

*Proceedings of the
15th Annual Conference of the
Florida Lake Management Society*



*Conference Theme:
A Tale of Many Waters:
Florida's Limnic Resources*

June 7-10, 2004

**Saddlebrook Resort
Tampa, Florida**

Harvey H. Harper and Sharon H. Darling, Editors

15th Annual Conference of the Florida Lake Management Society

Program & Proceedings



*Saddlebrook Resort
Tampa, Florida
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Hosted by the Florida Lake Management Society

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Abstracts

List of Authors

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Requests for additional copies of this program and information about the Society may be sent to the following address: Florida Lake Management Society; ATTN: Julie McCrystal; 775 Brantly Road; Osteen, FL 32764; online at flmshome@aol.com or on the web at www.flms.net

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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.

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.

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

The 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.

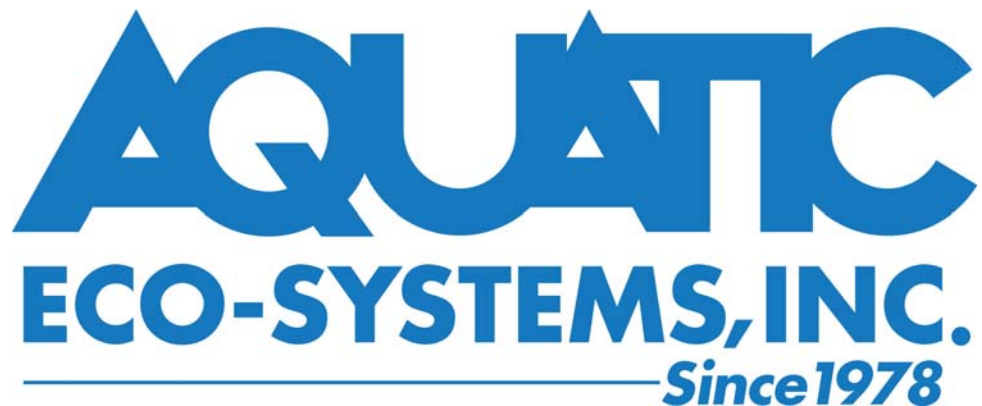
The President's Award is given by the President of the Society to an individual for outstanding support of the work of the Society during the past year.

EXHIBITORS



AMJ Equipment Corporation

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Aquatic Eco-Systems, Inc. is the world's largest distributor of aquatic equipment and supplies, for pond and lake aeration, water quality monitoring, and water conditioning. In business for over 25 years, they take pride in a complete inventory of the highest quality and lowest priced products in the industry.

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Aquatic Vegetation Control, Inc. (AVC) is an eighteen year old Florida corporation 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 noxious 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. AVC was founded on the basis of providing innovative and cost-effective services to public and private clients with projects that include natural resource or water management concerns. Services are provided in a professional and personal manner, such that clients are kept informed and included in each phase of a project. This interaction is achieved by providing experienced, competent professionals that function as an extension of a client's staff. Although AVC was founded strictly as a vegetation management firm, the current senior staff has extensive experience in managing a wide variety of small and large-scale environmental projects ranging from re-vegetation to protected species inventory to plant growth regulation. In addition, the senior staff has worked together on projects for over ten years. As a result of this long-term relationship and experience, we offer our clients a proven team of environmental professionals with diverse backgrounds capable of meeting resource management and consulting needs within specified timeframes and budget.

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BCI Engineers & Scientists, Inc. is a mid-sized, Florida-based, multi-disciplinary engineering, geologic and environmental science firm with a 25 year reputation for providing comprehensive professional services in the Government, Insurance, Industry, Construction & Land Development, and Mining business sectors. With offices located in Lakeland, Orlando, Tampa and Palatka, we are able to provide clients with a dedicated staff of 100 engineering and environmental professionals in the areas of Water Resources, Environmental & Ecological Services, Geotechnical Engineering, Geologic Hazards, Civil & Infrastructure Design, Mining, and Investigative/Forensic Engineering. In addition, BCI maintains a full-service soils and materials testing facility as well as a specialty algal and cyanotoxin laboratory (GreenWater Laboratories/CyanoLab). BCI's success results from its dedication to employ and retain qualified staff and its corporate commitment to maintain exceptional levels of responsiveness and service to our clients. We listen to our clients', understand their objectives and needs, and communicate frequently to accomplish our assignments professionally, timely and within budget.

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CDS Technologies – CDS business strategy is to focus on solutions to the problems of wet weather flows where the company's products and integrated solutions have good fit and provide value to our clients.

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Dredging & Marine Consultants, LLC (DMC) offers specialized engineering and environmental services with knowledgeable and experienced professionals in the following areas: **sediment removal engineering, shoreline erosion stabilization, coastal engineering & Waterfront structures, dredging & marine construction inspection & monitoring, wetland & habitat restoration consulting, ecological & water quality monitoring, and environmental permit processing (local, state & federal).** We specialize in sediment removal (dredging) feasibility studies, identifying state and federal funding sources, public education, permitting, engineering, design, technical bid preparation, construction observation, permit-compliance inspection, monitoring and management of sediment, including identifying beneficial reuse options. In addition, we provide similar services related to the design and assessment of waterfront facilities such as marinas, docks, boat ramps, fishing piers, seawalls, retaining walls, rock revetments and shoreline erosion stabilization. We work for both the public and private sectors. We have established a good working relationship with regulatory agencies, contractors and product manufacturers that allows us to “design-permit-build” your project. Our experience in implementing projects, enable us to prepare and solicit bids, review bids with the client, recommend contractors, and conduct a pre-construction meeting to get the construction started on the right track. Let our team lead you through your next project. Serving the governments and citizens of State of Florida responsibly and professionally is our primary goal. We look forward to listening to your needs and working with you to successfully achieve your goals.

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Environmental Consulting & Technology, Inc. (ECT) is an employee-owned multidisciplinary environmental engineering consulting firm of 190 professionals officed in nine locations throughout Florida and two locations in Michigan. ECT offers a broad range of services, including water resources, ecology, air resources, contaminated site assessments and remediation, facility planning/siting/licensing and permitting, industrial hygiene, and transactional environmental audits. Our company's water resources staff includes engineers, hydrologists, geologists, and oceanographers providing expertise in the lacustrine, estuarine, and marine environments. ECT has successfully completed numerous lake restoration program projects in Florida and the mid-West.

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Environmental Research & Design, Inc. (ERD) is an environmental engineering firm which specializes exclusively in projects related to lake management, water quality, and stormwater. Virtually all work efforts performed by ERD involve research projects or studies related to lake restoration, water quality, stormwater management, sediment characterization, and sediment-water column interactions. In addition to engineers, scientists, and design professionals, ERD also maintains a fully equipped research laboratory which is certified by the FDEP and NELAP. ERD owns a wide variety of field monitoring equipment for hydrologic, stormwater, surface water, groundwater, and sediment sampling and analysis. ERD has developed a reputation for a high quality and detailed product completed in a timely manner, and has received awards for technical excellence and innovative stormwater practices.

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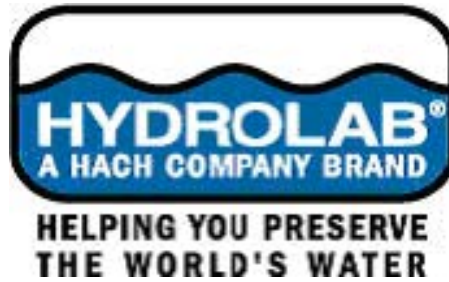


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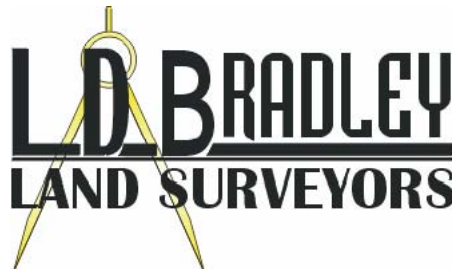
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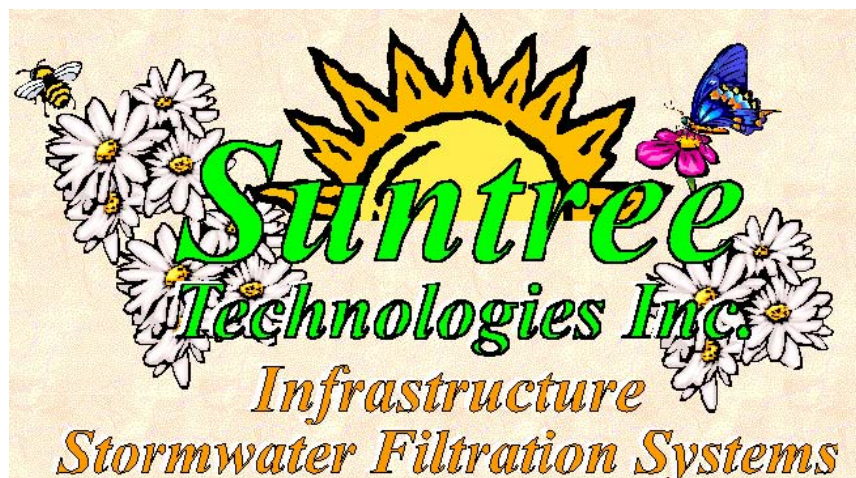
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**15th ANNUAL CONFERENCE OF THE
FLORIDA LAKE MANAGEMENT SOCIETY**

