*
Suwannee River Water Management District, Live Oak, Florida

Springs are among the most visible and prized natural and recreational resources of the Suwannee River Water Management District (District). The District has the highest concentration of first magnitude springs in the United States and the highest concentration of springs in Florida. There are 309 known springs within the District. During low flow periods the Suwannee River, Santa Fe River, and Withlacoochee River essentially become spring runs due to substantial groundwater inputs. Other rivers such as the Ichetucknee and Wacissa are primarily spring-fed year round. This unique environmental condition truly makes the District the springs heartland of Florida. Our Heartland Springs Initiative is a comprehensive, multi-faceted approach involving every aspect of the District's management and regulatory programs.

The highly interactive character of ground and surface water in the District makes springs much like the proverbial "canary in the coal mine". The extraordinary drought conditions in 2012 brought extreme low flow conditions to many springs, and provided focus on the multiple values of springs from citizens to the Florida legislature. The use of minimum flows and levels (MFLs) to protect priority springs is one important tool. To date, the District has developed and implemented MFLs for the following springs: Little Fanning Spring, Fanning Spring, Madison Blue Spring, Manatee Spring, and Levy Blue Spring. The District is currently in the process of setting the MFLs for the Lower Santa Fe and Ichetucknee rivers and springs, and the status of this effort will be reviewed. Projects to enhance aquifer recharge not only sustain our water supply, but sustain our springs and other water resources. Water quality programs and projects are also important. Examples of District strategies important to springs' health will also be discussed.

## EVIDENCE OF SPRING FLOW DECLINES DUE TO REGIONAL GROUNDWATER EXTRACTIONS

*Robert L. Knight, Ph.D., Director*
Howard T. Odum Florida Springs Institute

A variety of methods were used to examine the importance of rainfall/recharge vs. groundwater pumping on spring flows in North Florida. Floridan Aquifer water balance estimates by others indicate that under pre-development conditions of zero extraction, the annual average outflow from the entire Floridan Aquifer was about 13.9 billion gallons per day (BGD). The historic average combined flow from 591 of Florida's 1,000+ springs was independently estimated as 10.6 BGD. The remainder of the Floridan Aquifer discharge is presumed to be from a combination of diffuse leakage and spring flows in Florida and neighboring states. In 2000 the total estimated groundwater extraction from the Floridan Aquifer was about 3.6 BGD or 26 percent of the total estimated recharge. The average cumulative reduction in Florida spring flows during that period was about 44 percent. Silver Springs flow reduction for the most recent decade was 32 percent. Average rainfall declines in North Central Florida were about 10 percent over that same period. These independent estimates indicate that current groundwater extractions are significantly reducing average spring flows.

## THE RESEARCH COMPONENT OF THE SPRINGS PROTECTION INITIATIVE OF THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

*Edgar F. Lowe, Ph.D.*
St. Johns River Water Management District, Palatka, FL

There have been substantial changes in the ecological character of many of Florida's springs. These changes include reduced flow rates, increased levels of nitrate, increased biomass and cover of algae and invasive aquatic plants, decreased abundance of native submerged aquatic vegetation, and changes in fish and invertebrate communities.

Recognizing the economic and ecological significance of springs, the St. Johns River Water Management District has developed a Springs Protection Initiative. The initiative has three major components: projects, regulation, and research. The research objectives are three-fold. First, improve the scientific foundation for management of nitrate loading to springs. In this objective, we will work towards a finer delineation of the spatial heterogeneity in the spring shed. This delineation will consider the spatial variation in hydrologic conveyance, nitrogen sources, and nitrogen transformation and loss. Second, evaluate whether nitrate reduction alone will be sufficient to restore the balance between benthic filamentous algae and native aquatic plants. It is clear that non-nitrate drivers influence primary producer community structure. It may be that forcings from these other drivers could maintain high benthic algal abundance at much lower concentrations of nitrate. Third, assess the relative influence and manageability of each of the various drivers controlling the balance between benthic filamentous algae and native aquatic plants. If nitrate control is insufficient or infeasible this ranking will indicate which other drivers could cost-effectively be managed.

The unifying focus of the work is the influence and controllability of forcings affecting the ecological structure and function of spring systems, especially the abundance of benthic filamentous algae. The primary focus of the research will be the Silver Springs system; the Wekiva system will be a secondary

focus. In addition, cross-system analyses for all springs with sufficient data will be used to explore the interrelationships among environmental drivers and ecosystem attributes.

# Session 2: FDEP Standards and Stuff

(Richard Petty Room)

**Tuesday, June 18, 1:50 pm to 3:00 pm**

## REVISED DISSOLVED OXYGEN (DO) CRITERIA FOR FLORIDA'S FRESH AND MARINE WATERS

*Russ Frydenborg and Garry Payne*
Florida Department of Environmental Protection, Tallahassee, FL 32399

The Florida Dept. Environmental Protection (FDEP) conducted an extensive statewide freshwater DO study during 2005 to 2006 (in lakes and streams) to collect data required to fully assess the accuracy of the current criteria and to revise the State's DO criteria, if warranted. The study found that DO concentrations in approximately 70 percent of the minimally disturbed streams and 52 percent of the minimally disturbed lakes sampled during the study would inappropriately fail the existing criteria of 5 mg/L (with 10 percent or more of the measurements falling below the criteria).

FDEP derived the revised freshwater DO criteria using the regression relationships between the daily average DO saturation and a measure of stream aquatic life health, the Stream Condition Index, coupled with an evaluation of DO concentrations in minimally disturbed reference sites. FDEP determined the DO saturation required to achieve an average SCI score of 40 (healthy) at the 90th percentile confidence interval.
FDEP selected DO percent saturation rather than concentration because a) the daily average DO saturation provided the best correlation with SCI scores, and b) saturation automatically accounts for the inherent relationship between temperature and DO. FDEP developed different regional criteria to account for the observed regional differences in measured DO levels and biological expectations, and used the confidence interval to account for the uncertainty in the relationships and the naturally expected diel fluctuations in the DO levels.

Based on the results of the regional regression models of average SCI scores and the daily average DO saturations, daily average DO levels of 67, 38, and 34 percent saturation for the Panhandle West, Peninsula, and Big Bend + Northeast bioregions, respectively, were determined to support healthy, well balanced biological communities.

To derive revised DO criteria for Florida's marine waters, FDEP used the USEPA Virginian Province approach using fish and invertebrate species known to inhabit Florida's waters. The Virginian Province method utilizes observed laboratory responses of species sensitive to low DO levels to calculate DO concentrations and durations that will protect against acute and chronic effects to aquatic life. The application of the Virginian Province method resulted in a minimum allowable DO saturation of 42 percent. To ensure additional protection against chronic effects, FDEP also determined minimum weekly and monthly average DO concentrations of 51 percent saturation and 56 percent saturation, respectively. Maintaining weekly and monthly average DO concentrations at or above these levels will protect against the adverse effects of low DO on the larval recruitment of sensitive species.

Based on the analyses conducted, the revised DO criteria for Florida's Class I and III freshwaters are expressed as:

*No more than ten percent of the daily average percent DO saturation values shall be below 67 percent in the Panhandle West bioregion, or 38 percent in the Peninsula and Everglades bioregions, or 34 percent in the Big Bend and Northeast bioregions.*

The revised DO criteria for Florida's Class II and III marine waters developed from the application of the USEPA Virginian Province approach to Florida specific fish and invertebrates is expressed as:

*The daily average percent DO saturation shall not be below 42 percent in more than ten percent of the values.*
*AND*
*The weekly- and monthly average percent DO saturations shall not be below 51 and 56 percent, respectively.*

Other components of the new DO criteria include:

- Implementation provisions, including how DO grab samples are adjusted via a time-of-day-specific translation of the daily average criterion to minimize assessment errors;
- Specific criteria to ensure protection of threatened and endangered aquatic species;
- Use an EPA-sanctioned provision to take into account the natural DO regime; and

A clause that would protect aquatic systems that have DO levels naturally higher than the minimum protective concentration. The clause would require that higher ambient DO levels be maintained, except as allowed under Rule 62-302.300 and 62-4.242, F.A.C. (anti-degradation provisions). Waterbodies will be identified as impaired if there has been a statistically significant decreasing trend in DO levels, or an increasing trend in the range of daily DO fluctuations, at the 95 percent confidence level, and a causative pollutant is identified. This trend will be determined using a one-sided Seasonal Kendall test for trend, after controlling for or removing the effects of confounding variables, such as climatic and hydrologic cycles, quality assurance issues, and changes in analytical methods

## USE OF THE STREAM CONDITION INDEX TO ASSESS BIOLOGICAL HEALTH IN FLORIDA STREAMS AND RIVERS

*Nia Wellendorf and Russ Frydenborg*
Florida Department of Environmental Protection, Tallahassee, Florida

The Florida Department of Environmental Protection (FDEP) has recently added biological assessment criteria, including the Stream Condition Index (SCI) to the Florida water quality standards (62-302, Florida Administrative Code [F.A.C.]) and impaired waters rule (62-303, F.A.C.). The SCI assesses how closely the macroinvertebrate community (*e.g.,* aquatic insects, clams, and crayfish) of a stream resembles the macroinvertebrate community of an undisturbed or "reference" condition. The method consists of collecting macroinvertebrates via 20 D-frame dipnet sweeps in the most productive habitats in a 100 m reach of stream. The organisms are sub-sampled and identified to the lowest practical taxonomic level. Ten metrics comprise the final index; eight metrics decrease in response to human disturbance, and two metrics increase in response to human disturbance. FDEP determined what SCI score represents a healthy aquatic community based on consensus of aquatic macroinvertebrate experts and the distribution of reference site scores. The SCI will be utilized in streams and rivers to inform decisions of potential waterbody impairment related to "imbalances of aquatic fauna" and

nutrient concentrations. Given the key role of the SCI in new rules, there is an increased need for state, regional, and local governments and private consulting firms to conduct SCI field sampling and lab analysis. FDEP has an ongoing field audit program to ensure that samplers are proficient in the SCI sample collection method, and now FDEP is also conducting QA activities to ensure that private and public taxonomic labs are properly following FDEP standard operating procedures (SOPs) for SCI sample processing, macroinvertebrate taxonomy, and SCI calculation. These audits will provide assurance to FDEP that SCI results produced by these private and public local labs are consistent with FDEP SOPs and can be used for legally defensible environmental decisions.

# Session 3: Lake Apopka and Other Applied Research

(Richard Petty Room)

**Tuesday, June 18, 3:30 to 5:00 pm**

## HISTORY AND MONITORING OF SUBMERSED AQUATIC VEGETATION IN LAKE APOPKA

*Jim Peterson*[1], *Paul Ek*[1], *Roxanne Conrow*[2]
[1] St. Johns River Water Management District, Mount Dora, FL
[2] St. Johns River Water Management District, Palatka, FL

Submersed Aquatic Vegetation (SAV), is an important component to healthy lakes. SAV provides a variety of ecological functions which include reducing water column turbidity, stabilizing sediments and providing food and habitat for fish and other species. SAV is often used as a barometer to gauge the health of lake or aquatic systems.

Lake Apopka is a large 31,000 acre lake in central Florida with a perimeter of just under forty miles. Prior to and just after the turn of the 20th century, Lake Apopka was a popular fishing destination for recreational largemouth bass, Micropterus salmoides floridanus. The water in the lake was exceptionally clear and the lake bottom was densely populated with SAV. Lake water quality conditions began to deteriorate after the mean water level was lowered following canal construction and nutrient inputs rose significantly from agricultural and municipal wastewater discharges. As the lake water quality declined, nutrient-driven algal blooms first occurred in 1947. Most of the lake SAV was shaded out over the next several years and stayed absent for over forty years.

As restoration efforts reduced nutrients in the lake, the first measureable beds of SAV returned in 1995 coinciding with the first statistically significant improvement in Lake Apopka water quality. St. Johns River Water Management District staff subsequently began monitoring and tracking the return of volunteer SAV beds of mainly eelgrass, Vallisneria americana. The work to encourage and measure the expansion of SAV in the lake has often been difficult due to extreme fluctuations in lake water levels. The changes in water level affect water quality and have created several events where littoral zone areas have dried and re-flooded. Fluctuating water levels have also created ideal conditions for tussock formation and plant competition with native invasive emergent plants such as cattail, Typha spp. and the invasive exotic submersed plant Hydrilla verticillata. Complete lake SAV mapping data were collected in 1996, 1997, 1998, 2000, 2006, and 2009. Additional field data were collected in later events including plant densities and sediment descriptions and depths. Lake Apopka experienced drought conditions in 2001-2002, 2006-2007, and 2012-2013. Budget-related reductions in staff and increasing SAV areas necessitated a new mapping technique in order to continue SAV estimates. A new stratified random method of mapping was developed and used in 2011 and 2012. Despite periodic drought-related drying of SAV beds and the concomitant fluctuations in water quality, native SAV is re-establishing in the lake.

# SAV MONITORING ON LAKE APOPKA IN 2011 AND 2012: A STATISTICAL APPROACH TO QUANTIFYING SAV RECOVERY

*Pam Bowen[1], Roxanne Conrow[1], Mike Coveney[1], and Jim Peterson[2]*
[1]St. Johns River Water Management District, Palatka, Florida
[4]St. Johns River Water Management District, Mount Dora, FL

Lake Apopka, in Orange and Lake counties, is the fourth largest lake in Florida with surface waters covering approximately 12,465 hectares (30,800 acres) (Hoge et al. 2003). The lake's perimeter is approximately 58,000 meters. In 1959, Vallisneria americana, eel grass, was common along the southwestern shore and the southern half of the eastern shore (Clugston 1963). Over the years, repeated plankton blooms, resulting from excess nutrients, reduced the extent of Vallisneria and other submersed aquatic vegetation (SAV) species in the lake.

SAV is sensitive to light penetration and provides a useful biomonitor to assess water quality improvements in Lake Apopka. During the early years of monitoring, when little SAV was present, whole-lake mapping could be accomplished fairly easily. However, as water quality has improved and the extent of SAV has increased, whole-lake mapping has become more labor intensive. As a result, in 2011 and 2012, a statistical sampling approach was developed to quantify the recovery of SAV on Lake Apopka using methods that were less labor intensive than those used in whole-lake mapping.

A geographic information system (GIS) was used to create 100-meter line segments around the perimeter of the lake. Based on field observations, the lake perimeter was categorized into four strata according to density of SAV beds; high, medium, low, and none. Each 100-meter line segment was classified based on the stratum it occurred in. A predetermined number of line segments to be surveyed for SAV were randomly selected from each stratum. During the 2011 and 2012 surveys, if SAV was present, the area of the SAV patches was mapped using a GPS. Water depths, representing the shallow, middle, and deep depths of each SAV patch, were recorded. In 2011, sediment cores were taken in each patch and the sediment types in each core were identified. In 2012, in addition to taking cores and identifying the sediment types, the depth of each sediment layer was measured. If SAV was not present on a line segment, its absence was noted and a core was taken in the center of the line segment to identify the sediments present at that site.

In 2011, between March and July, 133 line segments were sampled; 88 of the line segments had SAV and 45 had no SAV. In 2012, 107 line segments were sampled between June and February; 81 line segments had SAV and only 26 had no SAV. The mean hectares of SAV were calculated for each strata in each year and were used to quantify the amount of SAV in the lake using the total number of line segments in each strata. In 2011, a total 23 hectares (58 acres) of SAV were estimated for the lake. Despite worsening drought conditions in 2012, a total 23 hectares (56 acres) of SAV was calculated. Six SAV species were recorded in 2011 and five species were recorded in 2012. In both 2011 and 2012, Vallisneria americana was the dominant species; 17 hectares (41 acres) were estimated in 2011 and 21 hectares (52 acres) were estimated in 2012. The shallowest depth recorded on an SAV patch in 2011 was 0.0 ft and the deepest depth recorded was 6.0 ft. The mean mid-depth for SAV patches was 2.3 ft. In 2012, the shallowest depth recorded was 0.0 ft and the deepest depth was 4.6 ft. The mean mid-depth of the SAV patches was 1.5 ft. The lower depths in 2012 were reflective of the lower lake levels associated with drought conditions. The geographic distribution of SAV patches revealed that Vallisneria was no longer confined to the southwestern shore or the southern half of the eastern shore. Vallisneria patches were also found along the northeastern and northwestern shores of Lake Apopka.

