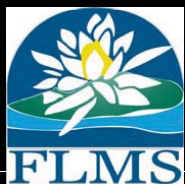


The 20th Annual
Florida Lake Management Society and
The North American Lake Management Society
Southeast Regional Conference

Celebrating 20 years of

Advancing the Science of Lake Management



Key Largo Grande
Key Largo, FL
June 8 – 11, 2009



**20th ANNUAL CONFERENCE OF THE
FLORIDA LAKE MANAGEMENT
SOCIETY & THE NORTH AMERICAN
LAKE MANAGEMENT SOCIETY
SOUTHEAST REGIONAL
CONFERENCE**

PROGRAM & PROCEEDINGS



**“Celebrating 20 Years of Advancing the Science
of Lake Management”**

June 8-11, 2009

Key Largo Grande, Key Largo, Florida



MISSION STATEMENT

The mission of the Florida Lake Management Society is to promote protection, enhancement, conservation, restoration, and management of Florida's aquatic resources; provide a forum for education and information exchange; and advocate environmentally sound and economically feasible lake and aquatic resource management for the citizens of Florida.

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Request for additional copies of this program and information about the Society may be sent to the following address:

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email: flmshome@aol.com

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AWARDS

The Florida Lake Management Society

presents the following annual awards:

The Marjorie Carr Award is the Society's highest award and is given for lifetime 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.

Past recipients include: Hal Scott (1990), Vince Williams (1991), Cassie and David Gluckman (1993), Johnny Jones (1994), Richard Coleman (1995), Nat Reed (2000), Mike Kasha (2001), Everett Kelly (2002), Joe E. Hill (2003), Jake Stowers (2004), Henry Dean (2005), not awarded (2006), Dean Barber (2007), and Ross Hamilton (2008).

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

William Beck (Florida A&M University, 1990), Jim Hulbert (FDEP, 1991), Howard T. Odum (1993), Tom Crisman (1994), Marty Wanielista (1995), Karl Havens (1999), Claire Schelske (2000), and Betty Rushton (2003) – not awarded in 2004, 2005, 2006, 2007, Mark Hoyer (2008).

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 known

activist on behalf of Lake Okeechobee and was a member of the steering committee that founded FLMS at the time of his death.

Past recipients include: Helen Spivey (1990), Jim Hawley (1991), Wayne Nelson (1993), Jim Thomas (1994), Tom Reese (1995), Judith Hancock (1999), Carroll Head (2000), Mary Carter (2001), Al Cheatum (2002), Thomas E. Fortson (2003), Beverly Sidenstick (2004), Joanne Spurlino (2005), Barbara Ketchum (2006), Robert King (2007), and Lake Powell Community Alliance (2008).

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. This award is named in honor of Richard Coleman who was a founder and first president of FLMA and, prior to his death, worked tirelessly to protect and restore aquatic resources throughout the State of Florida.

Past recipients include: Eric Livingston (1990), William Wegener (1991), Paul Shaffland (1993), Jeff Spence (1994), Sandy Fisher (1995), Kim Schildt (2000), Jess Van Dyke (2001), Patrick J. Lehman (2002), Lothian Ager (2003), Dr. Marty Kelly (2004), Dr. Harvey H. Harper, III (2005), Dr. Edgar F. Lowe (2006), Rae Ann Wessel (2007), and Michael Hill (2008).

The Marjorie Stoneman Douglas Award is given to individuals in the media who report on aquatic resource issues. This award is named in honor of Marjorie 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.

Past recipients include: John Morgan (2000), Georgia Davis (2001), Victor Hull (2002), Dave McDaniel (2003), Bob Hite (2004), Ron Littlepage (2006), not awarded (2007), and Bruce Ritchie (2008).

The Bob Graham Award is given to persons elected to office who demonstrate a commitment to lake and aquatic resource conservation. Bob Graham is remembered for his support of many environmental initiatives, including the purchase for preservation of thousands of acres of Gulf Coast wetlands.

Past recipients include: Robert B. Rackleff and Debbie Lightsey (2001), Shannon Staub (2002), Cliff Barnes (2003), Senator Ken Pruitt (2005) and John Delaney and Senator Jim King (2006), Don Ross (2007), and Cindy Meadows (2008).

The President's Award is given by the President of the Society to an individual for outstanding support of the work of the Society during the past year.

Past recipients include: Nancy Page (1999), Julie McCrystal (2000), Erich Marzolf (2001), Chuck Hanlon (2002), Chuck Hanlon (2003), Jim Griffin (2004), Erich Marzolf (2005), John Burns and Michelle Jeansonne (2006), Erich Marzolf (2007), Michael Perry (2008).

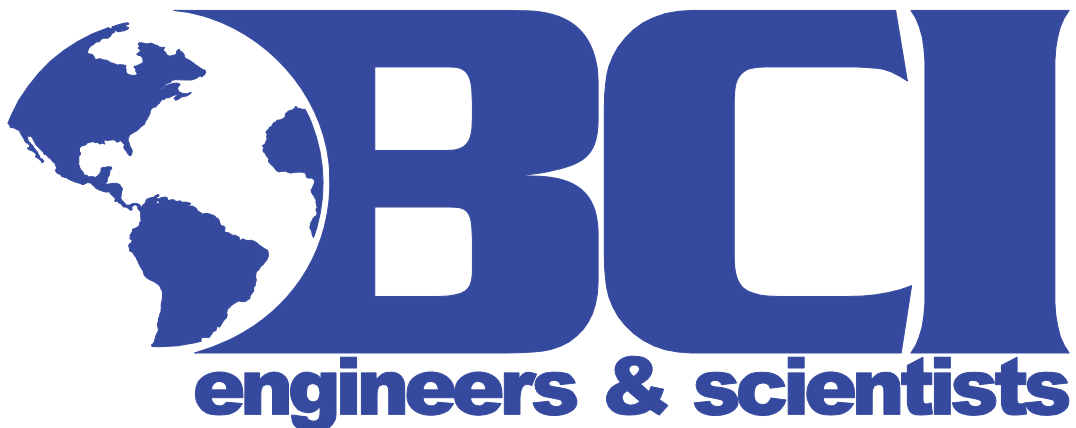
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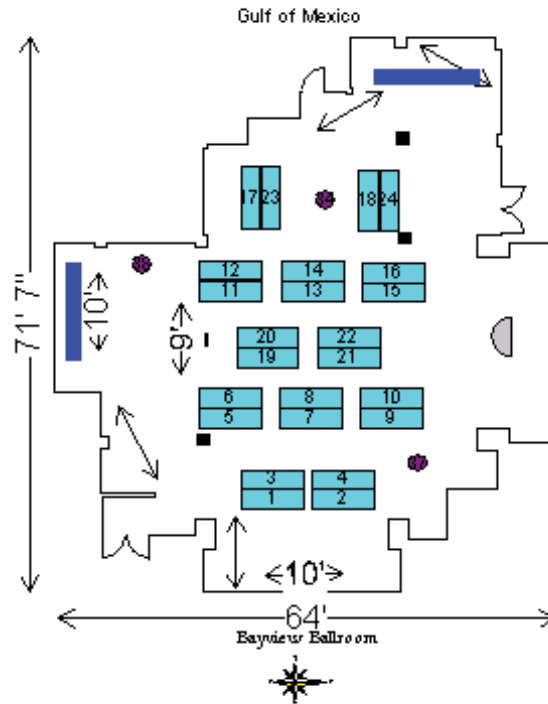
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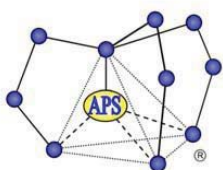
Floor Plan



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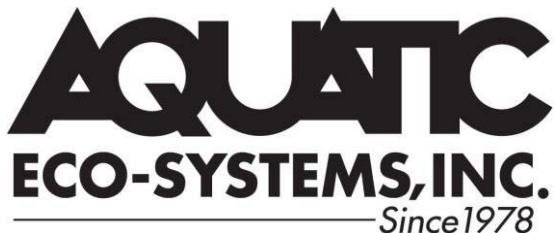
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Aquatic Vegetation Control, Inc. (AVC) is a Florida corporation founded in 1986 offering vegetation management and general environmental consulting services throughout the southeast. Since its establishment as an exotic/nuisance vegetation management company specializing in the control of invasive wetland and upland species, AVC has broadened its scope of capabilities to include chemical mowing, certified lake management, re-vegetation, restoration services, roadside and utility vegetation management, and general environmental/ecological consulting.

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Arc Surveying & Mapping, Inc.

Arc Surveying & Mapping, Inc., a small business located in Jacksonville Florida, is comprised of a group of innovative professionals that specialize in topographic and bathymetric surveys. Arc serves clients in the southeast United States and the Caribbean, focusing primarily on projects which require the excavation of contaminated sediments. The company has performed bathymetric and sub-bottom surveys in harbors and rivers from Chicago to Puerto Rico and in numerous fresh water lakes throughout Florida. Recently Arc completed Bathymetric and Sediment Distribution Surveys of fifteen Lakes in the Tsala Apopka chain of lakes in Citrus County Florida. The survey, for Florida Wildlife & Fisheries Commission, required the identification of lake bottoms and the bottom of lake sediments. Specialized surveying technology was used to accurately survey lakes congested with aquatic growth. For more information visit our website www.arcsurveyors.com.

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BCI has been involved with the restoration, conservation, and management of Florida's aquatic resources for 30 years. Our experienced staff provide expertise in the following areas: ecological & environmental services; lake diagnostics & restoration; watershed management planning; flood prediction & mapping; hydrodynamic modeling; integrated ground & surface water modeling; water quality modeling; stream, lake, and wetland hydroecology; TMDLs; MFLs; stream assessment & restoration; ecosystem & statistical modeling; wetland delineation & mitigation planning; wetland assessment & restoration; biological assessments; database management; water quality & hydrologic monitoring; and stormwater services. Please visit www.bcieng.com for a complete description of our services and demonstrated experience.

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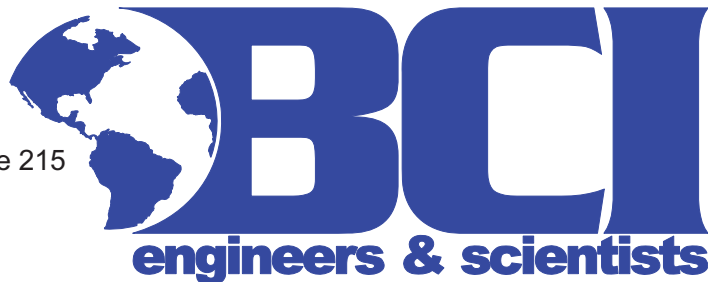
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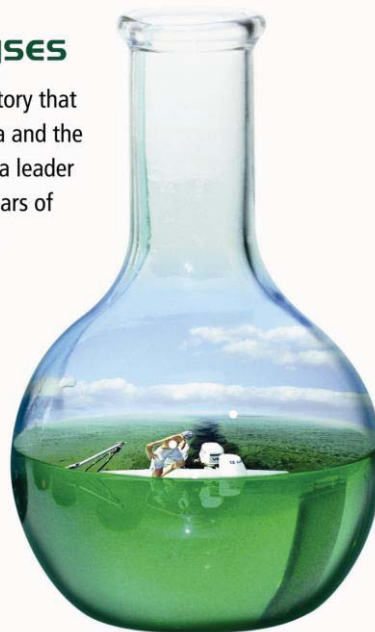
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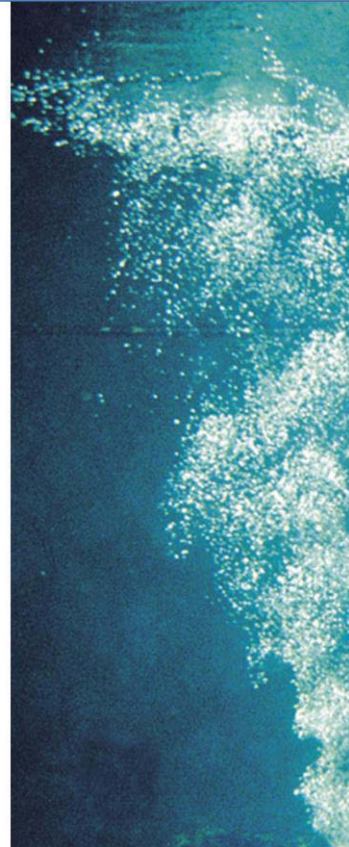
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SCHEDULE

**20th ANNUAL FLORIDA LAKE MANAGEMENT SOCIETY CONFERENCE & 2009
NALMS SOUTHEAST REGIONAL CONFERENCE**

Conference Theme: Celebrating 20 Years of Advancing the Science of Lake Management

Key Largo Grande, Key Largo, FL
June 8-11, 2009

FINAL PROGRAM

MONDAY - JUNE 8, 2009 – Workshops

8:00 am-5:00 pm	Check-In and Registration (Pre-Function Area)
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8:15-11:45 am	Workshop 1: Planning a Dredging Project (Room: Largo 1) - Shailesh Patel, Dredging & Marine Consultants
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8:15-11:45 am	Workshop 2: TMDLs: Coming to a Waterbody Near You (Room: Largo 2) - John Walkinshaw and Scott Deitche, GPI Southeast, Inc.; Kelli Hammer Levy, Pinellas County; Ann Shortelle, Ph.D., MACTEC Engineering and Consulting Inc.; and Shannon Carter Wetzels, Seminole County
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9:30-10:00 am	MORNING BREAK – LARGO LOBBY
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12:00-1:00 pm	LUNCH (provided with full-day Workshop registration) – LARGO TERRACE
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1:15-4:45 pm	Workshop 3: Identification and Management of Nuisance Filamentous Algae (Room: Largo 1) - Andy Chapman, GreenWater Labs.
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1:15-4:45 pm	Workshop 4: Compilation, Analysis, and Interpretation of Environmental Data (Room Largo 2) – Harvey Harper, Ph.D., P.E., Environmental Research and Design, Inc.
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3:00-3:30 pm	AFTERNOON BREAK – LARGO LOBBY
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TUESDAY - JUNE 9, 2009

8:00 am-4:00 pm	Check-In and Registration (Pre-Function Area)
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7:00 am-8:30am	Breakfast (Treetops Restaurant)
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8:00 - 8:20 am	Opening Remarks: (Largo 1-2)	Shailesh Patel – FLMS President Todd Olson – FLMS Conference Chair Kelli Hammer Levy - FLMS Program Chair
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Session 1: Water Quality Part I: Groundwater and Water Quality Evaluations

Moderator: David Evans

8:20-8:40 am **Winter Haven Chain of Lakes Groundwater Seepage and Sediment Study –**
Dave Tomasko, Emily Hyfield Keenan, Pam Latham, Tim Mann

8:40-9:00 am **Physicochemical Factors Affecting Near-Bottom Dissolved Oxygen Concentration in Reservoirs of Southwest Florida – John R. Cassani**, Kevin Watts, Edwin M. Everham III, David W. Ceilley

9:00-9:20 am **Septic Tank Nutrient Loadings to a Rural Oligotrophic Lake in Orange County Florida – Ronald Novy**

9:20-9:40 am **An Evaluation of Groundwater Seepage and Nutrient Influx in Central Florida Lakes** – Ronald Novy, Brandon M. Jarvis, Ann B. Shortelle

9:40-10:00 am **Water Quality Responses to Land Use Changes in the Lake Sawyer Drainage Basin - Did Development Improve Water Quality? – Harvey H. Harper**

10:00-10:20 am	MORNING BREAK – LARGO LOBBY
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Session 2: Vegetation Management, Monitoring, and Control Part I

Moderator: Stacia Hetrick

10:20-10:40 am **Challenges Associated with the Use of Herbicides for Submersed Plant Control** – Michael D. Netherland

10:40-11:00 am **Submerged Aquatic Vegetation (SAV) Distribution Within the Lower St. Johns River Driven by Extremes in Water Quality: A decadal Review – Jennifer J. Sagan**

11:00-11:20 pm **High Frequency Submerged Aquatic Vegetation Sampling Reveals Short-Term Responses to Salinity Pulses** – Dean R. Dobberfuhl, Jennifer Tallerico, Christina Register

11:20-11:40 pm **Geostatistical Mapping: SAV Response to Salinity** – Christina Register, Dean R. Dobberfuhl, Jennifer Tallerico

11:40 – 12:00 pm **Integrated Hydrilla Management on the Winter Park/Maitland Chain of Lakes**
– Timothy J. Egan and Marissa Rodriguez

12:00-1:00 pm	BOX LUNCH (Bay View Room with outdoor seating at Sunset Terrace)
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TUESDAY – JUNE 9, 2009 (Continued)

Session 3: Water Quality Part II: Assessment, Modeling, and Monitoring

Moderator: Jim Griffin

- 1:00-1:20 pm **Assessment of Variability in Eutrophication Parameters of the Coastal Dune Lakes Located in Walton County, FL** – Julia B. Terrell
- 1:20-1:40 pm **A Water Quality Model of Lake Apopka From 1990-2002** – Scott A. Lowe and James McCabe
- 1:40-2:00 pm **Detection of Long-Term Mean for the Monitoring Program in the St. Lucie River and Estuary** – Deo Chimba and Jing-Yea Yang
- 2:00-2:20 pm **Hydrological Geodatabase Design for the Lake Carroll, Hillsborough County Catchment** – Robert Collaro, Bruce C. Mitchell, Katherine Whitley

2:20-2:40 pm	AFTERNOON BREAK – LARGO LOBBY
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Session 4: Critters and Aquatic Interactions Part I

Moderator: Dana Bigham

- 2:40-3:00 pm **Lack of Exotic Hydrilla Infestation on Plant, Fish, and Aquatic Bird Community Measures** – Mark V. Hoyer, Michael S. Allen, Daniel F. Canfield, Jr.
- 3:00-3:20 pm **Mosquito Control in Florida's Aquatic Environment** – Joseph M. Faella, Jonas Stewart, William Greening, Shailesh K. Patel
- 3:20-3:40 pm **Recreational Exposure to Microcystins During Algal Blooms in Two California Lakes** – Lorraine C. Backer, Sandra V. McNeel, Terry Barber, Barbara Kirkpatrick, Christopher Williams, Mitch Irvin, Yue Zhou, Trisha B. Johnson, Kate Nierenberg, Mark Aubel, Rebecca LePrell, Andrew Chapman, Amanda Foss, Susan Corum, Vincent R. Hill, Stephanie M. Kieszak, Yung-Sung Cheng

Session 5: BMPs Part I

Moderator: Jennifer Sagan

- 3:40-4:00 pm **The Use of Iron Salts for Lake Restoration** – Vic Johnson and Bengt Hansen
- 4:00-4:20 pm **Stormwater Ponds: An Untapped Resource** – Shannon Carter-Wetzel, Kim Ornberg, Ann B. Shortelle
- 4:20-4:40 pm **Preliminary Evaluation of Curb and Grate Inlet Baskets as an Effective Watershed Management Tool in Orange County Florida** – Brian Cantanzaro and Gary Jacobs

5:30-6:30 pm	POSTER SESSION (Pre-Function Area)
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6:30-8:30 pm	EXHIBITORS' SOCIAL (Bay View Room)
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WEDNESDAY - JUNE 10, 2009

8:00 am-3:00 pm Check-In and Registration (Pre-Function Area)

7:00 am-8:30 am Breakfast (Treetops Restaurant)

Sessions Largo 1

Session 6: Vegetation Management and Control Part II

Moderator: Stacia Hetrick

8:30-8:50 am **Feast for Fifty! - Controlling *Hydrilla verticillata* in Lake August** – [Erin McCarta](#) and Clell Ford

8:50-9:10 am **Status of the Demonstration Project on Hydrilla and Hygrophila in the Upper Kissimmee Chain of Lakes** – [Stacia Hetrick](#)

9:10-9:30 am **100 Years of Aquatic Weed Control in Florida** – [William T. Haller](#)

Session 7: Monitoring for Results

Moderator: Kym Rouse Campbell

9:30-9:50 am **Flow Measurement Planning at a Stormwater Treatment Area Near Lake Okeechobee** – [Kwaku Oben-Nyarko](#), Jie Zeng, Jing-Yea Yang

9:50-10:10 am **Long-Term Water Chemistry Trends in Florida Lakes** – [Dana L. Bigham](#), Mark V. Hoyer, Daniel E. Canfield, Jr.