**Conference Theme:
A Tale of Many Waters: Florida's Limnic Resources**

Saddlebrook Resort Tampa
June 7-10, 2004

FINAL PROGRAM

MONDAY - JUNE 7, 2004

7:00 am-7:00 pm	Exhibitor Set-Up
8:00 am-5:00 pm	Check-In and Registration
8:00-11:45 am	Workshop 1: Lake and Pond Watershed Management – A Primer (Coordinators: Don Moores and Julia Palaschak – Berryman & Henigar)
8:00-11:45 am	Workshop 2: Nutrient Management Methods (Coordinator: Dr. Harvey H. Harper, P.E. – Environmental Research & Design, Inc.)
8:00-11:45 am	Workshop 3: Aquatic Plant Identification and Monitoring (Coordinator: Kenneth Langeland – UF Center for Aquatic and Invasive Plants)
8:00-11:45 am	Workshop 4: Sediment Control (Coordinators: Eddie Snell – Applied Polymer Systems, Inc., and Cheryl Moore – R.H. Moore and Associates)
9:45-10:15 am	MORNING REFRESHMENT BREAK
12:00-1:00 pm	LUNCH (provided with Workshop registration)
1:15-5:00 pm	Workshop 5: Lake and Pond Restoration: The Adopt-A-Pond Approach (Coordinator: John McGee – Hillsborough County Adopt-A-Pond)
1:15-5:00 pm	Workshop 6: Lake and Watershed Planning Using GIS (Coordinator: Jim Griffin – Southwest Florida Water Management District)
1:15-5:00 pm	Workshop 7: Cyanobacteria Identification (Coordinators: John Burns – PBS&J and Andy Chapman – Green Water Laboratories)
1:15-5:00 pm	Workshop 8: Managing a Sediment Removal Project (Coordinator: Shailesh Patel – Dredging & Marine Consultants, LLC)
3:00-3:30 pm	AFTERNOON REFRESHMENT BREAK

TUESDAY - JUNE 8, 2004

- 8:00 am-4:00 pm Check-In and Registration
- 9:00-9:45 am Opening Remarks: Shailesh Patel – FLMS President
Gene Medley – NALMS President-Elect
Jim Griffin – Conference Chairman
Harvey Harper – Program Chairman
- Plenary Speaker: **Mr. David Moore - Executive Director
Southwest Florida Water Management District**
- 9:45-10:15 am MORNING BREAK (*Exhibit Hall*)

Session 1: Watershed Management in the Lake Okeechobee Basin

Moderator: Chuck Hanlon

- 10:15-10:35 am **Using Hyperspectral Analysis to Find Nutrient Hotspots in the Lake Okeechobee Watershed** – Mark Brady, Frank Margiotta, and Michael Barnes
- 10:35-10:55 am **Phosphorus Load Reduction Measures on Existing and Former Dairy Properties in the Lake Okeechobee Watershed** – James A. Laing
- 10:55-11:15 am **Restoring Wetlands Naturally to Reduce Phosphorus Loading into Lake Okeechobee** – Jace W. Tunnell
- 11:15-11:35 am **Water Quality Models Used to Assess Sediment Management in Lake Okeechobee** – R. Thomas James and Curtis D. Pollman
- 11:35-11:55 am **Seed Germination in Wild Celery, *Vallisneria Americana* Michx. from Lake Okeechobee, Florida, USA: Preliminary Experimental Results** – H.J. Grimshaw, W.A. Matamoros, and B. Sharfstein
- 12:00-1:15 pm LUNCH (*provided*)

Session 2: Restoration Projects I

Moderator: Erich Marzolf

- 1:15-1:35 pm **Restoration Process at Area 7 of the Emerald Marsh Conservation Area** – Janet C. Nunley, Walter F. Godwin, Christine Schluter, and Walter Reigner
- 1:35-1:55 pm **Aeration of a Subtropical Hypertrophic Lake: A Band-Aid Approach That's Working** – Keith Kolasa, Clell Ford, Jennifer Brunty, and Woo-Jun Kang
- 1:55-2:15 pm **Initial Operation and Performance of the Lake Apopka Marsh Flow-Way** – E. Marzolf, M. Coveney, R. Conrow, L. Battoe, and E. Lowe
- 2:15-2:35 pm **Lake Panasoffkee Restoration Plan: Dredging to Restore Fisheries Habitat and Restore the Historic Shoreline** – Lizanne Garcia and Michael L. Holtkamp
- 2:35-3:00 pm AFTERNOON BREAK (*Exhibit Hall*)

TUESDAY – JUNE 8, 2004 (Continued)

Session 3: Biological Responses

Moderator: Rick Baird

- 3:00-3:20 pm **Adult Chironomid Response to New River Walk Lights at Lake Monroe, Sanford, Florida** – Joseph M. Faella and Jonas Stewart
- 3:20-3:40 pm **Adventures in Forensic Limnology: What Caused the Algal Bloom in Lake Butler?** – Lawrence Battoe, Forrest Dierberg, and Edgar F. Lowe
- 3:40-4:00 pm **Relating Sediment Quality to Benthic Macroinvertebrate Community Composition in Northeastern Florida Aquatic Environments: The Composite Benthic Sediment Quality Index** – Doug Strom and David Evans
- 4:00-4:20 pm **Effects of Introduced Groundwater on Water Chemistry and Fish Assemblages in Central Florida Lakes** – Patrick Cooney and Micheal Allen
- 4:20-4:40 pm **TMDL Bioassessment Sampling of Benthic Macroinvertebrates for Lake Jesup and Lake Seminary in Seminole County** – Gloria M. Eby and John A. Osborne
- 4:40-5:00 pm **Factors Affecting Total Coliform and *Escherichia coli* (*E. Coli*) Bacterial Counts at 30 Lakes in Hillsborough County, Florida** – Jennifer L. Donze and Daniel E. Canfield, Jr.
- 5:00-7:00 pm **EXHIBITOR'S SOCIAL / POSTER SESSION** (*Exhibit Hall*)
- Poster Session:**
1. **Acute Toxicity of Alum and Sodium Aluminate to *Pimephales Promelas* and *Cyprinella Leedsi*** – Joy M. Ryan, Ann B. Shortelle, Victoria R. Hoge, and Walt Godwin
 2. **Evaluating Effects of “Grubbing” *Lyngbya* spp. On Non-Algal Submerged Aquatic Vegetation (SAV) in King’s Bay (Citrus County), Florida** – Kris Kaufman, Amy H. Remley, and Dave Tomasko
- 8:00 pm-Midnight **HOSPITALITY SUITE** (Sponsored by ERD)

WEDNESDAY - JUNE 9, 2004

8:00 am-3:00 pm Check-In and Registration

8:00-8:30 am Continental Breakfast

Session 4A: Management of External Inputs

Moderator: Jeff Herr

8:30-8:50 am **Broadway Outfall Stormwater Retrofit Project** – Betty Rushton

8:50-9:10 am **Construction and Evaluation of the McIntosh Park Enhanced Stormwater Treatment Wetland** – James C. Griffin and Jeffrey L. Herr

9:10-9:30 am **Lake Tarpon Surficial Groundwater Nutrient Study** – Donald C. Hicks, David E. Wiley, and Dave Slonena

9:30-9:50 am **Comparative Removal Efficiencies of CDS and TST Units for Removal of Phosphorus in Lake Okeechobee Tributaries** – Harvey H. Harper, Rodolfo (Odi) Villapando, Yanling Zhao, and Taufiqul Aziz

Session 4B: Governmental Initiatives

Moderator: Carlos Fernandes

8:30-8:50 am **Wateratlas.org: The Use of the Internet in Recruiting Volunteers-** Christiana Schumann and Shawn Landry

8:50-9:10 am **Clean Lakes Initiative: A Start to Excellence in Lake Stewardship** – Ronald Novy

9:10-9:30 am **The TMDL Process: A Local Government's Perspective** –Kim Ornberg

9:50-10:20 am MORNING BREAK (*Exhibit Hall*)