This statistical method of sampling provided a less labor intensive protocol for monitoring and quantifying the recovery of SAV on Lake Apopka.

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## EFFECTS OF SEDIMENTS ON THE GROWTH OF *VALLISNERIA AMERICANA* IN LAKE APOPKA

*Ellen Bailey*[1] and Patrick Inglett[2]
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[2]University of Florida, Gainesville, FL

American eelgrass, *Vallisneria americana* has a long history in Lake Apopka and we investigated some of the mechanisms for recolonization and expansion which are not entirely understood. Eelgrass is a submersed plant adapted to a wide range of conditions including brackish rivers, black water and a range of oligotrophic to eutrophic lakes and rivers. Conditions for growth in Lake Apopka are suboptimal due to poor water clarity and highly organic and flocculent sediments, yet the acreage has been expanding in recent years. Eelgrass is an important indicator of the health and success of restoration activities. Common parameters of study include light, nutrient limitations, bulk density, organic matter content and competition. Understanding it better will aid in restoration management. Several sediment studies were conducted in Lake Apopka to study the availability of phosphorus and understand the nature of the sediments. Less research has been done in the littoral zones and in relation to the plants themselves.

We looked at the effects of sediment on growth of eelgrass in Lake Apopka. While eelgrass has grown predominately in sand substrates, it has been documented in Lake Apopka expanding in organic sediment types, peat and muck. In this study, parameters of interest included nitrogen, phosphorus and carbon of sediments and shoots as well as measurements of growth characteristics. The goal was to determine the better-quality substrate among organic and mineral sediment that supports healthier plants in Lake Apopka. It was hypothesized that sand substrates would produce healthier plants, based on previous studies and due to the higher percentage growth occurring in sand. The advantages of sand substrates include higher bulk density and redox potential and few growth inhibiting organic complexes and toxic compounds. Light, while an important component of growth, was adequate at all sample sites.

While more study needs to be performed, the results show that the eelgrass growing in sand were not healthier than those in the organic or peat sediment. Nutrients appear to be the main driver of growth form, though soil redox potential and age of plants may also be involved. There were significant

differences between organic and mineral substrates in overall sediment conditions (nutrients, bulk density, organic content, etc.), carbon accumulation in the shoots, plant density (stem $m^{-2}$), plant biomass (g $stem^{-1}$), and average length. Despite these differences, the plants had similar total biomass (g $m^{-2}$) and are expanding in most areas of the lake. Comparisons in the literature to other water bodies suggest overall health of eelgrass in Lake Apopka is low, based on biomass and density measures. Future research is needed to compare health of Lake Apopka eelgrass to those from other local lakes.

## EVALUATION OF BACTERIAL WATER QUALITY CHANGES AROUND THE COASTAL TOWN OF SUWANNEE, FLORIDA AFTER SEPTIC TANK PHASE OUT

*Larry J. Danek*[1], *Gary Dalbec*[1]
[1]Environmental Consulting & Technology, Inc., Gainesville, Florida

*Salmonella* contamination was detected in 1989 in commercially harvested oysters from an area around the town of Suwannee, Florida. The contamination was suspected to be caused in part by onsite sewage treatment and disposal systems (OSTDS) in the town. A central wastewater treatment plant was constructed in 1997 to alleviate the potential *salmonella* contamination source by abandoning all OSTDS. Prior to commencement of the wastewater treatment plant operations, a water quality study was conducted around the town of Suwannee during November and December of 1996. Thirteen years after the completion of the wastewater treatment plant and closure of the septic tanks, the same study was repeated in November and December of 2009 to evaluate differences in water quality that may be attributed to OSTDS closure. Both studies focused on sampling of nitrogen species, coliforms, and *salmonella* at stations upstream and downstream of the town on the Suwannee River and in canals within the town as well as in a groundwater monitoring well. The 1996 study indicated that there were more occurrences of *salmonella* in the river than in the canals, suggesting the town was not the primary source of *salmonella*. The 2009 study showed that *salmonella* occurrences were equal in the river and the canals, again indicating the canals were not the primary source of *salmonella*. Fecal coliforms decreased from 1996 to 2009 in both the canals and the river stations, whereas total coliforms increased from 1996 to 2009. Statistical comparison of the 2009 data with the 1996 data indicated there were statistically significant decrease in fecal coliforms in the canal stations ($P < 0.001$), increase in total coliforms in the river stations ($P < 0.001$), and decrease in total nitrogen in the river stations ($P = 0.011$).

# Session 4: Poster Session

(Bill France Room)

**Tuesday, June 18, 3:30 to 5:00 pm**

## EFFECTS OF MOTORIZED BOATING ON THE AQUATIC PLANT COMMUNITY OF THE RAINBOW RIVER, FLORIDA

*Amanda C. Croteau, Charles E. Cichra, and Jesse Stephens*
University of Florida, School of Forest Resources and Conservation,
Program of Fisheries and Aquatic Sciences, Gainesville, Florida

The Rainbow River is one of the largest spring-fed rivers in Florida, and recreational use of the river has increased steadily in recent years. Motorized boating can directly impact aquatic plants when propellers cut or dislodge them from the substrate. Motorized boating activity and plant damage was observed to determine if the quantity of damage was related to specific boat types or sizes, size of motor, or to operator behavior. A total of 269 motorized boats were observed during 2011 and 2012. The boats were categorized into eleven boat "types", length was estimated, and engine horsepower was recorded. The most common types included pontoon, Jon, and bay boats (82%). No damage was observed from the Gheenoe, inflatable, air boat, skiff / flats boat, or jet ski categories. Of the 126 pontoon boats recorded, 86.5% were not observed to cause damage to the aquatic plants, and those that did were due to operator behavior. Independent of boat type, larger boats caused more damage. No damage was observed for the 36 boats less than 15 feet in length. For boats from 16 to 20 feet, 12.4% caused damage, while 20.5% of boats 21 feet or longer caused damage. Independent of type or length of boat, higher horsepower engines caused more damage. The highest percentage of damage occurred from 76 to 100-HP engines. Within this category, 4 of the 7 boats caused plant damage due to operator behavior rather than engine size. Having a large engine does not necessarily lead to plant damage. This information could be used to target motorized boat operators for whom regulations or an educational program could be developed and implemented.

## ASSESSMENT METHODS FOR HILLSBOROUGH COUNTY LAKES AND STREAMS

*David Eilers*
Florida Center for Community Design and Research, Tampa, Florida

The Florida Center for Community Design and Research at the University of South Florida has been conducting lake and stream assessments in Hillsborough County with funding from both Hillsborough County and the Southwest Florida Water Management District. These resource assessments have focused on the vegetation communities, morphological characteristics and water quality of the systems. The integration of in-field and in-office technologies and varying assessment techniques have resulted in effective data collection and data processing as well as reporting for resource managers.

## IMPACTS OF RECLAIMED WASTEWATER ON BENTHIC FAUNAL DIVERSITY AND DECOMPOSITION RATES: PRELIMINARY FIELD STUDY

*Patrick Goodwin and Kelly Smith*
The University of North Florida, Department of Biology, 1 UNF Drive, Jacksonville, FL 32224

The University of North Florida (UNF) has two retention ponds that receive reclaimed wastewater directly, at varying rates. The lake with greatest influx, has also received wastewater directly for more than 5 years (GLC Lake). Another lake receives less influx and was more recently established (Fountains Lake). GLC Lake has become eutrophic and continues to show poor water quality, and Fountains Lake has begun to show similar signs of eutrophication. Adjacent to water quality monitoring sites, we sampled benthic fauna (4 Ekman Grab samples per site) in these lakes receiving reclaimed water and compared them to a more natural lake (Oneida Lake) in the same geographic area. Simpsons and Shannon diversity indices indicated increased fluxes of reclaimed waste water correlated with reduced diversity of the lake benthos. We compared plant litter decomposition characteristics between the same 3 lakes (160 litter bags of 250 µm mesh containing dried *Lemna* plants). Initial samples, 3 day, 7 day, 15 day, and 30 day in situ incubations at the sediment surface were conducted. Results of before and after dry masses, total Phosphorous and Carbon will be discussed.

## AERIAL APPLICATION OF GRANULAR ALUM IN BLUE CYPRESS WATER MANAGEMENT AREA-WEST, UPPER ST. JOHNS RIVER BASIN

*Victoria R. Hoge*[1], *Dianne Hall*[1], *Dean Dobberfuhl*[1], *Lawrence Keenan*[1], *Steven J. Miller*[1], *and Angelique Bochnak*[2]
[1]St. Johns River Water Management District, Palatka, FL
[2]AMEC, Jonesville, FL

The Ansin West tract comprises approximately 1,780 acres of the St. Johns River Water Management District's Blue Cypress Water Management Area – West (Ansin West) in Indian River County. This area is comprised of a mosaic of slough and herbaceous and shrub-dominated marshes with a few scattered tree islands and provides valuable foraging and nesting habitat for the endangered snail kite (*Rostrhamus sociabilis*). Since the completion of L-77 in 1991 and the widening and deepening of C-52, coverage of cattail and nuisance vegetation in Ansin West has expanded greatly resulting in a substantial reduction in suitable open foraging habitats for the snail kite. Extensive soil testing conducted in October 2011 revealed elevated bioavailable phosphorus in the sediments of Ansin West, which is likely responsible for the observed cattail encroachment. A chemical amendment strategy was chosen to reduce sediment P and granular alum [$Al_2(SO_4)_3$] was selected as the most cost-effective option. Previous application of liquid alum by barge on a District restoration area was not effective due to the capture of the chemical by dense vegetation. Given the concentration and distribution of phosphorus in the soils of Ansin West, approximately 600 acres of marsh required treatment at an application rate of 500 lbs/acre. The most efficient method of treatment was via aerial application. Prior to the alum application, the treatment area was herbicided and then burned in early August, 2012, removing vegetation that might otherwise intercept the alum. On August 29 – 31, 2012, a Huey aircraft, using GPC coordinates, spread a total of 300,000 pounds. Initial water quality results were excellent displaying no dramatic alkalinity or pH

depression. Vegetation and soil sediment changes will be tracked in the future to ensure that the bioavailable P fraction has been sufficiently reduced to prevent further cattail expansion.

## SUCCESSION PATTERNS OF ZOOPLANKTON DURING SPRING CYANOBACTERIAL BLOOM IN A SHALLOW, SUBTROPICAL LAKE

*Akeapot Srifa*[1], *Linghan Dong*[2], *Mary F. Cichra*[1] *and Edward J. Phlips*[1]
[1]Program of Fisheries and Aquatic Sciences, SFRC, University of Florida, Gainesville, FL
[2]Institute of Marine Sciences, University of North Carolina at Chapel Hill, Morehead City, NC

Intensive field observations were carried out in Lake George, Volusia County, Florida during the spring bloom of March – April 2009. Three-month, bi-weekly samples from 2 sampling sites were obtained for zooplankton, phytoplankton, and associated water chemistry and physical variables to identify patterns in planktonic community structure changes. The study period featured two major cyanobacterial blooms, in April and in June, which coincided with rainfall events and increases in water color and nutrients. Patterns of successions in zooplankton community from rotifers to cladocerans and copepods were identified along with changes in phytoplankton community structure from diatoms to cyanobacteria. Changes in phytoplankton composition and abundance were examined within the context of nutrient levels and hydrological conditions (i.e. water color, rainfall, and water residence time). Changes in zooplankton composition and abundance were evaluated in terms of their relationships to parameters related directly or indirectly to phytoplankton, including food preferences of zooplankton, elevated cyanobacterial toxins (saxitoxin, microcystins, and cylindrospermopsin), temperature variations, and dissolved oxygen levels. The trends are discussed in terms of how shifts in planktonic communities might affect the integrity of the ecosystem. We also discuss how anticipated climate changes (warming temperature, sea level rise, and changes in rainfall pattern), increased water demand, and eutrophication could alter relationships between phytoplankton and zooplankton.

# Session 5-A: Lake Okeechobee Research

(Richard Petty Room)
Wednesday, June 19, 10:30 to 12:00 pm

## LAKE OKEECHOBEE'S DYNAMIC MARSH – ECOLOGICAL RESPONSES TO NATURAL AND HUMAN IMPACTS

*Chuck Hanlon*,
South Florida Water Management District, West Palm Beach, FL

Lake Okeechobee's 40,000 ha marsh provides important habitat for sport and forage fish, wading birds, endangered Everglades snail kites (Rostrhamus sociabilis), and numerous other wildlife. The quality of fish and wildlife habitat (e.g., plant distribution and species composition) in the marsh is primarily influenced by hydrologic conditions including the frequency, duration and depth of inundation. Results from ecological monitoring studies evaluating the areal changes in plant distribution across the marsh landscape and the response of foraging colonies of wading birds and nesting snail kites to natural and management based environmental changes will be discussed. Planned long-term management of the system includes activities in the watershed north of the lake that would reduce the frequency and duration of historic extreme high and lower water events which negatively impact desired flora and fauna. Recent hydrologic conditions are generally thought to be favorable and reflect ecological conditions that could occur more often after proposed management activities in the watershed are implemented.

## SUBMERGED AQUATIC VEGETATION (SAV) MONITORING IN LAKE OKEECHOBEE, 2000-PRESENT

*Amy L. Peters and Chuck Hanlon*
South Florida Water Management District, West Palm Beach, FL

Submerged aquatic vegetation (SAV) in Lake Okeechobee provides important habitat for fish and wildlife and the associated food web that supports them. Dense stands of SAV help stabilize bottom sediments thereby reducing turbidity. SAV also provides substrate for periphyton and other attached algae that remove phosphorus from the water column. For the past thirteen years, District scientists have conducted quantitative and qualitative sampling to evaluate the relationship of stressors such as light availability, total suspended solids (TSS), and changes in water levels on both spatial and temporal changes in the abundance and distribution of SAV in the lake. Over this time, the Lake Okeechobee regulation schedule was modified and several major physical perturbations including hurricanes, tropical storms, and droughts directly impacted the system; resulting in dramatic changes in lake levels and water quality. The changes in SAV, TSS concentrations, and water transparency associated with both natural and human disturbances will be presented.

Additionally, an empirical model that predicts light penetration based on TSS samples (used as a surrogate for turbidity) at a given lake stage will be presented. This spatial mathematical model was built as a GIS project that utilizes current bathymetry data to predict areas within the lake that are likely locations for SAV colonization when conditions become favorable based on the secchi depth to total

depth ratio and TSS values. Implementation of this tool could be used in future modeling projects to attempt to assess how SAV communities would respond to implementation of proposed CERP (Comprehensive Everglades Restoration Plan) projects, other lake restoration efforts, and global climate change.

## AN UPDATE OF THE LAKE OKEECHOBEE WATER QUALITY MODEL (LOWQM): CALLIBRATING TO EXTREME EVENTS

*R. Thomas James*
South Florida Water Management District, West Palm Beach, FL

The Lake Okeechobee Water Quality Model (LOWQM) evaluates in-lake and sediment nutrient responses to management scenarios of nutrient and hydrologic loads over a multi-decadal scale. Originally calibrated to water quality data from 1983-2000 (James et al. 2005), the model was recalibrated to the 1983-2012 period, which included the effects of three hurricanes--Frances and Jeanne in 2004 and Wilma in 2005--and a two year drought (2006-2007). These weather events dramatically changed the water quality of Lake Okeechobee (James et al. 2008). A major factor in the model recalibration was to update the sediment resuspension forcing function, which was developed with a mass-balance technique used to match simulated and observed suspended solids data (Figure 1a).

The original and recalibrated model were compared using a total maximum daily load (TMDL) scenario, which reduced total phosphorus (TP) loads to meet the Lake Okeechobee phosphorus TMDL. Both models predicted very similar TP concentrations, indicating the importance of sediment-water interactions, which under most conditions exceed biological fluxes of P in the water-column (Figure 1b). These results also indicate the importance of sediment phosphorus in the nutrient dynamics of the lake.