10:10-10:30	MORNING BREAK – LARGO LOBBY
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Session 8: Nutrient Limitation

Moderator: Kelli Hammer Levy

10:30-10:50 am **Role of Nutrient Limitation in Lake Restoration** – [Harvey Harper](#)

10:50-11:10 am **Spatial and Temporal Distribution of Limiting Nutrients in Florida Lakes** – [Jim Griffin](#), John McGee, David Glicksberg

11:10-11:30 am **Whole Lake Alum Applications for Control of Internal P Loading Long Term Benefits and Unintended Consequences** – [Timothy J. Egan](#)

11:30-11:50pm **The Use and Limitations of the State of Florida's Trophic State Index (TSI) as a Tool for Setting Water Quality Targets for Lake Management** – [Dave Tomasko](#)

12:00-1:30 pm	BANQUET LUNCH/FLMS ANNUAL MEETING (Largo 2, 3, 4)
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WEDNESDAY - JUNE 10, 2009 (Continued)

Session 9: These Regulatory Times

Moderator: Clell Ford

- 1:30-1:50 pm **Comparison of Southeastern States' Responses to the TMDL Planning Process and Implementation of TMDLs: Are we Working too Hard or Not Hard Enough?** – Ann B. Shortelle, K.A. Reed, A. Vandelay
- 1:50-2:10pm **Using a Decision Matrix to Develop Fecal Coliform BMAPs for Impaired Waters in the Hillsborough River Watershed** – Gerold Morrison and Terry Hansen
- 2:10-2:30 pm **Rules and Regulations that Affect Agriculture or How to Speak to a Farmer** – Vic Johnson
- 2:30-2:50 pm **The Watershed Management Plan for Lake Istokpoga: Are you Kidding Me?** – Clell Ford
- 2:50-3:10 pm **The Use of the Florida Lake Vegetation Index to Identify Anthropogenically Impaired Lakes in Florida** – Roger W. Bachmann, Mark V. Hoyer, Daniel E. Canfield

3:10-3:30 pm	AFTERNOON BREAK - LARGO LOBBY
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Session 10: BMPs Part II

Moderator: Shannon Carter-Wetzel

- 3:30-3:50 pm **The Benefits of Vegetation and Biological Engineering Practices for Maintaining Ponds** – Zachary Marimon
- 3:50-4:10 pm **Construction and Preliminary Results of an Off-Line Nutrient Reduction Facility to Improve Water Quality Downstream of Lake Apopka** – Lance M. Lumbard, Ronald L. Hart, Steve Yarkosky
- 4:10-4:30 pm **Polymer Enhanced Best Management Practices for Erosion and Sedimentation Control, Water Clarification with a Focus on Pond and Lake Management Including Nutrient Control and Soil Stabilization** – Seva Iwinski

4:30-5:30 pm	FLMS BOARD MEETING (Largo 1)
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THURSDAY - JUNE 11, 2008

7:00 am-8:15 am Breakfast (Treetops Restaurant)
10:00 am-12:00 noon Exhibitor Breakdown

Sessions Largo 1-2

Session 11 Watershed and Lake Management

Moderator: John Walkinshaw

8:15-8:35 am **Assessment of Three Estuaries Located in the Panhandle of Florida**– Julia B. Terrell

8:35-8:55 am **Rapid Lake Assessments of Small to Medium Sized Lakes in Hillsborough County Florida** – David Eilers, Jim Griffin, John McGee, David Glicksberg

8:55-9:15 am **The Killearn Chain of Lakes Restoration, A Clean Lakes Project** – Sean McGlynn

9:15-9:35 am **Wetland Change and Ecological Effects; A Case Study of Vientiane Capital City, Laos** – Chanhda Hemmavanh

9:35-10:00 am	MORNING BREAK
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Session 12: Critters and Aquatic Interactions Part II

Moderator: Julia B. Terrell

10:00-10:20 pm **Spatial and Temporal Differences in the Benthic Macroinvertebrate Community of Wetlands in a West Central Florida Natural Area** – Kym Rouse Campbell and Todd S. Campbell

10:20-10:40 pm **Control of Invasive Exotic Island Apple Snails (*Pomacea insularium*) in Regional Stormwater Facility #1, Leon County, FL.** – Sean McGlynn and Jess Van Dyke

10:40-11:00 pm **A Comparison of Long Spine Sea Urchin, *Diadema antillarum*, Population Densities on Path Reef and Rubble Habitats in Dry Tortugas National Park** – Joni E. Barreda and Wayne A. Bennett

11:00-11:20 pm **Concluding Remarks:** Kelli Hammer Levy, FLMS President 2009-2010

11:30	CONFERENCE ADJOURNED
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SESSION 1

WATER QUALITY PART I GROUNDWATER AND WATER QUALITY EVALUATIONS

WINTER HAVEN CHAIN OF LAKES GROUNDWATER SEEPAGE AND SEDIMENT STUDY

Dave Tomasko, Emily Hyfield Keenan, Pam Latham and Tim Mann
PBS&J, Tampa, FL

The Winter Haven Chain of Lakes (WHCL) are Southwest Florida Water Management District (SWFWMD) Surface Water Improvement and Management (SWIM) priority waterbodies. The WHCL consists of 24 interconnected lakes divided into the Southern and Northern Chains. FDEP did not propose TMDLs for impaired lakes in the Northern Chain of Lakes due to the uncertainty associated with pollutant loadings from atmospheric deposition, groundwater, septic tanks and bottom sediments.

Four lakes in the Northern Chain of the WHCL (Haines, Rochelle, Smart, and Conine) were studied to examine the potential influence of groundwater seepage on water and nutrient budgets. Surficial aquifer wells were installed and monitored adjacent to each of the four lakes and groundwater infiltration and water quality was measured with using a total of sixteen seepage meters. Sediment cores were collected from each lake to evaluate potential differences in sediment characteristics between these lakes. Finally, long-term rainfall, lake levels, and groundwater data were reviewed and used to evaluate the relationships between rainfall, surficial aquifer water elevations, and lake stage. Groundwater seepage into the lakes was verified using both the surficial aquifer data and seepage meters. Groundwater inflow volumes and TN and TP loading rates were then estimated for three of the four lakes. When compared to existing studies, the groundwater inflow and TN loading were comparable. However, TP loadings to Lake Haines, Rochelle and Conine were much greater than prior estimates, indicating that groundwater may play a larger role in water and nutrient budgets than was previously estimated.

NOTES

PHYSICOCHEMICAL FACTORS AFFECTING NEAR-BOTTOM DISSOLVED OXYGEN CONCENTRATION IN RESERVOIRS OF SOUTHWEST FLORIDA.

John R. Cassani¹, Kevin Watts¹, Edwin M. Everham, III², and David W. Ceilley²

¹Lee County Hyacinth Control District, Ft. Myers, FL

²Florida Gulf Coast University, Ft. Myers, FL

Near-bottom dissolved oxygen concentration (NBDO) was monitored bi-monthly at one site for four years and 10 additional sites during late summer of 2007 and 2008 in Lee County, Florida to determine the influence of reservoir morphometry on NBDO dynamics. Maximum depth, surface to volume ratio, fetch distance, relative depth (Z_r) and specific conductance were assessed individually on NBDO using linear regression analysis. A significant ($P = 0.01$) inverse relationship ($r^2 = 0.549$) existed between NBDO and maximum depth during late summer of 2007 at eleven sites but not again in 2008 at the same sites, suggesting factors other than maximum depth may be important in regulating NBDO in relatively shallow reservoirs of coastal southwest Florida. Relatively strong but non significant ($P = 0.08$) relationships occurred between NBDO and surface / volume ratio (direct relationship) and east-west fetch distance (inverse relationship) in 2007, but as with maximum depth, not again in 2008. Relative depth (Z_r) was found to be a poor predictor of NBDO in the reservoirs we sampled. An additional finding revealed that a narrow, more dense layer of water as measured by sharply elevated specific conductance near the soil water interface was negatively correlated with NBDO at two sites more proximal to the Gulf of Mexico and saltwater intrusion via groundwater is suspected to contribute to this condition. The influence of submersed aquatic vegetation (SAV) on NBDO was also examined at one site during four growth seasons, indicating the presence of extensive SAV may resist vertical mixing and contribute to relatively low NBDO. These findings will contribute a greater understanding of how reservoir morphometry in southwest Florida may affect NBDO which has a major influence on nutrient dynamics at the sediment water interface, the distribution of biota within reservoirs and the potential for affecting off-site waters resulting from reservoir discharge.

NOTES

SEPTIC TANK NUTRIENT LOADINGS TO A RURAL OLIGOTROPHIC LAKE A IN ORANGE COUNTY FLORIDA

Ronald Novy

Orange County Environmental Protection
Orlando, FL

Lake Price is a 90-acre waterbody surrounded by a combination of forested and rural residential development. Lake Price is considered one of the “cleanest” lakes in Orange County with typical TSI values in the mid 20’s. Upon a completion of a full hydrological and nutrient assessment, it was determined that the lake is beginning a transformation to a more mesotrophic system.

After evaluation all loading sources, one source in particular stood out as a major contributor to the phosphorus load. The specific source was septic tank drain fields, but not the typical back yard systems; the culprit was the front yard systems. These systems were comprised mainly of elevated drain fields located adjacent to the front yard stormwater swales. The setbacks from most swales were no more than 5-10 feet. These vegetated swales collected the typical adjacent yard and roadway runoff, but in addition, were close enough to the mounded systems to allow groundwater seepage to enter.

In analyzing the chemical components of the swales after several rainfall events, it was determined that a large fraction of the phosphorus was in the soluble and not the particulate form as is most stormwater runoff. Concentrations from three swale sampling sites ranged from 245 to 970 ug/l-TP with the soluble reactive fraction making up 45-64% of the total contribution, respectively. Although the drainage basin for this lake is very small (96 acres), the stormwater component makes up over 50% of the total phosphorus load to Lake Price with a portion of that load associated with front yard septic systems.

NOTES

AN EVALUATION OF GROUNDWATER SEEPAGE AND NUTRIENT INFLUX IN CENTRAL FLORIDA LAKES

R. Novy¹, B. M. Jarvis², and A. B. Shortelle. Ph.D.²

¹Orange County Environmental Protection Division, Orlando, FL

²MACTEC Engineering and Consulting, Newberry, FL

Groundwater seepage is gaining recognition as an important hydrologic component of Central Florida lakes. Variations in groundwater flow rates and associated nutrient loads complicate assessment of seepage both seasonally and spatially within an individual lake, and limit comparison of seepage rates between regional lakes. An evaluation of groundwater seepage in four Central Florida lakes (Lakes Cane, Catherine, Clear, and Mann) was performed using groundwater seepage meters to quantify flow rates throughout each lake. An analysis of the contributing watershed was also performed to investigate spatial patterns and controlling factors of groundwater seepage from the surrounding watershed, including land use types, soils, topography, septic systems, and existing best management practices (BMPs). Chemical characterization of groundwater seepage samples was accomplished to evaluate nutrient concentrations and loadings as part of the nutrient budget development for the lakes. Seepage flow rates and nutrient loads are compared with results from similar studies from the central Florida area. A comparison of nutrient loads entering the lakes with watershed characteristics was also performed to identify potential contributing factors to seepage nutrient loads. Based on these results, recommendations for watershed BMPs were developed to provide strategies for nutrient load reductions and improvements to lake water quality.

NOTES

WATER QUALITY RESPONSES TO LAND USE CHANGES IN THE LAKE SAWYER DRAINAGE BASIN - DID DEVELOPMENT IMPROVE WATER QUALITY?

Harvey H. Harper, Ph.D., P.E.
Environmental Research & Design, Inc.
Orlando, Florida

Introduction

Lake Sawyer is a 93 acre lake located in northwest Orange County. Lake Sawyer is hydrologically connected to Little Lake Sawyer, a 65 acre water body, through a navigable canal. Lake Sawyer and Little Lake Sawyer form the headwaters of Cypress Creek which is part of the Kissimmee River basin. Lake Sawyer is relatively deep with a mean depth of 15.5 ft and a maximum water depth of 34 ft. The watershed area discharging to the lake is approximately 156 acres. Soils in the drainage basin are well-drained (HSG A) with the exception of wetland areas adjacent to the lake.

Methods

A field monitoring program was conducted by ERD from April-December 2006 to collect hydrologic and water quality data for use in developing hydrologic and nutrient budgets for the lakes. Hydrologic and nutrient budgets were developed which include estimated inputs from precipitation, stormwater runoff, interconnected lake inflow, internal recycling, and groundwater seepage. A water quality model was developed to evaluate potential changes in water quality from recommended water quality management projects. Historical water quality data were reviewed, and trends were evaluated for significant trophic state indicators.

Results

Water quality data for Lake Sawyer are discontinuous, with extensive monitoring conducted from 1991-1998 and again from 2004-2008. The available water quality data suggest that Lake Sawyer is a phosphorus limited lake. During the period from 1991-2004, Lake Sawyer was characterized by eutrophic and hyper-eutrophic conditions with elevated concentrations of total P and chlorophyll-a and poor water column clarity (ERD, 2008). A dark green coloration of the water column is clearly visible in aerial photographs taken through 2004.

Prior to 2004, the historical land use in the watershed was agriculture, with a combination of pasture, row crops, and silvaculture. During this period, single-family homes occupied approximately 10% of the basin area.

Beginning in 2004, the drainage basin began a rapid conversion to single-family homes constructed with stormwater management systems consisting of wet detention and dry retention ponds. Virtual complete build-out of available land within the basin was accomplished by 2008. During this period, a significant improvement in water quality was observed in Lake Sawyer with substantial reductions in water column concentrations of total P, chlorophyll-a and TSI. Nine of the 10 water quality monitoring events conducted from 2005-2008 indicated oligotrophic conditions with mesotrophic conditions during the other event. Field monitoring conducted by ERD from April-November 2008 indicated classic oligotrophic conditions with isograde profiles of temperature, conductivity, and dissolved oxygen to water depths in excess of 5 m even during summer conditions.

The nutrient budget developed by ERD estimates an annual phosphorus loading of 98.5 kg/yr under current conditions. This calculated loading generated good predictions for ambient concentrations of total P and chlorophyll-a over the period from 2005-2008 using a modified Vollenweider model. After calibration, the model was used to calculate the total P loading required to obtain the eutrophic/hyper-eutrophic water quality characteristics observed from 1991-2004. The TP loading necessary to achieve the observed eutrophic/hyper-eutrophic conditions is approximately 267 kg/yr, more than 2.8 times the estimated current loading.

Conclusions

Although limited, the historical water quality data appear to suggest that water quality in Lake Sawyer has improved as development has encroached upon the watershed. The constructed stormwater management systems rely on dry retention and wet detention which are the two most efficient stormwater management techniques commonly used today. The stormwater management systems constructed with the new development appear to have reduced loadings of total P to Lake Sawyer to levels less than the loadings associated with the historical agricultural activities, resulting in improved water quality under current conditions.

References

Environmental Research & Design, Inc. (2008). "Lake Sawyer and Little Lake Sawyer Hydrologic/Nutrient Budget and Management Plan," Final Report to Orange County Environmental Protection Department.

NOTES

SESSION 2

VEGETATION MANAGEMENT, MONITORING, AND CONTROL PART I

CHALLENGES ASSOCIATED WITH THE USE OF HERBICIDES FOR SUBMERSED PLANT CONTROL

Michael D. Netherland¹ and Jeremy G. Slade²

¹US Army ERDC, Gainesville, FL

²University of Florida, Center for Aquatic and Invasive Plants, Gainesville FL

Herbicide use to control aquatic vegetation in Florida can elicit a wide range of responses and concerns from the fishing community, lake property owners, and the general public. Debates regarding the need to control aquatic vegetation, how much to control, and the herbicides chosen can often be divisive. This talk will discuss the various pros and cons of herbicide use, but will focus on the technical factors that should be considered when implementing an herbicide program for control of submersed plants. Experience suggests that lake managers and aquatic plant managers need to improve communication when it comes to issues such as herbicide use patterns, plant selectivity, toxicology, and management objectives. There are currently eleven herbicide active ingredients registered for aquatic use. Glyphosate and imazapyr are used strictly for emergent plant control, while copper, endothall, and fluridone are used almost exclusively for submersed plant control. Diquat, carfentrazone, imazamox, penoxsulam, triclopyr, and 2,4-D are used for both emergent and submersed plant control. Many of these compounds have been used since the 1950's and 60's for aquatic plant management. Each compound has unique properties that impact the recommended use rates and use patterns, label restrictions, and plant selectivity. While there are many challenges associated with control of submersed plants, rapid dilution or dispersion of the herbicide from the target area remains the greatest technical challenge. The introduction of hydrilla (*Hydrilla verticillata*) in the 1950's and the subsequent rapid spread of the plant through the 1970's and 80s increased the complexity of management decisions. This fast growing species is viewed as both beneficial and detrimental to water bodies throughout Florida. While some see hydrilla as invasive species that requires intense management, others see the plant as providing a valuable ecological service in many aquatic systems. Despite political and environmental challenges, herbicides continue to provide an option for site-specific aquatic plant management at a wide variety of scales.

NOTES

SUBMERGED AQUATIC VEGETATION (SAV) DISTRIBUTION WITHIN THE LOWER ST. JOHNS RIVER DRIVEN BY EXTREMES IN WATER QUALITY: A DECADE REVIEW

Jennifer J. Sagan

BCI Engineers & Scientists, Inc.
Lakeland, FL

Since 1998 submerged aquatic vegetation (SAV) and water quality (WQ) monitoring have been conducted at permanent monitoring sites within the Lower St. Johns River (LSJR), Florida. From 1998 through 2007, two droughts (1999 – 2001 and 2006 – present), one tropical storm (September 2001), and three hurricanes (September 2004) occurred within this basin. The extremes in water quality resulting from this natural phenomenon have provided an opportunity to investigate what stressors drive SAV distribution within this system, specifically the dominant species, *Vallisneria americana*. Drought induced increases in salinity (biweekly maximum value = 25 ppt) have caused dramatic declines or die-offs of SAV in historical SAV habitat within the downstream oligohaline/mesohaline section of the LSJR (river mile 27 – 40). Despite light attenuation coefficients as high as 8.3 m^{-1} following the 2004 hurricanes, salinity appears to be the dominant factor driving SAV declines and resurgence in the downstream reach. During the ten-year period salinity was negatively correlated ($p < 0.001$) with SAV percent occurrence. In the upper, freshwater extent of the LSJR (river mile 75), SAV decline and resurgence are related to increases in light attenuation due to colored dissolved organic matter (CDOM). CDOM increased to 500 cobalt platinum units (CPU) following extreme hydrologic events such as tropical storms and hurricanes and resulted in SAV declines in this region to less than 10% coverage. Throughout the hydrologic extremes that have occurred between 1996 and 2007, it has become apparent that water quality changes occur along a gradient within the river. Depending on the hydrologic event of the moment, SAV at the extremes of the LSJR are usually reacting differently to the resultant water quality changes. While declines were seen in the oligohaline portion of the river during the 1999 – 2001 drought, the upstream, freshwater portion showed signs of expansion (Fig. 1). Drought conditions greatly reduced the input of CDOM-laden runoff from wetlands into the LSJR which disproportionately benefits the upstream portion because it is flanked by wetlands. However, drought conditions decreased the amount of freshwater input into the system which allowed salinities to increase in the downstream reach. Conversely, periods of above normal precipitation eliminate the salinity stress on SAV within the oligohaline section but increase light attenuation stress in the upper extent. Understanding how natural perturbations effect SAV is critical to investigating the additive effects of anthropogenic stressors on the system.

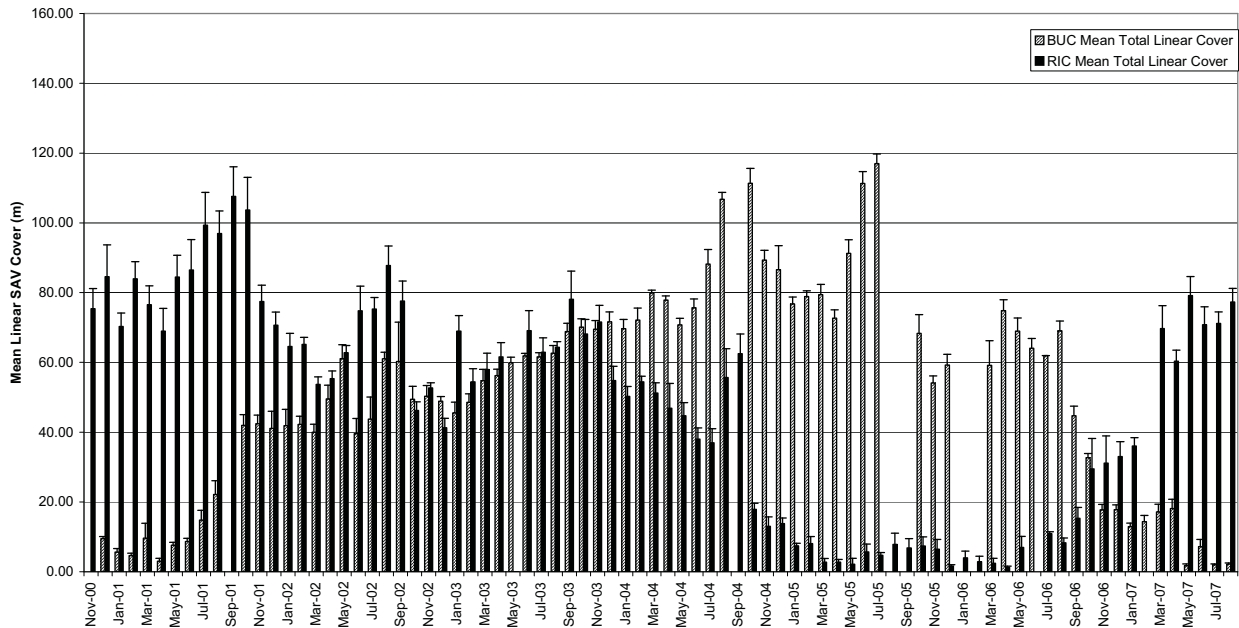


Fig. 1 The See Saw Effect: Monthly (n = 5) comparison of total SAV cover for years 2000 - 2007 between upstream (RIC) and downstream sites (BUC) in LSJR.