WEDNESDAY – JUNE 9, 2004 (Continued)

Session 5A: Use of Coagulants for Water Quality Improvement and Lake Management

Moderator: Mike Perry

- | | |
|------------------|---|
| 10:20-10:40 am | Experiences in Coagulants for Manure Treatment and Phosphorus Runoff Control: Evaluations of Systems for Small and Large CAFO Operations - Christopher Lind |
| 10:40-11:00 am | The Feasibility of Using Sodium Aluminate with Alum for Nutrient Control at Eustis Muck Farm – <u>Maria L. Jones</u> , Brad Uhlmann, Ann B. Shortelle, Victoria R. Hoge, and Walt Godwin |
| 11:00-11:20 am | The Use of Liquid Alum for Nutrient Control at Eustis Muck Farm – <u>Victoria R. Hoge</u> , Walt Godwin, Ann B. Shortelle, Maria L. Jones, and Brad Uhlmann |
| 11:20-11:40 am | Evaluation of an Off-Line Nutrient Reduction Facility to Improve Water Quality Downstream of Lake Apopka – <u>Lance M. Lumbard</u> , Ronald L. Hart, and Jeffrey L. Herr |
| 11:40-12:00 noon | Lake Hollingsworth Alum Treatment – <u>Harvey H. Harper</u> and Gene Medley |

Session 5B: Watershed Evaluation and Modeling

Moderator: Jim Griffin

- | | |
|----------------|--|
| 10:20-10:40 am | A GIS Approach to Watershed Non Point Source Pollution Load Modeling – <u>James C. Griffin</u> and David T. Jones |
| 10:40-11:00 am | Lake Istokpoga and Arbuckle Creek: Progress in Watershed Evaluation and A Summary of Water Quality Concerns – Jennifer Brunty |
| 11:00-11:20 am | Pollution Load Modeling Using the Southwest Florida Water Management District's Data Model – <u>David T. Jones</u> and James C. Griffin |
| 11:20-11:40 am | Tools and Standards for Integrating Water Resource Data into GIS – <u>Kyle Campbell</u> and Shawn Landry |
| 12:00-1:30 pm | BANQUET LUNCH / PROGRAM |

WEDNESDAY - JUNE 9, 2004 (Continued)

Session 6A: Restoration Projects II

Moderator: Shailesh Patel

- 1:30-1:50 pm **Field and Laboratory Assessments for Sediment Reduction and Nutrient Control in Restoring Mullet Lake (Central Florida)** – Forrest E. Dierberg, Janelle Potts, and Tom Workman
- 1:50-2:10 pm **Lake Seminole Stormwater Retrofit Project** – Jeffrey L. Herr and James C. Griffin
- 2:10-2:30 pm **Orlando Easterly Wetlands Project: Treatment Wetlands Renovation** – Mark D. Sees and Thomas L. Lothrop

Session 6B: Introduction to Tours

- 1:30-2:00 pm **Watershed Education** – John J. Walkinshaw
- Overview of Saddlebrook** – Saddlebrook Staff
- 2:30-3:00 pm AFTERNOON BREAK (*Exhibit Hall*)

Educational Tours

- | | | |
|----------|-------------------|--|
| TOUR #1: | Leaves at 3:30 pm | Florida Aquarium |
| TOUR #2: | Leaves at 2:00 pm | Cross Bar Ranch and Brooker Creek Education Center |
| TOUR #3: | Leaves at 3:00 pm | Saddlebrook Resort and Wetlands |
- 8:00 pm-Midnight **HOSPITALITY SUITE** (Sponsored by ERD)

THURSDAY MORNING - JUNE 10, 2004

8:00-9:00 am Continental Breakfast

Session 7: Lake Assessment Techniques

Moderator: Dharmen Setaram

9:00-9:20 am **Assessing Florida Lakes via a Floristic Quality Index** – Russel Frydenborg

9:20-9:40 am **Development of Phosphorus Load Reduction Goals for Seven Lakes in the Upper Ocklawaha River Basin, Florida, USA** . – Rolland S. Fulton and Dale R. Smith

9:40-10:00 am **Development and Use of Sediment Assessment Techniques in Freshwater Sediments of Florida** – Thomas L. Seal, Gail M. Sloane, and Thomas P. Biernacki

10:00-10:30 am MORNING BREAK (*Exhibit Hall*)

Session 8: Toxic Algae Issues

Moderator: Doug Robison

10:30-10:50 am **Cyanobacteria Populations in Seven Central Florida Lakes** – Andrew Chapman, Chris Williams, Mark Aubel, and Mike Perry

10:50-11:10 am **Recreational Exposure to Freshwater Cyanobacteria in Florida Lakes: A Prospective Epidemiology Study** – John Burns, Ian Stewart, Penelope M. Webb, Philip J. Schluter, Lora E. Fleming, Lorraine C. Backer, and Glen R. Shaw

11:10-11:30 am **Evaluation of the Production and Toxicity of *Lyngbya* spp. in Florida Springs** - John Burns, Jennifer Joyner, Hans Paerl, and Glen Shaw

10:30 am-12 noon EXHIBITOR BREAK-DOWN

12 noon CONFERENCE ADJOURNED

EXTENDED ABSTRACTS

SESSION 1

WATERSHED MANAGEMENT IN THE LAKE OKEECHOBEE BASIN

**USING HYPERSPECTRAL ANALYSIS
TO FIND NUTRIENT HOTSPOTS IN THE
LAKE OKEECHOBEE WATERSHED**

Mark Brady

South Florida Water Management District – West Palm Beach, FL

Frank Margiotta

Agriculture Facilities Administration and Management Corp. – Rockledge, FL

Michael Barnes

The Galileo Group Inc. – Melbourne, FL

The watershed to the north of Lake Okeechobee is an area of intense agricultural land use. Dairy farms, beef cattle operations, truck crops, and citrus are the major agricultural land uses in the watershed. There has historically been concern over the amount of nutrient runoff draining from these properties and ultimately adding to the nutrient load in Lake Okeechobee. The traditional method of monitoring agricultural runoff has been to take water grab samples during runoff events. One shortfall of this method is that there is no way to predict how much each property upstream of the sampling location contributed to the load at the sampling site.

This project is designed to examine the feasibility of using a hyperspectral airborne sensor to collect watershed scale image data to identify nutrient "hotspots". Using hyperspectral data, as opposed to traditional imagery, allows for the processing of many more ranges of reflected electromagnetic radiation, well beyond and below the visible portion of the spectrum. Mining companies have successfully used this technology to select potential sites for their operations. The goal of this project is to use the same concepts of hyperspectral image processing to find areas with high nitrogen and phosphorus loads. This will allow landowners and water managers to better evaluate where residual nutrients have accumulated and which Best Management Practice or Best Available Technology is the best choice for a particular property.

NOTES:

PHOSPHORUS LOAD REDUCTION MEASURES ON EXISTING AND FORMER DAIRY PROPERTIES IN THE LAKE OKEECHOBEE WATERSHED

James A. Laing

South Florida Water Management District
West Palm Beach, FL

The objective of the Dairy Best Available Technologies (BATs) Program was to identify, select, monitor and oversee implementation of BATs that would significantly reduce the export of phosphorus (P) from dairy operations into tributaries and Lake Okeechobee. Various alternatives were evaluated to determine the best comprehensive system of technologies to address the multiple dairy farm components (waste management system, pastures, etc.). The goal of the program was achieved using an objective methodology that allowed for review and input by a multi-agency team (Florida Department of Environmental Protection, Florida Department of Agriculture and Consumer Services, United States Department of Agriculture – Natural Resources Conservation Service, University of Florida – Institute of Food and Agricultural Sciences, and the South Florida Water Management District) and stakeholders throughout the technology selection and implementation process. Implementation of the selected technology, edge of farm stormwater retention/detention and reuse followed by alum chemical treatment, has occurred at three distinct project sites and preliminary design of a fourth site is underway. The Davie Dairy site is a sub-regional flow through surface water treatment system using alum flocculation. The Butler Oaks and Dry Lake Dairy sites feature surface water retention/detention for reuse and if necessary chemical treatment using alum flocculation prior to off-site discharge. The presentation will include aerial photography for overview as well as detail photography for an in-depth description of system components.

The objective of another initiative on a former dairy site was to implement one or more alternatives to minimize P discharges from residual P accumulated on Lamb Island Dairy Remediation Project site. The implemented alternatives were chosen to minimize P discharges to the maximum extent practicable while taking into consideration cost effectiveness as well as the minimization of long term operation and maintenance requirements. The design and implementation of this project also received review and input from a multi-agency team. The final design of the chosen remediation measures include lagoon remediation, stormwater retention/detention, and constructed wetlands. This design build project will be presented using aerial photography of the project area, graphic presentation of the final design plans, and detail photography showing construction of the project components. The engineering strategies used to derive the final design will be described in detail.