Compared to measured data, both models produced similar results for chlorophyll and TP (Table 1). The recalibrated model more closely matches measured data (based on percent bias) for total nitrogen and soluble nutrients. The improvements were minor. A number of model enhancements are recommended to improve performance. These include, phytoplankton space/refugia control, improved nitrogen/ammonia uptake preference, an improved method to simulate nitrogen-fixation, and multiple layers for the water column to separate the euphotic and aphotic zones. Including these enhancements should further improve model calibration results and prediction reliability. Even without the enhancements, the updated model now encompasses a wider range of hydro-meteorological conditions, which is expected to provide improved water quality predictions for management scenarios.

### References

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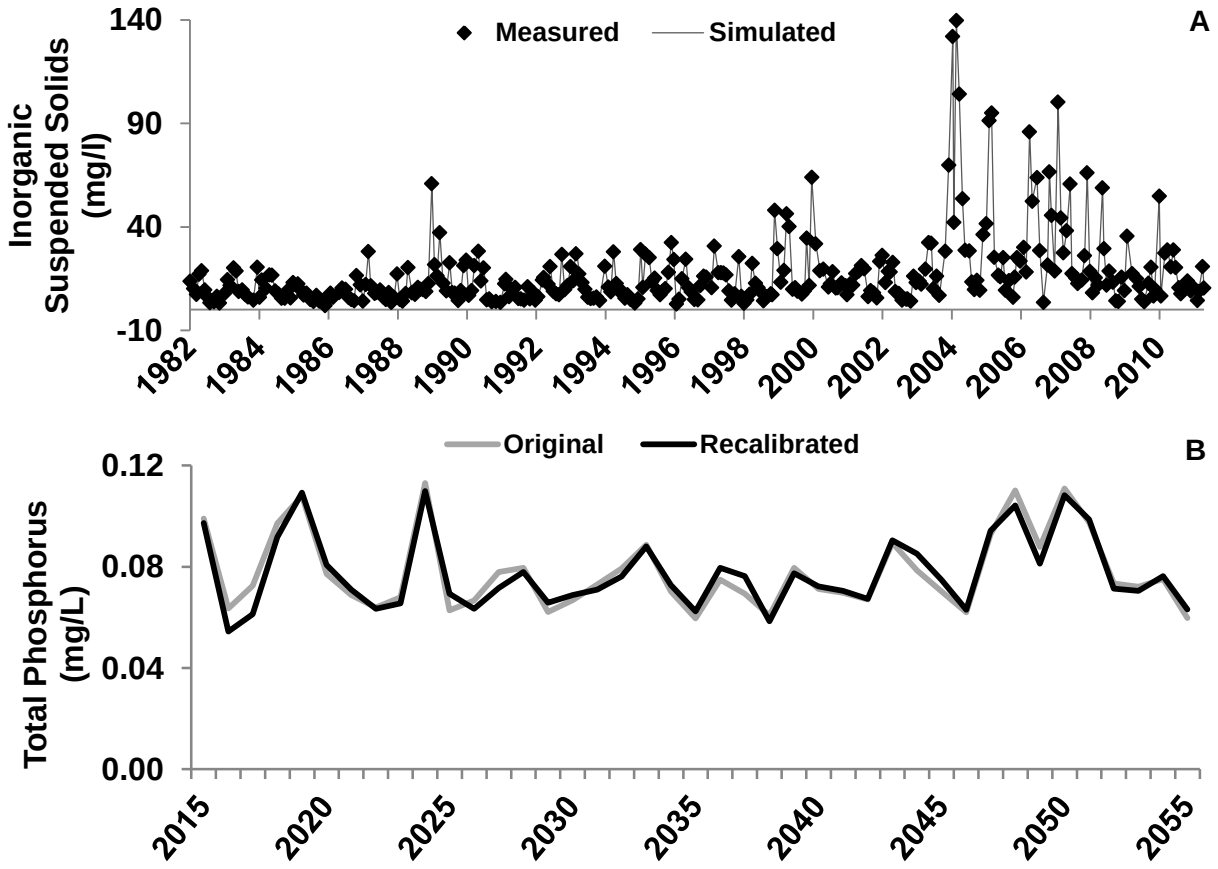
James R. Thomas, Chimney Michael J., Sharfstein Bruce, Engstrom Daniel R., Schottler Shawn P., East Therese, Jin Kang-Ren. 2008. Hurricane effects on a shallow lake ecosystem, Lake Okeechobee, Florida (USA). Fundamental and Applied Limnology. 172(4):273-287.

Table 1. Numeric comparisons of simulations and measured data (percent bias and $R^2$ of monthly averaged values: N=340).

| | Statistic | Total Phosphorus | Chlorophyll a | Dissolved Inorganic Nitrogen | Soluble Reactive Phosphorus | Total Nitrogen |
|---|---|---|---|---|---|---|
| **measured** | **mean** | 0.12 | 22.1 | 0.19 | 0.04 | 1.56 |
| | **standard deviation** | 0.07 | 16.8 | 0.21 | 0.03 | 0.48 |
| **2000** | **mean** | 0.11 | 21.8 | 0.22 | 0.04 | 1.80 |
| | **standard deviation** | 0.03 | 18.7 | 0.14 | 0.03 | 0.67 |
| | **percent bias** | -1.7% | -4.9% | 23.5% | 20.4% | 16.6% |
| | **$R^2$** | 0.74 | 0.13 | 0.08 | 0.42 | 0.29 |
| **2012** | **mean** | 0.11 | 22.7 | 0.17 | 0.04 | 1.45 |
| | **standard deviation** | 0.03 | 19.6 | 0.16 | 0.03 | 0.64 |
| | **percent bias** | -2.6% | -1.3% | -3.8% | 3.2% | -6.3% |
| | **$R^2$** | 0.66 | 0.09 | 0.06 | 0.41 | 0.28 |

Figure 1. A) Observed and simulated Inorganic Suspended Solids in the water column of Lake Okeechobee, B) Annual average simulated values of TP for the Total Maximum Daily Load scenario.




## MONITORING ORGANIC SEDIMENT REMOVAL PROJECTS ON LAKE OKEECHOBEE FOR CHANGES IN FISH, PLANT AND AVIAN COMMUNITIES

*Alyssa Jordan, Brent Bachelder, Tyler Beck, and Donald Fox*
Florida Fish and Wildlife Conservation Commission, Okeechobee, Florida

The littoral zone of Lake Okeechobee Florida suffers from unnatural buildup of organic sediment due to poor lake water level management, the Herbert Hoover dike and increased nutrient input. This sediment buildup has cut off hydrologic flow to portions of the marsh resulting in extremely dense vegetation to build up. Various sediment removal projects have been implemented on Lake Okeechobee since 2001 with the objectives of improving fish and wildlife habitat, increasing diversity of plant species, improving water quality, and improving water flow within littoral areas by allowing the flushing of accumulated detritus. Past projects did not monitor the effects of sediment removal on the plant, fish and avian communities. Two locations in the northwestern littoral zone have been selected as areas of future projects. The first area, called Indian Prairie Canal (IPC) slough was at one time an area of open water that was responsible for the exchange of lake water into the nearby littoral zone

marsh. The second area, called First Point connector was once part of the Kissimmee River delta. This area currently consists of extremely dense cattail and detritus which is partially due to hydrologic isolation.

Annual plant, fish and avian surveys are being conducted in these areas to document pre-restoration conditions. Surveys are also being conducted in a control area that is not designated for sediment removal. After sediment removal, additional surveys will continue until the communities appear to stabilize. Any changes in communities during this time will be documented, hopefully showing a positive result from restoration. Plant surveys consist of macroplots using line intercept surveys and quadrats. Avian surveys by using point counts and aerial surveys. Fish surveys are conducted using airboat electrofishing, throw traps and fish traps. The fish surveys are undergoing further study to determine which methods will be best.

# Session 5-B: A Systems Approach to Freshwater Management I

(River Room)

Wednesday, June 19, 10:30 to 12:00 pm

## WATERBODY MANAGEMENT, THE UNIMPLIMENTED PILLAR OF THE CLEAN WATER ACT, IS ESSENTIAL: WATER CIRCULATION BENEFITS

*H Kenneth Hudnell*
Medora Corp. & University of North Carolina, Dept. Env. Sci. & Eng., Chapel Hill, NC

U.S. policy for freshwater management is insufficient and overly expensive. Approximately 44% of river and stream miles, and 64% of lake and reservoir acres are impaired pursuant to Clean Water Act (CWA) Section 303(d). The U.S. Environmental Protection Agency (EPA) estimates that eutrophication of lakes and reservoirs increased from 10-20% in 1972 to about 50% in 2007. A recent EPA assessment of 2008-2009 data for our Nation's rivers and streams found that 66% contained excessive levels of phosphorus, a primary cause of eutrophication, up from 47% in 2004. CWA legislation established three pillars of freshwater management to restore and protect freshwater designated uses, the: 1) Clean Lakes program (CLP; i.e. Waterbody Management, WBM) for restoring publicly-owned lakes and reservoirs in Section 314 (1972); 2) National Pollution Discharge Elimination System program regulating point-source pollutant discharges in Section 402 (1972), and; 3) Nonpoint-Source Management program to prevent pollutant runoff using Best Management Practices (BMPs) in Section 319 (1987). However, only about $145M was awarded for Section 314 CLP projects since 1976, none since 1995, and the Agency no longer requested appropriations. EPA allowed states to apply for CLP funding through Section 319, but WSM BMP projects received almost the entire $3.9B budget. Policy targeted pollution prevention (Watershed Management, WSM), but ignored internal loads, air deposition, the cost inefficiency of many BMPs, and WBM. WBM is the application of technologies, biological principals, and hydrologic manipulations within waterbodies to sustainably restore and protect their designated uses. WBM methods reduce stress on impaired biochemical processes to enable recovery by harmful algae suppression that allows nutrients to ascend trophic levels improving fisheries, removing nutrients, binding or degrading toxic substances, and inactivating pathogens. Continuous circulation of the water column is a fundamental treatment for accomplishing these goals. Data from freshwater studies will demonstrate harmful algae suppression, manganese oxidation, and the prevention of mercury methylation. Data from wastewater studies will demonstrate promotion of nitrification and denitrification, and pathogen inactivation. These data and those from other presentations in these sessions indicate that the originally intended CWA policy - complementing WSM with WBM - provides greater management flexibility, restoration and protection effectiveness, and cost efficiency than the current policy of WSM alone. It is time for Congress or the EPA to reassess current freshwater management policy.

## WATER QUALITY MANAGEMENT PRACTICES USING TREATMENT TECHNOLOGY WITHIN THE WATERBODY

*Eddie Snell*
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Current regulatory practices for rehabilitating impaired waterbodies revolve around load reduction best management practices (BMPs). These are designed to reduce impairments through incremental reductions of a target pollutant. However, these practices often leave the existing lake, river, pond, or stream to languishing in an unhealthy condition for years and even decades. The condition of these waterbodies is often in need of immediate remedial treatment. The road to recovery starts with practices that address issues of oxygenation and water circulation within the waterbody.

Dissolved Oxygen (DO) is often the first parameter needing stabilization. DO and water circulation can be improved by adding aerators, bubblers, and pump devices. Once the DO levels are stabilized, other measures can be taken to address specific waterbody parameters.

Organic sediment reduction can be effectively reduced by several technologies. RCID tested two methods (oxygen injection and bacterial inoculums) and produced a 60% reduction of sediment thickness within 14 days. Nitrogen and Phosphorus were also reduced by 40% and 30% respectively.

Phosphorus and turbidity from sediment can be reduced using Anionic Polyacrylamide (PAM) blends to bind these pollutants. The PAM treatment can be incorporated into the water circulation device or it can be used as a separate system. Phosphorus and Chlorophyll-a reductions of >75% can be achieved through proper application of the PAM material.

Several case histories and supporting data for water quality improvement will be presented. Improving internal water quality quickly is a technique that can often be applied to small to medium sized waterbodies. Then the benefits of pollutant load reduction in the watershed will allow for long-term recovery.

## BIOLOGICAL AUGMENTATION OF WATER BODIES

*Peter G. Kalogridis*

As all living species depend on water for life one of the major environmental challenges today is maintaining good water quality, including the prevention of harmful algal blooms (HABs). A bacterial group that functions to purify water is classified as Purple Sulfur Bacteria (PSB). Water quality management utilizing PSB biological augmentation is simply "load in and load out" by enhancing the native bacterial populations to compensate for the excess nutrient load entering the waterbody. PSB solidify the benthos by decomposing carbon compounds, convert nitrate into nitrogen gas for true removal and remove nutrient from the water column as their biomass increases, thereby making them unavailable for harmful blue-green algae. This biotechnology has proven to be effective in limiting the frequency, intensity and duration of algae blooms. Case study results as presented for an eleven acre freshwater lake located in Central Florida utilized as an irrigation reservoir and augmented with nutrient

rich reclaimed water that produced a negative effect on water quality. Biological augmentation consisted of an initial treatment of 250 gallons of PSB inoculums with a 30 gallon monthly PSB maintenance treatment. Conventional treatment methods were also integrated into a treatment train which included two types of submerged water mixers which created both vertical and horizontal water circulation within the mixing zone of the lake. This water circulation effectively dispersed the bacterial inoculum while increasing the dissolved oxygen content, increasing the native microbial biomass and inhibiting the HABs. Also the water level is annually drawn down in the dry season to oxidize the exposed bottom sediments and to harvest aquatic vegetation within the littoral zone. The result of this utilization of synergies among complimentary treatment methods over a three year period eliminated HABs, solidified the benthos and reduced nitrate levels by 90% as determined from a site specific monitoring well mandated by permit and sited specifically to measure seepage from the lake. This monitoring well is sampled quarterly by a third party certified independent water quality laboratory for regulatory compliance. Biological augmentation utilizing PSB inoculums is a safe and effective treatment method for reducing the nutrient loading and improving water quality. Developing water management synergies which compliment the biological function of PSB can produce outstanding results providing for both water quality enhancement as well as significant aquatic ecosystem restoration. By working with nature instead of overriding nature good water quality can be achieved while effectively restoring aquatic ecosystems in a sustainable manner.

## FLOATING WETLANDS AS A TOOL FOR NUTRIENT POLLUTION REMEDIATION

*Steve Beeman, M.S.*
President, Beemats, L.L.C.; New Smyrna Beach, Fkorida

Nutrient pollution in stormwater runoff is an issue of national concern. Although nitrogen and phosphorus are critical for all plant growth, excess nutrients can be carried by rain water into lakes, streams and rivers. Stormwater ponds are commonly used to intercept and hold runoff prior to its introduction to natural water bodies. In the December, 2011 issue of STORMWATER Journal, Drescher, Sanger and Davis conducted a study of 112 stormwater ponds in coastal South Carolina. More than half of the ponds exhibited poor water quality and algal blooms, and half of those contained "harmful algae blooms (HABs)" , potentially toxic to people and wildlife. The authors commented "Stormwater ponds were originally intended to manage localized flooding; however over the past decade, they have been increasingly expected to address water quality concerns for receiving waters, including the removal of pollutants". They concluded that wet detention ponds " are likely to accumulate contaminants, sediments and nutrients at higher concentrations, prior to discharging to waters of the state".

In his report to Indian River County, Florida in 2011, Allen Stewart clarified the differences between active and passive nutrient removal by stormwater treatment systems. "Passive biological treatment systems serve more as nutrient storage facilities than nutrient removal and recovery facilities." However, "Active treatment systems are sustained by harvesting biomass with accumulated nutrients, thereby establishing pollutant removal accountability". One of the new active treatment tools is the use of floating wetlands. Macrophyte plants, along with the biofilm matrix supported by the suspended root mass, extract, convert and store nitrogen and phosphorus, in competition with algae and nuisance aquatic vegetation. Floating wetlands can be employed to intercept stormwater runoff before it enters natural waterways or even to help clean up impaired water bodies within a watershed. Regular harvest of the biomass from the floating wetlands is crucial to remove stored nutrients from the water.