NOTES

HIGH FREQUENCY SUBMERGED AQUATIC VEGETATION SAMPLING REVEALS SHORT-TERM RESPONSES TO SALINITY PULSES

Dean R. Dobberfuhl¹, Jennifer Tallerico², Christina Register²

¹ St. Johns River Water Management District, Palatka, FL

² BCI Engineers and Scientists, Inc. Palatka, FL

Introduction

The St. Johns River Water Management District (SJRWMD) has undertaken a study of the potential effects of surface water withdrawals from the St. Johns River. Preliminary analysis indicated one of the most important potential impacts was salinity effects on submerged aquatic vegetation (SAV) in the estuarine portion of the river. The salinity regime in the lower St. Johns River basin is dynamic and stochastic. In the oligo/mesohaline reaches salinity intrusion events can spike salinity 15-20 ppt and return to low levels over a couple of days. While these brief, acute salinity events affect SAV condition, water quality and SAV monitoring have been oriented around long-term (e.g., seasonal or monthly) monitoring. To understand and quantify short-term effects of salinity on SAV, the SJRWMD embarked on a study to make high-frequency salinity and SAV measurements. The overall goal of the study is to refine estimates of SAV salinity tolerance by addressing exposure intensity, duration, and return frequency.

Methods

In cooperation with the U.S. Geological Survey, real-time water quality stations were installed on the Buckman (mesohaline) and Shands (oligohaline) Bridges in April 2007. Temperature, dissolved oxygen, and conductivity were measured hourly from the surface and near the bottom. For the analyses in this paper, the strong tidal signal in the water quality data was removed by using daily averages.

SAV data were collected weekly from two sites adjacent to the Buckman and Shands Bridges. At each site, samples were collected on a 10 x 10-point orthogonal grid extending from the shore to the deep edge of the grassbed. Spacing between the points was proportional to the grassbed width. For example, if the grassbed was 100-m wide then point spacing was 11-m. If the grassbed was 60-m wide then point spacing was 7-m. This design kept the majority of points in the grassbed and reduced X, Y directional bias in subsequent geostatistical analyses. At each sample point, estimated total percent cover and species canopy height were obtained from a 25 x 25-cm area. We also calculated a biovolume index (BVI) using the product of mean canopy height and percent cover.

Data were analyzed both over the whole grassbed and within three relatively distinct zones based on SAV structure. Non-parametric rank correlations were used to relate salinity and SAV metrics.

Results and Discussion

SAV coverage was surprisingly dynamic over short time scales. At the oligohaline site, weekly SAV coverage changed by two fold, particularly in the spring, and increased somewhat throughout the summer (Fig. 1). There was also a small decrease in coverage in September, possibly suggesting decreased growth at the end of the growing season (Fig. 1). Weekly SAV coverage at the mesohaline site changed in a similar manner to the oligohaline site. An important difference was a precipitous decline in coverage late in the growing season (Fig 2). This decline was coincident with an intense salinity spike caused by reverse flows associated with tropical storm Fay.

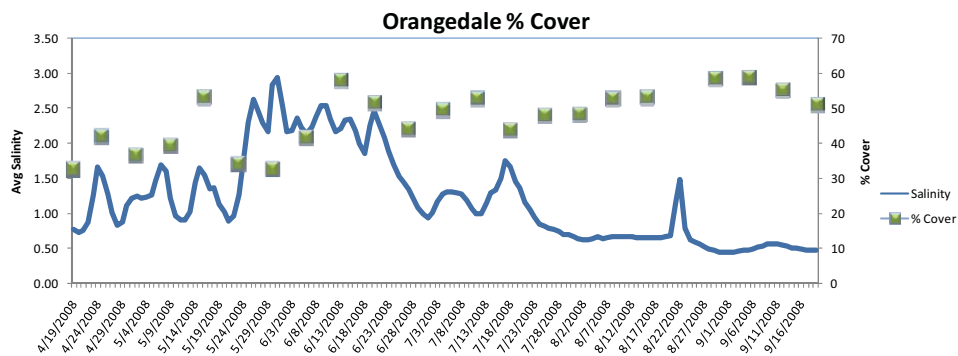


Figure 1. Time series showing mean weekly SAV coverage and daily salinity for the oligohaline site in the St. Johns River.

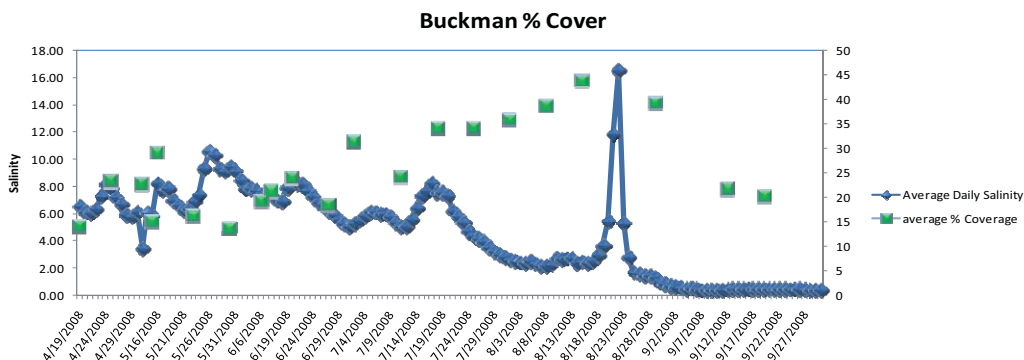


Figure 2. Time series showing mean weekly SAV coverage and daily salinity for the mesohaline site in the St. Johns River.

Salinity was significantly and negatively correlated with both percent cover ($\rho = -0.46$, $p = 0.036$) and BVI ($\rho = -0.59$, $p = 0.005$) across the whole grassbed at the oligohaline site. These relationships were largely driven by salinity induced changes in the zone nearest the deep edge of the bed. Salinity was significantly and negatively correlated with only percent cover ($\rho = -0.51$, $p = 0.022$) at the mesohaline site, while BVI was not related. As with the oligohaline site, most of the relationship appeared to be driven by the deep-edge zone.

This study has demonstrated that SAV can be highly dynamic even at a short time scale. Salinity was correlated with changes in SAV at this same time scale. However, salinity only explains a portion of the variance in SAV dynamics. Clearly, other factors like light availability are important and operating concomitantly on the SAV community. Additional work is underway to identify and quantify other environmental factors and their interactive effects with light.

NOTES

GEOSTATISTICAL MAPPING: SAV RESPONSE TO SALINITY

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Introduction

The lower St. Johns River flows from the confluence of the St. Johns and Ocklawaha rivers north 156 km, into the Atlantic Ocean at Mayport, FL. Water supply utilities within the St. Johns River Basin are looking to withdraw water from the St. Johns River to supply increasing demands. As part of a study of the impacts these withdrawals may have upon submerged aquatic vegetation (SAV) dynamics, grassbed characteristics and salinity were monitored at a mesohaline and an oligohaline site. Total percent cover and *Vallisneria americana* average height krigings were performed to show a visual representation of grassbed span and height throughout the sampling period. When comparing grass cover and height maps to salinity, the relationship between grassbed structure and response to salinity can be seen.

Methodology

Two study sites were selected based on continual, long-term sampling efforts as well as accessibility. The mesohaline site is on the east shore just south of the Buckman Bridge, Jacksonville. The oligohaline site is also on the east shore, just north of the Shands Bridge, in Orangedale. Salinity was measured every 15 minutes during the study period by permanent monitoring stations deployed by USGS. SAV was surveyed weekly beginning April 4, 2008 and ending September 19, 2008 on a 10 x 10 point sample grid. SAV canopy height, percent cover and water depth were measured at each of the 100 sample points. All plant species found within the sites were monitored for coverage. *Vallisneria americana* was the dominant species of SAV in the lower basin from 1998-2007, comprising over 63% of SAV coverage (Sagan, 2007). Researchers have found that *Vallisneria* loses total biomass, local productivity, and leaf area index when exposed to salinities of 8 ppt for 2.5-months (Boustany et al. 2001). *Vallisneria* is therefore useful when comparing to salinity because it is found at sites with salinities up to 18 ppt. For each sampling event, maps of total percent cover and average *Vallisneria* height for the sampling areas were generated using Geostatistical Analyst in ArcMap. Of the Geostatistical Analyst kriging methods available, Universal Kriging was chosen because it accounts for a trending mean across a patchy grassbed allowing influence of a range of densities. Each grassbed had a unique trend. The mesohaline grassbed was centralized and parallel to shore with a northeast to southwest orientation, and the oligohaline grassbed was peripheral and parallel to shore with a northwest to southeast orientation. These maps can be used as a visual

representation of grassbed structure in response to the changing salinity levels throughout the sampling period.

Results

When comparing kriging maps, it is apparent that SAV coverage can change dramatically. The mesohaline site showed greater weekly changes in percent cover throughout the sampling period while the oligohaline site showed slower gradual changes; however, the oligohaline site had greater percent cover than the mesohaline site throughout the sampling period. When comparing maps of *Vallisneria* average height throughout the sampling period, it can be seen that canopy height also responded to salinity shifts as percent cover did. *Vallisneria* was more abundant and taller at the oligohaline site than the mesohaline site throughout the sampling period. When comparing maps of percent cover and *Vallisneria* height, it is evident that grassbed structure responded across the span and in height to salinity.

On August 22, 2008, Tropical Storm Fay remained stationary offshore from the St. Johns River. In response to the rainfall and nor' eastern influence of the storm, water levels increased and salinity quickly spiked causing a decline in percent cover at both sites.

References

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NOTES

INTEGRATED HYDRILLA MANAGEMENT ON THE WINTER PARK/MAITLAND CHAIN OF LAKES

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Introduction

Prior to 2004, hydrilla management on the Winter Park and Maitland Chain of Lakes consisted of periodic (every 3 to 8 years) whole lake treatments using fluridone, followed by as needed spot treatments using endothall. Fluridone applications were typically performed using Sonar in split treatments that were designed to maintain a low residual of active ingredient (4-6 ppb) in the water column for an extended period of time (12 weeks or more). The level of control approached 100% using this method and regrowth was minimal for multiple growing seasons (up to 8 years in some cases). Regrowth that was observed was treated with endothall (usually Aquathol Super K granular) at a rate of 3 ppm in the infested areas. Under this treatment regime, hydrilla coverage was maintained below 10% on most lakes.

Current Control Methods

During fluridone treatments in 2005, hydrilla in the Chain of Lakes began exhibiting resistance to the herbicide. Maintaining residual levels for longer periods of time and using higher concentrations (up to 20 ppb) failed to achieve more than 75% control on most treatments requiring follow up treatments using endothall. Extensive regrowth was being observed within one growing season. Due to budgetary constraints, the Cities of Winter Park and Maitland began treating hydrilla exclusively with endothall. By 2007, the cost of controlling hydrilla on the Chain of Lakes using herbicides alone had more than tripled. In an effort to reduce costs and improve control, Winter Park began evaluating other methods including biological controls. In 2008 Winter Park and Maitland worked with the Florida Fish and Wildlife Conservation Commission (FWC) to permit and stock triploid grass carp (TGC) in the Chain of Lakes at a rate of approximately 0.75 fish per acre. The City of Winter Park also began limited mechanical removal of hydrilla biomass in 2009.

Results and Discussion

The results of these efforts are still being evaluated, but preliminary observations indicate that control has been improved and herbicide use may be reduced in the future. Typical length of control using spot endothall treatments have ranged from 2 to 8 months, depending on whether or not the hydrilla root crown was killed, and rate at which existing tubers sprout. Since the stocking of TGC, five lakes in Winter Park have gone over 12 months with minimal re-growth of hydrilla observed. In July of 2009, the Chain of Lakes is scheduled to be included in FWC's funded program, and the hydrilla management program may be expanded to include new systemic herbicides.

Reference

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NOTES

SESSION 3

WATER QUALITY PART II ASSESSMENT, MODELING, AND MONITORING

ASSESSMENT OF VARIABILITY IN EUTROPHICATION PARAMETERS OF THE COASTAL DUNE LAKES LOCATED IN WALTON COUNTY, FL

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The coastal dune lakes located in Walton County are unique ecosystems because they intermittently connect to the Gulf of Mexico. Variability in Walton County's coastal dune lakes was examined by calculating the Coefficient of Variation for each trophic state parameter (total phosphorus, total nitrogen, chlorophyll and Secchi depth). Coefficients of Variations were also calculated for these same trophic state parameters using Florida LAKEWATCH data from 1,477 lakes in 47 counties. The results clearly show that the variability in trophic state parameters of Walton County's coastal dune lakes is significantly higher for each trophic state parameter than that in other Florida lakes (Table 1). This is consistent with the dynamic nature of the dune lakes.

Table 1. Comparison of the mean coefficient of variations (CV %) for trophic state parameters calculated using data from Walton County dune lakes and other Florida LAKEWATCH lakes (1,477 lakes from 47 Florida Counties) averaged by county.

	Mean CV % for 17 Walton County Coastal Dune Lakes	Mean CV % for 1,477 LAKEWATCH Lakes
Total Phosphorus ($\mu\text{g/L}$)	46	37
Total Nitrogen ($\mu\text{g/L}$)	34	27
Chlorophyll ($\mu\text{g/L}$)	90	71
Secchi Depth (ft)	38	29

Mean CV% were calculated for each of the 47 counties. The Coastal Dune Lakes in Walton County were ranked 43rd out of 48 for mean CV% for mean total phosphorus, 41st for mean CV% for mean total nitrogen, 40th for mean CV% for mean chlorophyll and 43rd for mean CV% for mean Secchi. There were only a few counties for each parameter that had higher CV%. Each county with a higher CV% also had very dynamic systems contained in the mean. For example, only Citrus, Alachua, St. Lucie, Lee and Collier counties had higher mean CV% for total phosphorus than the Coastal Dune Lakes in Walton County. The Tsala Apopka Chain of Lakes in Citrus County are variable because they are a network of islands, wetlands, canals, and lakes that are interconnected by natural and artificial means to each other and to the Withlacoochee River.

The Coastal Dune Lakes are all located within the same geological patterns, yet the Coastal Dune Lakes are quite variable from each other (Table 2). CV% for mean total phosphorus varies among the coastal dune lakes from a low of 23% at Fuller Lake to a high of 139% at Grayton Lake. CV% for mean total nitrogen on the coastal dune lakes ranged from a low of 19% on Deer to a high of 54% on Grayton Lake. CV% for mean chlorophyll and mean Secchi ranged from a low of 55% on Powell Lake to a high of 188% on Allen Lake and a low of 19% on Grayton Lake to a high of 64% on Fuller Lake, respectively.

Table 2. Minimum and maximum coefficient of variation (CV%) listed for 17 Coastal Dune Lakes in Walton County for the following trophic state parameters: mean total phosphorus (TP, µg/L), total nitrogen (TN, µg/L), chlorophyll (µg/L), and Secchi (ft). The minimum and maximum number of months sampled is also listed for the 17 Coastal Dune Lakes.

	N Months Sampled	CV % Mean TP (µg/L)	CV % Mean TN (µg/L)	CV % Mean CHL (µg/L)	CV % Mean Secchi (ft)
Coastal Dune Lake Minimum - Maximum	52-114	23-139	19-54	55-188	19-64

The implications of these findings are that background variability defined using data from other Florida lakes are probably too small and not appropriate for assessing these lakes. Using general statewide standards to assess the condition of these lakes is not necessary. Due to the efforts of groups like Florida LAKEWATCH and the Choctawhatchee Basin Alliance, there are significant amounts of data available on each of these lakes. Standards unique for each individual lake should be established using the available data.

NOTES

A WATER QUALITY MODEL OF LAKE APOPKA FROM 1990-2002

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One of the main purposes of developing water quality models is to use the model to predict the response of a system to given changes. Rarely are model predictions tested against reality by doing post audits. In this project Lake Apopka, the fourth largest lake in Florida, is used to do such a test. Lake Apopka has already had significant load reduction take place with a more than a 50% reduction in TP occurring over the study years 1990-2002. A QUAL2k water quality model was calibrated to a pre-load reduction year (1991) and run for subsequent years, 1990 - 2002. The aim was to see how the model responded to the load reductions as compared to the actual lake response. The results were mixed and as many questions were raised as were answered. One big limitation of the model was clearly that it is a steady model whereas the real lake is obviously a time varying system where the past effects the present. Steady state conditions in the lake were never reached or even approached, at least over the twelve years examined in this study.

NOTES

DETECTION OF LONG-TERM MEAN FOR THE MONITORING PROGRAM IN THE ST. LUCIE RIVER AND ESTUARY

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The existing monitoring program in the St. Lucie River and Estuary (SLRE) will measure the cumulative effects of the management measures on water quality and aquatic habitat. The goal of this paper is to determine the ability of the existing monitoring program to detect environmental change using a power analysis statistical technique for the SLRE. The existing monitoring program of interest for this project is for:

- Water Quality (WQ) and
- Seagrass density (i.e. number of shoots/m²)

The intention is to detect temporal trends. Power analysis was used focusing on detecting change in the long term means of the selected water quality and seagrass parameters. Statistical power analysis was used to determine the frequencies under mainly the following;

- How frequent the sampling is needed to enable statistical judgments that are accurate and reliable?
- How likely the statistical test will be to detect effects of a given frequency in a particular situation?

The main objective of this paper is to conduct a statistical power analysis on the existing monitoring programs in SLRE monitoring system for its respective water quality and seagrass parameters. At minimum, the following questions are addressed at seasonal (2 samples per year), quarterly, monthly, bi-weekly (i.e. every 14 days), weekly and daily frequencies depending on the available data:

- (i) What is the percent probability of detecting change at the above frequencies vs. the percent change in the long-term mean?
- (ii) What is the percent probability of detecting change vs. years of monitoring at the above frequencies?
- (iii) What is the minimum detectable change (percentage) vs. years of monitoring at the above frequencies?
- (iv) What is the percent coefficient of variation vs. years of monitoring at the above frequencies?

The main results and conclusions of this paper include the following:

- Monthly sampling produced the highest power percentage of detecting change for salinity, seagrass density and water quality data sampling
- Power percentage of detecting change increase with the increase in actual percentage of detecting long-term mean
- Power percentage of detecting change increase with the increase in years of monitoring
- Coefficient of Variation (CV %) is the highest at seasonal sampling followed by quarterly and monthly for seagrass density and water quality data sampling
- Minimum Detectable Change (MDC%) is the highest at seasonal sampling followed by quarterly and monthly for seagrass density and water quality data sampling

Reference

Chamberlain, R., and D. Hayward (1996). "Evaluation of Water Quality and Monitoring in the St. Lucie Estuary, Florida." Water Resources Bulletin, American Water Resources Association. 32(4): page 681-696.

NOTES

HYDROLOGICAL GEODATABASE DESIGN FOR THE LAKE CARROLL, HILLSBOROUGH FLORIDA CATCHMENT

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Geodatabases provide a robust, convenient, and scalable method for storing data related to the hydrologic features of basins, rivers and lakes in a Geographic Information System. By conceptualizing a series of thematic layers and structuring lake data into spatially referenced feature datasets, hydrologic modeling and hydrologic transport can be conducted and analyzed. A combination of vector and raster data including NHD, digital elevation models, remote sensing imagery, soil and landuse data and derived geometric network data can be stored in the geodatabase.

The design of this geodatabase modifies the basic Arc Hydro model to make possible a microassessment of the Lake Carroll catchment in Hillsborough County, Florida. ArcGIS software and CASE (Computer Aided Software Design) tools are used to model and create the geodatabase schema. Hydrographic features and storm water system, surrounding land, and transportation system are modeled. A network is constructed using geometric network modeling native to ArcGIS Network Analyst. With the catchment modeled as a network, it provides the ability to query data layers not often spatially associated with lake water quality. The major flow points and relationship to the surrounding storm water drainage system can be analyzed to assess sources of runoff. To evaluate the effect of runoff on water quantity and quality, data inputs from rainfall, temperature, lake level, and water quality gages from different agencies are spatially referenced to their monitoring points in or near the catchment.

NOTES

SESSION 4

CRITTERS AND AQUATIC INTERACTIONS PART I

LACK OF EXOTIC HYDRILLA INFESTATION ON PLANT, FISH AND AQUATIC BIRD COMMUNITY MEASURES

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The invasion of hydrilla into North America has provoked concern over loss of native flora and fauna and resulted in costly efforts to suppress hydrilla in lakes. We used two data sets to determine if common measures of ecosystem health; abundance, species richness, diversity and evenness were affected by the presence of hydrilla. Data Set 1 consisted of 27 Florida lakes, 11 of which had hydrilla present for approximately 4 to 8 years in varying abundances and 16 did not have hydrilla. Given the number of lakes, each was sampled only once in the summers of 1986-90 for community measures of aquatic plants, birds and fish. Data Set 2 consisted of 12 lakes, six with abundant hydrilla for over 23 years and six without hydrilla. These lakes were sampled every year (with a few exceptions due to weather conditions) between 1999 and 2006 for community measures of aquatic plants and fish. The results for both data sets show that presence of hydrilla had no statistically significant effect ($P > 0.05$) on all community measures tested (i.e., richness, diversity, abundance). Our conclusions support the hypothesis that hydrilla in these Florida lakes has not affected the occurrence or relative composition of native species of aquatic plants, birds, and fish. Because pond experiments have found negative effects of hydrilla, further focused research is needed to assist management decisions when considerable resources are to be spent each year on hydrilla suppression.

NOTES

MOSQUITO CONTROL IN FLORIDA'S AQUATIC ENVIRONMENT

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There are sixty mosquito control programs in the State of Florida. All share one common goal; that is, to protect the public from arthropod vector-borne diseases and nuisance-mosquitoes. Each mosquito control program is usually tasked with additional responsibilities, particularly in the realm of aquatic management. One may operate as the local mosquito control program as well as the aquatic weed control, environmental health or stormwater management division. As a result, the day-to-day operations of Florida's mosquito control programs can be extremely diverse.

Approximately seventy-four mosquito species have been found to exist throughout Florida. Since larvae can reside in aquatic environments ranging from tree holes to inland lakes and coastal salt marshes, mosquito control professionals must utilize an arsenal of techniques, often in lieu of chemical larvicide and adulticide applications. But there is usually no single method which is best utilized in a given situation. An Integrated Pest Management (IPM) approach, which combines a number of such methods, is the modern industry standard.