For program information visit: http://www.sfwmd.gov/org/wrp/wrp_okee/projects/bats.html

For project information visit: http://www.sfwmd.gov/org/wrp/wrp_okee/projects/lambisle_dairy.html

NOTES:

RESTORING WETLANDS NATURALLY TO REDUCE PHOSPHORUS LOADING INTO LAKE OKEECHOBEE

Jace W. Tunnell

South Florida Water Management District
West Palm Beach, FL

The Lake Okeechobee Isolated Wetland Restoration Program (IWRP) is a voluntary cost-share program that encourages and assists landowners to restore isolated wetlands on their property. The IWRP focuses on reducing total phosphorus (TP) loading into Lake Okeechobee by restoring more natural water flow into previously drained wetlands. The South Florida Water Management District (SFWMD) in cooperation with an interagency team consisting of Florida Department of Agriculture and Consumer Services (FDACS), Florida Department of Environmental Protection (FDEP), USDA Natural Resources Conservation Service (NRCS), U.S. Fish & Wildlife Service (USFWS), and University of Florida, Institute of Food and Agricultural Science (IFAS) completed a project in March of 2004 under this program.

The project is located approximately six miles north east of Lake Okeechobee off of State Highway 70, and has a 410 acre complex of wetlands that are being restored. About 170 acres of the restoration area still exists as native wetlands, of which two-thirds is comprised of herbaceous freshwater marsh. The other one-third is made up of forested swamp. Ditches were dug through the wetlands a number of decades ago to create drained pastures for beef cattle ranching. Four different soil mapping units are found within the proposed restoration area with the three most dominant being Floridana, Riviera, and Placid soils, depressional, Basinger and Placid soils, depressional, and Basinger fine sand. The least abundant soil type within the restoration area is Myakka fine sand.

The restoration project consists of earthen ditch plugs, low berms, a pair of culvert risers, and shallow spreader swales, rather than using more intensive methods of reducing TP loads such as constructed retention/detention ponds or wetlands with mechanical pumps and chemicals. The method of TP treatment was chosen for this program due to the low cost of project implementation and operation and maintenance and creation of a natural environment for wildlife, while receiving significant TP reductions.

A modeling system (MIKE11) for rivers and channels was used to determine structure placement and type on the project by running a 72-hour design storm with a 25-year return period. By determining the hydrologic constraints, berms could be constructed to eliminate offsite flooding, riser flashboards could be set at specific elevations to maximize wetland footprint, and ditch plug placement could be selected. Existing conditions show TP loads flowing into the wetland system at 4,647 Kg/yr and an outflow of 1,628 Kg/yr. MIKE11 hydrology model predicted a TP load reduction at the wetland outfall of 473 Kg/yr, which is a 71% reduction over pre-existing conditions.

Other activities for this project include removing exotic vegetation, yearly vegetation monitoring to track wetland growth and habitat, and long term water quality monitoring using autosamplers that collect P concentrations and measure water flow. By restoring historical hydrology to the Lake Okeechobee watershed wetlands in a natural way, water will be treated and retained while preserving wildlife habitat.

NOTES:

WATER QUALITY MODELS USED TO ASSESS SEDIMENT MANAGEMENT IN LAKE OKEECHOBEE

R. Thomas James, Ph.D.

South Florida Water Management District- West Palm Beach, FL

Curtis D. Pollman, Ph.D.

Tetra Tech, Inc. - Gainesville, FL

A three year study conducted by Blasland Bouck and Lee Inc. (2003), under a contract with the South Florida Water Management District, developed alternatives and a recommended plan to reduce sediment phosphorus (P) loads to Lake Okeechobee. This large (1730 km²) shallow (mean depth 2.7 m) eutrophic lake in south Florida has received excessive P loads over many decades that resulted in increased P laden mud sediment, reduced ability of the lake to absorb P, and increased water column Total P (TP).

Three alternatives were studied in detail: (1) No In-Lake Action that assumes external loads will be reduced to meet the current P Total Maximum Daily Load (TMDL) of 105 metric tons per year by 2015 (Florida Department of Environmental Protection, FDEP, 2001); (2) Chemical Treatment that adds alum to the lake to bind sediment P; and (3) Dredging that removes mud sediments from the lake. The Chemical and Dredging alternatives include the assumption that the TMDL is met by 2015.

A key element to evaluate these alternatives is the use of two different water quality models with different focuses. The first is the Internal Loading Phosphorus Model (ILPM), which describes the sediment P dynamics and sediment/water column interactions on an annual average basis. The second is the Lake Okeechobee Water Quality Model (LOWQM), which describes the nitrogen, silica and P cycles, algal dynamics and sediment water interactions on a daily basis. Both models were calibrated to observed data from Lake Okeechobee.

To evaluate the three alternatives, the historical record of hydro-meteorology from 1972 to 2000 was repeated four times to produce simulations beginning in 2000 and continuing through 2112. All alternatives began with a P load of 536 metric tons that was reduced to meet the TMDL of 105 metric tons per year by 2015. The No In-Lake Action Alternative achieves this TMDL. The Chemical Treatment Alternative includes chemical addition beginning in 2012, achieving maximum effectiveness from 2014 to 2022 and then declining as the chemical is removed by burial. The Dredging Alternative assumes 67% of the surface sediment P is removed from 2016 to 2030.

The two models gave similar results despite differences in methods to simulate each alternative and differences in model goals and objectives. No In-Lake Action reached a specified in-lake goal of 40 ppb of TP (FDEP, 2001) between 2050 (ILPM) and 2070 (LOWQM). Chemical treatment with alum accelerated the rate of recovery. The 40 ppb goal was reached in 2020. Dredging all of the mud sediments in Lake Okeechobee will be slow, costly and inefficient, and will leave a veneer of residual sediment enriched in P (Blasland Bouck and Lee Inc. 2003). This veneer will continue to supply phosphorus to the water column even after

dredging is complete. As a result, the Dredging Alternative included high cost and did not reduce water column P to any significant extent over the No In-Lake Action Alternative.

In addition to the time to reach the in-lake goal, other factors used to compare these alternatives were cost and feasibility. No In-Lake Action had no costs associated with it. Chemical Treatment was estimated to cost \$500 million, and Dredging was estimated to cost \$3 billion. Dredging was not considered a viable alternative because of the cost and predicted poor improvement relative to No In-Lake Action. Although the remaining two alternatives could provide the desired outcome, No In-Lake Action was selected as the preferred alternative because there was no additional in-lake cost and unlike the Chemical Treatment, there were no additional environmental issues that would have to be addressed. In addition, chemical treatment will be effective over the long-term only if external P loads to the lake are reduced, otherwise alum must be reapplied approximately every eight years. The final recommendations include a statement that Chemical Treatment should be reconsidered only if, as P loads are reduced, water column TP does not decline over time.

References

Blasland Bouck and Lee Inc. (2003). "Lake Okeechobee Sediment Management Feasibility Study." Boca Raton, Florida. Final report submitted to the South Florida Water Management District, West Palm Beach, Florida, Contract Number C11650.

Florida Department of Environmental Protection (2001) "Total Maximum Daily Load for Total Phosphorus Lake Okeechobee, Florida." Tallahassee, FL. Submitted to U.S. Environmental Protection Agency, Region IV, Atlanta, GA.

NOTES:

**SEED GERMINATION IN WILD CELERY, *VALLISNERIA*
AMERICANA MICHX. FROM LAKE OKEECHOBEE, FLORIDA
U.S.A.: PRELIMINARY EXPERIMENTAL RESULTS**

H.J. Grimshaw, W.A. Matamoros, and B. Sharfstein
South Florida Water Management District
West Palm Beach, FL

Environmental stimuli required for seed germination were investigated in our laboratory using *Vallisneria americana* fruits harvested 21 November 2002 from Lake Okeechobee, Florida. Under darkness, seeds were removed from these fruits, mixed, and introduced into plastic buckets containing sterilized lake water and sterilized lake sediments. Incubations of covered (dark) and uncovered buckets were conducted in a Revco[®] environmental chamber, set at 28 - 31°C on a 13L : 11D h photoperiod with a mean photosynthetic photon flux density of $96 \pm 20 \mu\text{mole photons m}^{-2} \text{ s}^{-1}$ (mean \pm SE; n = 40), while germination was monitored near-weekly as seedling recruitment.