During the past five years, several independent studies have been conducted to measure the effectiveness of Beemat floating treatment wetlands. At Clemson University, Dr. Sarah White compared mesocosm and controlled pond nutrient uptake rates with those in a wet detention pond. The observed efficiencies in the controlled environments were considerably higher than in the stormwater pond, where the concentrations in the water were affected by sediments, seepage and undocumented nutrient loading. She concluded "The floating plant root system provides adequate area for microbial colonization, filtration, sedimentation and plant nutrient uptake. An additional benefit is easier harvest of plant mass for additional nutrient removal. Floating mat systems exhibit great potential for nutrient remediation." During a two year study for the Florida Department of Transportation, Dr. Marty Wanielista, Dr. Na Bin Chang and their students also compared mesocosm experiments with field trials in wet detention stormwater ponds. Even with very low nitrogen and phosphorus loading rates, they concluded that the introduction of floating wetlands increased the nutrient uptake efficiency in the ponds by 12 % , as long as the biomass is harvested and replanted on an annual basis. Dr. Harvey Harper measured water concentrations and analyzed plant biomass from floating wetlands in a wet detention stormwater pond at Patrick Air Force Base in Satellite Beach, Florida during 2011 and 2012. Although undocumented nitrogen loadings from heavy bird utilization and possibly unmeasured phosphorus inputs from direct golf course runoff made water quality monitoring difficult, Dr. Harper determined by sequential biomass analysis, that the floating wetlands removed 6.1 % of the nitrogen loadings to the pond, and 14.5 % of the phosphorus loadings, by direct plant uptake alone.

There is a direct correlation between nutrient concentrations in stormwater and the uptake rates by plants. The calculated improvement in nitrogen and phosphorus removal for retention ponds with relatively low nutrient concentrations (i.e. clean water) is about 12 %. The load reduction in cases with higher nutrient concentrations (usually in ponds that exhibit algae or duckweed growth) is around 25 %. In the tests at Clemson University and the University of Central Florida, where there were no sediment or seepage issues, the decrease in nutrient concentrations was between 40 % and 50 %. While the mesocosm and experimental pond data provide a more accurate picture of the capabilities of floating treatment wetlands, the field studies document real world anomalies that make value analyses for these systems difficult. As a conservative estimate, for stormwater with moderate nutrient loading, an installation of floating wetlands equal to 5 % of the water body surface area, should provide at least 12 % to 15 % additional nitrogen and phosphorus removal over the pond alone. A key component is the regular harvest and removal of the mature plants with the accumulated nutrient loads.

# Session 6-A: Lake Jesup I plus - the Watershed

(Richard Petty Room)
Wednesday, June 19, 1:30 to 3:00 pm

## WATER QUALITY BEFORE AND AFTER LAKE JESUP TMDL

*Sherry Brandt-Williams, Ph.D*
St. John's River Water Management District, Palatka, Florida

A Total Maximum Daily Load (TMDL) and Basin Management Action Plan (BMAP) went to rule for Lake Jesup in 2006 and 2008 respectively. Many water quality improvement projects have been established since then, and a few before, that were expected to reduce external Total Phosphorus (TP) loading to the lake by approximately 9 MT over a 15 year period. This presentation looks at water quality in the tributaries and in the lake both before and after implementation of the first five years of the BMAP program. Estimated project reductions are compared to actual reductions in loads in the tributaries and responses within the lakes water column. Nutrient and phytoplankton data are analyzed for significant changes and relationships.

This is the introductory presentation to a special session on Lake Jesup which will cover specific treatment projects and lake sediment evaluations.

## STORMWATER TREATMENT RETROFITS: BAFFLE BOXES WITH MEDIA FILTRATION FOR THE LAKE JESUP WATERSHED

*Kelly H. Brock, Ph.D., P.E., LEED AP*
City of Casselberry, Florida

In 2010, the City of Casselberry was awarded an FDEP TMDL Water Quality Restoration Grant in the amount of $250,000 to assist with the installation and evaluation of five baffle boxes with media filters in two different basins within the Lake Jesup Watershed. As was the case with this project, baffle boxes are often employed as a storm sewer infrastructure retrofit, placed in-line with older existing storm sewer systems. They are intended to capture sediment, debris, leaves, hydrocarbons, and other pollutants prior to discharge to receiving waterbodies. The baffle boxes used in the City's project included both debris screens at the inlet point (to intercept gross pollutants), as well as specialized media filters at the outlet (intended to bind phosphorus, other nutrients, and pollutants). As part of the grant submittal, it was initially estimated the project would treat approximately 144 acres (mostly single family residential), providing 23.5 kg/yr TP removal (a 24% reduction). However, while second generation baffle boxes (which typically feature a debris screen but no media filters) have been studied extensively in Florida, it is the media filter feature of the boxes the City used that is relatively new in Florida and not well studied. Construction was completed in 2012, and an effectiveness evaluation of the retrofit project is currently underway that will evaluate three of the baffle boxes installed with this project, as well as one existing baffle box (without media filtration) and one existing CDS (continuous deflective separation) unit. Once concluded, the results of this study will help better assess the true

efficacy and lifecycle benefit to cost ratio for such installations, and also provide some comparison between differently equipped baffle boxes.

## LAKE JESUP NUTRIENT REDUCTION FACILITY-SOLDIERS CREEK REGIONAL STORMWATER FACILITY AT COUNTY ROAD 427

*Mark Flomerfelt*[1], Kim Ornberg[1], Harvey H. Harper, III[2], Greg Teague[3]
[1] Seminole County Public Works, Sanford, FL
[2]Environmental Research & Design, Inc, Orlando, FL
[3]Pegasus Engineering, Winter Springs, FL

The Lake Jesup drainage basin covers an area of approximately 87,331 acres. Soldiers Creek is a tributary to the Lake Jesup basin covering over 12,000 acres. The FDEP Final TMDL Report (2006) estimated the Soldiers Creek basin contributed 11% of the annual surface water runoff to Lake Jesup. The adopted BMAP for Lake Jesup requires reductions in surface water loading to the lake. It is estimated that 32,849 pounds per year of TP enter the lake through surface water runoff. Seminole County's allocation for TP reduction is 6411 TP over the 15 year BMAP implementation period, 2010 to 2024. Seminole County began planning its first Regional Stormwater Facility using alum in 2009 to meet these future BMAP goals. The presentation will discuss the preliminary engineering and final design phases of the project. An existing stormwater pond adjacent to Soldiers Creek will be modified to accept diverted flow from the creek. Alum will be added to precipitate nutrients, with the floc collected in a linear trough, pumped to a series of on-site storage tanks and transported to a WWTP for disposal. The annual phosphorus load conveyed through by the creek at the project location is 2,787 pounds/year. The design estimated annual load reduction is 2,134 pounds/year at 85 % of the annual volume treated. Funding considerations were investigated and the FDOT was underway with widening of US 17-92 which runs through the Spring Hammock Preserve. The original FDOT plans required land acquisition adjacent to the Preserve. An alternate treatment option was discussed with the SJRWMD staff to allow for the required FDOT load reductions to be achieved by the Seminole County project. The Seminole County project will provide FDOT's required TP reductions, thus allowing less disturbance in the area surrounding the Preserve. FDOT agreed to fund the construction of the Seminole County project in exchange for TP credits for the SJRWMD permit and future BMAP commitments to FDEP. Seminole County will maintain and operate the facility.

## UPDATE ON THE NUTRIENT REMOVAL EFFICIENCY OF STORMWATER CATCH BASIN INSERT (CBI) FILTER BASKETS WITHIN URBAN RESIDENTIAL AREAS IN ORANGE COUNTY - FLORIDA

*Sergio Duarte*
Orange County - Environmental Protection Division (EPD), Orlando, Florida

Each year, thousands of pounds of nutrient rich sediments, leaves and trash debris are transported directly into many of our local lakes from untreated stormwater associated with impervious streets, parking lots and driveways. These pollutants negatively impact the water quality, use and enjoyment of

the local lakes. That is why Stormwater Catch Basin Insert Filter Baskets (CBI) have become a useful option for Orange County's Lake Management Program. The CBI's are installed directly into the existing stormwater curb or grate inlet infrastructure and capture debris such as sand, leaves, and trash while allowing the water to drain into the stormwater system.

Orange County is one of the largest users of stormwater catch basin inserts (CBI) in the State of Florida, and has currently 550 CBI in 13 lake basins. Orange County has been working since 2008 exclusively with Suntree Technologies to achieve a product consistency and maintain quality standards, and plans to install an average of 200 CBI per year within the next 3 years. The CBI program was originally put in place as a means of supplementing the street sweeping programs in several Lake Taxing Districts.

Orange County EPD removes approximately 130,000 pounds of sediments/pollutants every year through the existing 550 Suntree Technologies CBI. Orange County has been monitoring the CBI pollutant removal efficiencies during the past five years and the existing data has been analyzed to investigate site/seasonal variations between lake basins, typical nutrient composition and removal rates for both grate and curb CBI.

As part of the assessment of the CBI as a Best Management Practice, the County has conducted or participated in three performance-based studies, including one with the Florida Stormwater Association (FSA), Florida Department of Environmental Protection (FDEP) and University of Florida (UF), and one as an ongoing monitoring effort required as part of an FDEP grant. Average performance to date has shown that each unit removes 0.44 lbs/year of Total Nitrogen (TN) and 0.11 lbs/year of Total Phosphorus (TP).

# Session 6-B: A Systems Approach to Freshwater Management I

(River Room)

Wednesday, June 19, 1:30 to 3:00 pm

## ASSESSING TOTAL PHOSPHORUS VARIABILITY IN FLORIDA'S NUTRIENT ZONES

*Christopher C. Anderson[1], Daniel E. Canfield Jr.[1], Mark T. Brenner[2], and Charles E. Cichra[1]
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[2]University of Florida, Department of Geological Sciences, Gainesville, Florida

Variability of total phosphorus (TP), total nitrogen and chlorophyll *a* has resulted in a wide range of trophic states (oligotrophic to hypereutrophic) in Florida lakes. Of these variables used to estimate trophic state, understanding TP variability may be the most important because phosphorus is known to be the limiting nutrient in many Florida lakes. Bachmann et al. (2012) used their knowledge of Florida limnology to create six TP zones to be considered in establishing numeric nutrient criteria for Florida lakes. However, some of the zones have wide ranges of TP concentrations (i.e. TP3 [TP] range: 3-1857 µg/L). The objectives of this study were to examine Florida lakes in the 10% and 90% quantiles of TP concentrations for each TP zone (TP1-TP6) to determine which physical, chemical and/or biological factors contribute to in-zone TP variability. 10% and 90% quantiles were chosen because they represent the oligotrophic and eutrophic/hypereutrophic lakes, respectively, in each TP zone. A total of twelve limnological factors were analyzed. Physical factors were chosen based on the variables used in the Vollenweider TP model and included surface area (ha), mean depth (m), dynamic ratio, surficial hydrologic connectivity (i.e., drainage versus seepage lakes), and Landscape Development Intensity index (LDI). Chemical factors were chosen based on the regulation classification system used by the United States Environmental Protection Agency and Florida's Department of Environmental Protection numeric nutrient criteria for Florida lakes and included true color (Pt-Co units) and total alkalinity (mg/L as $CaCO_3$). Biological factors were chosen based on the theory that shallow, eutrophic lakes exist in alternative stable states, which are classified as turbid, phytoplankton-dominated or clear-water, macrophyte-dominated. Each biological factor is an index of aquatic macrophyte abundance: percent area covered (PAC), percent volume inhabited (PVI), above-ground emergent zone biomass (kg/m$^2$), floating-leaved zone biomass (kg/m$^2$), and submersed zone biomass (kg/m$^2$). The distributions of each limnological factor in the 10% and 90% quantiles were compared within each zone, respectively. Surficial hydrologic connectivity, LDI, mean true color and three of the aquatic macrophyte abundance indices, percent area covered (PAC), percent volume infested (PVI), above-ground emergent zone biomass (kg/m$^2$) were the variables found to be significantly different between lakes in the 10% and 90% quantiles for multiple TP zones. Significant differences in surficial hydrologic connectivity (i.e., the proportion of drainage lakes to seepage lakes) were found in zones TP3 and TP4. For both zones, the 90% quantile had a significantly larger proportion of drainage lakes. Significant differences in LDI occurred in zones TP3 and TP4. In TP3, mean LDI was greater in the 90% quantile. Conversely, mean LDI was greater in the 10% quantile in TP4. Significant differences in true color existed in zones TP2, TP3, and TP4. For all three zones, mean true color was greater in the 90% quantile. Significant differences in PAC and PVI, respectively, were found in zones TP2 and TP4 with the 10% quantile in each zone having a greater mean for both PAC and PVI. Above-ground emergent zone biomass was significantly different in zones TP3 and TP4. For both zones, mean above-ground emergent zone biomass was greater for lakes in the 90% quantile. Of the variables that were significantly different between quantiles, only mean true

color, PAC, and PVI were significantly correlated to TP concentrations in individual quantiles of certain zones. TP was positively correlated to mean color for lakes in the 10% quantile of TP3 while it was negatively correlated to PAC and PVI for lakes in the 10% quantile of TP4. Significant correlations to TP concentrations for any variable were not found within (i.e., significant in both quantiles) or across TP zones. In terms of surficial hydrologic connectivity, drainage lakes and seepage lakes were compared regardless of quantile/TP zone to determine if significant differences in the limnological factors outlined above existed between the lakes in each group. Significant differences were found in TP, true color, surface area, dynamic ratio, LDI, PAC, above-ground emergent zone biomass, and above-ground floating-leaved zone biomass. Drainage lakes had greater means for TP, true color, surface area, dynamic ratio, PAC, above-ground emergent zone biomass, and above-ground floating-leaved zone biomass while seepage lakes had higher mean LDI values. Based on mean TP concentrations, most of the drainage lakes in this study would be classified as eutrophic while most of the seepage lakes would be classified as mesotrophic. These data suggest surficial hydrologic connectivity, mean color, and aquatic macrophytes are the most important factors affecting TP variability in Florida's nutrient zones. However, it is imperative more data, especially regarding aquatic macrophyte abundance and mean depth, be collected to increase the sample size of these factors within the quantiles of all six TP zones. Small sample sizes are likely causing the lack of consistent correlation between some of the limnological factors (e.g., mean depth, PAC, and PVI) and TP within quantiles and across zones. The presence of outliers was a common occurrence for these factors as well. In many comparisons, one or two outliers are likely causing the lack of significant differences between the quantiles of individual zones as well as the lack significant correlations between individual factors and TP within quantiles and across zones, respectively. Increasing the sample size for individual factors would likely reduce the effects of these outliers on the respective statistical analyses, which may increase the amount of TP variability explained by individual factors. Understanding which limnological factor or factors explain the majority of TP variability in Florida lakes is critical to instituting a regulatory classification system (e.g., nutrient zones) that is the basis for establishing numeric nutrient criteria for Florida lakes.

## EVALUATION OF SOIL ENHANCEMENT RETROFITS IN STORMWATER PONDS TO REDUCE NITROGEN LOADING WITHIN THE WEKIVA SPRINGSHED

*Lance M. Lumbard*[1], Sam Arden[1], William Tucker[1], Timothy Kelly[1], Mikhal Moberg[1], Terry Dykehouse[1], Vineela Griddaluru[1], Mark Flomerfelt[2], Kim Ornberg[2]
[1]AMEC Environment & Infrastructure, Inc., Orlando, FL
[2]Seminole County Public Works, Sanford, FL

Stormwater ponds are designed for new development areas in order to reduce the amount of storm water and associated pollutants that may otherwise be discharged directly to a waterbody. In most cases, nutrient and hydrologic inputs to surrounding waterbodies via groundwater movement are not considered in the design calculations. However, lake managers are keenly aware of the impacts these sources can have on surface waters through seepage, subsequent entry into ground water, and in the case of springs, subsequent direct connection with the Floridan Aquifer. In areas like the Wekiva River Basin, groundwater loading from nitrogen-rich surface sources has been identified as the primary source of impairment to Wekiwa Springs and the Wekiva River. Enhancement of existing pond pollutant removal function with soil amendments is one method that promises to be both economical and effective in achieving the Total Maximum Daily Load (TMDL) goals established for the Wekiva River.

More than thirty potential stormwater pond candidates were reviewed for this project in Seminole County to assess the ability to incorporate Bold & Gold™ or similar media for enhanced nitrogen removal and associated TMDL credit. Potential ponds were screened for a variety of criteria and the top five were selected for detailed geotechnical analyses. Of these five, three were selected for further analyses including development of site-specific EMCs and annual mass loading from the surrounding basin. Additionally, downstream groundwater quality was assessed along with potential loading reductions from the proposed conceptual redesigns of the pond bottom characteristics.