Public education and source reduction are usually the first steps. Mosquito complaints are often resolved by simply teaching the public to empty or flush water from artificial containers and bromeliad plants. In addition, mosquito control professionals throughout the state often work with the local school districts to conduct programs and workshops to make children aware of mosquitos and related environmental issues.

Next, biological control is normally considered. For example, *Gambusia affinis* and other small fishes are often stocked to prey upon immature mosquitoes. After heavy rain, mosquito control inspectors typically will capture the fish from established aquatic sources and release them nearby in new or temporary sources of water. Also, a biological larvicide such as *Bacillus thuringiensis* subspecies *israelensis* (BTI) can be applied instead of a chemical larvicide to various aquatic habitats. BTI is a bacterium which kills mosquito larvae but has minimal non-target impacts and breaks down rapidly in the environment.

Another option involves managing the environment. Reducing invasive macrophyte populations can effectively eliminate mosquito production substrate and expose larvae to predation. For example, water lettuce (*Pistia stratiotes*) and water hyacinth (*Echornia crassipes*) are amongst the most problematic invasive aquatic plants in Florida. Some mosquito larvae, such as *Mansonia sp.* and *Coquillettidia perturbans*, utilize these plants as substrate and are even adapted to pierce into the stems and root systems.

These two genera have been known to bite birds, horses and people. Specifically, they are medically important as carriers of heartworm in dogs as well as Eastern Equine Encephalitis (EEE) in horses, emus and humans. Obviously, by managing the invasive plant populations in lakes and other waterways, populations of such mosquitoes could be reduced significantly.

Nevertheless, each of Florida's sixty mosquito control programs utilize their own integrated or IPM approach to accomplish such mosquito control and aquatic management goals. Programs are as diverse as Florida itself. They range regionally from coastal to inland, northern to southern, etc. They also vary according to local biological abundance and diversity. With so many mosquito species utilizing such a broad range of aquatic habitats, it is no mystery why the day-to-day operations of Florida's mosquito control programs can be so diverse.

References

Florida Mosquito Control Association (FMCA) Website:

<http://www.floridamosquito.org/>

FMCA Mosquito Control Programs and Related Links:

http://www.floridamosquito.org/index_mosqinfo.html

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<http://mosquito.ifas.ufl.edu/>

Florida Department of Agriculture and Consumer Services – Bureau of Entomology and Pest Control: <http://www.flaes.org/aes-ent/mosquito/index.html>

US Environmental Protection Agency – Mosquito Control:

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NOTES

RECREATIONAL EXPOSURE TO MICROCYSTINS DURING ALGAL BLOOMS IN TWO CALIFORNIA LAKES

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We conducted a study of recreational exposure to microcystins in 81 children and adults planning recreational activities on one of three California reservoirs, two with significant, ongoing blooms of toxin-producing cyanobacteria, including *Microcystis aeruginosa* (bloom lakes) and one without a toxin-producing algal bloom (control lake). We analyzed water samples for algal taxonomy, microcystin concentrations, and potential respiratory viruses (adenoviruses and enteroviruses). We measured microcystins in personal air samples, nasal swabs, and blood samples. We interviewed study participants for demographic and health symptoms information. We found highly variable microcystin concentrations in bloom lakes (<10 µg/L to > 500 µg/L); microcystin was not detected in control lake samples. We did not detect adenoviruses or enteroviruses in any of the lakes. Low microcystin concentrations were found in personal air samples (< 0.1 ng/m³ [limit of detection] – 2.89 ng/m³) and nasal swabs (< 0.1 ng [limit of detection] – 5 ng). Microcystin concentrations in the water-soluble fraction of all plasma samples were below the limit of detection (1.0 µg/L). Our findings indicate that recreational activities in waterbodies experiencing toxin-producing cyanobacterial blooms can generate aerosolized cyanotoxins, making inhalation a potential route of exposure. Future studies should include collecting nasal swabs to assess upper respiratory tract deposition of toxin-containing aerosols droplets.

NOTES

SESSION 5

BMPs PART I

THE USE OF IRON SALTS FOR LAKE RESTORATION

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The use of inorganic coagulants, specifically aluminum salts for phosphorus precipitation in lake restoration projects is a well known application. Iron salts such as Ferric Chloride or Ferric Sulfate are generally not used because there is a concern that the ferric in the phosphate precipitate is reduced to ferrous under anaerobic conditions at the bottom of the lake potentially releasing the bound P.

A successful project should create a much more aerobic environment, minimizing the risk for reduction of the iron salt. But even when it occurs it shouldn't be considered as a risk since ferrous iron also precipitates phosphorus very well.

Our presentation will show cases where iron salts have been used for a successful lake restoration project. Phosphorus precipitation chemistry will be discussed and iron salts will be compared with aluminum salts. The theoretical discussions will be backed up with experiences both from waste water treatment experiences and from several lake restoration cases in both Europe and North America where iron salts have been used for lake restoration.

NOTES

STORMWATER PONDS: AN UNTAPPED RESOURCE

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Stormwater ponds serve many vital functions for the counties and municipalities nationwide, including, for example, flood control, stormwater treatment, as aesthetic amenities and habitat for wading birds. Without appropriate maintenance, however, their ability to provide these services deteriorates. Historically, the focus has been on water quantity/conveyance and flood control. Today, however, the potential functionality of stormwater ponds to reduce external loading to impaired waterbodies has been recognized. Additionally, for stormwater ponds serving as aesthetic amenities, water quality deterioration within the ponds themselves detracts from the ponds' value. In addition, in some situations, stormwater may be useful to augment nonpotable water supplies. Seminole County has 282 County-owned stormwater ponds and approximately 560 functional ponds which the County provides a shared maintenance responsibility with another entity, typically a homeowner's association. Together, these >800 stormwater ponds represent a significant resource to not only properly handle stormwater quantities, but also provide significant potential for water quality treatment of stormwater prior to discharge into waters of the State, and augmentation of nonpotable water supplies, for sustainable watersheds. Although these stormwater ponds have been individually inspected for NPDES reporting purposes, these ponds have not been assessed as a group to identify and prioritize ponds with the highest potential for water quality treatment, operational maintenance to enhance habitat, stormwater quantity handling or other factors. This paper reviews the potential utility of stormwater ponds, presents frameworks for screening and prioritizing ponds for stormwater sustainability, and strategies for improving their functionality. A two step screening process will be utilized to identify and rank ponds according to sustainability criteria (e.g. potential for water quality treatment based upon loading and capacity, proximity to impaired waterbodies, land availability for low impact development modifications, etc.). It is anticipated that this system will also be useful in prioritizing ponds for maintenance and operational upgrades to enhance sustainability. The initial screening step will be based upon readily available land use and availability, location, and surface area type parameters. The top 10% of ranked ponds will be reviewed in greater detail and subject to the second phase of ranking to prioritize and rank these ponds according to sustainability potential. The final step will be to examine the final "short list" of ponds in greater detail to produce preliminary conceptual designs for sustainable improvements for each selected pond. Conceptual designs currently being considered include the use of the black and gold medium from the University of Central Florida's Stormwater Management Academy, the use of polyacrylamides in conjunction with aeration and the use of wetland vegetation for nutrient uptake. This study is currently underway and the County hopes to continue implementing the proposed retrofits throughout the coming years. The core principal of this overall pond analysis is to provide the frame work for continued stormwater research opportunities and other potential stormwater treatment resources within the County.

NOTES

A PRELIMINARY EVALUATION OF CURB AND GRATE INLET BASKETS AS AN EFFECTIVE WATERSHED MANAGEMENT TOOL IN ORANGE COUNTY FLORIDA

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Specific removal efficiencies of curb and grate inlet filter baskets (CIB) remains relatively unknown and real world data is needed to make sound decisions for practical management purposes. In 2008, the Orange County Lake Management Section began evaluating the effectiveness of CIBs to remove various pollutants from several watersheds in Orange County. The evaluation results are then compared to other commonly used watershed treatment technologies. The results of this study will not only help preserve the water quality of healthy lake systems but will also provide a valuable tool for meeting load allocations on TMDL waterbodies.

Prior to the installation of the CIBs, Orange County chose to evaluate the application of CIBs based on several common parameters. Data is being obtained on a monthly basis for the following criteria; total weight of debris collected, percent full, percent sediment, percent leaves, and percent trash. Loading rates can also be compared to seasonal variations such as leaf litter or rain fall amounts. With the aid of GIS, the data can be mapped to illustrate seasonal variations and assist in identifying high loading areas.

While the evaluation is still ongoing the initial data review has shown the CIB to be an effective tool in watershed management. Comparisons with other common best management practices have identified the CIB to be a cost effective solution for reducing the pollutant loading from a watershed. The use of GIS technology has shown that seasonal variation is apparent and that physical stormwater conveyance designs also affect loading rates.

NOTES

POSTER SESSION

THE FAILURE OF THE LANDSCAPE DEVELOPMENT INTENSITY INDEX TO PREDICT WATER QUALITY IN FLORIDA LAKES

Roger W. Bachmann, Mark V. Hoyer, and Daniel E. Canfield, Jr.

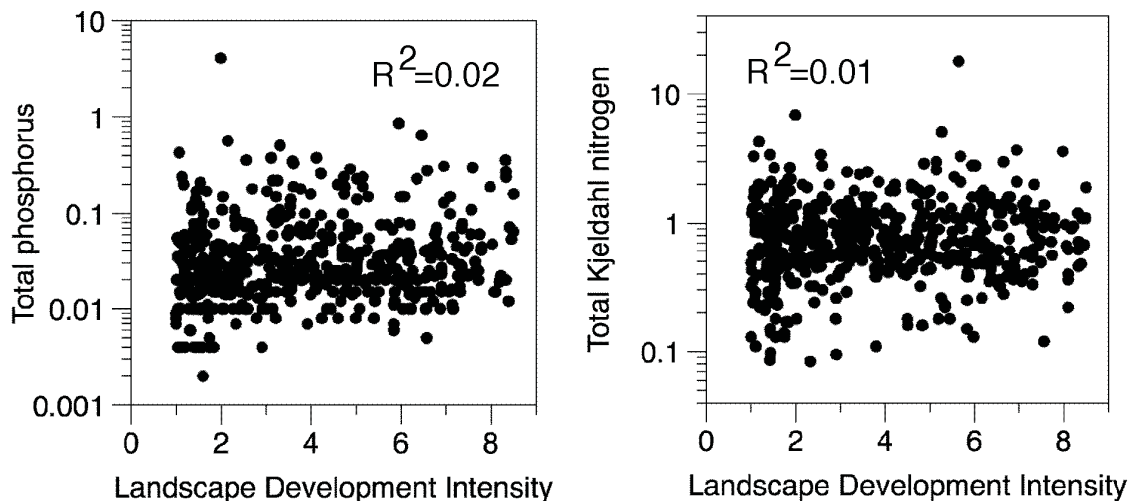
Fisheries and Aquatic Sciences, School of Forest Resources and Conservation,
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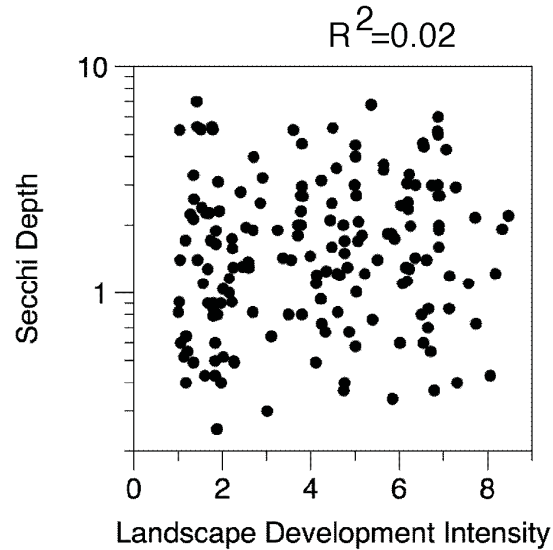
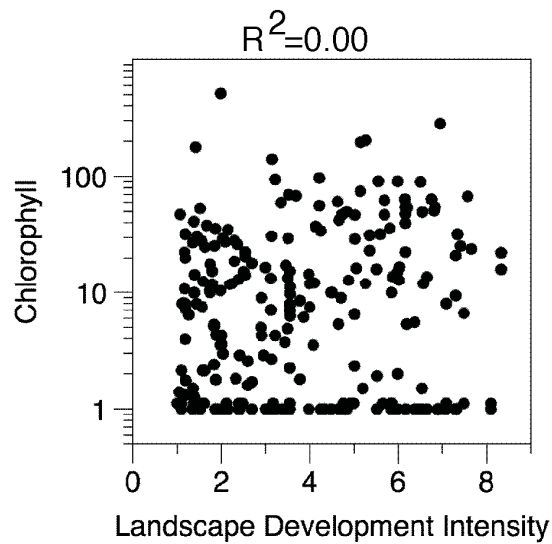
Introduction

The Landscape Development Intensity index (LDI) as developed by Brown and Vilas (2005) has been used by the Florida Department of Environmental Protection (FLDEP) as a measure of human impact on wetlands and lakes. The LDI is calculated from an examination of the land uses in a 100-meter wide band around a lake. The percentage area of each land use in the band is multiplied times a coefficient of energy use for that land use, and the sum of the products is taken as the LDI. The coefficients range from 1 for natural open water to 10 for high intensity central business district uses. The higher the value for the LDI the greater is the inferred impact on the lake.

Results

We compared the LDI values for 352 Florida lakes sampled across the state with several different measures of water quality in the same lakes. The data were collected by the FLDEP in a study to develop a macroinvertebrate-based lake condition index. Correlation analyses showed the LDI could only account for between 0.0 and 2 % of the variance in Secchi depths, and measured concentrations of total phosphorus, total Kjeldahl nitrogen, and chlorophyll *a*. There was no correlation with the macroinvertebrate-based lake condition index, and the LDI accounted for only 2.9 % of the variance in turbidity in the sampled lakes.





Conclusions

We have concluded that there is no relationship between the Landscape Development Intensity index and several common measures of water quality in Florida lakes. The results suggest that for this group of lakes, natural factors were more important in determining water quality than the human development adjacent to the lakes. We would like to discuss the meaning of these findings during the poster session.

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NOTES

OYSTER RECRUITMENT, SUSTAINABILITY, AND HABITAT UTILIZATION ON TWO CONSTRUCTED OYSTER REEFS IN THE CHOCTAWHATCHEE BAY

Joni E. Barreda, Donna Howsden, and Alison McDowell
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Eastern oysters (*Crassastrea virginica*) in the Choctawhatchee Bay of northwest Florida play an important role by improving water quality via filtration, as well as providing habitat for both fish species and invertebrates. To date, the Choctawhatchee Basin Alliance (CBA) has built two oyster reefs in the bay. One reef is located in the Fort Walton Beach area and the other in the Bluewater Bay area of Niceville. CBA monitors basic water chemistry parameters, live oyster size and density, macro-infauna invertebrate and fish habitat use, and total phosphorus and nitrogen at each reef quarterly. Three randomly selected 25cm x 25cm quadrats are sampled at each site by removing oyster shell to a depth of 10cm. CBA will continue to monitor these sites in order to ascertain each reef's ability to recruit and sustain oyster growth and determine habitat utilization by fishes and invertebrates.

NOTES

THE DIFFERENCES BETWEEN THE NPDES GENERIC PERMIT, NOI, AND THE FDEP DEWATERING PERMIT

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The purpose of this presentation is to explain the differences between the NPDES Generic Permit for Stormwater Discharge from Large and Small Construction Activities (NPDES permit), the NPDES Notice of Intent (NOI) and the Generic Permit for the Discharge of Produced Ground water from any Non-Contaminated Site Activity (FDEP dewatering permit). The NPDES and Dewatering permits both fall under the F.A.C. Chapter 62-621, Generic Permits.

The NPDES permit is required for any construction site that disturbs an acre or more of land. Construction sites are required to obtain the permit which consists of completing an NOI and SWPPP prior to commencing construction activities and implementing appropriate pollution prevention techniques to minimize erosion and sedimentation and properly managing stormwater. There are other types of NPDES permits, but the focus will be the Generic permit for construction activities.

The FDEP dewatering permit is a permit that was relatively unknown and not strictly enforced, until recently. There is no formal application for this permit, however, water samples must be taken, analyzed, and meet the parameters set within the permit in order for dewatering approval. The FDEP dewatering permit authorizes a generic permit for any person constructing or operating a system discharging produced ground water (i.e. Dewatering System) from any non-contaminated site activity which discharges by a point source to surface waters of the State—designed and operated in accordance with Rule 62-621.250, F.A.C., provided that all the conditions of this rule are met.

It is important for local government and industry to understand the importance of these permits and the consequences for not obtaining them prior to construction activities.

NOTES

ANNUAL SPATIAL VARIABILITY OF PHYTOPLANKTON AND NUTRIENT DISTRIBUTIONS IN CHOCTAWHATCHEE BAY

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In the past, Choctawhatchee Bay has experienced nuisance harmful algal blooms (HABs). The purpose of this study is to compare two bayous within Choctawhatchee Bay, Cinco and Garnier, which drain watersheds with markedly different land use. According to historical HAB monitoring data, Cinco Bayou, the more developed Bayou, has experienced considerably higher concentrations of the red tide forming organism (*K. brevis*), than has the less developed Garnier Bayou. The results of this study will help in an assessment of the different nutrient dynamics, if any, and may give clues as to why this spatial variability exists.

Water samples were collected for a one year period, October 2007 through October 2008. A harmful algal bloom occurred during the 2007 HAB season (October-January). Samples are currently being analyzed for nitrite, nitrate, phosphate, ammonium, and chlorophyll a. Polymerase chain reaction (PCR) techniques were used to assess the number of *K. brevis* cells in water samples collected during the 2007 bloom. The relative spatial and temporal variations in biogeochemical parameters and HAB population dynamics were used to infer information about the effect of land-use differences on coastal water quality.

NOTES

EVALUATION OF A HYDRAULIC DREDGE FOR HYDRILLA REMOVAL IN A RESTORED WETLAND

Kelly Crew¹ and Brian Sparks¹; Randy Roth² and Walt Godwin²; and Shannon White³

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Background

Restoration of the St. Johns River Water Management District's (SJRWMD) Emerald Marsh Conservation Area (EMCA) is a primary objective of the Upper Ocklawaha River Basin (UORB) Surface Water Improvement Plan. Restoration efforts have been compromised, however, by an infestation of the invasive aquatic plant *Hydrilla verticillata* (hydrilla). Quickly forming dense canopies, hydrilla can displace native submerged aquatic vegetation (SAV), constrict water flow and navigation, and reduce water column oxygen. Hydrilla in Florida typically reproduces from fragments and subterranean turions (tubers).

SJRWMD's recent management strategy for hydrilla in EMCA properties involves seasonal applications of the contact herbicide endothal (Aquathal K), which requires substantial time and labor. To evaluate the use of a hydraulic dredge as an alternative method for hydrilla control in EMCA, we designed an experiment in EMCA Area 3 (T-cell) comparing its long-term (one-year) effectiveness for controlling hydrilla to that of a traditional herbicide treatment.

Methods

This project was designed as a field-scale, un-replicated Before-After Control-Impact (BACI) experiment. Three 0.4 ha plots were created with shade cloth and PVC supports. Two of the plots were designated as "impact" (treatment) plots and the third plot was left undisturbed as a control. In June 2007, hydrilla biomass and tubers were sampled in each plot, pre-treatment. In August 2007, 10 gallons of Aquathol K were applied to one treatment plot. In the other treatment plot, a plant harvester and hydraulic dredge were used to remove hydrilla mechanically. Post-treatment sampling occurred in October 2007, and January, April and October 2008. Soil cores were also taken during each sampling event to determine how the hydraulic dredge might affect the soil profile and its tuber or native seed bank. A generalized linear mixed model (GLMM) using repeated measures analysis was used to test for significant changes in the differences between control and impact plots, before and after treatment (McDonald et al. 2000).

Results

Average hydrilla biomass in the dredge plot before treatment was approximately 10 kg/m², but remained less than 1 kg/m² for almost a year after treatment. By fourteen months after treatment, hydrilla in the dredge plot recovered to an average of 6 kg/m², but approximately 60% of the dredge plot was covered by *Pistia stratiotes* (water lettuce), which possibly inhibited the recovery of hydrilla. The native species *Ceratophyllum demersum* (coontail) colonized the dredge plot and was observed growing in patches (up to 3 m²) fourteen months after treatment.

Within six months after treatment, hydrilla biomass in the herbicide plot decreased from 7 kg/m² pre-treatment to less than 2 kg/m². Fourteen months after treatment, hydrilla recovered to over 12 kg/m². Less than 5% of the herbicide plot was covered by water lettuce. Coontail was not observed. Before treatment, average hydrilla biomass in the control plot was 7 kg/m². Hydrilla in the control plot experienced a winter die-back, but it increased in the summer and fall to an average of 13 kg/m², fourteen months after treatment. Results of the GLMM indicated that both the dredge and herbicide treatments had significant effects on hydrilla biomass compared to the control ($p < 0.0001$, $\alpha = 0.05$).

The spatial distribution of tubers was uneven in all three plots and tuber density varied from 0-824 tubers/m². Over the study period, tuber density decreased in both the dredge and control plots, therefore no significant change against the control occurred in the dredge treatment ($p = 0.2303$). Unexpectedly, tuber density appeared to significantly increase ($p < 0.0001$) in the herbicide plot compared to the control after the treatment.