In the first approximately 10 wk experiment, out of 122 total germinations, 121 or 99.2 % occurred in the light, while only one or 0.8 % occurred in the dark. Upon subsequent exposure to light, seeds previously held in the dark, began germinating after approximately 60 days, indicating secondary dormancy. During this 26 wk follow-up experiment the germination rate was only one germination per day, compared to 1.7 germinations per day in the original experiment. These observations suggest involvement of the phytochrome system in seed germination of *V. americana*, and have implications concerning the seed bank in turbid portions of Lake Okeechobee.

In a third, approximately 21 wk sediment-free light-dark experiment using sterilized lake water, 100% (25) of the light-exposed seeds germinated while none of the dark exposed seeds did; indicating that light is required for seed germination in *V. americana*, but environmental cues from the sediments apparently are not.

References

Bewley, J.D. (1997). "Seed germination and dormancy." *Plant Cell*. 9: 1055-1066.

NOTES:

SESSION 2

RESTORATION PROJECTS - I

RESTORATION PROCESS AT AREA 7 OF THE EMERALDA MARSH CONSERVATION AREA

Janet C. Nunley -BCI Engineers & Scientists, Inc.
Contracted with St. Johns River Water Management District - Palatka, FL

Walter F. Godwin - St. Johns River Water Management District - Palatka, FL
Christine Schluter - Jones Edmunds & Associates, Inc. - Gainesville, FL
Walter Reigner - BCI Engineers & Scientists, Inc. - Lakeland, FL

Area 7 is a 706-acre former muck farm that was once part of the larger Emeralda Marsh, formerly sawgrass marsh, wet prairie, and shallow marsh communities. Area 7 was developed for farm production by 1968 and produced corn, carrots, and radishes in the southern portion, and sod in the northern portion (Marburger and Godwin 1996). It is now one of seven properties that make up the Emeralda Marsh Conservation Area located in Lake County, Florida. St. Johns River Water Management District (SJRWMD) purchased the property in 1993 and flooded it to 59 ft NGVD. Due to years of subsidence during farming, the flooded property has remained too deeply flooded for development of submersed vegetation. SJRWMD and Florida Fish and Wildlife Conservation Commission (FWC) worked jointly on numerous plantings of native vegetation along the property margins that included eel grass (*Vallisneria americana*), giant bulrush (*Scirpus californicus*), and soft-stemmed bulrush (*S. validus*) (Marburger and Godwin 1996; Benton 2000). FWC attempted to develop a sport fishery at the site but the attempts were not successful (Benton 2000; Porak 2002). As part of the restoration process, Area 7 sediments were randomly sampled to assess residual contaminants resulting from organochlorine pesticide (OCP) use during farm production. OCPs were detected in the sediments. Whole fish samples were also analyzed and found to contain OCPs. In an effort to reduce exposure of fish to OCPs and to enable SJRWMD to continue with restoration efforts, this site was selected as a primary site for receiving dredge spoils from maintenance dredging in access canals surrounding Lake Griffin. The Area 7 project will serve 2 functions: 1) cap contaminated sediments, thus potentially reducing the risk to all species utilizing the site, including Federally-listed species, and 2) raise bottom elevations to increase potential habitat suitable for wetland vegetation. This is an experimental project to help determine the effectiveness of capping contaminated sediments with dredge spoil from relatively uncontaminated sites .

In the first phase of restoration, SJRWMD will accept dredge spoil from residential canals around Lake Griffin. BCI Engineers & Scientists worked in conjunction with the SJRWMD and Lake County Water Authority to design a disposal plan that will cap sediments with the highest OCP residues in Area 7. The goal is to reduce potential exposure of fish to OCP contamination by capping contaminated sediments with dredge spoil. As a first step in locating the highest contamination points, sample locations were mapped in GIS using GPS points recorded in the field during sampling. A spreadsheet of point locations and corresponding raw OCP concentrations were created from the collected data and included calculated values for DDTx and estimated total chlordane. Data were imported into ESRI's ArcMap to create a point shape file containing the 30 sample locations. The inverse distance weighting function with ArcMap's Spatial Analyst extension was used to create grids that represented the surface

concentration for each of the measured contaminants sampled at Area 7. Inverse distance weighting was the chosen interpolation method as it is best for interpolations of relatively regularly spaced, unclustered points. Each containment surface grid was made up of 10m x 10m cells. The inverse distance weighting function used is:

$$C(d)=1/d^p \quad (1)$$

Where C represents the concentration, d represents the distance from the cell of known concentration. The value of p used for our interpolation was 2 (the most common choice for relatively evenly spaced data). For this surface interpolation, 12 nearest neighbors were used to determine the value of each cell.

The containment location was selected to provide maximum coverage of 4,4-DDE and will also cover most of the elevated concentrations of 4,4-DDT and estimated total chlordane. BCI analyzed canal sediments to characterize properties such as settling rate, permeability, compressibility, and solids content for use in design of spoil containment. BCI developed a plan for transportation and containment of dredge spoil. Following dredge spoil deposition, monitoring of OCP contaminants in fish will be conducted quarterly for a minimum of 1 year. We will assess the value of capping contaminated sediments in Area 7 to reduce exposure of fish to OCPs. One would expect OCP levels to decline over time if our goal is achieved.

References

Benton, J. (2000). "Development of Emeralda Marsh for Producing Quality Sportfishing Areas, Annual Performance Report." Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

Marburger, J.E. and W.F. Godwin. (1996). "Emeralda Marsh Conservation Area: Conceptual Restoration Plan. Technical Memorandum No. 20." St. Johns River Water Management District. Palatka, Florida.

Porak, W. (2002). Emeralda Marsh Conservation Area Project, Division of Fisheries Operational Plan." Florida Fish and Wildlife Conservation commission, Tallahassee, Florida.

NOTES:

AERATION OF A SUBTROPICAL HYPERTROPHIC LAKE: A BAND-AID APPROACH THAT'S WORKING

Keith Kolasa and Woo-Jun Kang, Ph.D.

Southwest Florida Water Management District - Brooksville, FL

Clell Ford and Jennifer Brunty, Ph.D.

Highlands Soil & Water Conservation District - Sebring, FL

Lake Persimmon is a small, shallow, hypereutrophic lake located in southern Highlands County. Based on a comparison to 76 other lakes monitored in Highlands County by the District, Lake Persimmon has had a history of having the poorest water quality in the County. Initial diagnostic testing completed from 2000 to 2001 revealed that water clarity was very low due to (median Secchi - 0.29 m) continuous blue-green algae blooms. Due to the high algal production (median chlorophyll *a* - 82.9 $\mu\text{g/L}$) and high nutrient concentrations, the lake had the highest Florida Trophic State index in the County (median 79.2). Water column profile data revealed that this shallow lake (maximum depth 3.5 m) undergoes moderate anoxia most of the year, with severe anoxia and thermal stratification occurring during the height of the summer. Dissolved oxygen levels below 2 mg/L were common throughout the water column during the summer months. Anoxic conditions in the lake were accompanied by high concentrations of hydrogen sulfide released through sulfate reduction in the hypolimnion. In addition, ammonium concentrations measured in the hypolimnion ranged between 3 and 6 mg/L, far above Class III waters criteria. The lake suffers from nitrogen enrichment due to seepage of nitrate rich ground water. Concentrations of nitrate near or above 1 mg/L were common in the lake, while concentrations as high as 17 mg/L were measured in the adjoining canal. Much higher concentrations have been measured in some of the groundwater monitoring wells and potable drinking supply wells around the lake.

Aeration was selected as a restoration technique based on: (1) the lake's history of severe anoxia, (2) exceedingly high bottom ammonium concentrations, and (3) the small size (40 acres) of the lake. Under a contract managed by Highlands County, an aeration system was installed, starting operation in October 2002. The system consists of eight compressors feeding air through approximately 4000 linear feet of irrigation hose to 12 diffusers. Project specifications required that the dissolved oxygen be increased to 5 mg/L throughout the water column. The system was rated to turn the lake over twice per day.

Based on a comparison between water quality collected before aeration (duration of 16 months) and after aeration start-up (duration of 15 months), several key parameters have shown significant improvements. As shown in Figures 1-3 the Florida Trophic State Index (FTSI), chlorophyll *a* (trichromatic), and total nitrogen were significantly lower during the use of the aeration system (Mann-Whitney Test, $\forall = 0.0001$, 0.0001, and 0.003 respectively), while Secchi was significantly ($\forall = 0.0001$) higher (Figure 4). Other parameters that were also significantly lower during aeration included TSS, turbidity, and iron ($\forall = 0.0002$, 0.0002, and 0.0001, respectively). As to be expected, dissolved oxygen measured at the bottom strata of the lake

was significantly higher ($\chi^2=0.0004$) during the aeration. Water quality samples collected at the bottom of the lake also showed significantly lower ammonium, total nitrogen, total phosphorus, iron, and bicarbonate alkalinity ($\chi^2=0.0001, 0.0001, 0.001, 0.001, \text{ and } 0.0001$ respectively). In fact, the median ammonium concentration has decreased from roughly 1 mg/L to 0.1 mg/L.