## SHORELINE RESTORATION WITHIN A TRANSITION ZONE

*John Slupecki, CPESC*
Motz Enterprises, Inc., Tallahassee, FL

Flexamat is involved with several residential HOA boards and municipalities on restoring projects that reach 10-15 years in age. Local engineers are working with us to help design a new solution. This year (2013) project planning includes the Palms of Cortez, and Heritage Village (Bradenton, FL), the City of Deltona, and Reedy Creek Improvement District. Many of shorelines in Florida have slope designed beyond 4:1 and these shorelines don't last long when waves degrades the shoreline throughout the year with frequent tropical thunderstorms. Storm Water improvements include vegetating channels and outlet over concrete flume and recycled concrete rip rap and pump mats.

Flexamat enhances safety. Steep eroded banks make it hazardous to maintain or even walk along the shoreline. Many municipalities have regulations that ensure minimum slope requirements. The pyramid block shape allow for a solid foot hold for animals and people along the shoreline edge. Geotube and concrete edges are very slippery. Rock rip rap is very loose and a kids abuse the rocks by throwing them into and around the lake.

There are many benefits in utilizing Flexamat for shoreline applications. Flexamat makes the shoreline maintainable during high and low water transition zone. The matting locks into the subsoil with vegetation. Commercial mowers can be used to mow right up to the water's edge. There is also the option to let native vegetation grow wild within the Flexamat. The matting can also be vegetated with sprigging and live staking through the blocks.

It is environmentally friendly. Eroding sediment from shorelines is a major source of pollution. The eroded sediment has many negative impacts with natural ecosystems, such as making the water shallow, which leads to warmer water temperatures. Flexamat is the best solution because it re-enforces the natural vegetation and locks the shoreline in place.

## SIGNIFICANCE OF INTERNAL RECYCLING AS A NUTRIENT SOURCE TO CENTRAL FLORIDA LAKES

*Harvey Harper*
Environmental Research & Design, Inc.; Orlando, FL

Internal recycling of nutrients is a basic component of the phosphorus and nitrogen cycles in lakes which occurs as accumulated organic matter undergoes decomposition. The vast majority of the nutrients which accumulate in the sediments are retained through a variety of chemical and physical mechanisms. However, a portion of the sediment nutrient loading is continuously recycled and released from the sediments into the water column. This process occurs under both aerobic and anoxic conditions, although the rate of release is substantially enhanced under anoxic conditions. Oligotrophic lakes generally have a low rate of internal recycling. However, as lakes age and the quantity of organic sediments increases, the rate of recycling increases, and in extreme cases, nutrient loadings from the sediments are sufficient in magnitude to create or maintain eutrophic conditions even in the absence of external loadings.

Measurements of the rate of internal recycling have been conducted in approximately 25 lakes in Central Florida which ranged from oligotrophic/mesotrophic to hyper-eutrophic conditions. Release of phosphorus from anoxic sediments ranged from 0.15-1.54 $g/m^2$-day, compared with 0.032-0.894 $g/m^2$-day under aerobic conditions. Geometric mean values for sediment P release were 0.145 $g/m^2$-day under aerobic conditions and 0.408 $g/m^2$-day under anoxic conditions. According to Vollenweider, areal P loadings greater than 0.3 $g/m^2$-day are often sufficient to create eutrophic conditions, suggesting that internal loadings could maintain eutrophic conditions in some lakes even with aggressive treatment of external inputs. Although commonly ignored, sediments also release substantial loadings of nitrogen. In Central Florida lakes where nitrogen release has been measured, aerobic release ranged from 2.4-5.2 $g/m^2$-day, with anoxic release ranging from 5.5-13.98 $g/m^2$-day. Internal recycling reflects a significant nutrient source in many lakes that is often ignored in nutrient budgets and TMDL evaluations which can lead to incorrect conclusions concerning selection of water quality improvement projects and anticipated outcomes.

# Session 7-A: Lake Jesup II - The Lake

(Richard Petty Room)

Wednesday, June 19, 3:30 to 5:00 pm

## ASSESSMENT OF THE CYCLING AND COMPARTMENTALIZATION OF NITROGEN AND PHOSPHORUS IN SATURATED SOILS, SEDIMENTS AND THE WATER COLUMN IN LAKE JESUP, FLORIDA

*Serge Thomas[1], William Anderson[2,3], Leonard Scinto[2], Shauna Nielsen[2], David Fugate[4] and Reide Corbett[5]*

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[5]Department of Geological Sciences, ECU, Greenville, NC

Improved knowledge of sediment dynamics within a lake system is important for understanding lake water quality. This monitoring project focused on an assessment of the vertical sediment flux in the hypereutrophic (1.3 m average depth) and shallow drainage lake "Lake Jesup" located in central Florida. Sediment dynamics were assessed at varying time scales (daily to weekly) to understand the transport of sediments subsequent to external forcing such as wind, waves, precipitation and/or runoff.

Four stations running upstream downstream were selected within the lake using the water depths and the thicknesses of unconsolidated (floc) + consolidated sediments as selective criteria. At each of these stations, a 10:1 (length to diameter) high aspect ratio trap (STHA) was deployed over a two-year period to collect particulate matter for a one to two week period.

The water and sediment samples were collected and analyzed for total carbon (TC), total phosphorus (TP) and total nitrogen (TN). Mass accumulation rates (MAR) collected by the traps varied from 77 to 418 g $m^{-2}$ $d^{-1}$ over seven deployments.

Sediment TN, TP and TC concentrations collected by the traps were consistently higher than in the sediments collected by coring the lake bed and were most likely associated with water column biomass. Sediment oxygen demand (SOD) and floc oxygen demand (FOD) were also estimated, standardized to 20ºC and compared with 10 other Floridian lakes.

During this study the water column was always oxygenated. Supporting radionuclide data ($^{7}Be$, $^{137}Cs$ and $^{210}Pb$) were also collected from all trap material, floc and sediments to attempt to understand sediment mixing and potentially resuspension. Activities of $^{7}Be$ were too low to be accurately used to create a mixing model, but $^{137}Cs$ and $^{210}Pb$ yielded consistently reliable data that indicated periods of erosion and deposition.

A current meter (Acoustic Doppler Velocimeter – ADV) deployed at the most central location indicated that currents within the Lake Jesup are typically moving along the longest axis of the lake (longest length). Analysis determined that a wind speed at 2.24 m $s^{-1}$ (5 mph) is the lowest sustainable velocity required to resuspend sediments. This is significant, because the average wind speed for all deployments was 3.2 m $s^{-1}$ (7.1 mph). Prevailing winds that move in the north or south direction are most dominant in sediment transport.

A yearly nutrient flux budget was determined from August 2009 to August 2010 with flux estimated as 2,033,882 mt $yr^{-1}$ total material cycling through the lake. Yearly flux of TP as estimated from our approach varied from 22 to 23 mt $yr^{-1}$. Assuming floc is the most readily resuspendable material in the system, our estimates indicate the Lake Jesup's floc resuspended 47 times per year from August 2009 to 2010 and from April 2010 to April 2011 38 times per year.

## EVALUATION OF HYDROLOGIC AND NUTRIENT LOADINGS FROM GROUNDWATER SEEPAGE TO LAKE JESUP

*Harvey Harper*[1] *and Kim Ornberg*[2]
[1]Environmental Research & Design, Inc.; Orlando, FL
[2]Seminole County Public Works-Watershed Management Division; Sanford, FL

Lake Jesup is a 10,660 acre, shallow (mean depth 3-4 ft), hyper-eutrophic lake located in northern-central Seminole County. The drainage basin covers an area of 87,331 acres which includes portions of 2 counties and 11 separate municipalities. Lake Jesup is currently listed as an Impaired Water for nutrients and un-ionized ammonia. A TMDL report for Lake Jesup was issued during 2006 which includes estimates of annual phosphorus loadings from surface runoff, baseflow, septic tanks, artesian inputs, atmospheric deposition, and inflow from the St. Johns River. Estimates of groundwater seepage inflows to the lake were calculated using baseflow in gauged streams and assuming that this inflow occurs around the perimeter of the lake. Hydrologic inputs from groundwater seepage were estimated to be 7,832 ac-ft/yr.

A field monitoring program was conducted for Seminole County by ERD from June 2009-August 2010 to evaluate the hydrologic and water quality characteristics of shallow groundwater seepage inflows to Lake Jesup. Groundwater seepage meters were installed at 40 locations within Lake Jesup, and 9 separate monitoring events were conducted at each monitoring site over a 14-month field monitoring program. Total rainfall during the field monitoring program was approximately 18% less than normal. The mean measured seepage inflow into Lake Jesup was 1.18 liters/$m^2$-day, equivalent to 22,994 ac-ft/yr or 2.16 ft/yr over the entire lake surface. Seepage inflow to Lake Jesup was characterized by elevated levels of both total nitrogen and total phosphorus. Nitrogen influx from groundwater seepage contributes approximately 244 kg/day or 89,183 kg/yr, with phosphorus influx from groundwater seepage contributing approximately 26.0 kg/day or 9,484 kg/yr. The measured seepage inflow rates are substantially higher than values used in the TMDL report calculations. The measured seepage inflows contribute 12% of the total hydrologic inputs estimated in the TMDL report, along with 33% of the total annual nitrogen inputs and 36% of the phosphorus inputs, suggesting that seepage inputs to Lake Jesup are substantially larger than previously estimated.

A second field monitoring program was conducted by ERD from January 2012-March 2013 to evaluate the impacts of existing sediments on seepage characteristics entering Lake Jesup. Pairs of seepage meters were installed at 6 locations, with one meter installed on the existing sediments and the other inside an aluminum ring with the existing sediments removed. Six separate monitoring events were conducted from each of the pairs of seepage meters. With the possible exception of phosphorus, the sediments do not appear to have a significant impact on seepage characteristics which suggests that the elevated nutrient concentrations measured in the seepage originate within the watershed.

## AQUALUTIONS™ PERFORMANCE RESULTS AT LAKE JESUP, FLORIDA: A COMMERCIAL-SCALE, DUAL-NUTRIENT REMOVAL TECHNOLOGY WITH IMPLICATIONS FOR NUMERIC NUTRIENT CRITERIA COMPLIANCE

*Duane E. De Freese and William A. Eggers*
AquaFiber Technologies Corporation, Winter Park, Florida

In 2007, AquaFiber entered into a $2.5 million, 5-year, renewable, "pay for performance" contract with the St. Johns River Water Management District. The goal of this new technology demonstration project was to evaluate the ability to remove 1 metric ton of total phosphorus per year from the waters of Lake Jesup, FL, using AquaLutions™, a proprietary, dual-nutrient removal process developed by AquaFiber. The total capital costs for site preparation, permitting and facility construction were funded privately by AquaFiber investors. Initial start-up of the Lake Jesup prototype facility began on April 18, 2009 followed by a year of system testing to achieve stable water flow and treatment. AquaFiber was paid a fixed, non-market rate of $227 per pound of phosphorus from the SJRWMD, but only after AquaFiber quantified (and the SJRWMD verified) the amount of phosphorus disposed properly outside of the Lake Jesup sub-basin. AquaFiber used this prototype facility to engage in four years of rigorous commercial-scale testing of the AquaLutions™ process and its dual-nutrient removal efficiencies over a wide range of Lake Jesup water conditions. This presentation will provide performance data for both total phosphorus and total nitrogen removal over four years of commercial scale operations. AquaFiber will provide data that demonstrates the optimal capacity of AquaLutions™ to reduce nutrient concentrations by up to 90 percent for total phosphorus and 60% for total nitrogen. Average performance over the first four years of facility operations approximated 70% for TP and 50% for TN. The potential of AquaLutions™ as a technology "jump-start" for whole lake restoration as well as an effective, efficient and affordable tool for stakeholders responding to numeric nutrient criteria will be discussed.

## LAKE JESUP COOPERATIVE EFFORTS: VEGETATION RESTORATION

*Gloria Eby[1] and Ed Hayes[2]*
[1]Seminole County Lake Management Program, Sanford, FL
[2]Florida Fish and Wildlife Conservation Commission, Eustis, FL

Lake Jesup is the largest and most eutrophic lake (historic average TSI; 80) in Seminole County, Florida. It is located on a tributary of the St. Johns River and is prone to frequent algal blooms and fish kills resulting from decades of poor management practices. The Florida Department of Environmental Protection (FDEP) identified Lake Jesup to be impaired by nutrients and un-ionized ammonia, and in 2006, adopted Total Maximum Daily Loads (TMDLs) for total phosphorus ([TP] 0.096 mg/L) and total nitrogen ([TN] 1.27 mg/L) for the lake. The Basin Management Action Plan (BMAP) represents the joint efforts of multiple stakeholders to prepare a restoration plan for Lake Jesup to implement the adopted TMDL. This BMAP includes prioritized projects to limit external phosphorus loading into the lake and concurrent research projects to guide effective long-term restoration efforts.

In conjunction with these identified BMAP efforts/projects, the Seminole County Lake Management Program is also focusing on in-lake activities for Lake Jesup, such as vegetation, habitat quality, and restoration. As cooperators with the Florida Fish and Wildlife Conservation Commission (FWC) Aquatic Habitat Restoration Enhancement (AHRE) Program, a series of in-lake restoration projects has been

initiated which targets invasive species and shoreline enhancement within a *Phragmites* dominant community of Lake Jesup as well as planting 2 one acre size exclosures with eelgrass (*Vallisneria americana*).

Additionally, in July 2007, a baseline vegetation survey was conducted with interagency cooperation (FDEP, FWC, SJRWMD) in efforts to track BMAP projects and in-lake changes and again in May, 2010 for comparative analysis. The next survey is scheduled for June 2013.

This paper will discuss these various vegetation restoration projects as cooperative efforts in and around Lake Jesup.

# Session 7-B: Applied Research

(River Room)

Wednesday, June 19, 3:30 to 5:00 pm

## EFFECTS OF IRRIGATING FIVE COMMON LANDSCAPE SPECIES WITH WATER TREATED WITH BISPYRIBAC AND PENOXSULAM

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Beginning in the summer of 2013, the City of Winter Park will consider incorporating two new EPA approved ALS-inhibiting herbicides to manage hydrilla. Galleon (active ingredient: penoxsulam) and Tradewind (active ingredient: bispyribac) are slow-acting herbicides that suppress and control the spread of the invasive submersed plant Hydrilla (*Hydrilla verticillata*). Historically, management efforts have primarily focused on the use of contact herbicide endothall and the bleaching herbicide fluridone. However, fluridone-resistant hydrilla was documented in Winter Park lakes in 2005, and in January 2010, two lakes in the Winter Park Chain were found to have hydrilla populations which are tolerant to label rates of endothall. Subsequent management strategies have involved an integrated approach where herbicides are used in combination and in conjunction with sterile grass carp that feed on hydrilla. Preserving and encouraging the abundance and diversity of native aquatic plants is critical in this system as it has been recognized as central Florida's leading largemouth bass fishery.

Given the recent history of herbicide resistance on Winter Park Lakes, introduction and rotation of new herbicide modes of action is seen as integral to a long-term strategy for selective control of hydrilla. Both penoxsulam and bispyribac are applied at generally low concentrations (~20 to 40µg/L); however, they require long exposure periods (60+ days) and current irrigation language on the labels has previously precluded introduction of these products into the Winter Park Chain. Many of the homes surrounding these lakes are professionally landscaped with a variety of ornamental perennials. Due to the lengthy irrigation restrictions associated with using penoxsulam and bispyribac, a study was conducted to evaluate the potential for these new herbicides to impact five common landscape plants found in residential yards. Species in this study included Japanese yew (*Podocarpus* spp.), sand cordgrass (*Spartina bakeri*), viburnum (*Viburnum* spp.), Burford holly (*Ilex cornuta burfordii*), and border grass (*Liriope spicata*). Plants were irrigated weekly with one inch of water at eight different rates for each herbicide ranging in concentration from 0-320 µg/L. Weekly injury ratings were observed and documented, and visual changes in biomass were noted. Results of these studies will help dictate how these products are integrated into the Winter Park Chain hydrilla management program.