The soil core sampling revealed that the dredged material consisted mostly of an unconsolidated floc layer and an underlying muck or mucky peat layer. An estimated 200-250 m³ of soil was removed by the hydraulic dredge. Based on the average pre-treatment tuber density in the dredge plot and the estimated volume of soil removed, over 444,000 tubers out of an estimated one million were potentially removed by the dredge. Although the dredge did not statistically impact the tuber population because of high sampling variability, removing approximately half of the tubers might have contributed to the lower biomass in the dredge plot (6 kg/m²) compared to the herbicide (12 kg/m²) and control plots (13 kg/m²) one year after treatment.

Because of the recovery of hydrilla in the dredge plot, this study did not provide evidence that removal by a hydraulic dredge alone is a cost-effective method for long-term hydrilla control in EMCA sites. However, initial control by hydraulic dredge followed by early 'spot treatments' of recovering hydrilla with herbicide might provide an effective method for hydrilla control.

This approach would substantially reduce herbicide use compared to herbicide-only treatment and may improve survival potential of native SAV.

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NOTES

CITY OF LEESBURG REDUCES POLLUTANT LOAD FROM STORMWATER RUNOFF TO LAKE HARRIS

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The City of Leesburg (City) reduced pollutant loads to Lake Harris through design and implementation of stormwater retrofit projects. The FDEP set a Total Phosphorus (TP) TMDL of 18,302 pounds per year for Lake Harris and determined that the TMDL would not be met following implementation of the Upper Ocklawaha River Basin Management Action Plan (BMAP). Municipalities were encouraged to propose additional projects to reduce pollutant loads. AECOM updated the City's Stormwater Master Plan and identified locations within the City as potential retrofit locations. AECOM planned, designed, and obtained grant funding for two baffle box installations. The TP load from the targeted watersheds was estimated to be 110 pounds per year prior. The two baffle boxes are anticipated to lower the cumulative TP load to approximately 66 pounds per year.

NOTES

EVALUATION OF AQUATIC HERBICIDES FOR CONTROLLING *NYMPHOIDES CRISTATA* IN BIG LAKE FAIRVIEW IN ORANGE COUNTY, FLORIDA

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In recent years, the non-native aquatic plant species *Nymphoides cristata* has become established in Big Lake Fairview located in Orange County. This exotic species has not responded favorably to conventional herbicides. With expansion of the *Nymphoides cristata* in several areas in the lake, the Orange County Lake Management Section began a three phase evaluation of commonly used aquatic herbicides to determine their effectiveness in controlling the plant.

- Phase I: Control effectiveness of two newer herbicide products: Hardball and Stingray.
- Phase II: Control effectiveness of fluridone.
- Phase III: Control effectiveness of the Aquathol / Hydrothol combination.

Initial evaluation of Phase I and Phase II showed good initial results, however re-growth occurred within a relative short time and it became apparent that repetitive treatments would be required. Phase III results showed the Aquathol / Hydrothol combination to be very effective initially and provided a substantially longer term control. Results of the Phase III continue to be monitored for long-term control. While initial results for Phase III were excellent in the treatment of isolated coves, further evaluation of herbicides need to studied for controlling isolated patches of *Nymphoides cristata* located around the lake.

NOTES

A MANAGEMENT PLAN FOR THE COASTAL DUNE LAKES OF WALTON COUNTY

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The Choctawhatchee Basin Alliance (CBA) of Northwest Florida State College works in partnership with citizens, local governments, and technical experts to monitor, sustain, and provide optimum utilization of our local water resources in Okaloosa and Walton counties. CBA recently coordinated the development of a comprehensive management plan for the coastal dune lakes of Walton County. The TEAM approach (“Together for Environmental Assessment and Management”)—originally developed by UF-IFAS—was used to bring stakeholders together to identify, prioritize, and reach consensus on the most critical management issues on the coastal dune lakes. The real success story here is the action and genuine progress that has occurred since the final management plan was published in Fall 2008. It is not uncommon for years of work to be invested and compiled in a management document that evolves promptly into a bookend. Conversely, *A Management Plan for Walton County’s Coastal Dune Lakes* was immediately adopted by the Coastal Dune Lakes Advisory Board and the Walton County Commission. Since then it has proved to be a catalyst for the advancement of science, action, and participation in environmental management in Walton County. With CBA’s guidance, government officials and citizens alike have remained engaged in the process of caring for and about the unique ecological and cultural resources of Walton County represented by its coastal dune lakes.

NOTES

QUANTIFICATION OF SEAGRASS ABUNDANCE IN CHOCTAWHATCHEE BAY, FLORIDA USING LANDSAT TM IMAGERY

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The Choctawhatchee Bay system is a drowned river plain surrounded by shallow shelf slopes and inshore bayous (Livingston, 2001). The bay is aligned east to west with a major alluvial river basin to the east and a dredged Gulf pass to the west. Freshwater input is supplied by the Choctawhatchee River, the third largest in Florida in terms of freshwater discharge. The bay also receives secondary inflows from a series of bayous located primarily on the northern shore. Choctawhatchee bay currently has one of the least developed emergent vegetation zones of the various Gulf estuaries in the region (Livingston, 2001). Analysis of aerial photographs from 1955 and 1985 indicated that here was an overall loss of 20% of submerged aquatic vegetation (SAV), including shoalgrass (*H. wrightii*). Suggested reasons for this deterioration include optical changes in the water column (color, turbidity), or changes in salinity associated with fluctuating freshwater input from the Choctawhatchee river and its associated bayous. Anthropogenic activities such as stormwater runoff, sewage, etc have been suggested as contributing factors to SAV deterioration.

Seagrass is an important component of coastal ecosystems. Seagrass beds help to stabilize sediments, cycle nutrients, provide valuable nursery habitat, and can be a significant source of detrital material for estuarine food webs (Dekker et al., 2005). Although seagrass beds in Choctawhatchee Bay are considered important, only limited studies have been conducted in the area to determine the status and trends of seagrass. The most recent study was conducted by USGS in 1992, through the use aerial photographs and field ground truthing. Their analysis provided an estimate of 1,726 ha. In 1972, McNulty et al. reported 1,237 ha of SAV in Choctawhatchee Bay. Livingston (1986) estimated 307 ha of SAV, but only examined the western part of the bay. In their 1992 report, USGS suggests that efforts should be made to continue the monitoring of seagrass distribution and changes in distribution. They suggest standardized mapping of seagrass beds (field survey) every 5-10 years, along with monitoring of seagrass beds through digitized mapping. Currently, no monitoring studies have been conducted since the 1992 study conducted by USGS.

The use of advanced satellite and/or airborne remote sensing technology provides an opportunity to undertake more cost effective and objective monitoring of seagrass distribution (Duarte et al. 2004). Landsat 5 TM was the first satellite system that supplied broad spectral band environmental data with a spatial resolution of 30 m from 1984 onwards. Others have utilized Landsat 5 TM to create coarse scale seagrass maps with an accuracy of 75-85% (Mumby & Edwards, 2002; Mumby et al., 1997). Multi-date satellite remote sensing is a repeatable cost effective method for detecting large changes in seagrass distribution or extent over time.

This study aimed to assess the use of such technology is mapping of seagrass beds in the Choctawhatchee Bay area.

Cloud-free Landsat 5 TM imagery for Choctawhatchee Bay was acquired using the USGS Global Visualization Viewer (<http://glovis.usgs.gov>). Imagery collected close to the USGS 1992 study date was utilized for this trial study. The nearest cloud-free collection occurred in February of 1992. The Landsat 5 TM image was corrected both geometrically and geographically. Spreadsheets created by Glen Green at Indiana University's CIPEC were utilized for Landsat 5 TM calibration. Systematic radiometric and geometric accuracy was derived from data collected by the sensor and spacecraft. The scene was rotated, aligned, and georeferenced to UTM map projection (WGS 1984 UTM 16N).

For these data, ERDAS Imagine 9.2 was used to collect 192 class signatures from the Landsat 5 TM imagery. Vector files from the USGS 1992 seagrass coverage maps were used as a guide. For these analyses, the 45-85% coverage groups (attributes PSG3 and PSG4) were utilized for signature collection. A Maximum Likelihood Supervised Classification was run using Imagine 9.2. Data were exported as a raster file for further analyses in ArcMap 9.3. A polygon mask was digitized to maintain spatial consistency between the remotely-sensed coverage and the area defined by USGS in their 1992 study. The remote sensing analysis yielded an estimate of 1289 ha of 45-85% seagrass coverage, while the USGS study yielded 927 ha of 45-85% seagrass coverage.

Utilizing Landsat 5 TM remotely sensed imagery *only* for quantification of seagrass abundance in Choctawhatchee Bay, FL is not recommended based upon these analyses. The two estimates (USGS and Landsat 5 TM) yielded at 71% difference between total hectare measurements for the 45-85% seagrass coverage. Utilizing higher resolution imagery (>30m), may yield a more accurate estimation of seagrass coverage for this area. However, the precision and placement of the seagrass beds utilizing remotely-sensed imagery may provide field biologists with probable locations for seagrass meadow sites within this large study area.

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NOTES

THE BENEFITS OF VEGETATION AND BIOLOGICAL ENGINEERING PRACTICES FOR MAINTAINING PONDS

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This project is designed to assess the pollutant (nutrient/heavy metals) uptake possibilities from the use of native vegetation, swale constructions, and wetland reproductions along retention ponds. The purpose is to use this method as a preventative strategy to reduce pollutants from entering ponds and satisfy NPDES (National Pollutant Discharge Elimination System) permitting. This research provides the rationale for use of vegetation and biological engineering for cost-efficient methods to naturally clean ponds.

Issues in water quality such as toxic algal blooms and the need for safe processes to clean water has become one of the most pressing issues today. The use of chemicals to manage invasive plant species can be problematic even with “environmentally safe” products because of the released nutrients from dead plant biomass, which is counterproductive to the service of retention ponds. There is a significant need for biological methods of control at nonpoint sources of pollution which include retention ponds that are meant to control pollutants. The retention ponds inevitably flow into our main water bodies and are costly to clean up at that point.

Positive resulting research has been performed and is used at facilities such as the Orlando Wetlands using wetlands to clean pollutants from wastewater, which provides a basis for using such methods to clean water before it flows to main water bodies. These methods are not only cost-effective but provide natural habitats for animals big and as small as the various invertebrates involved in the biological cycles to recycle and clean our water bodies.

My basis for continued experimentation is based on the research of Dr. Martin Quigley, who has found results in using *Typha latifolia* or Cat-Tails, for the removal of nitrogen, an algae promoting nutrient. This has been accomplished by transpiration (absorption and release of nitrogen) and subsequent habitat creation for microbes necessary to the process. The continued research to be performed will focus on the use of vegetated swales on the littoral zone of UCF lakes as well as less-invasive emerged plant species for preventative management of pollutants. These methods will capture runoff to be filtered through plants and percolate into the soil to ease the work necessary by retention ponds and limit the inevitable sediment build up which requires dredging over time.

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NOTES

A COMPARISON OF HYDROLOGIC FLUXES AND NUTRIENT REGIMES IN WESTERN CHOCTAWHATCHEE BAY

Alison McDowell

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The understudied Choctawhatchee Bay estuary needs sound, scientific research in order to provide a basis for managing and conserving this critical resource. The western portion of Choctawhatchee Bay offers an opportunity for comparison between two large bayous, Garnier and Cinco. Both bayous have freshwater input at the head. However, Cinco Bayou and Gap Creek, which feeds into the bayou, are developed to saturation, while large tracts of undeveloped land surround Lightwood Knot Creek and Garnier Creek, the two creeks that flow into Garnier Bayou, and large portions of Garnier Bayou itself. Comprehensive comparisons, taking into account hydrological input, physiochemical and nutrient data, along with land-use and rainfall, can begin to identify biogeochemical differences between the bayous and underlying causes, especially as relates to land-use and nutrient loading. Twelve sampling events, during both ambient and storm-event conditions, were performed over the course of 12 months. Samples were analyzed for nitrite, nitrate, ammonium, and orthophosphate. Dissolved organic nitrogen analyses are currently planned. Random samples will be split and also analyzed for TP/TN in order to assess the use of TP/TN as indicators of estuarine trophic condition. Rainfall data are compared to nutrient concentrations to determine nutrient response to high-flow events. Samples from nine events have been analyzed and preliminary study of the results suggests that background levels of nitrite+nitrate and orthophosphate in Garnier Bayou are higher than those in Cinco Bayou.

NOTES

STRENGTH OF THE FLORIDA LAKE VEGETATION INDEX AND RESPONSES TO CRITICISM

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The Lake Vegetation Index (LVI) is a multimetric index of the biological integrity of Florida lake plant communities, based on a rapid field sampling method. It was developed by the Florida Department of Environmental Protection (DEP) to help resource managers statewide identify impaired lakes and prioritize restoration efforts. The LVI is an index similar to DEP's Stream Condition Index (SCI), which has been in use for more than a decade. Other states have developed vegetation indices for lakes and wetlands, and these indices are tools that the US Environmental Protection Agency (EPA) promotes and supports (see references for examples of other indices).

In 2005, data from 95 lakes were used to establish a relationship between a human disturbance gradient (HDG) and metrics of plant community composition. Three elements comprised the final HDG: landscape development intensity (LDI), lake habitat assessment (DEP protocol that includes biologists' observations of shoreline disturbance and development, nuisance plant growth, water clarity, and sediment conditions), and a water quality index (includes probabilistically derived scores for phosphorus, nitrogen, specific conductance, and algal growth potential). Four plant metrics were chosen for the final LVI: percent native taxa, percent invasive exotic taxa (per the Florida Exotic Pest Plant Council), percent sensitive taxa, and the coefficient of conservatism (rate of sensitivity to disturbance) of the dominant taxa. Two index validations in 2005 and 2007, using data from 230 lakes, strongly supported the correlations between the HDG and the LVI.

To determine what LVI values would constitute impairment of the plant community, and what values would be considered exceptional, DEP held a workshop following EPA's Biological Condition Gradient (BCG) model. The BCG is a scale from 1-6 in which level 1 represents pristine natural condition and level 6 represents a highly degraded system. Precise definitions of community structure and ecological function are provided to ensure consistency in ranking all six categories. At this workshop, 20 field botanists from Florida with extensive experience with lakes assessment examined the plant lists (not LVI scores) from 30 lakes throughout the state and assigned each lake a BCG category (1-6). The LVI was strongly correlated with the average BCG scores assigned by the botanists, clearly showing that the index provides community level human disturbance information to environmental managers which is consistent with ecological principles. Participating botanists at the workshop also provided DEP their professional opinions of at what BCG level impairment of the plant community occurs, and what level should be considered exceptional. DEP will consider this input, along with guidance from EPA, to determine an impairment threshold to be used for the LVI in regulations.

Critics of the LVI incorrectly argue that the LVI is more correlated with pH than with human disturbance. Human activity increases the pH of Florida waters through various means, including from stormwater runoff containing ions from the soil and a variety of anthropogenically derived materials and increased phytoplankton production and carbon fixation due to excess nutrients from humans. While there is a natural range of pH values in minimally disturbed Florida's lakes, effects of human activity results in a complete absence of low pH lakes wherever human disturbance is moderate to high. DEP believes that this phenomenon explains why the LVI is correlated with objective measures of human disturbance and pH simultaneously.

Some peer reviewers of the LVI have expressed concern that portions of the habitat assessment and water quality components of the HDG can be influenced by both human activity and natural factors, and they recommended that we rely more heavily on the LDI as the sole measure of human disturbance. The most recent validation of the LVI showed that it is almost as highly correlated with the LDI (Spearman's $r = -0.60$) as with the full HDG (Spearman's $r = -0.72$), suggesting that the index is responding convincingly to a robust and objective measure of human disturbance (in this case, the intensity of anthropogenic landscape alterations). It should be noted that the HDG was only used to select metrics; the independent BCG exercise was used to determine whether or not the index had validity in assessing the response of valued ecological attributes (the plant community) to human influences. The LVI threshold of impairment is based upon the BCG exercise, coupled with an analysis of the reference site distribution. DEP believes the LVI is an important tool for Florida lake managers, providing a reliable measure of biological health to assess both human impairment and the effectiveness of lake management strategies.

Data collection, index development and calibration, index validation, and threshold determination are described in Fore (2007), available on the DEP website (ftp://ftp.dep.state.fl.us/pub/labs/assessment/sopdoc/lvi_final07.pdf).

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NOTES

SESSION 6

VEGETATION MANAGEMENT AND CONTROL PART II

FEAST FOR FIFTY! – CONTROLLING HYDRILLA VERTICILATA IN LAKE AUGUST

Erin McCarta and Clell Ford

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Sebring, FL

Lake August is a 50 acre lake in Lake Placid, FL. In December of 2006, residents of the lake noticed Hydrilla growth along the shoreline. Four months later, the lake was experiencing an infestation of more than 60% of its area.

A test for resistance was performed in May of 2007, in which the Hydrilla from Lake August was determined to not be resistant to conventional herbicides typically used for control. The test revealed that a maintenance residue of 4-6 ppb of Fluoridone would achieve more than 75% biochemical injury of the Hydrilla. After a series of treatments of Fluoridone at this concentration from September through December of 2007, it appeared the treatment had been successful.



Figure 1. Lake August, topped-out hydrilla in foreground



Figure 2. Fish Fence installed on outlet to Lake June

Within five months, the Hydrilla had complete re-growth, becoming topped-out over 50% of the lake's surface. This re-growth indicated that the Hydrilla in Lake August had some resistance to Fluoridone, and therefore required an adaptive management strategy. A subsequent treatment of Aquathol-K was applied in November of 2008, specifically designed to simply knock-down the topped-out portions. This was in preparation of a grass carp installation, which occurred on December 12, 2008.

Fifty grass carp were introduced into Lake August, at the discernment of some residents who believed it was several hundred too few. This introduction of carp translated to one fish per acre of water, but approximately 2 fish per acre of Hydrilla.

A relatively conservative ratio was selected for this lake due to its very healthy native aquatic plant communities on the shoreline, which most residents installed with their own money.

Early monitoring results following the Aquathol-K treatment and Grass carp introductions indicated that the herbicide controlled more than just the topped-out Hydrilla. A true evaluation of the grass carp success was not expected for at least 3 months. Staff continued to monitor the conditions into the spring of 2009, finding an overall 75% reduction in Hydrilla coverage.

Highlands County lake management staff concludes that the Hydrilla in Lake August has been effectively controlled while preserving native plant communities and important habitats. Further tweaking of the management plan, as required by changing conditions of the lake and watershed, is expected to maintain effective control of Hydrilla. Water quality studies and continued monitoring will assist staff in making appropriate management plan adjustments to ensure the health of Lake August continues well into the future.

NOTES

STATUS OF THE DEMONSTRATION PROJECT ON HYDRILLA AND HYGROPHILA IN THE UPPER KISSIMMEE CHAIN OF LAKES

Stacia A. Hetrick¹ and Kimberly Lawrence²

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²Osceola County, Kissimmee, FL

Osceola County was awarded a \$2.881 million grant to discover new herbicides, develop new technology processes or practices, or a new combination or uses of technologies, processes or practices for the purpose of proving technologically feasible and cost effective means to manage hydrilla, hygrophila and other exotic aquatic vegetation in Osceola County. The specific objectives of the project are to evaluate the effectiveness of experimental use permit herbicides and biological controls in the treatment of hydrilla and hygrophila; to evaluate new technology processes or practices, or a new combination or uses of technologies, processes or practices for the control of hydrilla and hygrophila using small-scale field work; to implement and monitor successful practices and processes identified in the previous objectives using large-scale field demonstrations; and to demonstrate the project efforts in alternative technologies to manage hydrilla and hygrophila and disseminate to the public the results of the project. Over the past 2 years, progress has been made toward accomplishing each of these objectives. This talk will explore the progress that has been made so far and the plans for the future of the project.

NOTES

100 YEARS OF AQUATIC WEED CONTROL IN FLORIDA

William T. Haller

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The introduction of the water hyacinth into the St. Johns River, Florida near Palatka in the mid-1890's initiated a century of mechanical and chemical control efforts. The naturally rich, warm and shallow aquatic systems in Florida provide excellent habitat for both temperate and tropical aquatic weeds. While water hyacinth is no longer a significant problem due to aggressive maintenance control programs, the introduction and spread of submersed weeds in the middle 1900's has once again offered new challenges in aquatic plant management. The improvement in chemical and biological control have helped solve some of these problems but significant challenges remain. This paper will discuss the evolution of aquatic weed control over the past 100 years and outline the current situation.

NOTES

SESSION 7

MONITORING FOR RESULTS

FLOW MEASUREMENT PLANNING AT A STORMWATER TREATMENT AREA NEAR LAKE OKEECHOBEE

Kwaku Oben-Nyarko¹, Jie Zeng², Emile Damisse² and Jing-Yea Yang¹

¹Stanley Consultants Inc., West Palm Beach, FL; ²South Florida Water Management District, West Palm Beach, FL

Stormwater Treatment Areas (STAs) operated by South Florida Water Management District (District), are designed to remove pollutants such as phosphorus and nitrogen from the agricultural water in areas surrounding Lake Okeechobee before discharging them into the everglades. These STAs play a vital role in ensuring continuous flow of good quality water to sustain ecosystems downstream.

In order to maintain high pollutant removal rates, flow volume in and out of these STAs through culverts, pumps, spillways and weirs need to be well managed and controlled. Establishment of a good flow rating equations for different control structures in STAs is one of the key elements of mandatory permit compliance. For these structure-specific flow ratings, collecting good field flow data is the first and most important step.