Although the aeration system does not address long term goals for the reduction of nitrates within the watershed, the system has at least produced in-lake water quality improvements that have been achieved over a short period of time. With these improvements underway, future work can now focus on the reduction of external nitrate loading and internal cycling of phosphorus. In addition to water quality improvements it is also anticipated that the aeration system has improved the fisheries and benthic communities of the lake. A post aeration bioassessment is planned for this summer by staff of FDEP to compare to an earlier bioassessment completed prior to installation of the aeration system (Rutter 1999).

It should be noted that the resulting improvements in water clarity and color have been evident to the local homeowners, and subsequently, they have shown their support for the continued operation and maintenance of the aeration system currently being provided by Highlands County. The monthly utility cost for the system is roughly \$370, with the overall total annual operation and maintenance at approximately \$6,000 (\$150 per acre per year).

References

Rutter, R. P. (1999). A Bioassessment of Six Lakes in Charlotte, Highlands and Lee Counties, Florida. Florida Department of Environmental Protection. Punta Gorda, Florida. 73 p.

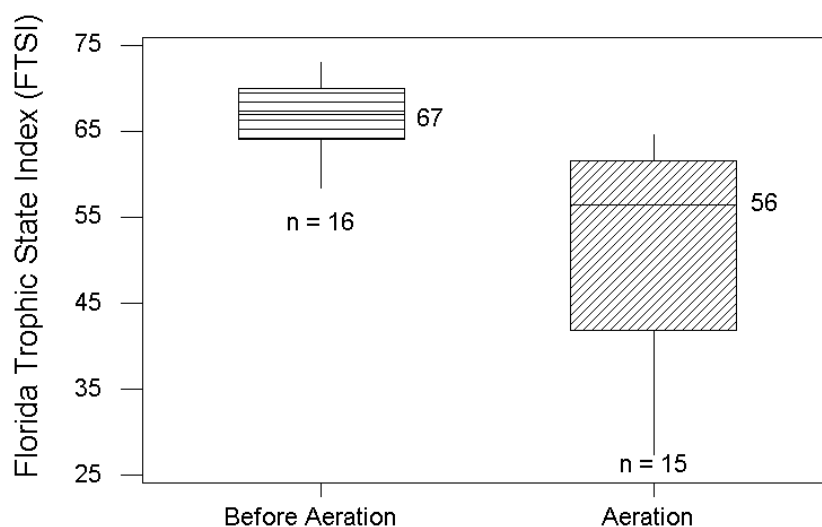


Figure 1. Comparison of boxplots representing the Florida Trophic State Index (FTSI) calculated for 16 monthly sampling events before aeration to 15 monthly sampling events after aeration. Overall medians are shown to the right of each boxplot (67 and 56).

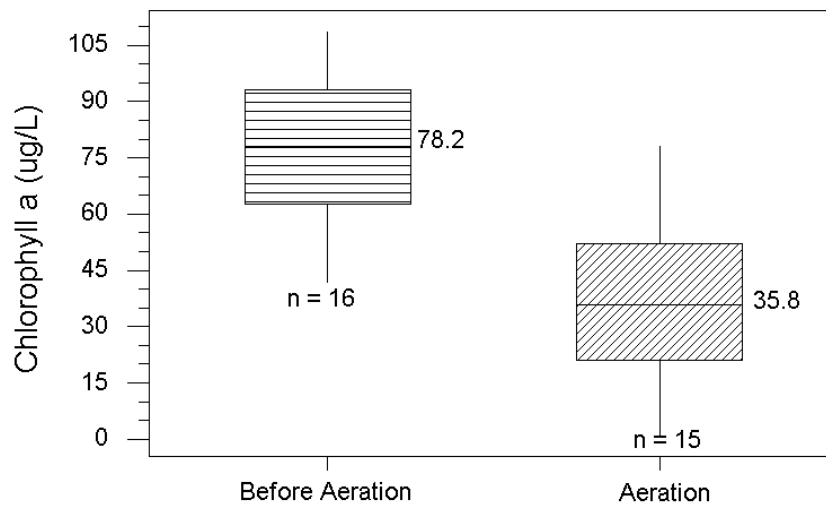


Figure 2. Comparison of boxplots representing chlorophyll *a* (ug/L) measured for 16 monthly sampling events before aeration to 15 monthly sampling events after aeration. Overall medians are shown to the right of each boxplot (78.2 and 35.8 ug/L).

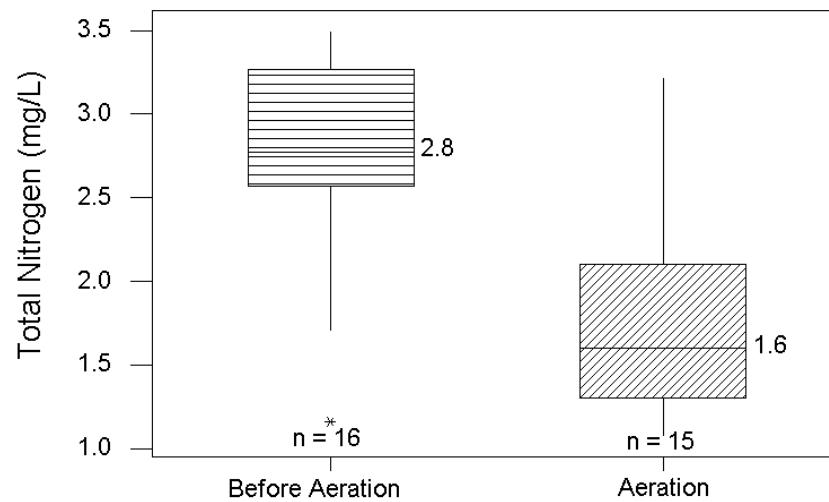


Figure 3. Comparison of boxplots representing total nitrogen (mg/L) measured for 16 monthly sampling events before aeration to 15 monthly sampling events after aeration. Overall medians are shown to the right of each boxplot (2.8 and 1.6 mg/L).

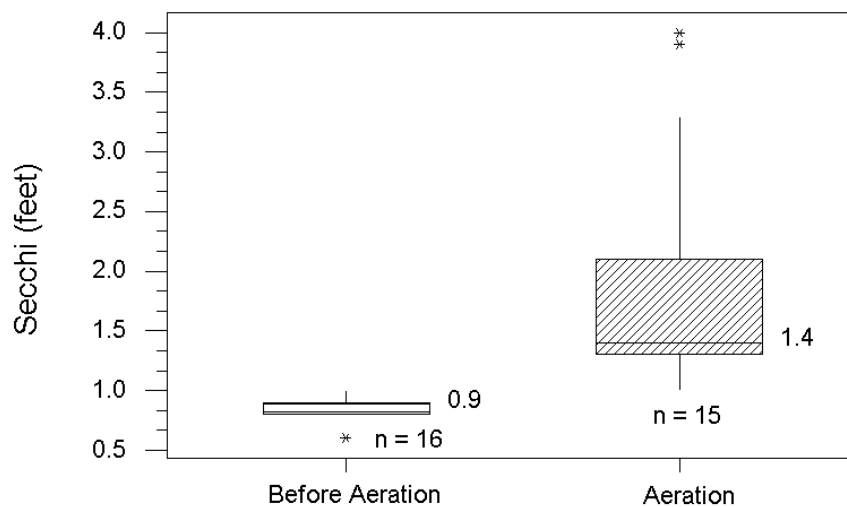


Figure 4. Comparison of boxplots representing Secchi (ft) measured for 16 monthly sampling events before aeration to 15 monthly sampling events after aeration. Overall medians are shown to the right of each boxplot (0.9 and 1.4 ft).