## VEGETATION COMMUNITY DRIVEN CHANGES IN POTENTIAL EVAPOTRANSPIRATION

*Dean R. Dobberfuhl, Dianne Hall, Kimberli Ponzio*
St. Johns River Water Management District, Palatka, Florida

Carolina willow (*Salix caroliniana*) has been steadily expanding throughout wetlands in the upper basin of the St. Johns River (USJRB). While willow is native, it is exhibiting invasive characteristics like replacing herbaceous vegetation and outcompeting other woody shrub species. We have now recognized that land management practices and hydrology facilitated the expansion by providing bare organic soils during spring germination. Perhaps more interesting, the willow expansion may have significantly altered water budget in affected marsh areas. Previous work has shown that willow is relatively unique in that it can transpire at rates two to four times higher than herbaceous species or other shrub species. Therefore, we hypothesized that willow expansion may have increased water losses from marsh restoration areas in the USJRB. We constructed a spreadsheet model using literature values for species and community evapotranspiration (ET) rates and spatial coverage estimates from our large-scale vegetation community mapping. Results demonstrate that recent vegetation community changes may have an important effect on water losses. For example, in the St. Johns Marsh Conservation Area willow increased from 3466 to 3845 ha from 2001 to 2008 and the corresponding predicted ET increase was 22,434 $m^3$ $d^{-1}$. Similar changes were predicted in other marsh conservation areas suggesting potential increases in water loss throughout the basin leading to two important implications. First, willow is an ecosystem engineer, drawing down the local water table, which may negatively affect other wetland plants and provide a positive feedback for its expansion. Second, willow is negatively affecting water supply potential downstream; millions of gallons per day are potentially being lost to the atmosphere where it might otherwise flow downstream supporting other beneficial uses.

## ALGAE SCRUBBERS FOR PHOSPHORUS REMOVAL IN IMPAIRED WATERS

*Hugo R. Sindelar, Mark T. Brown, Treavor H. Boyer*
*University of Florida, Gainesville, FL 32611*

Algae scrubbers are a developing technology used for nutrient removal from many different impaired waters, including: agricultural runoff, wastewater, and animal operation waste. *Hydromentia, Inc. (2005) reported a phosphorus (P) recovery rate of 37 g P/m$^2$/yr at a hydraulic loading rate (HLR) of 368 cm/day, showcasing the ability of algae to both survive in environments with high flow velocities and treat large volumes of water. This adaptation to high HLRs helps overcome space issues associated with other biological treatment systems, in which low HLRs necessitate large areas for effective treatment. Although algae scrubbers have shown promise for recovering P, no detailed studies have been completed to study conditions for maximum P uptake. Previous studies have suggested that higher flow rates and pulsed inflow conditions are necessary for high biomass production. In addition, studies have theorized that the calcium-phosphorus (Ca-P) co-precipitation is the driving P removal mechanism. As a result, the goal of this study was to determine the effect of the following operating parameters on P uptake: (1) flow rate, (2) pulsed versus constant inflow, (3) calcium addition to inflow water, (4) calcium seed addition, and (5) 24-hr versus 12-hr operation. Results show that 12-hr operation significantly increases P uptake in algae scrubber systems from an average of 24 g P/m$^2$/yr to 87 g P/m$^2$/yr. The high P removal rate can be attributed to the stabilization of Ca-P minerals during 12-hr operation. Algal photosynthesis*

*increases daytime pH values (9–9.5) driving Ca-P co-precipitation, and 12-hr operation prevents these minerals from solubilizing during the night as the pH decreases back to neutral (7–7.5).*

**REFERENCES**

Hydromentia, Inc. (2005). S-154 single stage algal turf scrubber final report. *South Florida Water Management District, Contract No. C-15933*.

## LAKE RESTORATION USING AERATION AND ALUM: A FLORIDA CASE STUDY

*Josette M. La Hée*
Vertex Water Features and Aquatic Systems Inc.

Bahia del Mar is a 14 acre, 50 foot deep, man-made community lake located in St. Petersburg, Florida. The lake has a history of nutrient and organic matter loading that has resulted in an extreme case of hyper-eutrophication, the symptoms of which included algal blooms, extensive fish kills and persistent pungent odors. In January, 2012 a management strategy was devised to restore the lake to a healthy and stable state. The strategy incorporated the use of aeration for an extended period to improve lake water quality, followed by two alum treatments to reduce the extremely high levels of nutrients in the water column and increase the phosphorus binding capacity of the sediment. One day after aeration installation, stratification in the deepest part of the lake was completely eliminated. Over the next several weeks, oxygen levels increased while turbidity, BOD and nutrient levels decreased markedly. Once conditions in the lake stabilized, two alum treatments were applied, resulting in further drastic reductions in phosphorus levels and increases in water clarity. The results of this study will be presented along with a discussion of the importance of considering multifaceted treatment options for lake restoration and management.

# Session 8-A: A Systems Approach to Freshwater Management II

(Richard Petty Room)

Thursday, June 20, 8:30 to 10:00 am

## SATELLITE MEASUREMENTS OF PHOPHORUS ON LAND AND IN WATERBODIES

*Milt Baker*
Blue Water Satellite

There is increasing concern regarding the amount of Phosphorus that is entering rivers, lakes, ponds, and streams from land based sources. This Phosphorus contributes to the eutrophication of water bodies and the increased productivity is often a causative factor in the proliferation of Harmful Algal Blooms (HABS). These HABS can produce toxins such as Microcystin which can be injurious to human and animal health. An example of eutrophication can be found at Clear Lake in California which is an approximately 43,000 acre lake that is over productive and frequently has algae and HAB problems.
In order to remediate Phosphorus and reduce HAB blooms, Lake County in California sought to investigate new approaches to determine the sources of Phosphorus on land and in water and to work cooperatively to reduce Phosphorus entering the lake.

Typical methods in use today to measure Phosphorus on land involve sending discrete soil samples to a laboratory for analysis. This technology is a low density sampling regimen which lacks spatial resolution due to cost and time factors. Typical sample density is one sample for every 8 to 15 acres. It is therefore difficult to apply this methodology to Clear Lake's 305,000 acre watershed. Phosphorus measurements in water taken by grab sampling also lack the spatial resolution for water body quantification.
As a contrast Satellite imagery with the use of spectral imaging algorithms can be used to cover watersheds and water bodies with a high spatial resolution of approximately 5 samples per acre and can cover land and water areas from 50 acres to millions of acres.

This paper describes the scientific principles behind measuring Phosphorus on land and in water using satellite imagery. The paper describes Clear Lake, California, as a practical use case, where satellite imaging of Phosphorus on land and in water is being used to gain new insights into the problem of Phosphorus entering the lake from a large watershed. Data is presented to show potential areas of Phosphorus on land and in water based on satellite imagery. A publically available website for the data has been created and will be shown in the talk.

The conclusion of the paper will propose a new methodology using satellite imaging to be considered for controlling Phosphorus in water as a key step in assessing Phosphorus remediation strategies that can lead to reductions in lake eutrophication.

# APB ALERT: USING NANOTECHNOLOGY FOR NON-POINT SOURCE NUTRIENT POLLUTANT CONTROL

*Edward Weinberg, P.E*
ESSRE Consulting, Inc.

Nutrient pollution, mainly nitrogen and phosphorus, continues to be one of the top causes of degradation in impaired watersheds. Pathways of phosphorus sources to surface waters include wastewater treatment plants (point sources), stormwater (urban, non-point sources) and livestock and farm runoffs (non-point sources). See attached Figure 1. Phosphate runoff into rivers, lakes and other fresh water reservoirs can lead to eutrophication. Impairment of US watersheds, such as Lake Jesup, has been attributed to nutrient (N, Ammonia-Nitrogen and P, Phosphorus) overloading. As a result, aggressive TMDLs ("nutrient pollution diets") establish ultra-low P discharge levels for point sources as low as 0.1 mg/L or lower, Total P. In many cases, these ultra-low phosphorus discharge criteria are beyond the limits of biological phosphorus removal technologies.
The present work describes research and field demonstration that apply high surface area nanotechnology for the enhanced chemical removal and recovery of dissolved phosphate via adsorption and ion exchange mechanisms. Three nanomaterials are discussed: (1) novel Synanomet nanocomposites recently invented and synthesized by the UALR Nanotechnology Center Little Rock AR: (2a) commercially available ion exchange resin dispersed with nano iron oxides, Layne RT™ sold to municipalities to remove naturally occurring Arsenic from drinking water supplies and (2b) commercially available MetaMateria - Phosphate Red. Photographs of (1) and (2a) are attached as Figure 2. These nano-adsorbents are adaptable for point source or non-point source nutrient pollutant control.

The Synanomet nanocomposite materials are an aggregate of tannin derived or woodbased carbon materials combined with nano-iron oxides. The nanocomposites developed for phosphate treatment incorporate nano magnetite, as the best performing iron oxide, and fully exploit the unique properties of magnetite at the nano scale. The significant increase in surface area effected by the use of nano iron oxides justifies the research, design/development and commercialization of such materials as adsorbents for the removal of phosphate, and other dissolved oxyanions, from wastewater streams, as a result of super fast adsorption kinetics. The paper describes the features/benefits of nanoadsorbants used for non-point source phosphorus nutrient removal and recovery.
The Layne RT ion exchange media is built upon licensed technology invented by Lehigh University, whose researchers were able to disperse nano iron oxide within the surface of conventional polystyrene ion exchange beads. Thus, the high surface adsorbent becomes a permanent part of a standard water/wastewater treatment macromaterial used and regenerated for decades in commerce. The nano iron oxides used in these nano-adsorbents are regenerable via a weak caustic rinse and regeneration to "fresh" material not only lowers operating costs, it also provides a "rich" phosphate fertilizer solution for sustainable reuse of finite resourced P nutrient. The paper will also describe approaches to reuse regenerated solutions on site or to export them to locations depleted or in need of dissolved phosphate nutrient. In a sense, the nanotechnology has the potential to restore impaired watersheds and the natural "P" cycle.
This paper summarizes the results of this bench study and the bench-scale comparison of both nanomaterials against:

- Commercially available (macro) media intended for phosphate removal and recovery,
- Each other,

in a series of beaker dose/mixing (equilibria) screening tests under a variety of laboratory controlled conditions. (See Figure 3)

In addition, the laboratory testing demonstrated that the commercially available Layne RT is a better performer in terms of percentage total phosphorus removed of all the materials and media evaluated. Independent testing has demonstrated that MetaMateria's nanoadsorbent has a greater adsorption capacity compared to Layne RT or Synanomet's media. Based on the laboratory results and commercial history Layne RT and Meteria's media have been adapted for use at non-point source applications and the paper describes tests of field pilot demonstration for phosphorus removal and recovery at a non-point source farm drainage ditch in Maryland, including the enhancement of Floating Island technologies in two configurations: elevated bioswales and floating islands. Regeneration of spent media can take place at the field test site or at the supplier's regeneration center in Arizona or Ohio, and the latter location was selected for the field demonstration.

The nano-adsorbants described herein, are applied as filters for point source control of P and as "enhanced" Best Management Practice (BMP) for non-point source control.
Either nanomaterial is adaptable as a P removal enhancer to stormwater control products (e.g., bioretention cells) or ag runoff control BMPs (bioswales, ditch filter structures) or impaired freshwater bodies of water (Floating Islands or on-shore pond, lake, lagoon treatment). See Figure 4. The paper describes the features/benefits of nanoadsorbents used to enhance various types of non-point source P pollutant removal (and recovery) BMPs .
The widespread application of nano-based, disruptive technology for all sources of pollutant P control will help reduce nutrient pollution of local streams that feed nutrient impaired major watersheds, such as Lake Jesup. Utilization of this low-cost, nano-based chemical removal and recovery technique for phosphorus will provide all users nutrient trading credits, where these programs exist, via off site regeneration, i.e., exporting of phosphate for reuse in areas deplete in P. Moreover, municipal and industrial WWTPs users of nanoadsorbents will eliminate the creation of tons of sludge waste that need to be disposed providing sustainability of finite resourced phosphate via landfill diversion of unreactive insoluble P.