In this paper, STA-1E is used as case study. The focus is to establish a framework for flow data collection planning. The result of such an exercise will offer STA-1E:

- (1) An established range of need of flow measurements based on the operation of the STA;
- (2) Recommendations on future flow measurements based on the rating developed and used for the flow type(s) in question; and
- (3) Recommendations on future streamgauging based on the historical data and operational needs of each structure.

A dimensional-analysis-based-plan approach is also proposed as part of the framework for planning flow data collection. This approach aims to assess adequacy of flow measurement data required to provide high quality flow rating, while it also considers the optimization of streamgauging resources. In an effort to reduce the limitations of weather conditions and operation restrictions of the structures, the District is developing Computational Fluid Dynamics (CFD) analysis to generate synthetic data to supplement field measurements. This planning framework can also be applied to numerical data generation.

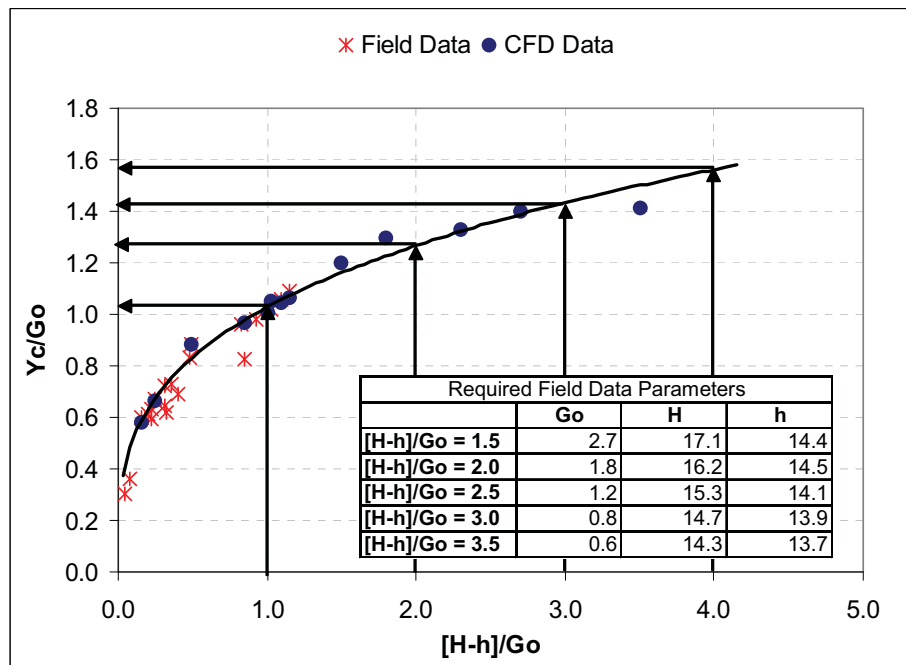


Figure 1: Dimensional-analysis-plan plot of S369C culvert

*S369C culvert in STA-1E is one of the structures involved in the streamgauging planning. Figure 1 shows that the field data (red) is not sufficient for very high head differentials. With the operational range requiring flow data identified, the streamgauging teams can be deployed to collect additional data to cover the remaining operational range of the structure. Preliminary results from CFD simulations also present reasonable estimates in Figure 1 (blue dots). They are consistent with field measurement data and suitable for rating and calibration of spillways and culverts.

NOTES

LONG-TERM WATER CHEMISTRY TRENDS IN FLORIDA LAKES

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A working hypothesis among many lake managers is that watershed development around lakes adversely affects lake trophic state indicators (total phosphorus, total nitrogen, chlorophyll, and Secchi depth). The State of Florida has experienced substantial human population growth; from 1970 to 2008 the Florida population has increased by 176%. With this large population growth and the attending land development, concerns of eutrophication have increased (see Harper 1992). Point-source pollution has been reduced in the United States shifting the focus, especially in Florida, to non-point source pollution (FDEP 2008). Therefore, the increased population growth and associated watershed development would be expected to increase nutrient concentrations and decrease water clarity in Florida lakes. However, a past assessment of Florida lakes (Terrell et al. 2000) showed no significant changes in trophic state indicators across three periods of rapid population growth (1967-1972, 1979-1981, and 1996-1997). The present study uses a population of Florida lakes and another decade of data to examine the possible effects of population growth and watershed development on lake trophic state indicators.

Long-term trophic state data were obtained from Florida LAKEWATCH for 173 Florida lakes (22 counties) consistently sampled for at least 15 years (29 lakes were sampled for 15 years, 29 for 16 years, 39 for 17 years, 23 for 18 years, 35 for 19 years, 9 for 20 years, and 9 for 21 years). Linear regression analyses of individual lakes indicated that total phosphorus significantly increased in 32% (56 lakes) of the lakes, while 12% (21 lakes) significantly decreased, and 56% (96 lakes) showed no significant change. Total nitrogen increased in 39% of the lakes (67 lakes), decreased in 9% (15 lakes), while 52% (91 lakes) showed no change. Chlorophyll concentrations increased in 24% of the lakes (42 lakes), decreased in 16% (27 lakes) decreased, while 60% (104 lakes) showed no change. Secchi depth increased in 10% of the lakes (18 lakes), decreased in 32% (55 lakes), and 58% (100 lakes) showed no change.

Lakes showing significant trends (increasing or decreasing) for the trophic state indicators were compared to their respective county population growth. Population increases ranged from 12% to 172% for the 22 counties where the 173 lakes were located. Counties were grouped into three categories; those counties with population change <25%, 26% to <74%, and >75%. For each population change category, regression analysis was used to determine the slope of population change. Comparing the slope of population growth to the mean slopes of the lakes with increasing and decreasing trophic state indicators yielded no significant trends among categories.

It would be expected that Flagler County (172% population increase) would have the steepest increasing slope for total phosphorus, total nitrogen, chlorophyll, and the steepest decreasing slope for Secchi depth; however, this speculation was not documented for this sample of Florida lakes.

It is difficult to determine if the significant increases or decreases in the regression lines of trophic state indicators over time are influenced by the normal temporal variance. Terrell et al. (2000) addressed the same issue and concluded data falling outside of the 95th percentile of a month-to-month variance reflects a true significant change. Another method of examining this “limitation” is to use the percent average deviation. Mean total phosphorus, total nitrogen, chlorophyll, and Secchi depth values were determined for an individual lake by year (annual average lake value). Mean total phosphorus, total nitrogen, chlorophyll, and Secchi depth values were then determined for all lakes among all years (grand average lake value). The percent average deviation for each year was calculated by subtracting the grand average lake value from the annual average lake value, dividing by the grand average lake value, and multiplying by 100. The percent average deviations for total phosphorus ranged from -42% to 39% with a mean of -2.6%, total nitrogen ranged from -23% to 14% with a mean of -3.0%, chlorophyll ranged from -83% to 7.6% with a mean of -21%, and Secchi depth ranged from -7.7% to 43% with a mean of 8.4%. These percent average deviations help to identify major changes at individual lakes. For example, Little Lake Santa Fe and Lake Santa Fe (Alachua County) showed extreme percent average deviations for 2008 (+ 300%).

These population analyses and examples illustrate a need to examine lake trophic state indicators not at both a population and individual lake level. Discussion among lake managers as to what factors have caused these quantifiable changes at specific lakes is imperative and will greatly help to fit all the pieces of this puzzle together.

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NOTES

SESSION 8

NUTRIENT LIMITATION

ROLE OF NUTRIENT LIMITATION IN LAKE RESTORATION

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Introduction

The role of nutrient limitation in regulating algal productivity in lakes has been well known for many decades. During the 1970s, Schindler performed whole lake limiting nutrient studies in the Experimental Lakes Area in Canada which demonstrated, both visually and chemically, algal responses to differential additions of nitrogen and phosphorus to the water column (Schindler and Fee, 1976). The TN:TP ratio, based on a conceptualized molecular formula for algal biomass, is commonly used as a metric to identify conditions where nitrogen or phosphorus may be limiting. Harper (1979) showed, in a series of algal bioassay tests, that algal productivity may also be limited by an extreme imbalance in nutrient ratios in spite of an excess of available nitrogen and phosphorus.

Discussion

Nutrient ratios are commonly used to characterize lakes into nitrogen limited or phosphorus limited systems and to justify selection of lake restoration techniques. Although this approach has value, there are many instances in which the use of nutrient ratios to identify nutrient limitation may fail to directly identify appropriate lake restoration options. First, many lakes which appear to be N-limited based on the calculated TN:TP ratio do not have low nitrogen concentrations. Most lakes originate as highly P-limited ecosystems. Due to the higher retention of phosphorus compared with nitrogen, lakes tend to accumulate phosphorus over time, resulting in a decrease in the TN:TP ratio and an apparent trend toward increasing N-limitation as the lake ages. Many highly eutrophic lakes appear to be nitrogen limited based on the TN:TP ratio. However, a more functional view of the trophic state dynamics may be that phosphorus is too high rather than nitrogen too low. Highly eutrophic lakes are also capable of nitrogen fixation which makes nitrogen control impractical. The most appropriate restoration strategy for these lakes may be phosphorus control in spite of the apparent N-limiting conditions.

From a practical perspective it is not possible to provide control for only nitrogen or phosphorus loadings to a lake. Virtually any BMP which removes phosphorus will also remove nitrogen. However, significant nitrogen removal is difficult. The most effective method of nitrogen removal, denitrification, occurs under anoxic conditions which are unsuitable for phosphorus removal.

Therefore, phosphorus reduction may be the most effective nutrient reduction strategy even in lakes which appear to be nitrogen limited. Eutrophic waterbodies are rarely impacted by a single nutrient source, and restoration projects must take care to address all significant inputs, such as inflows, seepage, and sediments.

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NOTES

SPATIAL AND TEMPORAL DISTRIBUTION OF LIMITING NUTRIENTS IN FLORIDA LAKES

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²Hillsborough County Public Works Department, Tampa, FL

Purpose and objectives

The Florida Center for Community Design and Research (FCCDR) Lake Assessment Group at the University of South Florida (USF) has conducted lake assessments of Hillsborough County Lakes for over ten years, reporting the results of these assessments in the Hillsborough County [Water Atlas](#). In a review of these data, an interesting trend was observed. For many lakes the nitrogen to phosphorus ratio (N:P) decreased (changed towards nitrogen limiting) over time. In 1998 when the first assessment reports were published it was a rare case for a lake to be anything but phosphorus limited; however by the 2008 report many lakes were being reported as balanced though none were reported as nitrogen limited. This paper explores this trend for Hillsborough County Lakes and compares them to a large Water Atlas dataset of lake nutrient data for Florida Lakes. The reason for this study was to determine (1) if a similar trend was observed in other areas; (2) if a similar trend is observed, was there other similarities which might explain the trend and (3) what might the implications of this type of study be for lake management in Florida.

Scope

This paper explores the spatial and temporal variation of limiting nutrients for a large group of Florida Lakes that are maintained within the [Florida Atlas of Lakes](#). Geostatistical analysis is used in limnology to better understand the spatial distribution of various lake health parameters as they relate to components such as soils, landuse, atmospheric deposition and other spatially distributed factors (<http://landscape.zoology.wisc.edu/Projects/NTLLTER.html>, [Carpenter, et. al., 2006](#)). Researcher scientists such as Glenn E. Griffin and Dan E Canfield, Jr., have explored the relationship of lentic systems to changes in their surrounding environment concluding that these systems are connected both spatially and functionally to other lentic and lotic systems and to the related watershed. In 1997 the first comprehensive geospatial analysis of Florida Lakes was accomplished with the publication of [Lake Regions of Florida](#) (G.E., Griffin, 1997). This USEPA report concluded that, based on spatial variances, 47 unique lake regions could be mapped in Florida. At that time lake phosphorus and lake alkalinity were used in addition to region ecology to create the assessment schema. Our research takes a similar approach to evaluate limiting nutrient patterns (N:P ratio) for the data period of that report 1986-1996 and for the period 1997-2008 to determine if a trend similar to that observed for Hillsborough County lakes exists for other Florida Lake Regions or Counties. The report focuses on temporal and spatial changes in N:P ratios and attempts to determine relationships between these and factors such as differenced in land use, land cover and soils.

Methods

The source for all data used in the analysis was the [Water Atlas](#) lakes database, developed by USF to support the [Florida Atlas of Lakes](#). The Water Atlas has an extensive multi-source database that is managed by a powerful, on-line [data retrieval](#) and visualization system. This system was used for all data retrieval and initial data review and formatting. Florida LAKEWATCH data was used exclusively because it offered the most extensive data record in terms of spatial and temporal distribution and because all LAKEWATCH data is processed through a single laboratory at the University of Florida which reduced the likelihood of variances from different laboratory procedures. All data was downloaded as Excel 2007 files and analyzed through the use of pivot tables and simple statistics (mean, regression) after calculation of N:P ratio for a set of 441 Florida lakes that have consistent data for the periods of 1986-1996 and 1997-2008. Annual N:P mean values for all lakes were determined using a pivot table to summarize this large lake database and grouped by County for comparison. Initially a series of trend graphs for the period of consistent data records was created for comparison by Region and County.

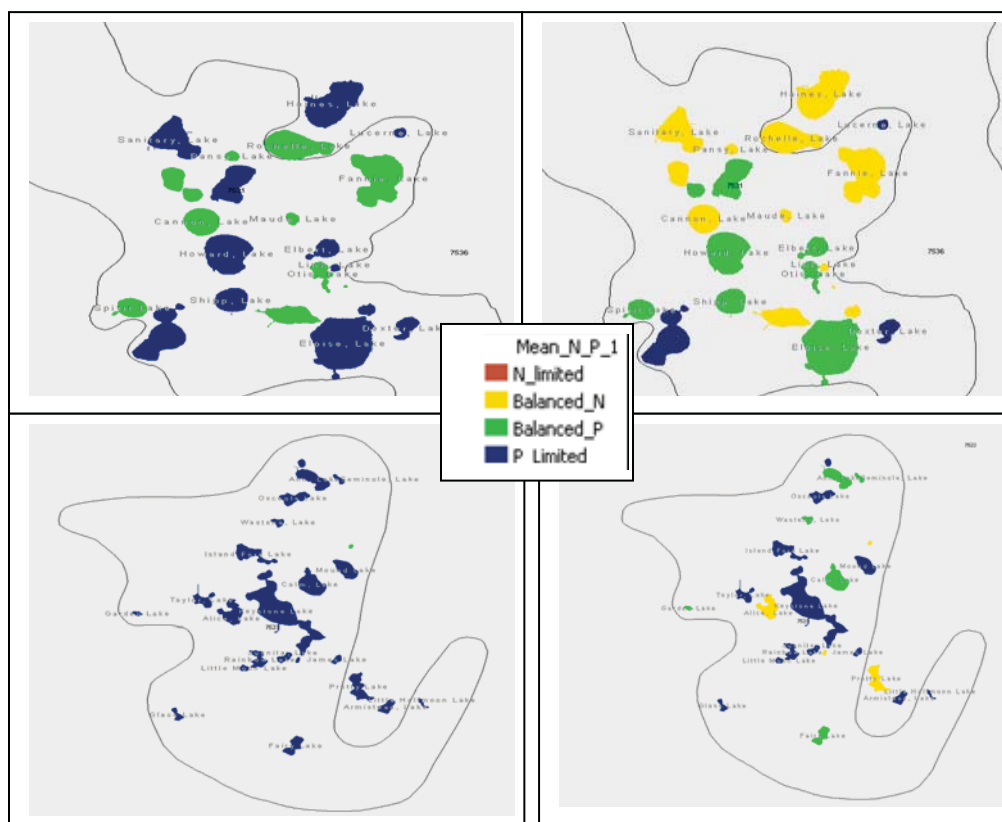


Figure 2 . N:P Ratio Spatial Distribution 1986-1996 and 1997-2008 for Winter Haven Lakes (Polk County) and Odessa Lakes (Hillsborough County).

Initial Results

The mean annual values for areas as large as a County, though useful as a screening method, mask much of the temporal changes that may occur. However, this change is easily seen in spatial comparisons of the two periods similar to that shown in Figure 1. As seen above, for period before 1996, the Polk County lakes in the Winter Haven region were primarily p-limited or on the p side of balanced (N:P 11-15) and the Odessa Lake region in Hillsborough County was p-limited. However, after 1997, a shift occurs that moves many of the lakes in both areas to “balanced” and some to the nitrogen-side of balanced. This type of trend was seen in many but not all Counties. Research continues to determine what causative factors may explain this change and the implications to lake management practices.

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NOTES

WHOLE LAKE ALUM APPLICATIONS FOR CONTROL OF INTERNAL P LOADING LONG TERM BENEFITS AND UNINTENDED CONSEQUENCES

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Winter Park, FL

Introduction

The City of Winter Park has used whole lake alum applications on Lakes Mizell and Virginia to reduce internal P cycling from the sediments to the water column. Studies had shown that significant percentages of the overall P load to these lakes was due to internal cycling. On Lake Virginia, it was estimated that 32% of the total P load was from internal sources. Prior to the applications secchi disk values on Lake Mizell averaged about 1 meter annually. Funding for the Lake Virginia treatment was a cooperative effort between Winter Park and the State of Florida and included a 50% match grant from the FDEP under the Florida Forever Program.

Methods

Sediment sampling was performed on each lake to determine the concentration of available P in the top ten centimeters. Phosphorus isopleths were developed to aid in calculating the proper alum dose for each portion of the lake bottom. Applications in Lake Mizell took place in three phases in 1997 and 1998. Alum was delivered by tanker truck and transferred to a tank on a boat equipped with a pump and application boom. The boat then spread the alum across the lake's surface delivering the calculated dose to each portion of the lake. The treatments were split to prevent excessive pH depression which can cause fish kills. Alum applications on Lake Virginia were performed in three phases in the spring of 2007 using the same methods as on Lake Mizell. For approximately 18 months prior to the applications the clarity on Lake Virginia had been steadily increasing. By the time the alum applications were scheduled to begin secchi disk values had increased to around 4 meters. City staff debated whether or not to proceed with the project. Ultimately it was decided that the load was still occurring and that there would be a long term benefit if the application was performed.

Results and Discussion

After the final treatment on Lake Mizell, secchi disk values were higher than pre-treatment levels, but fell steadily until they returned to pre-treatment levels by 2000. Beginning in 2003, significant improvements in water clarity were observed. Improvements continued through 2008 when secchi disk values averaged 3.9 meters.

Within six months of the final application on Lake Virginia, secchi disk values fell to less than 50% of their pre-treatment levels, and remained low for the next 14 months. Both chlorophyll a and P concentrations were increasing during this time period as well. By December of 2008, it appeared that water clarity was beginning to improve on the lake, and the in first three months of 2009 continuously higher secchi disk values were observed. By April of 2009 the secchi Disk transparency had recovered to over 4 meters. The cause of the decrease in water clarity is not known, but several potentially contributing factors are being considered and will be evaluated if any future treatments are performed.

Reference

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NOTES

THE USE AND LIMITATIONS OF THE STATE OF FLORIDA'S TROPHIC STATE INDEX (TSI) AS A TOOL FOR SETTING WATER QUALITY TARGETS FOR LAKE MANAGEMENT

Dave Tomasko

PBS&J

Tampa, FL

The Florida Department of Environmental Protection (FDEP) developed the Trophic State Index (TSI) as a tool to allow for a state-wide assessment of water quality for lakes and estuaries, especially where different researchers were using different water quality indicators. The TSI allows for the incorporation of information related not only to phytoplankton abundance (expressed in terms of levels of the pigment chlorophyll-a) but also the abundance of nutrients, nitrogen and phosphorus, likely to affect phytoplankton levels.

As useful as the TSI is for assessments of water quality across and between geographic regions, it can be somewhat less useful (or not useful at all) for developing target nutrient levels for chlorophyll-a in individual lakes. In lakes with high levels of tannins, nutrient levels can be “disconnected” from any meaningful relationship with phytoplankton abundance. In high tannin lakes, TSI calculations can suggest nutrient impairment even when phytoplankton levels are not themselves elevated. Conversely, low tannin lakes can be more susceptible to nutrient availability than would be suggested based on their corresponding TSI values. In low tannin lakes, locally-derived target nutrient levels for a given TSI value for chlorophyll-a may require more substantial reductions than would be derived from the use of corresponding TSI values for nutrient concentrations.

Additionally, low color lakes (i.e., PCU values < 40) may not be able to meet their associated TSI target of 40 without a substantial amount of submerged aquatic vegetation, as the nutrient concentrations for nitrogen and phosphorus that correspond to TSI values of 40 are typically less than even mean concentration values for stormwater runoff from even an undeveloped landscape. The value of developing locally-derived water quality targets will be addressed.

NOTES

SESSION 9

THESE REGULATORY TIMES

**COMPARISON OF SOUTHEASTERN STATES' RESPONSES TO THE TMDL
PLANNING PROCESS AND IMPLEMENTATION OF TMDLS:
ARE WE WORKING TOO HARD OR NOT HARD ENOUGH?**

A. B. Shortelle, Ph.D., K. A. Reed, P.E., A. Vandelay, E.I.T.,
MACTEC Engineering and Consulting
Newberry, FL

Total Maximum Daily Load (TMDL) is a regulatory term from the U.S. Clean Water Act. The TMDL sets forth the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. USEPA and States implementing the Clean Water Act establish TMDLs for impaired waterbodies. In general, States develop inventories of waterbodies that do not fully support their designated beneficial uses (e.g. recreation, fisheries, etc.), and TMDLs are then developed for those impaired waterbodies. Load allocations are made for point and nonpoint source contributions, and plans are made for the implementation and enforcement of the TMDL. However, there is wide variation in State programs. This presentation will compare various aspects of TMDL programs for States in the southeastern U.S., including examples.