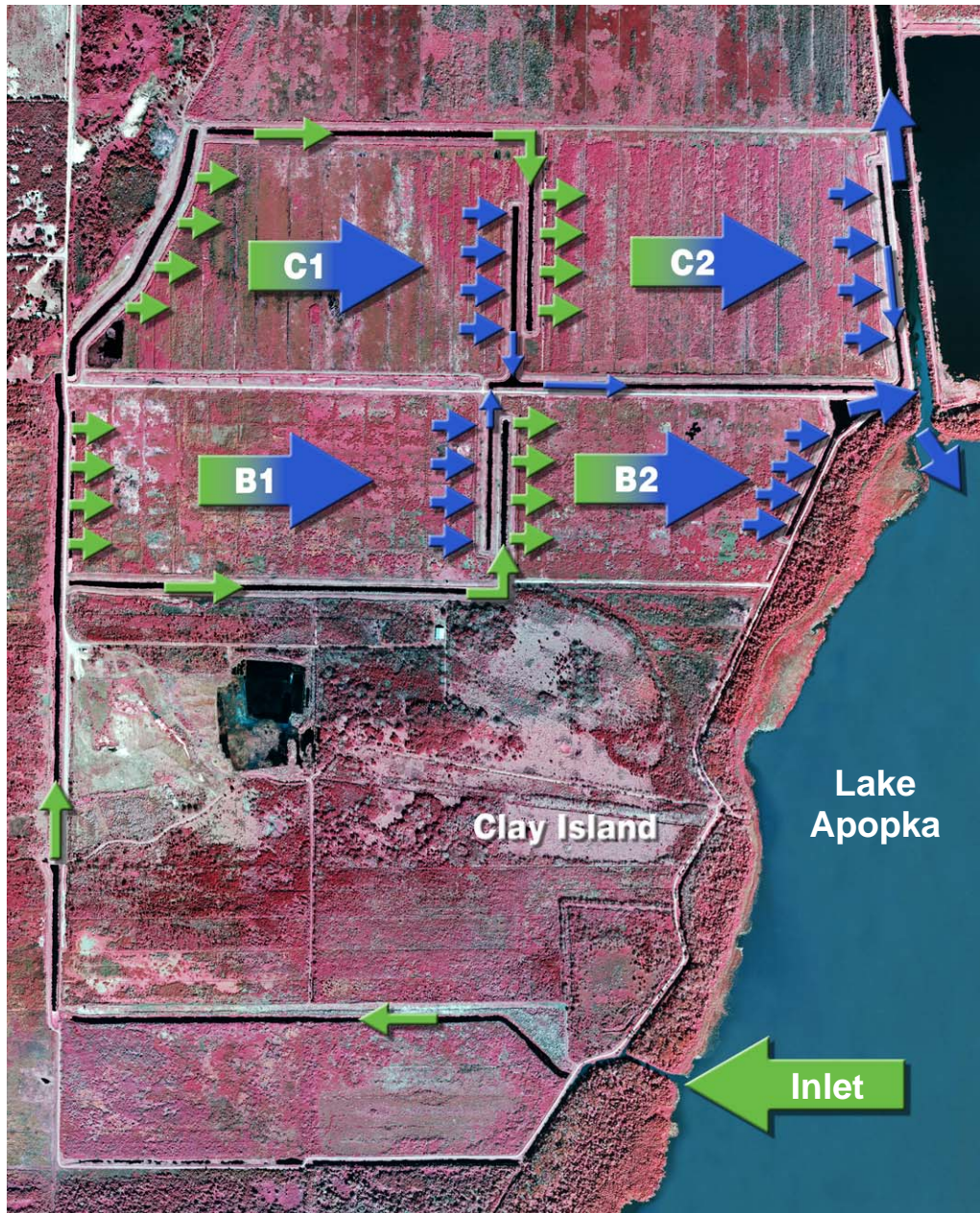
NOTES:

INITIAL OPERATION AND PERFORMANCE OF THE LAKE APOPKA MARSH FLOW-WAY

E. Marzolf, M. Coveney, R. Conrow, L. Battoe, and E. Lowe
Division of Environmental Sciences
St. Johns River Water Management District - Palatka, FL

Lake Apopka is a shallow, 125 km² hypereutrophic lake northwest of Orlando Florida. One component of the multi-part restoration program is the Marsh Flow-Way (MFW), a wetland filter designed to remove suspended solids and associated nutrients from the lake's water and return the treated water to Lake Apopka and the downstream chain of lakes. Unlike most treatment wetlands, the MFW is not intended to remove dissolved forms of nutrients. Phase I of the system consists of four independent treatment cells with approximately 656 acres of treatment area built on former muck farms on the lake's north shore. The system began operation in November 2003, and we incrementally increased flows through the system up to full capacity, 150 cfs. At this capacity, Phase I should filter three-quarters of the lake's volume each year. Net removal of suspended solids began within days of start up; net removal of total nitrogen began within 10 days. The initial start-up was dominated by flushing of the water which had been sitting in the cells for over a year and was enriched with dissolved phosphorus. This pulse of phosphorus created an initial cumulative export of phosphorus which peaked at 585 kg P. Net phosphorus removal occurred once the system was completely flushed and after flows exceeded 100 cfs (day 53). Since then, net phosphorus removal has leveled off at ~25%. This has occurred in spite of significantly lower nutrient concentrations in the lake than were anticipated when the system was designed. In Lake Apopka current low levels of phosphorus and chlorophyll and high water clarity have persisted longer than at any time since the District began monitoring in the mid-1980s. Total phosphorus has remained below 90 mg/L for the past 9 months, chlorophyll below 70 mg/L for the past 10 months and Secchi depth has remained above 30 cm for the past 10 months. These improvements and the MFW will continue to provide the cleanest water flowing out of Lake Apopka to the downstream Ocklawaha lakes in decades.

The high rate (>95%) of suspended solids removal results in approximately 12 metric tons of dry solids being removed per day. These solids in addition to cattail litter are rapidly burying the farmed soils and their associated organochlorine pesticide residues. By burying the farmed soil the MFW is reducing pesticide exposure and rebuilding some of the many feet of soil lost during the decades of farm activity. Rebuilding soil elevations will facilitate the creation of littoral wetlands, which can be reconnected to the lake once MFW operation has ceased.



NOTES:

**LAKE PANASOFFKEE RESTORATION PLAN:
DREDGING TO RESTORE FISHERIES HABITAT
AND RESTORE THE HISTORIC SHORELINE**

Lizanne Garcia and Michael L. Holtkamp
Southwest Florida Water Management District
Tampa, FL

Lake Panasoffkee in Sumter County is the third largest of approximately 1,800 lakes in west central Florida, and is a regionally important environmental and economic State resource as indicated by the following designations:

- Identified by the Florida Department of Environmental Protection as an Outstanding Florida Water
- Included on the Southwest Florida Water Management District's Surface Water Improvement and Management (SWIM) Priority Water Body List
- Nationally recognized as a freshwater fishing destination, especially for redear sunfish

Although fishing remains popular at Panasoffkee, the lake's future as an important statewide recreational resource is threatened. The fisheries there have declined considerably during the last 30 to 40 years. In the mid-1950s, when the lake's fishery was first being studied, at least 15 fish camps operated there. In 1998, only three fish camps remained.

The threat to Lake Panasoffkee has been the loss of desirable fish habitat. Since the 1940s, there has been a substantial loss of necessary fish bedding areas and open water through the build-up of sediment and subsequent encroachment of emergent vegetation. Under seasonal low water conditions portions of the lake become un-navigable.

Lake Panasoffkee's good water quality is mostly due to substantial groundwater flows into the lake from the Floridan Aquifer. Ironically, groundwater is also the major source of sediment filling in the lake. When groundwater, which carries large amounts of dissolved calcium carbonate, mixes with lake water, the calcium carbonate solidifies producing sediments that settle on the lake bottom covering fish spawning areas. These factors have negatively impacted the lake's fishery and to promote increased shoreline vegetation and tussock formations, thus limiting recreation and navigation.

In 1998, out of concern for Lake Panasoffkee, the Legislature established the Lake Panasoffkee Restoration Council (Council) within the Southwest Florida Water Management District (District). The Council was charged with identifying strategies to restore the lake and to look specifically look at sport fish recovery strategies, shoreline restoration, sediment control, exotic species management, water quality and fisheries habitat improvement. The Council was required to report to the Legislature by November 25th of each year. In its initial 1998 report, the Council presented the restoration plan for Lake Panasoffkee.

The Council's Lake Panasoffkee Restoration Plan identified the following restoration goals to be addressed in priority order: fisheries habitat improvement, shoreline restoration and improved navigation. Furthermore, maintenance of the existing good water quality in the lake was an important consideration in implementation of any recommended strategy.

The key management strategy for Lake Panasoffkee is a multi-step dredging project designed to remove sediment and encroaching vegetation from the lake. The plan calls for dredging approximately 1,900 acres of the 4,800-acre lake to restore fisheries habitat and the historic shoreline of the lake. Total costs for the project are estimated at approximately \$26 million. Construction of the upland spoil disposal facility for Steps 2 and 3 began in December 2003. Dredging is expected to begin by July 2004 and is expected to continue through 2007.

Costs for each step include costs for design, permitting, construction management, submerged aquatic vegetation (SAV) monitoring and dredging.