**Figure 1 Phosphorus Sources: Their Pathways to Surface Water**
Adapted from Wind, 2007

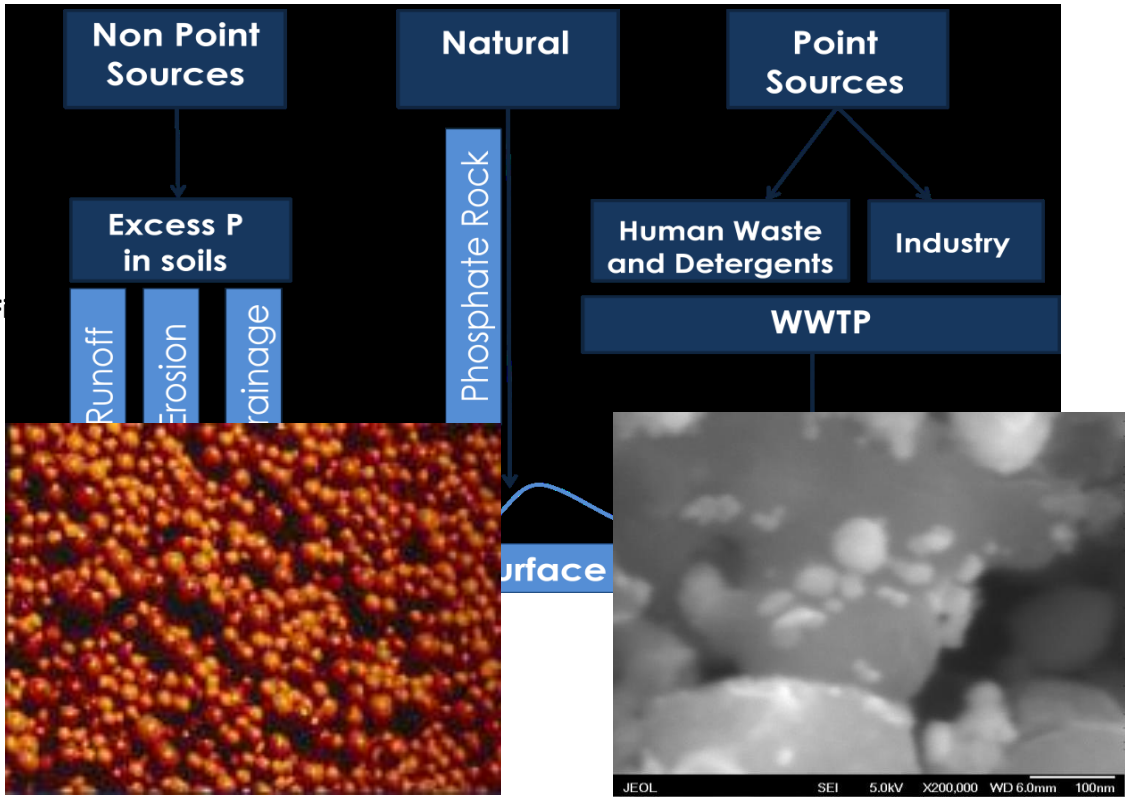


**Figure 3 Phosphate Removal Effectiveness:**
**Comparison of Synanomet Nanocomposites and Layne RT**

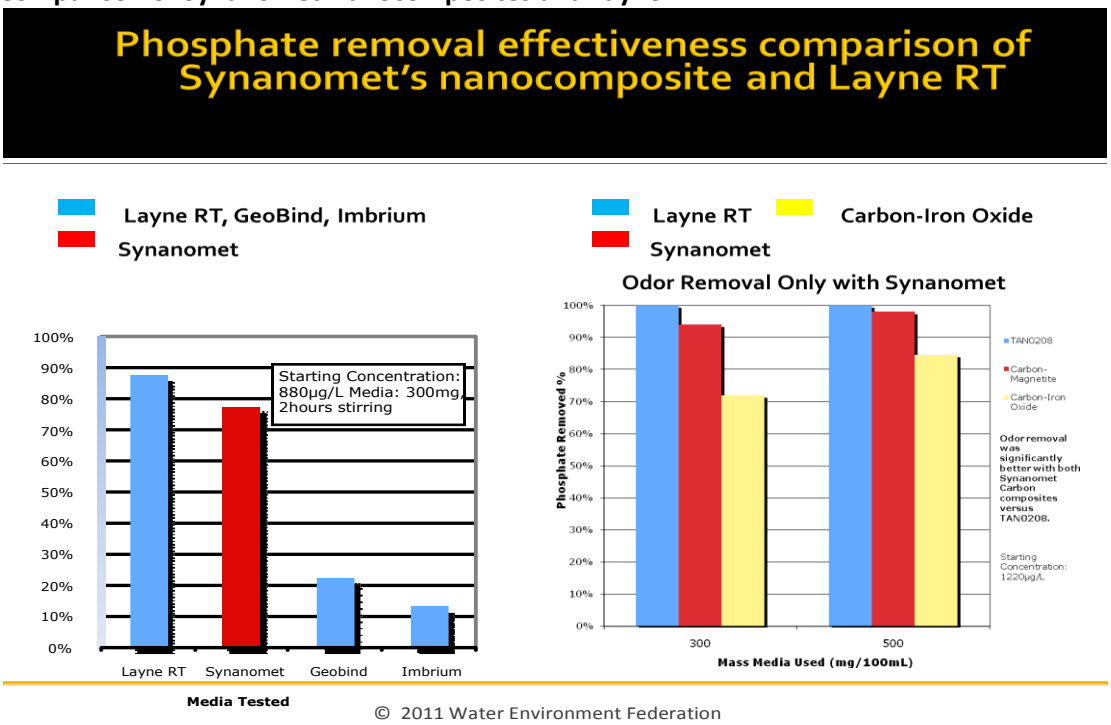
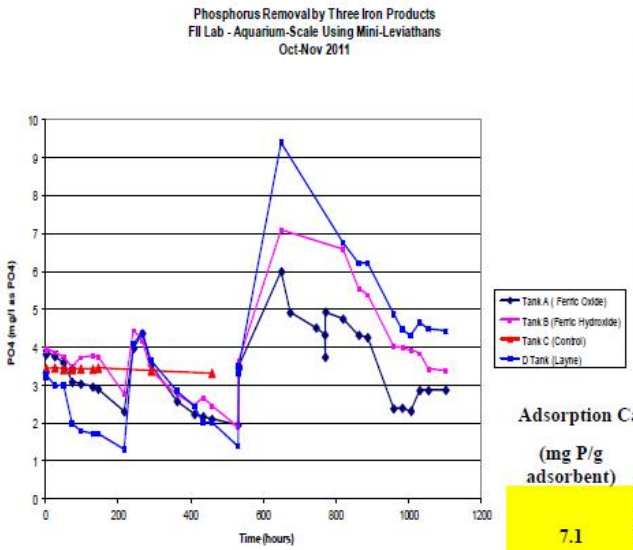




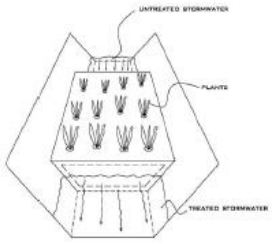

**Figure 4 Layne RT Bench Top Comparison to Macro Media in a Simulated "Enhanced" BioSwale for P Removal:**




Floating Island International Inc. All rights reserved.

**Adsorption Capacity**

| (mg P/g adsorbent) | Media |
|---|---|
| 7.1 | Iron Oxide |
| 6.3 | Ferri Hydroxide |
| 8.4 | Layne RT |



## POND AND LAKE CLARIFICATION DURING DREDGING AND WHEN NUTRIENTS ARE AN ISSUE

*Seva Iwinski*
Applied Polymer Systems

Turbid ponds and lakes, whether caused by sediment or nutrients, are often the cause of eutrophic conditions leading to harmful algae blooms, surface water quality degradation, and in some cases out of compliance discharges. This presentation will focus on clarification of ponds and lakes that have or are currently undergoing dredging practices leading to highly turbid water and ones that have high loads of phosphorus that can or have already led to nuisance algae blooms. When dredging, historically, liquid polymer flocculants have been used by drip feed or injection systems for water quality control before discharge. These systems are many times unreliable in performance or require power sources, injection pumps and metering devices which require a significant amount of manpower to operate. Newer methods will be discussed using polymer logs using passive dosing methods. This technology has shown very high performance results for water quality without personnel oversight and greatly reducing costs. Historically, when clarifying lakes high in phosphorous levels that have led to algae blooms, algaecides and other harsh chemicals have been used that can be harmful to aquatic life and the overall health of the aquatic ecosystem. Anionic water soluble polymer technologies used in conjunction with aeration/circulation systems that are non-toxic to aquatic life and have no adverse effect to the environment to remove phosphorus and algae will also be discussed. The presentation will also address ways to use this same type of technology to stabilize the surrounding areas of water bodies to prevent phosphorus from entering a pond or lake due to heavy fertilization

## OLD SCHOOL ALUM TREATMENT FOR LITTLE LAKE JACKSON – HOW IT LOOKS TEN YEARS LATER

*Clell J. Ford*
Highlands County Parks and Natural Resources Department, Sebring, Florida

Little Lake Jackson in Highlands County has long been identified as having high nutrient levels, particularly phosphorus, and poor transparency. Rated as having very degraded biota by Rutter in 1994 (FDEP), and subsequently investigated by both UF (Whitmore and Brenner), and SWFWMD (Kolasa), levels of nutrients in the lake are documented better than most in Highlands County; it has been monitored more or less continually since 1995 by LAKEWATCH volunteers. Historically the lake was connected through a now drained bay swamp with another stained system, paleolimnology shows that around a century ago the lake was artificially connected with the much larger Lake Jackson. From there, as with many lakes on the Lake Wales Ridge, the hydrology of Little Jackson was substantially altered by golf courses, highways, residential and commercial development and flood control projects; the long-term geometric mean tsi for the lake in 2012 was 66, down slightly from the peak of 67.7 in 2006. Cooperatively funded beginning in 2001 by SWFWMD, the City of Sebring, Highlands County, and ultimately FDEP, Little Jackson's alum plant was completed in 2007, at a relatively modest $239,000. The system did not become fully operational for various reasons until the summer of 2011. Though addressing less than ½ of the lake's watershed, the treatment subbasin was identified by SWFWMD as contributing the largest phosphorus load to the lake. In-lake phosphorus concentrations have declined since the system became fully operational, but trends in both total nitrogen and transparency indicate that the lake is trending to more impaired. This is not uncommon to Florida lakes, particularly in more

rural parts of the state; much of the watershed is in the City of Sebring, but few lake and canal-front homes are connected to central sewer, a fact to inform future efforts in the lake watershed.

# Session 8-B: Sustainable Water Resources at the Local Level

(River Room)

Thursday, June 20, 8:30 to 10:00 pm

*Introduction*

## PROTECTING THE LAKES IN WINTER HAVEN, FLORIDA FOR FUTURE GENERATIONS: IMPLEMENTING SUSTAINABLE WATER RESOURCE MANAGEMENT

*Mike Britt, PE*

Fifty freshwater lakes border or are contained within the city limits of Winter Haven, Florida, "The Chain of Lakes City." The lakes which cover almost one-third of the 25 square miles of the City are the lifeblood of the community: *environmentally, socially, and economically*. The lakes are a reflection of the enormous stores of water—for people and natural systems—that are potentially contained within the landscape. The City's economy, its quality of life, and its current and future viability depend on preserving and sustaining the health of its water resources, the most valuable of which are the lakes.

The lakes and water resources in Winter Haven are damaged and depleted. The Florida Department of Environment Protection has determined that 25 of the 50 lakes in the City have impaired water quality (18 of 25 in the Winter Haven Chain of Lakes). The Southwest Florida Water Management District has designated all of DeSoto, Hardee, Manatee and Sarasota counties, and parts of Charlotte, Highlands, Hillsborough, and Polk counties—an area encompassing 5,100 square miles, including Winter Haven—as a water use caution area. Groundwater withdrawals throughout the region have lowered aquifer levels more than 50 feet in some areas and lowered lake levels in the upland areas of Highlands and Polk counties.

Past efforts to manage water by draining, piping, and covering recharge areas in the City's watershed and regional aquifer drawdowns have had, and will continue to have, negative effects on Winter Haven's water resources, including its lakes. At best, today's regulations keep things the same but do not provide for restoration. At worst, they allow the further gradual degradation of water resources.

To address the long-term water quality, water supply, flood protection, and environmental needs of the City, Winter Haven has conducted impact assessments and developed plans for water quality restoration and water resource sustainability, including:

- Winter Haven Sustainable Water Resource Management Plan
- Winter Haven Chain of Lakes Water Quality Management Plan
- Winter Haven Interior Lakes Water Quality Management Plan

With economic recovery (local, state, and national), the development of the CSX Integrated Logistics Center (a transportation hub that uses trucks and railways to distribute goods across the country), continued growth in the regional telecommunications network, and the opening of the entertainment park at LegoLand, the small community of Winter Haven will experience rapid economic growth. How the community chooses to manage its limited water resources in the face of this economic opportunity will determine the fate of the community for better or worse.

The four presentations in this session detail the City's approach to sustainable water resource management, lake restoration, valuing ecosystem services, and building an institutional framework for local, regional, state, and national decision-making for sustainability.

## SUSTAINABLE WATER RESOURCE MANAGEMENT: LINKING ENVIRONMENTAL, SOCIAL, AND ECONOMIC DEMANDS

*Thomas L. Singleton*
Thomas L. Singleton Consulting, Inc., Monticello, FL

Human economic and social systems are inextricably linked to ecosystems and the physical environment that sustains all living things, including humans. Sustainable water resource management is the coordinated development and management of water, land, and related resources to maximize social and economic welfare—without compromising the vital ecosystems upon which we depend. The consumption of renewable natural resources is sustainable if it *does not* exceed the rate of long term renewal and impair the health and productivity of ecosystems, communities, or the economy. In the environmental-social-economic model presented (Swackhamer, 2010), something is sustainable if it is viable, bearable, and equitable.

The sustainable water resource management principles that guide the Winter Haven sustainability plan are (Sustainable Water Resource Roundtable, 2010):

- **Value and limits of water** - as a natural resource and a social and economic good; there are environmental, social, and economic costs of depleting or damaging water resources;
- **Shared responsibility** - water does not respect political boundaries; a participatory and multi-disciplinary approach to managing water is required;
- **Equitable access** - including equitable allocation and costs; continuous monitoring is required to detect problems as they occur, as are means to correct problems;
- **Stewardship** – understanding the implications of water resource decisions on future generations and the ecosystems upon which they will rely

There are different types of sustainability ranging from technical/structural solutions that balance supply and demand and offer least cost solutions to institutional/nonstructural solutions that provide the capacity to plan, manage, and operate the systems for natural resource protection, social welfare, and economic development (modified from Katsiardi et al. 2005). In the new paradigm of sustainable water resource management, water, regardless of its form—wastewater, stormwater, floodwater—is managed as a resource rather than a waste product or nuisance; and the services and goods provided by ecosystems, including clean water, water supply, flood protection, habitat, and food, are valued for the benefits they provide.

Sustainable water resource management is an iterative process of planning, implementing, measuring, and learning. It is an adaptive approach that can accommodate emerging challenges, constraints, and changing social priorities. It is a means to sustainability and not an end. It is a cooperative approach that integrates the resources of the public and private sectors to the benefit of the community.

## THE NEED FOR HOLISTIC WATER MANAGEMENT: AN EXAMPLE FROM WINTER HAVEN, FLORIDA

*David Tomasko, PhD*
Atkins, Tampa, FL

While Florida is the fourth largest state in the US (and predicted to be the third largest by 2015), in terms of population, it is only 22nd in terms of size. Inland waters comprise slightly less than 8 percent of the land area of Florida, a total of 4,511 square miles. While an impressive amount, the totality of inland waters in Florida is smaller than the smallest of the Great Lakes (Lake Ontario) and it is less than 5 percent of the combined area of the Great Lakes. As of 2011, however, the State of Florida had contributed more than 30 percent of all the water quality data in STORET, the nation's water quality data warehouse. Those 24 million data entries result in Florida having a greater density of water quality data than anywhere else in the US. Despite this data richness, various water management programs in Florida are quick to use complex water quality models for resource management plans. These water quality models are often notable for their use of rate coefficients that aren't locally derived. This has often resulted in water quality models being "calibrated" through the modification of rate coefficients that have never been locally measured.

The over-reliance on complex water quality models to develop lake management plans has given rise to a number of problematic TMDLs for a variety of Florida lakes. This issue may be related to the tight timelines laid out in the TMDL program's authorization. The enabling legislation for TMDLs automatically leads from the determination of impairment to the development of TMDLs and nutrient reduction strategies, without time for consideration of the totality of impacts that can affect the water quality and ecology of Florida lakes.

Florida is in need of a more holistic approach to lake management, where the effects of hydrologic alteration, *Hydrilla* eradication efforts, and internal nutrient loads from discontinued point sources are considered, as well as the current focus on nutrient loads from stormwater. In this presentation, examples are given of the importance of hydrologic modifications and other factors, and how incorporating such into lake management strategies can increase the probability of success of lake management strategies.

## VALUING ECOSYSTEM SERVICES

*Valerie Seidel*
The Balmoral Group, Winter Park, FL

Economics is what makes sustainability sustainable. If there is no measurable benefit to a change in behavior, there is little incentive for policymakers to shift from a traditional approach to an untested approach. Fortunately, there are economic tools to assist in this process. In considering the comparison of natural approaches to engineered solutions, the critical link is the ability to monetize ecosystem services. Without the ability to quantify the benefits that are not immediate cash impacts, it is very difficult to meaningfully compare alternatives that have both tangible and intangible implications. We may "know it when we see it," as the Supreme Court Justice has said, but until we can show it in dollars and cents, we are unlikely to move the needle.

The Winter Haven Sustainability Plan has at its crux two critical ecosystem services: recharge, and storage. While there are more than 70 specific actions in the Plan, they boil down to these two overarching categories. How do you value recharge and storage? There are engineered solutions, as we all know: building reservoirs, constructing new water treatment and storage facilities, rapid infiltration basins, and the list go on. The costs of building, maintaining, and at some point replacing, these capital improvements are relatively straightforward. The natural alternative is less so, at least in Florida.

There are other communities in the US and internationally where the natural approach is the first and assumed option. Generally, in these communities, a holistic analysis of the social, environmental, and financial costs and benefits associated with the policy decision at hand is required by the public. The Pacific Northwest, Australia, New Zealand and Canada offer some great examples. At some point, those communities required infrastructure choices to take into account viability for the environment and equitable distribution of both the immediate and long-term costs.

Valuing the ecosystem services associated with improved recharge and storage will take into account the expected water quality improvements; the avoided costs of alternative water supply associated with additional treatment facilities; the improved recreational opportunities and economic impact they create; the improved habitat for wildlife—with an eye to values accepted by experts in the field, calibrated to Winter Haven's demographic, topographic, and logistic conditions and corrected to avoid double-counting; and reflective of Winter Haven's stakeholder preferences. A sophisticated analysis also considers whether impacts—both costs and benefits—are distorted to certain groups, and if so, whether such market distortions make sense for the community.

Winter Haven's Sustainability Plan reflects the growing recognition in Florida society that change is needed in our approach to many public policy choices. The economic analysis of policy choices recognizes—sometimes with surprising results—that the costs of alternatives are only one small piece of the resource allocation question.

## DECISION-MAKING FOR SUSTAINABILITY BEGINS AT THE LOCAL LEVEL

*Mike Britt, PE*
City of Winter Haven, Winter Haven, Florida

Luna Leopold, famous Chief Hydrologist with the U.S. Geological Survey in the 1950's and 1960's once said: "Water is the most critical resource issue of our lifetime and our children's lifetime. The health of our waters is the principal measure of how we live on the land". This premise represents an absolute truth linking land and water management. In Florida, the long-term health of our waters is uncertain. With many lakes, springs and rivers falling below acceptable standards for water quality and quantity, we are having difficulty upholding this basic principle.

Local governments make land use and many other decisions related to water resources, including water supply, stormwater, flooding, water quality and wastewater management. Local communities are also at the center of making decisions related to economic development and social/cultural improvements. Local agencies generally do not have the expertise or inclination to make long term water resource management decisions partly due to the short term nature of the political process and the demand for

economic growth. State and regional agencies are inclined to operate within a regulatory framework, granting permits after the land use and economic development decisions are made at the local level. Both parties generally encourage the other to continue a pattern of unsustainable short term decisions, with little consideration that actions will result in the continued long-term decline of water resources.