NOTES

USING A ‘DECISION MATRIX’ APPROACH TO DEVELOP FECAL COLIFORM BMAPS FOR IMPAIRED WATERS IN THE HILLSBOROUGH RIVER WATERSHED

Gerold Morrison¹ and Terry Hansen²

¹BCI Engineers and Scientists, Inc., Lakeland, FL

²Florida Dept. of Environmental Protection, Tallahassee, FL

This project developed and applied a decision-support tool — conceptually similar to the ‘decision matrix’ that is currently used by the Tampa Bay Estuary Program to assess water quality in Tampa Bay — to guide the selection of management actions for a Basin Management Action Plan (BMAP) addressing fecal coliform impairments and TMDLs in the Hillsborough River watershed. The decision-support framework used in the project is based on technical approaches and resource management strategies recommended by the U.S. National Research Council, the World Health Organization, the European Union and U.S. EPA. In addition to fecal coliform levels it incorporates other relevant information, such as the presence and relative magnitudes of human fecal contamination and other potential sources of human pathogens within BMAP management areas that are currently classified as impaired due to elevated fecal coliform levels. Because the impaired portions of the Hillsborough River watershed include or discharge to water bodies which are used for public recreation and/or as sources of potable water supply, the project focuses on these two designated uses and potential exposure routes for the purpose of managing water quality conditions to help reduce human health risks posed by waterborne pathogens. In addition to its use in the fecal coliform TMDL/BMAP process, the approach may also provide a conceptual framework that could help water quality managers address other indicators of waterborne health risks in water bodies that are used for recreational purposes and as shellfish harvesting areas and sources of potable water supplies.

NOTES

RULES AND REGULATIONS THAT AFFECT AGRICULTURE OR HOW TO SPEAK FARMER

Vic Johnson

North America Kemira Water Solutions, Inc.
Phil Campbell, AL

As regulatory agencies enact legislation and rules such as the CAFO final rule (Confined Animal Feeding Operations) it has become necessary for those not directly involved in Agricultural production to become more familiar with everything from the terminology used in Agriculture to how these criteria affect the way producers operate to protect surface water quality.

This presentation will discuss the final CAFO rule and how producers implement advanced treatment systems and other management practices to comply with the rule while protecting their farms from nutrient overloads and not allowing these loads to reach surface water.

Examples of terminology not familiar to the layperson will be included and explained using case studies of active treatment systems. Additionally, key points of the CAFO final rule will be included in the presentation.

NOTES

THE WATERSHED MANAGEMENT PLAN FOR LAKE ISTOKPOGA: ARE YOU KIDDING ME?

Clell Ford

Highlands County Natural Resources Department
Sebring, FL

Located 60 miles northwest of Lake Okeechobee, Istokpoga (27,000 acres, 1.8m z_{avg}), Florida's 5th largest lake, has a 600 mi² watershed that includes three towns. Istokpoga is the largest single source of consumptive use water in the Kissimmee Valley, with CUP withdrawals averaging > 100 mgd; the lake is home to the largest osprey population in the world – estimated between 270 and 300 nesting pairs; it also has one of the most persistent Hydrilla infestations in Florida, with millions of dollars spent on what ultimately has become a management, rather than eradication effort. The lake is a FFWCC Fish Management Area for sportfish and is also home to thousands of riparian property owners, many of whom access the lake through residential canals. Land use in the watershed is dominated by agriculture, including dairy, citrus, unimproved pasture, and sod. From the water quality arena, total phosphorus levels have steadily increased and Secchi transparencies steadily declined since monitoring began 1988, with the lake being designated as an impaired water in 2006 by FDEP. Into this soup of user conflicts, a citizen's group is progressing in this Quixotic endeavor. They have crafted a mission statement that focuses on protecting the ecological and economic sustainability of the lake and its environs. They have also developed objectives focused on habitat management, water resources and watershed management, and the local economy. Development of the plan has included changes in land use, fisheries, lake front development, downstream consumption, TMDLs and many other factors. Developing the plan is just the beginning.

NOTES

THE USE OF THE FLORIDA LAKE VEGETATION INDEX TO IDENTIFY ANTHROPOGENICALLY IMPAIRED LAKES IN FLORIDA

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Introduction

The Florida Department of Environmental Protection (FLDEP) has proposed the use of a macrophyte-based Lake Vegetation index (LVI) to order to identify lakes that are anthropogenically impaired. The LVI is calculated from a standardized assessment of the littoral aquatic plants in a lake. It is based on four metrics, the percent native taxa, percent invasive taxa, percent sensitive taxa, and the average tolerance value of the taxon present over the largest area. The tolerance value applied was a Coefficient of Conservatism (CC) score that was developed for most of the plant species found in depressional wetlands in Florida and applied to the littoral vegetation of lakes. The scores for individual species, which range from 0 to 10, were developed from the opinions of a group of botanists. In this system, plants with higher scores were considered the most desirable.

Testing the method

The LVI method was tested by the FLDEP on a selected group of Florida lakes. Correlations between the LVI and their measure of human impact called the Human Development Gradient (HDG) were used to verify the method. We analyzed the same data the FLDEP used to establish the LVI and found that the LVI cannot be used to separate out natural processes that determine the vegetation quality in a lake from human actions. In particular the FLDEP Human Development Gradient used to link the LVI to human actions is not a valid indicator of human actions, because it includes several natural factors such as water chemistry, and bottom sediments not related to human activities. Another component of the HDH, the Landscape Development Intensity index (LDI) they used to link lake impairment to human actions was not related to water quality in Florida lakes based on a statistical analysis of their data from a large sample of Florida lakes. The experimental design did not take into account known natural factors that influence the distribution of aquatic plant species.

The role of pH in determining the LVI

In particular pH was found to be more important than the LDI in explaining the variance in the Lake Vegetation Index.

A detailed look at pH (Fig. 1) shows that pH is correlated with the LVI and the 4 plant metrics making up the LVI including the % native plants, % sensitive plants, % invasive plants, and % Category I and II invasive plants. It is also correlated with the coefficient of conservatism (CC) of the dominant and codominant plants in a lake. In general the lakes on the acidic end of the scale are more likely to have higher percentages of native and sensitive plants and to be dominated by plants with narrow ecological requirements (high CC score) while more alkaline lakes are more likely to have invasive plants and be dominated by plants able to tolerate a broader range of ecological conditions (lower CC scores).

Conclusion

Once pH is accounted for, there is no statistically significant relationship between the LVI and any index of human development. We conclude that the Lake Vegetation Index cannot be used to determine if lakes are impaired by human activities.

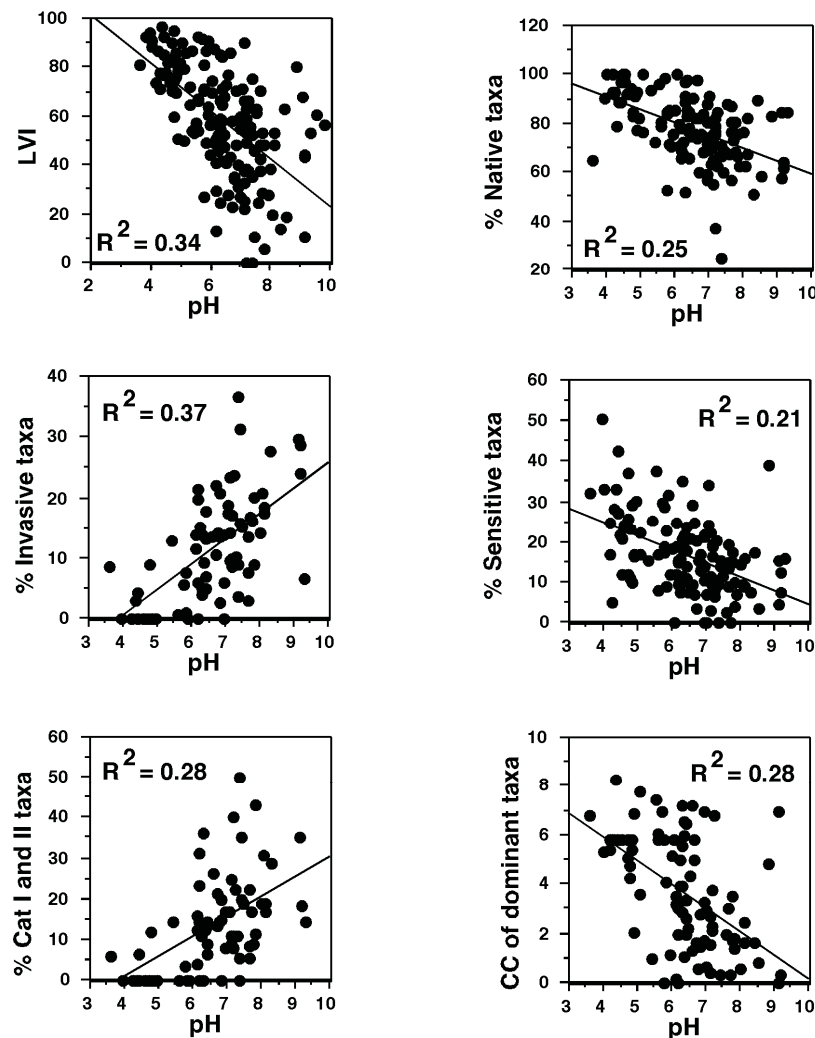


Figure 1. Relationships between pH and the LVI and its component metrics.

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SESSION 10

BMPs PART II

THE BENEFITS OF VEGETATION AND BIOLOGICAL ENGINEERING PRACTICES FOR MAINTAINING PONDS

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Orlando, FL

This project is designed to assess the pollutant (nutrient/heavy metals) uptake possibilities from the use of native vegetation, swale constructions, and wetland reproductions along retention ponds. The purpose is to use this method as a preventative strategy to reduce pollutants from entering ponds and satisfy NPDES (National Pollutant Discharge Elimination System) permitting. This research provides the rationale for use of vegetation and biological engineering for cost-efficient methods to naturally clean ponds.

Issues in water quality such as toxic algal blooms and the need for safe processes to clean water has become one of the most pressing issues today. The use of chemicals to manage invasive plant species can be problematic even with “environmentally safe” products because of the released nutrients from dead plant biomass, which is counterproductive to the service of retention ponds. There is a significant need for biological methods of control at nonpoint sources of pollution which include retention ponds that are meant to control pollutants. The retention ponds inevitably flow into our main water bodies and are costly to clean up at that point.

Positive resulting research has been performed and is used at facilities such as the Orlando Wetlands using wetlands to clean pollutants from wastewater, which provides a basis for using such methods to clean water before it flows to main water bodies. These methods are not only cost-effective but provide natural habitats for animals big and as small as the various invertebrates involved in the biological cycles to recycle and clean our water bodies.

My basis for continued experimentation is based on the research of Dr. Martin Quigley, who has found results in using *Typha latifolia* or Cat-Tails, for the removal of nitrogen, an algae promoting nutrient. This has been accomplished by transpiration (absorption and release of nitrogen) and subsequent habitat creation for microbes necessary to the process. The continued research to be performed will focus on the use of vegetated swales on the littoral zone of UCF lakes as well as less-invasive emerged plant species for preventative management of pollutants. These methods will capture runoff to be filtered through plants and percolate into the soil to ease the work necessary by retention ponds and limit the inevitable sediment build up which requires dredging over time.

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NOTES

**CONSTRUCTION AND PRELIMINARY RESULTS OF AN OFF-LINE
NUTRIENT REDUCTION FACILITY TO IMPROVE WATER
QUALITY DOWNSTREAM OF LAKE APOPKA**

Lance M. Lombard, Ronald L. Hart, and Steve Yarkosky

Lake County Water Authority, Tavares, FL

Harvey Harper

Environmental Research and Design, Inc., Orlando, FL

Lake Apopka is a shallow 125-km² hypereutrophic lake located at the headwaters of the Harris Chain of Lakes northwest of Orlando, Florida. Historically, water from Lake Apopka drained slowly over 80 km² of wetlands, but discharge is now confined to the Apopka-Beauclair Canal (ABC) flowing seven miles north to Lake Beauclair. Construction of the canal reduced Lake Apopka's normal elevation by several feet and allowed intensive agricultural activity within the North Shore Area beginning in the 1940s. Once known worldwide as a sportsman's paradise, Lake Apopka declined rapidly after the onset of agricultural activity and is now regularly described as being one of the most polluted lakes in the State of Florida.

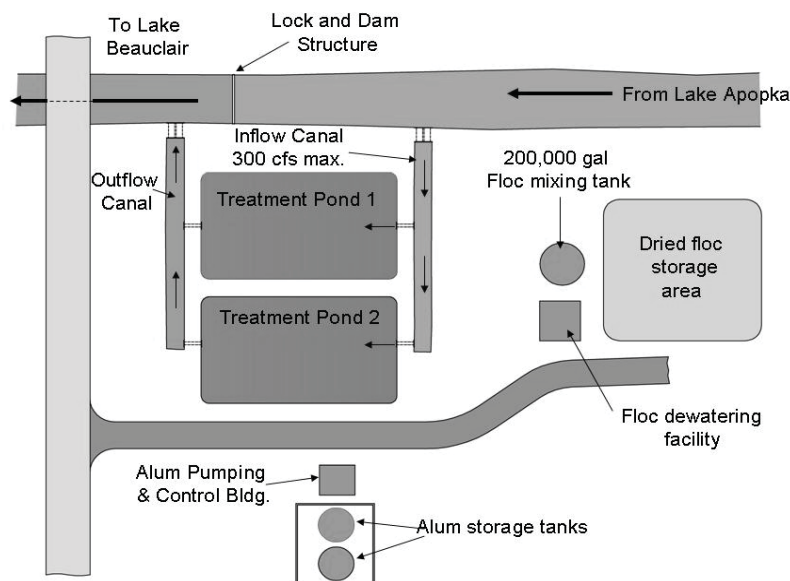
Major efforts are currently underway to restore Lake Apopka and reverse water quality degradation within the Harris Chain of Lakes. One of these efforts is the Lake County Water Authority's (LCWA) alum-based offline Nutrient Reduction Facility (NuRF). The confined nature of the Apopka-Beauclair Canal and orientation of the NuRF around the existing ABC Lock and Dam provides a unique opportunity to treat the entire Lake Apopka watershed at one location and without the need for pumps. With the capacity to handle approximately ninety percent of the total average discharge from Lake Apopka, the NuRF is expected to remove nearly two-thirds of the total phosphorus (TP) load to Lake Beauclair. The NuRF will work in concert with other restoration efforts to ultimately meet the established Total Maximum Daily Load (TMDL) goals for four lakes downstream of Lake Apopka with a combined surface area of 89 km².

The LCWA's \$7.272 million dollar NuRF facility took slightly more than eighteen months to construct and represents seven years of effort on behalf of the agency and close cooperation with the Florida Department of Environmental Protection (FDEP) and the St. Johns River Water Management District (SJRWMD). The FDEP provided funds for half of the construction costs while the SJRWMD provided the land upon which the project is constructed. Average annual operating and maintenance costs for the facility are expected to be approximately \$1 million and will vary depending on the dose rate, the price of alum and the amount of water treated.

Designed by Environmental Research and Design, Inc., and constructed by Gibbs & Register, Inc., the NuRF is a gravity flow system with a simple operating principle (Figure 1).

Incoming water is dosed with liquid aluminum sulfate, the precipitant containing the target nutrients is retained within the settling ponds and clean water exits the facility and travels downstream. Alum floc is collected from the bottom of the settling ponds using a cable-guided dredge and pumped to a centrifuge system where the flow is dewatered to the consistency of a semi-dry transportable cake which can be moved to other locations on the site for further drying. Because of its ability to continue to bind phosphorus compounds, this dry residual material is expected to prove very useful in other restoration or remediation projects involving nutrient-enriched soils.

Figure 1. NuRF Schematic



The NuRF began initial operation on March 2, 2009. Preliminary performance data indicate an average TP removal efficiency of sixty-five percent after treating approximately 2.4 million cubic meters through April 30, 2009. This equates to the removal of approximately 150 kg of TP during this two-month period. Nearly 380,000 liters of alum were applied at a dose rate of 10 mg Al / L and a cost of \$67,000.

Rate of improvement downstream of the NuRF is entirely dependent on rainfall and discharge from Lake Apopka. Under average flow, the nine million cubic meters of water in Lake Beauclair is exchanged once every two months (Fulton, 1995). The facility is presently operating at about five percent of capacity and twenty-five percent of expected average because of low water conditions. At the current discharge rate, the NuRF will have treated the volume in Lake Beauclair within approximately seven months. In addition to meeting the stated TMDL goals, the NuRF is expected to increase water clarity in Lake Beauclair to provide sufficient light for an additional 200 acres of submerged aquatic vegetation.

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NOTES

POLYMER ENHANCED BEST MANAGEMENT PRACTICES FOR EROSION AND SEDIMENTATION CONTROL, WATER CLARIFICATION WITH A FOCUS ON POND AND LAKE MANAGEMENT INCLUDING NUTRIENT CONTROL, AND SOIL STABILIZATION

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Applied Polymer Systems
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Sedimentation and excess nutrient loads, including phosphorous, entering our Waterbodies from erosion, fertilizers, manures, and crop runoff cause eutrophic conditions that lead to algal blooms and surface water quality degradation. Using water soluble polymer technologies to enhance our current best management practices (BMPs) we are able to greatly reduce sediment and nutrients from leaving a site as well as reducing the amount of sediment and or nutrients in a given water body. Two possible solutions are as follows: (1) Capture or retain the sediment and nutrients before it can wash into a water body or (2) use polymer enhancement in conjunction with aeration systems, fountains, water falls, etc. to remove nutrients and turbidity from contaminated waters. Through various tests and case studies a 75-85 percent reduction of phosphorous has been found as well as a 95 percent reduction in TSS and NTU's. Besides meeting compliance standards, TMDL's and ELG's the importance of such reductions lies in the fact that contaminants attach to fine particulates and are thus transported into our various water bodies. Such contaminants include nutrients, phosphorous, bacteria, pesticides, and endocrine disruptors which have negative effects when discharged. These particulates make up turbidity which we measure in NTU's. As aesthetic effects caused by turbidity may seem unpleasant this cannot even compare to the detrimental effects that very low levels of turbidity have on aquatic life. Various papers and studies have shown that as low as 10-100 NTU fish will start to show signs of stress. The general focus of this paper will therefore illustrate the most common and effective Polymer Enhanced Best Management Practices (PEBMPs) that have been quantified and are currently being used across various geographical locations to control sedimentation at the source so that it is not transported into our waters and if it is to perform water clarification by reducing turbidity. Such systems will include the following: soil stabilization including polymer enhanced soft armoring applications, de-watering systems, pond and lake clarification including nutrient reductions, de-mucking, and SRBs (Sediment Retention Barriers).

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NOTES

SESSION 11

WATERSHED AND LAKE MANAGEMENT

ASSESSMENT OF THREE ESTUARIES LOCATED IN THE PANHANDLE OF FLORIDA

Julia B. Terrell

Choctawhatchee Basin Alliance of Northwest Florida State College
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NOAA developed coastal assessment criteria in 1999 and EPA is developing numeric criteria for Gulf Coast Estuaries. Using these two classification schemes, three Gulf Coast Estuaries were assessed. NOAA's coastal assessment criteria provide a low, medium, high or hypereutrophic (for chlorophyll) label for total phosphorus, total nitrogen, and chlorophyll. The percentage of stations within each category for each estuary is listed in Table 1.

Table 1. Total phosphorus, total nitrogen and chlorophyll data collected at Pensacola Bay, Choctawhatchee Bay, and St. Andrews Bay were evaluated using coastal assessment criteria proposed by NOAA in 1999.

	<i>NOAA Total Phosphorus Criteria</i> Low (<10 µg/L) Medium (≥10 µg/L, <100 µg/L) High (≥100)	<i>NOAA Total Nitrogen Criteria</i> Low (<100 µg/L) Medium (≥100 µg/L, <1000 µg/L) High (≥1000)	<i>NOAA Chlorophyll Criteria</i> Low (≤5 µg/L) Medium (>5 µg/L, ≤20 µg/L) High (>20 µg/L, <60 µg/L) Hypereutrophic (≥60 µg/L)
Pensacola Bay	Low = 9% Medium = 73% High = 18%	Medium = 100%	Low=29% Medium=71%
Choctawhatchee Bay	Low = 3% Medium = 97%	Medium = 100%	Low=59% Medium=41%
St. Andrews Bay	Low = 2% Medium = 98%	Medium = 100%	Low = 70% Medium=30%

EPA's numeric criteria for the Gulf Coast Estuaries was developed by Hagy et al 2008 using only data for Pensacola Bay. Using data from Choctawhatchee Bay, total phosphorus, total nitrogen and chlorophyll were evaluated within various salinity zones. Data were also compared to reference conditions defined for Ecoregion 75a (Table 2).

Table 2. Summer medians for Choctawhatchee Bay, Pensacola Bay and reference condition for ecoregion 75a published in an EPA Report in 2008 proposing numeric criteria for evaluating Gulf Coast Estuaries. Values in parentheses are the number of observations for each median.

	<i>Summer Median Total Phosphorus (µg/L)</i>	<i>Summer Median Total Nitrogen (µg/L)</i>	<i>Summer Median Chlorophyll (µg/L)</i>
<i>Oligohaline (Salinity <5 ppt)</i>			
Ecoregion 75a	21 (6)	328 (6)	2.1 (6)
Pensacola Bay	27 (32)	409 (49)	5.6 (103)
Choctawhatchee Bay	22 (14)	433 (14)	7.8 (14)
<i>Mesohaline (Salinity 5-18 ppt)</i>			
Ecoregion 75a	17 (7)	371 (7)	4.1 (7)
Pensacola Bay	17 (47)	444 (59)	7.3 (233)
Choctawhatchee Bay	21 (20)	336 (19)	7.8 (19)
<i>Polyhaline (Salinity >18 ppt)</i>			
Ecoregion 75a	23 (6)	287 (6)	3.5 (6)
Pensacola Bay	13 (56)	458 (57)	5.8 (107)
Choctawhatchee Bay	15 (19)	251 (19)	4.2 (19)

Pensacola Bay, Choctawhatchee Bay and St. Andrews Bay are located in the panhandle of Florida within 60 miles of each other. Total phosphorus was significantly different at all three estuaries, yet chlorophyll was only significantly different in Pensacola Bay (Table 3).

Table 3. Total phosphorus (µg/L), total nitrogen (µg/L) and chlorophyll (µg/L) for three Gulf Coast Estuaries located in the Panhandle of Florida: Choctawhatchee Bay, Pensacola Bay and St. Andrews Bay.

<i>Estuary</i>		<i>Total Phosphorus (µg/L)</i>	<i>Total Nitrogen (µg/L)</i>	<i>Chlorophyll (µg/L)</i>
Pensacola Bay (1999-2004)	Mean	60 ^a	380	6.7 ^a
	STD (N)	56.6 (11)	173.4 (11)	3.1 (52)
Choctawhatchee Bay (2001-2007)	Mean	16 ^b	291	5.1
	STD (N)	5.2 (79)	62.1 (79)	2.2 (79)
St. Andrews Bay (1990-2008)	Mean	19 ^c	305	4.5
	STD (N)	5.5 (146)	76.6 (146)	2.2 (145)

^{a,b,c} denote significant differences.

Using a standard classification system to assess these three estuaries is not appropriate—even if they are in the same ecoregion. Classification systems established for Pensacola Bay (EPA numeric criteria) should not be used for the other two systems—Pensacola Bay is significantly more productive when measured by chlorophyll than Choctawhatchee Bay and St. Andrews Bay.

There are many differences morphologically across these estuaries that result in different expressions of trophic state parameters. Individual classifications systems should be established for each estuary, especially since there is ample data available due to the efforts of groups like Florida LAKEWATCH and Choctawhatchee Basin Alliance.

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NOTES

RAPID ASSESSMENTS OF SMALL TO MEDIUM SIZED LAKES AND RIVER STREAM REACHES IN HILLSBOROUGH COUNTY FLORIDA

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²Hillsborough County Public Works Department, Tampa, FL

Purpose and Objectives

The purpose of this paper is to describe the new methods now being developed and implemented for small to medium size lake and stream reach assessments. Hillsborough County and the University of South Florida have over ten years of experience in the use of rapid lake assessments. The objective of these assessments is to catalog the general health of small to medium size lakes by taking a snapshot of the lake's morphology, vegetation and water chemistry through an intense, one-day data collection effort. For this field work, one or two small boats (john boat and kayak) are used with crews of between three and four field scientists and student interns. Data collection includes bathymetry, quantitative and qualitative vegetation appraisal and physical water chemistry profiling and water chemistry sampling. Following the field assessment, a written report is developed for each lake and this report is published in various forms on the [Hillsborough and City of Tampa Water Atlas](#). In 2009, the assessment methodology has been expanded to include river reaches for the Hillsborough and the Alafia Rivers and the introduction of sediment volume estimate.

Scope

This report discusses changes to the assessment methodology and the expansion of the program to include stream reach assessments.

Field Methods

The University of South Florida's Lake and Stream Assessment is developed to collect a significant amount of data in a relatively short time by reducing duplication of efforts, managing data in the field and through improvements to post-field data processing and report generation.



Figure 1. Use of kayak

The method also incorporates small truck or van-transportable boats and kayaks (Figure 1) to improve ease and speed of access to these many-times difficult to access waterbodies.

Several of the methods have been discussed in earlier papers presented at FLMS (Eilers, 07) so, this paper will concentrate of new approaches and methods and our application of the methods proven for lakes to river reaches and reservoirs. The field methods include: (1) bathymetry to determine bottom contour; (2) bathymetry and the use of side looking sonar imaging to determine submerged vegetation, (3) percent volume infestation (PVI) and percent area coverage (PAC); (4) identification and mapping of invasive and non-native as well as native aquatic plants; (5) quantitative assessment of submerged vegetation biomass and the parallel determination of nutrients held in vegetation; (5) physical profiling with the use of a multi-probe and (6) water quality sampling.

This year we are evaluating the further use of side scanning sonar (HumminBird) to augment bottom scanning sonar (Lowrance) to help determine vegetation presents and absence (P/A) and to estimate sediment volume. This study is being carried on with the support of both Hillsborough and Polk Counties. For small, shallow lakes and river reaches we have adapted a two-man kayak to carry both our GPS enabled bathometer and our GPS enabled side-scanning sonar and for sediment and vegetation estimate work. The great advantage of a kayak is its shallow draft and ease of transport. We have augmented the stability of the kayak through the use of handmade outriggers and we have added a motor mount for a small electric motor for propulsion.

Sediment volume is estimated by comparing the soft and hard bottom returns from bathymetric traces and through the use of a either of $\frac{1}{2}$ inch or $\frac{3}{4}$ quarter inch diameter, metal rod or plastic tube and a Secchi Disk. The rod or tube and Secchi Disk are used to measure the muck layer and this measurement is compared to the bottom and side sonar traces of the Humminbird Bathymeter as well as the hard and soft bottom values from the Lowrance Bathymeter.



Figure 2. Secchi Disk and calibrated rod.

As in Figure 2, a hole is drilled in the Secchi Disk to allow the calibrated tube to move freely through the disk. The disk is used to indicate the top of sediment and the plastic tube core (Figure 3) is used to determine muck-sand interface. Measurement of the distance between this interface and top of soft bottom from Secchi Disk is used as an estimate of muck depth. To remain consistent with other methods used in Polk County, three sediment measurements are made for each acre of water surface.

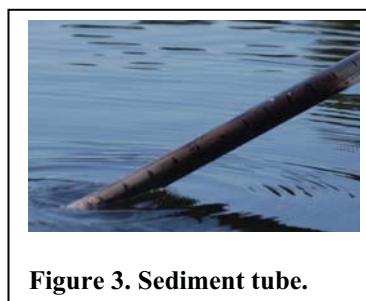


Figure 3. Sediment tube.

A Humminbird image (Figure 4) is collected for each core sample to determine vegetation P/A and correspondence of muck depth with soft/bottom bathymetry response.

Conclusions

Small shallow-draft boats coupled with bathymetry and the use of calibrated poles and cores can be a useful augmentation to lake and river assessment methods.

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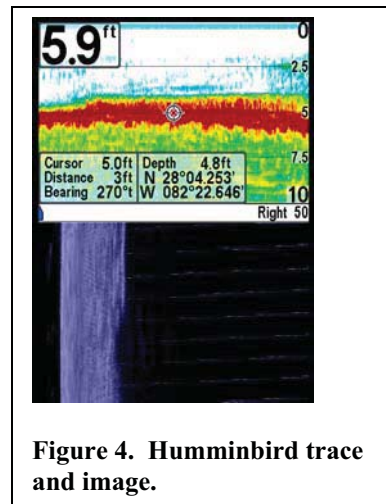


Figure 4. Humminbird trace and image.

NOTES

**THE KILLEARN CHAIN OF LAKES RESTORATION, A CLEAN LAKES PROJECT.
A FLORIDA FOREVER GRANT, FUNDED BY THE NORTH WEST FLORIDA
WATER MANAGEMENT DISTRICT AND LEON COUNTY**

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McGlynn Laboratories Inc.
Tallahassee, FL

The Killlearn Chain of Lakes is a heavily urbanized interconnected series of Lakes in northern Leon County, in the Red Hills region of the Florida Panhandle. These Lakes drain into Lake Iamonia, a 5757 acre natural Karst Lake and an Outstanding Florida Waterbody (OFW). Due to its degraded water quality and substantial infilling with silt, Lake Blue Heron, a 50-acre lake within the chain of lakes network was selected as the focus for restoration efforts. This restoration depended on strong community support from the residents and local government and the success of changing local land use habits. This restoration included: the removal of the years of accumulation of sediments; the establishment of Best Management Practices (BMPS) and educating the community on how each individual can make a difference in the water quality. The educational outreach effort won the American Water Works Association's *The 2007 Water Conservation Award for Excellence in Public Education*.

The first part of this project removed 17,600 cubic yards of sediment from Lake Blue Heron. The purpose was to remove loose unconsolidated nutrient rich sediment, which was frequently resuspended in the shallow lake resulting in the subsequent release of nutrients. Sediment sumps were also constructed at the four stormwater outfalls in Lake Blue Heron to prevent re-siltation in the Lake. Bathymetric surveys, before and after excavation, showed that the amount the removal of 32,400 cubic yards of sediment by haulers amounted to 50,000 cubic yards of wet sediment. Dewatering the sediments in the lake decreased the excavation cost by 35%.

The second part of this project, BMP Implementation, included: lime rock installation in the outfalls leading to the constructed sediment sumps; paving access roads; berms and swales; educational programs; storm drain plaques; removing and replacing diseased shoreline trees; vegetating shoreline buffer zones; artificial marsh and rain garden construction. The educational program included: building a web site (www.Killlearnlakes.org); bimonthly newsletters; disseminating educational packets to property owners; newspaper publicity; presentations at fishing tournaments and other public meetings; design contests for storm drain plaques at local schools; and the installation of these plaques by local high school students.

In addition both storm and synoptic water quality sampling and analysis monitored water quality improvements. Stormwater and Synoptic samples were taken assess pre and post restoration pollutant loading. They showed water quality improvements despite three hurricanes and two sewage spills during the restoration effort.



Figure 1: The 2007 Water Conservation Award for Excellence in Public Education with winning storm drain plaques.



Figure 2: Fishing tournament on the Killearn Chain of Lakes

NOTES

WETLAND CHANGE AND ECOLOGICALLY EFFECTS: A CASE STUDY OF VIENTIANE CAPITAL CITY LAOS

Chanhda Hemmavanh

Secretary Unit of the Prime Minister Office, Laos

Wetlands in Vientiane Capital City Laos which are of direct importance to Vientiane city residents include waste assimilation and groundwater recharge, also provide critical habitat for fish and wildlife. Some report shows that 70% of food protein in Laos comes from aquatic resources. An application of remote sensing and GIS was done in order to provide basic data for local decision-making as well as sustainable wetland management. Results reveal that Wetland area from 1992 to 2002 changed from 4831 ha in 1992 to 2325 ha in 2002. It mainly changes to farmland, grassland and resident land. This research also valued changes in ecosystem services delivered by wetland area using value coefficients published by Costanza et al. [Nature 387, 1997, 253–260]. Sensitivity analysis suggested that these estimates were relatively robust. Lack of understanding of the ecological and economic value of wetlands, low priority given to conservation and protection of urban wetlands, poorly understood hydrological and ecological functions of wetlands are the main reason of the wetland change in Vientiane capital City Laos. An application of GIS and Remote Sensing was a suitable method for investigating the wetland changes. In the end of this research paper, we also put forward a few proposals concerning the future wetland use policy formulation and sustainable ecosystems.

NOTES

SESSION 12

CRITTERS AND AQUATIC INTERACTIONS PART II

SPATIAL AND TEMPORAL DIFFERENCES IN THE BENTHIC MACROINVERTEBRATE COMMUNITY OF WETLANDS IN A WEST-CENTRAL FLORIDA NATURAL AREA

Kym Rouse Campbell and Todd S. Campbell
ENVIRON International Corp. and University of Tampa
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We have been studying native amphibian populations, as well as the spread, impacts, and potential for managing the introduced Cuban treefrog (*Osteopilus septentrionalis*), in four types of wetlands (borrow pits, isolated marshes, isolated cypress wetlands, and riverine swamps) at an approximately 2,430-hectare natural area owned by the Southwest Florida Water Management District in West-Central Florida since 2004. As of 2001, Cuban treefrogs, which eat and compete with native amphibians, were not established at the site, which includes Tampa Bay Water's Morris Bridge Wellfield and a Hillsborough County Park known as Flatwoods Park. However, during our initial study at the site during Summer 2004, large populations of Cuban treefrogs were found at half of the wetlands we studied (Guzy et al. 2006).

As part of this project, tadpole surveys are conducted approximately every three weeks from about mid-June through October, depending on when the rainy season begins, at wetlands containing water. During a tadpole survey, ten dip net sweeps are conducted at a wetland, and if the water depth is greater than 0.5 meters, five sweeps are conducted in the deep zone, and five are conducted in the shallow zone. The results of each sweep are dumped into a sorting pan, and the tadpoles, benthic macroinvertebrates, and fish are counted and identified. To date, preliminary data are available for the past three years.

From 2006 through 2008, we collected benthic macroinvertebrates from five borrow pits, 18 marshes, eight cypress wetlands, and three riverine swamps. Approximately 40 macroinvertebrate taxa have been collected to date, including eight different families of Coleopterans. Marshes contained the most benthic macroinvertebrate taxa (32 taxa), while riverine swamps contained the least (16 taxa). Libellulids, damselflies, and backswimmers were the most common taxa found in borrow pits from 2006 through 2008. Aeshnids, *Hydrocanthus* sp., and giant water bugs were the most common macroinvertebrate taxa found all three years in marshes.

Due to drought conditions, three consecutive years of surveys could be conducted in only one isolated cypress wetland and no riverine swamps. Backswimmers and mayflies were the most common taxa found in the cypress wetland from 2006 through 2008. Because of their longer hydroperiods, more similar taxa have been collected every year in the borrow pits and marshes as compared to the cypress wetlands and riverine swamps.

We plan to continue the tadpole surveys through Summer 2010 and are currently reviewing the data collected in 2004 and 2005 for inclusion into the project database. We are currently working with a Florida Department of Environmental Protection benthic macroinvertebrate taxonomist to identify and verify all of the benthic macroinvertebrate taxa that have been collected to date. We hope to evaluate the effect of wetland type on benthic macroinvertebrates, and if the drought ends before our study is over, the effect of drought.

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NOTES

**CONTROL OF INVASIVE EXOTIC ISLAND APPLE SNAILS (*POMACEA*
INSULARUM) IN THE REGIONAL STORMWATER FACILITY #1,
LEON COUNTY, FL**

Sean McGlynn¹ and Jess Van Dyke²

¹McGlynn Laboratories Inc., Tallahassee, FL

²Van Dyke Environmental, Tallahassee, FL

The littoral shelf of this Pond was planted with \$565,000 worth of aquatic plants. This 15-acre pond was designed with a long Sheet Pile Wall to funnel the stormwater through a planted marsh system populated with aquatic plants to remove nutrients and cleanse stormwater before discharge. In addition, this pond was designed to be a public park. Immediately, after planting, herbivorous invasive exotic island apple snails (*Pomacea insularum*) began consuming the plants. After one growing season 75% of the plants were gone. Of the original species planted only Soft Rush (142,124 planted) and Duck Potato (51,227 planted) have survived. All the Arrowhead (22,673 planted) and Pickerel Weed (27,468 planted) have vanished. Blue Print 2000 and Leon County funded a vigorous snail control. The aquatic plant population was stabilized and the remaining plants were saved.

After planting a hand harvesting effort by M-Inc, fall 2007, removed a large number of adult Island Apple Snails. A population of juvenile snails survived, which were too small to harvest by hand. Re-colonized of the pond by the invasive snails was apparent before the end of the summer. This resulted in an odd situation where there was basically one size class of snails in the pond (approximately 1.2 cm in diameter).

In the spring of 2008 specially designed baited traps and predator release brought the snail population under control. Michael Hill (FFWCC) stocked snail eating fish, Redear Sunfish or Shell Crackers (*Lepomis microlophus*), in the pond. Since these efforts were instituted there has been no subsequent loss of plants in the pond. The surviving plants are growing and reproducing. The remnant invasive exotic snail population is currently controlled by maintenance traps and has declined by 99%. Island Apple Snail population can be successfully managed indefinitely in this manner. Since these are spread throughout the watershed, they have not been eliminated yet. In 2008, 7333 pounds, or 146,660 individual Island Apple Snails were removed from this 15-acre pond.

The authors have developed and patented these traps. This paper will discuss the life history of these invasive exotics as well as control technique.

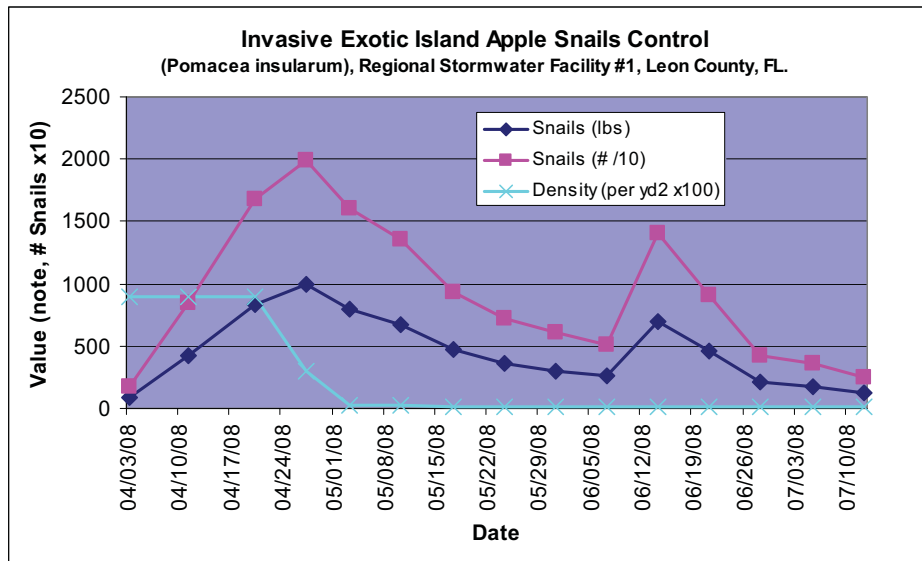


Figure 1: This table tabulates the Island Apple Snail population during the 2008 growing season.

Table 1: Aquatic plant survival statistics

REGIONAL STORMWATER POND #1: AQUATIC PLANTS	Total Planted Plants (04/07)	Total Surviving Plants (07/08)
Soft Rush (33% survival)	142124	46559
Duck Potato (25% survival)	51227	12668
Arrowhead (0% survival)	22673	0
Pickrel Weed (0% survival)	27468	0

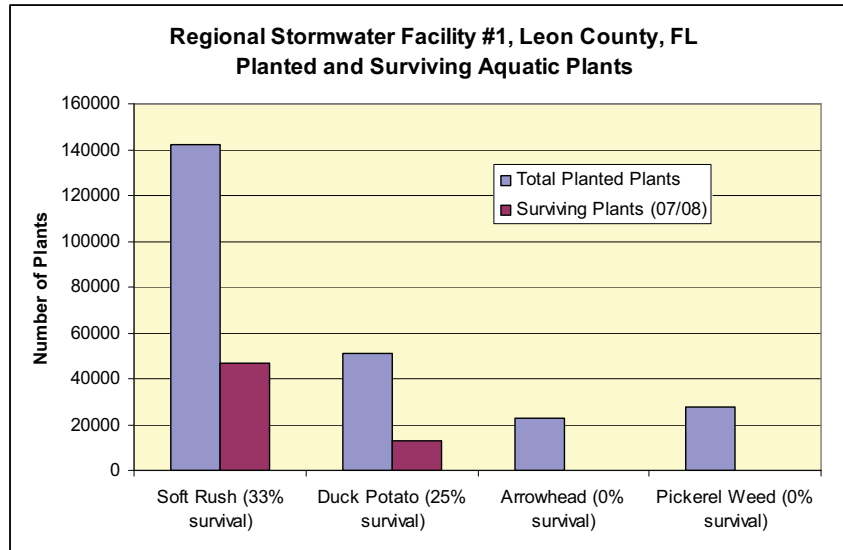


Figure 2: A graphic of the number of planted aquatics by species (April 2007), versus the surviving plants in the pond. There have been no significant losses of plants since Van Dyke Environmental and McGlynn Labs began Snail Control Project in May 2008, the surviving plants have begun to flourish.



Figure 3: Jess Van Dyke working on trapping and baiting Island Apple Snails, Regional Stormwater Facility #1, Leon County, Florida, 6/27/08.



Figure 4: Island Apple Snails mating in Regional Stormwater Facility #1, Leon County, Florida, 5/09/08.



Figure 5: Snail eggs on Soft Rush



Figure 6: Snail eggs on wooden stake



Figure 6: Snail eggs on wooden stake

NOTES

**A COMPARISON OF LONG SPINE SEA URCHIN, DIADEMA ANTILLARUM,
POPULATION DENSITIES ON PATCH REEF AND RUBBLE HABITATS IN DRY
TORTUGAS NATIONAL PARK**

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Following a mass mortality event due to a water-borne pathogen in 1983 and 1984, a keystone species *Diadema antillarum*, the long spine sea urchin, suffered large reductions (between 87% and 93%) in population densities throughout the Caribbean. Post-mortality studies over the last 20 years indicate that recovery has increased less than 3.5% from pre-mortality densities. In June 2009, we will count long spine sea urchins in the Dry Tortugas National Park. Further counts will be accomplished during subsequent years. Our research will quantify long-spine sea urchin densities within the Dry Tortugas National Park and compare densities between patch reef and rubble habitats.

NOTES

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