Accountability for water resource decisions is difficult to discern, but since local communities ultimately bare the social, economic and environmental costs of water resource decisions, local communities are the logical choice to begin a sustainable decision-making process. Water is unique in that the sustainability of water is easily discernible at the local level. The sustainability decision making model is also unique in that it is a process as well as a framework that builds consensus from the grass-roots level.

A commitment to follow a sustainable approach puts local communities and watersheds in a leadership role. Local communities, operating within their watersheds and ground water basins, must envision the desired balance between economic growth, cultural resources and the environment. Once this process takes place, interagency and private sector tools such as water quality credits, mitigation banking, regional stormwater permitting and ecosystem management planning can be applied. Significant education and leadership will be required at the local, regional and state levels to begin a sustainable approach, but there are many examples that indicate that communities and agencies are ready for this challenge.

The Sustainable Water Resource Management Plan for the Peace Creek Watershed was adopted by the City of Winter Haven, Polk County and the Charlotte Harbor National Estuary Program and begins this process in Central Polk County. This plan will be used to outline the initial stages to achieve sustainable water resources. One thing is certain, without a new approach, many of Florida's water resources will have a difficult recovery.

# Session 9-A: Saved the Best for Last I

(Richard Petty Room)
Thursday, June 20, 10:30 to 12:00 pm

## DRAWDOWNS OF FLORIDA LAKES AND TROPHIC STATE ASSESSMENT

*Bradley L. Jones*
South Florida Water Management District, West Palm Beach, FL

The Kissimmee Chain of Lakes is regulated to provide flood protection for the region south of Orlando and water supply for the greater Kissimmee-Okeechobee-Everglades system. Water levels are also managed for environmental purposes, but current regulation schedules prevent the lakes from reaching the extreme highs and lows that formerly sustained littoral habitats naturally. The narrow range of stage fluctuation can lead to dense vegetation growth that may occasionally require a managed drawdown to allow desiccation and removal of plants and accumulated organic material. Although these drawdowns are beneficial to the lakes' ecological health, the lower lake levels may allow greater opportunity for subsequent algal blooms by reducing macrophyte coverage, increasing light penetration, enhancing sediment-water interactions, and mobilizing soluble phosphorus after the littoral zone substrate is reinundated. If these post-drawdown blooms are atypical of lake conditions, an argument could be made for excluding drawdown years when assessing trophic state. To test the hypothesis that post-drawdown levels of phytoplankton chlorophyll *a* are not significantly different from levels in non-drawdown years, over 30 years of data from the five lakes were examined. This period included four managed drawdowns. The intensity and duration of summer algal blooms following these drawdowns were not significantly different than blooms occurring in non-drawdown years.

## EFFECTS OF USER INTERACTIONS, RIVER MORPHOLOGY, AND PLANT COMMUNITY ON PROP SCARS IN THE RAINBOW RIVER, FLORIDA

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Propeller scars (prop scars) from boats have been characterized as paths within which vegetation has been removed from the sediments. In the Rainbow River this is a particular concern due to potential habitat loss, increases in sedimentation and erosion, and the potential to aid in the colonization of hydrilla. Prop scars were mapped in October-November 2011, following peak river use season, using a Trimble GPS and Lowrance depth finder. Species of plant damaged, length and width of scars, and water depth were recorded. Data was analyzed using ArcGIS 10, and 305 m buffers were created around key recreational hotspots to determine if congestion had an impact on the incidence of scarring. A total of 61 prop scars were recorded. The average depth of the scars was 0.92 m. Within the KP Hole County Park boat launch

buffer, 16 scars (26.2%) were observed. Of the two main tuber take-out points, only the state park campground take-out point had prop scars near it. Within this tuber take-out point buffer, 14 scars (23.0%) were recorded. Between the points at which tubers enter and exit the river, 17 scars (23.0%) were recorded. Many of the scars occurred at shallow depths, or inside bends of the river. A number of scars were located near boat docks. Other areas with high densities of scars include large shallow expanses of water with no well-defined deep channel. A subsample of 26 scars was resampled in spring of 2012 to quantify regrowth. Overall, mean length and width of scars decreased. Eleven of the scars had completely closed in with regrowth from the adjacent plant community, primarily *Sagittaria kurziana*.

## POTENTIAL IMPACTS OF SEAGULLS ON NUTRIENT LOADING AND WATER QUALITY IN LAKE WEIR

*Rolland Fulton*
St. Johns River Water Management District, Palatka, Florida

St. Johns River Water Management District was approached by residents concerned about water quality effects of large numbers of seagulls that rest on Lake Weir, and are believed to feed at a nearby landfill. Christmas Bird Counts have estimated populations of Ring-Billed gulls as high as 15,000 on Lake Weir. Literature information indicates that large bird populations can significantly affect nutrient and bacteria levels in lakes under some circumstances. Lake Weir has relatively good water quality compared to other lakes in the basin, but does show significant increasing trends in nutrient and chlorophyll concentrations, and occasional occurrences of high bacteria levels at beaches on the lake. SJRWMD has developed a Pollutant Load Reduction Goal for Lake Weir and estimates external loading of total phosphorus (TP) and nitrogen (TN) to the lake. Literature values for nutrient excretion rates were used to develop maximum estimates of TP and TN loading to Lake Weir from a range of bird population sizes. Results indicate that gull populations could make a significant impact on TP loading to Lake Weir, dependent on assumptions that thousands of gulls are present for much of the year, and feed outside of the lake. However, water quality in Lake Weir is within the range for other lakes in its ecoregion, and the recent deterioration could be explained by increases in external nutrient loading and decreases in lake water level.

Background material:

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Hoyer, M.V., and D.E. Canfield, Jr. 1994. Bird abundance and species richness on Florida lakes: influence of trophic status, lake morphology, and aquatic macrophytes. Hydrobiologia 297/280: 107-119.

Portnoy, J.W. 1990. Gull contributions of phosphorus and nitrogen to a Cape Cod kettle pond. Hydrobiologia 202:61-69.

**LAKE EULALIA WATER QUALITY IMPROVEMENT PROJECT**

*Marissa Williams*
Stormwater and Lakes Manager, City of Maitland, Florida

In place of more traditional stormwater treatment methodology, the City of Maitland has been in search of new approaches to surface water quality improvements within its 22 lakes. Six acre Lake Eulalia was an excellent candidate to pioneer the implementation of created wetland cells for removal of excess Nitrogen and Phosphorous. Through the use of a standard irrigation intake, surface water is mechanically pumped through City Park property and filtered via artificial wetlands stocked with native submerged and emergent aquatic vegetation before its return to the water body. Coined the Lake Eulalia Water Quality Improvements, this project was designed to accomplish a multi-pronged approach of pollutant removal, public education, and park rehabilitation. Constructed in the fall of 2012, project monitoring remains in its infancy, but success has already been achieved with community involvement and education.

# Session 9-B: A Systems Approach to Freshwater Management I

(River Room)
Thursday, June 20, 10:30 to 12:00 pm

## INVASIVE SPECIES MAPPING IN HILLSBOROUGH COUNTY LAKES AND STREAMS

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The Florida Center for Community Design and Research at the University of South Florida has been conducting lake and stream assessments in Hillsborough County with funding from both Hillsborough County and the Southwest Florida Water Management District. These resource assessments have focused on the vegetation communities, morphological characteristics and water quality of the systems. The results of the vegetation assessments from 2006 to 2012 were examined in ArcGIS. By mapping the presence and absence of Florida Exotic Pest Plant Council (FLEPPC) of Type I and II species trends were observed. Beginning in 2010, the Lake Vegetation Index (LVI) from the Florida Department of Environmental Protection (FDEP) was also performed on sampling lakes. The role of FLEPPC type II plants in calculation of the LVI was examined through the use of the new metrics developed by FDEP which do not include FLEPPC type II species.

Hydrology played an important role in the transmittance of certain species of submerged and floating leaved vegetation namely *hydrilla verticillata, eichhornia crassipes, nymphoides cristata* and *pistia stratoides*. These species were common in connected lake systems were fragments or whole plants were easily transferred through stream segments in the Rocky Brushy Creek Watershed, Sweetwater Creek Watershed and Pemberton Creek Watershed.

## DEVELOPING A PUBLIC EDUCATION PROGRAM FOR AQUATIC PLANT MANGEMENT ACTIVITIES THAT INCLUDE THE USE OF SYSTEMIC HERBICIDES (BISPYRIBAC AND PENOXSULAM) IN RESIDENTIAL LAKES

*Timothy J. Egan*
City of Winter Park, Winter Park, Florida

The City of Winter Park has been involved in the management of hydrilla (Hydrilla verticillata) since the late 1960's. The city's education program has evolved as new control techniques and products have been incorporated into the hydrilla management program. The emergence of fluridone and endothall resistant hydrilla in some of the city's lakes has necessitated the development of an integrated management approach that includes herbicide rotation using newly available systemic herbicides which could require lengthy irrigation restrictions. Historically, Winter Park has used aquatic herbicides that required relatively short irrigation warnings of three to fourteen days and for some of these products, the irrigation restrictions have been lifted entirely. The current labels and treatment rates associated with bispyribac and penoxsulam, two herbicides which recently received EPA approval for aquatic use, could result in the city posting irrigation warnings that range from 60 to 120 days. The lakes in Winter Park are surrounded by large residential properties with elaborate and often expensive landscaping and

many of these properties are irrigated using lake water. The city was concerned that using these herbicides without first providing residents detailed information, and adequate advanced notice, would generate a large public outcry.

An informational campaign was needed that would provide residents an explanation of why these products needed to be used, what impacts they could realistically expect and that would give them time to find an alternative irrigation source if they desired. The program would have to include city administrators and elected officials as they would also be on the receiving end of questions and complaints related to any irrigation restrictions. To achieve these goals, lake management staff has implemented a multi-pronged educational effort that specifically addresses residents, citizen advisory boards, city administration and elected officials. Vehicles for the dissemination of information have, or will include internal staff meetings, public hearings, web notices, newsletter articles and direct mailing. Costs were minimized by using existing outreach mechanisms. New costs are estimated at less than $2,000 over the next two years and are limited to the cost of the direct mailing campaign.

## Empirical Evidence for Water Level Recovery in Isolated Natural Systems Following Reduced Groundwater Production in the Northern Tampa Bay Area

*Dan Schmutz, M.S.*
GPI Southeast, Inc., Orlando, FL 32809

Documentation of natural system recovery, following reductions in groundwater production, was necessary to support renewal of Tampa Bay Water's Consolidated Water Use Permit No. 2011771.00 (CWUP) under 40D-80 Florida Administrative Code (i.e., "Recovery and Prevention Strategies for Minimum Flows and Levels"). The objective of this study—completed in December 2009 and included in the CWUP renewal application submitted by Tampa Bay Water in February 2010—was to provide a concise, accurate summary of hydrologic changes documenting environmental recovery within isolated natural systems (i.e., wetlands and lakes) in the Northern Tampa Bay Area.

Data compilation and analyses were performed both for the entire CWUP permit-defined area and smaller areas of interest which include individual wellfields within the CWUP Area and sites located in a Regional Reference Area outside the CWUP Area. The overall approach to document hydrologic recovery consisted of comparing changes in median water levels for isolated natural systems between a six-year period under higher production (WY1997-WY2002) and a six-year period under reduced production (WY2003-WY2008). Regional rainfall and production by wellfield area were summarized for these periods to confirm the appropriateness of the chosen time periods.

Groundwater production was substantially reduced between the higher production (151 MGD average) and lower production (97 MGD) periods by approximately 54 MGD, or 36%. Production cut-backs varied widely by individual wellfield area. The largest reductions in average monthly production—greater than 7 MGD—occurred at Eldridge-Wilde, Cypress Creek, South Pasco, and Cross Bar Ranch wellfields, while the smallest reductions—less than 1.6 MGD—occurred at North Pasco, J.B. Starkey, Northwest Hillsborough, and Cypress Bridge. Intermediate reductions occurred at Cosme-Odessa, Morris Bridge, and Section 21 Wellfields.

Rainfall was found to be highly variable even among nearby monitoring stations, but overall was found to be greater in the lower production period (WY2003-WY2008). Overall, the CWUP Area was wetter during the lower production period by approximately 1 inch per year while the Regional Reference Area was wetter during the lower production period by about 3 inches per year.

A spatial database containing 497 monitoring site locations with water level data was assembled, with 135 from the Southwest Florida Water Management District and the remainder from Tampa Bay Water. A final analysis file was prepared including 344 isolated, nonaugmented sites that were uniquely monitored. Available water level time series were reviewed for data appropriateness—especially period of record length and apparent dry value substitution changes. About one-quarter of the time series were considered unsuitable for median water level change analyses. Separate appropriateness evaluations were also performed for assessing the suitability of mapping the higher and lower production period Historical Normal Pool Offsets (NPO).

Overall, both the CWUP Area sites and the Regional Reference Area sites showed statistically significant increases in median water levels between the higher production and lower production periods. The typical CWUP wellfield area site showed a 1.64 foot increase in median water levels between the two periods, or 1.26 feet more than the typical Regional Reference Area site, which showed only a median 0.38 foot increase over the same period. Because the six-year rainfall total was higher in the recent period in both the CWUP and Regional Reference Areas, one would expect increases in median water levels in both areas. Since the rainfall difference was greater in the Regional Reference Area than the CWUP Area, this additional increase of 1.26 feet in the CWUP Area water levels beyond those observed in the Regional Reference Area may be considered a conservative estimate of recovery.

Water level recovery varied substantially among the individual wellfield areas of interest with those wellfield areas with the largest negative NPOs in the higher production period showing the largest rebound of water levels in the lower production period. The magnitude of water level recovery also was found to be related to the amount of reduction in groundwater production. These two factors—magnitude of depressed water levels and the reductions in production—varied together as those areas with lower NPOs in the higher production period also tended to experience the largest production cut-backs. Generally, those areas with the largest water level recoveries—Cross Bar Ranch, South Pasco, Section 21, and Cypress Creek—showed both low water levels to begin with (NPOs lower than -4.00 feet) and large percentage reductions in groundwater production (>30%) for the time periods compared.

Three series of maps using inverse squared distance weighted spatial interpolation were prepared showing the distribution of median data for: 1) higher production period NPOs, 2) lower production period NPOs, and 3) the change between the two periods. The general pattern apparent in all the maps is that the largest negative NPOs in the higher production period were located within the CWUP Area, particularly on or near the wellfields, while the Regional Reference Area sites showed consistently higher water levels relative to their long term indicators of inundation. The lower production period maps show that the larger negative NPOs observed in the high production period became relatively rare occurrences during this time period, being restricted primarily to selected areas located in the Cross Bar Ranch, Cypress Creek, and the central/western J.B. Starkey wellfield areas. Improvements in water levels in the South Pasco and Cypress Creek wellfield areas are particularly noticeable. The change maps show that there was very little change in the Regional Reference Areas while many of the wellfields showed large magnitude water level recoveries, especially: Cross Bar Ranch, Cypress Creek, South Pasco, Section 21, Cosme-Odessa, and Eldridge-Wilde. The Northwest Hillsborough wellfield area—which was not

connected to the Regional System until 2011—showed little to no change. Changes were patchily distributed in the Cypress Bridge, Morris Bridge, J.B. Starkey, and North Pasco Regional Wellfield areas. (The J.B. Starkey and North Pasco Regional Wellfields were not interconnected to the Regional System until December 2007.)

In summary, the documentation presented in this study provides substantial graphical and statistical evidence of water level improvements in the CWUP Area associated with groundwater production cut-backs, with these recoveries far exceeding increased water levels at Regional Reference Area sites attributable to higher rainfall. The largest water level improvements were observed to be concentrated in those areas with the historically most depressed water levels and the greatest reductions in groundwater production. The spatial interpolation method presented in this study appears to be an effective tool for visualizing both regional patterns in natural system water levels and changes in those levels. Since December 2010, the 12 month running average for groundwater production permitted under the CWUP has been below 90 mgd. Tampa Bay Water intends to perform similar analyses in order to assess the magnitude of further recovery.

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# Next year FLMS will celebrate its 25th Anniversary at our June Symposium!

# We will be also hosting the North American Lake Management Society's International Convention in November.

# Be sure to watch for conference information and don't miss these exciting events!