Table 1. Restoration Steps showing acreage, sediment volume and costs

Restoration Step	Area Acres	Volume Cu. Yards	Total Contracted Costs
Step 1 - Coleman Landing Pilot Project ¹	24.5	138,035	\$760,007
Step 2 - Dredge to Hard Bottom	915	3,442,071	\$12,050,894
Step 3 - Dredge East-side Emergent Zone	1,062	4,767,664	\$11,949,246
Step 4 - Canals ²	34	162,000	\$961,000
Total:			\$25,721,147

Notes:

1. Step 1 was completed in December 2000. Costs include reclamation costs for the spoil disposal site.
2. Estimates for the canals are taken from the 2001 Report to the Legislature. In October 2001, the Council allocated \$200,000 to Sumter County toward implementation of this step.

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SESSION 3

BIOLOGICAL RESPONSES

**ADULT CHIRONOMID RESPONSE
TO NEW RIVER WALK LIGHTS AT
LAKE MONROE, SANFORD, FL**

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Lake Monroe, central Florida, produces high abundances of chironomids, particularly *Glyptotendipes paripes* and *Chironomus crassicaudatus*, which regularly emerge to invade the lakeside city of Sanford. A new River Walk project is expected to add over 200 new decorative lights to be situated along Sanford's shoreline. Since adult chironomid occurrences there are likely to increase in response to such a lighting increase, a short-term study was initiated. This study was conducted by Volusia County Mosquito Control, from September 16 to October 14, 2003, to predict the effect of the lighting increase on adult occurrences and to recommend potential alterations to the River Walk design.

In this study, sticky sampling panels were constructed and installed for midge collection at each of nine total sites along the Sanford shoreline. Three River Walk lights were installed with sampling panels as the experimental set according to the relative positions projected in the completed River Walk design. Three preexisting adjacent streetlights were selected as a competing set of light sources. And three non-competing streetlights were selected as a control set, located at distant locations from the others along the shoreline. Then, resting adult midges were enumerated on the sampling panels at each of the nine sites during six separate sampling periods. Four additional sampling periods were conducted without the River Walk lights turned on. During all ten sampling periods, panels were set up in the evenings after sunset and collected after sunrise the following morning. Recorded data was tabulated and analyzed via Microsoft Excel. Also, light intensity was measured via light meter at each site and observations were made to consider additional correlations between light sources and chironomid responses.

According to data collected on the sticky sampling panels, the mean ratio of adults collected at new River Walk-type lights to non-competing distant streetlights was 11.9:1. Also, with River Walk lights on, the ratio of adjacent to distant streetlights was 2.2:1; without River Walk lights, the ratio increased to 5.6:1. Therefore, it is expected that the completed River Walk project will not only draw a greater concentration of adult chironomids toward Sanford, but also draw many away from Sanford's preexisting light sources and toward the new River Walk itself. It was observed that, despite River Walk lights often projecting less intense light than preexisting streetlights, the River Walk light panels collected larger numbers of adults. It seems that the nondirective light emitting from the River Walk lights is more attractive to the chironomids than the more light-limiting directive designs provided by the preexisting streetlights. This study was conducted for a limited amount of time during the fall season, when chironomid activity was relatively low. A similar, but longer-term study is recommended in the near future at a time of year when Lake Monroe's chironomid activity is consistently at its highest (late spring to summer). Based upon the results and observations of this short-term study, light manipulation techniques have been explored and may soon be tested to help manage Sanford's projected shoreline lighting problem at Lake Monroe.

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NOTES:

ADVENTURES IN FORENSIC LIMNOLOGY: WHAT CAUSED THE ALGAL BLOOM IN LAKE BUTLER?

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Introduction

Between March and July 2002, plant material and sediment were removed from an eight-acre cove (Windermere Botanical Garden Cove, WBGC) on ~1,800 acre Lake Butler near Orlando, Florida. The WBGC was isolated from Lake Butler by a sand berm and a double turbidity curtain during excavation, and the turbidity curtain remained after the excavation. During the second half of 2002, the area experienced 58.75 inches of rain (2002 total rainfall was 79.46 inches; second highest on record) following a three-year drought. This normally oligotrophic lake experienced an algal bloom in November 2002, and the total phosphorus concentrations [TP] in the lake increased from about limits of detection (2.5 ug/L) to 25 ug/L over the course of the year. Due to the temporal sequence of cove dredging followed by an algal bloom, some lakeside residents believed the dredging caused the bloom. We were asked to determine if the excavation of the WBGC caused the algal bloom in Lake Butler.

No data were collected until late in 2002 (well after the onset of the algal bloom), so no direct estimate of loading from the cove could be made. We therefore sought to explore several indirect, independent paths of investigations to determine the probable cause of the TP concentration increase.

P Mass Excavated at WBGC

The excavated spoil had been deposited on a nearby sandy, upland soil. After determining the P concentration and bulk density of the soil from an adjacent, undisturbed wetland, and the volume of soil and amount of P contained in the spoil after 12-16 months of excavation, we could account for 96% of the estimated soil volume and 111% of the estimated P mass. Based on this mass balance, only negligible amounts of sediment and P during the excavation of WBGC could have been contributed to the lake.

In Situ Soluble and Total P Gradients in the Water Column

We measured the Secchi disk transparency, temperature, and dissolved oxygen, soluble reactive P (SRP), and TP concentrations in the water column on August 13, 2003. On that day, SRP concentrations inside and outside of the WBGC were close to undetectable, indicating that there was no supply of bioavailable P from inside the WBGC for export to the lake. Aqueous TP concentrations were only slightly higher (by 2-4 µg/L) for the bottom waters inside the turbidity

curtain than outside. This difference is slight, and likely means that any higher TP mass inside the curtain is not being transported under the curtain since the higher concentrations were not detected in the bottom waters outside the curtain.

Sediment TP Concentrations

Surficial sediment TP concentrations inside the WBGC were not substantially higher than the surficial sediment concentrations in the vicinity near the outside of the cove, implying that there is not a source of P-enriched sediment within the WBGC that contaminated the water outside the cove.

Theoretical Considerations

There is one discharge point into WBGC. Its advective flow into the cove is of such low magnitude that resuspension of sediment is likely not to occur. Furthermore, since WBGC had been a depositional environment (i.e., a former wetlands) prior to the excavation, it will likely serve as a depositional environment post-excavation, especially with the turbidity curtain remaining in place.

Stormwater P Export Within the Watershed

We measured P concentrations and flows from the sub-basin draining into WBGC, as well as another, larger sub-basin. We found that the P mass exported by the sub-basin draining into WBGC was 5-7 times less than what we measured for the other sub-basin. This implies that the sub-basin draining into WBGC is a minor contributor to the lake compared to other sub-basins and possibly other diffuse sources such as lawn and golf course fertilization and septic systems.

Predictive P Models

We used an empirical relationship for predicting TP concentration in the lake based on external P loading, predicted P retention, and areal water loading. The predicted TP concentration of 19 ug/L compares favorably with 14 and 16 ug/L measured in the surface waters of Lake Butler in September and November of 2002, respectively, by Orange County Environmental Protection Department.

Conclusions

Based on these independent lines of investigations, we conclude that rainfall and runoff over the entire watershed at Lake Butler was primarily responsible for the increase in TP concentrations and the algal bloom. Neither the excavation of the WBGC, nor subsequent drainage through it from the surrounding sub-basin, contributed a disproportionately high amount of phosphorus to the lake. Prolonged drought may have delayed the onset of eutrophication associated with progressive development of the drainage basin. The drafting and adoption of a detailed lake and watershed management and restoration plan was strongly recommended. The reports of two independent peer reviewers were supportive of our results.

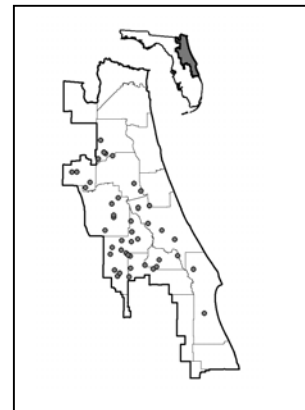
RELATING SEDIMENT QUALITY TO BENTHIC MACROINVERTEBRATE COMMUNITY COMPOSITION IN NORTHEASTERN FLORIDA AQUATIC ENVIRONMENTS: THE COMPOSITE BENTHIC SEDIMENT QUALITY INDEX

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The potential for harm to aquatic species due to sediment contamination is a subject of critical concern for environmental management agencies (USEPA 1997). The St. Johns River Water Management District sponsored the District-wide assessment project to document sediment conditions in northeastern Florida waterbodies and to assess the effects of contamination on benthic macroinvertebrates (Durrel et al. 2004; Evans et al. 2004). Sediment and macroinvertebrate samples were collected concurrently from 242 sites in 1999 and 2002 including 50 lakes (Figure 1). The intent of the project was to integrate biological, water quality, and sediment contamination information, and to develop data interpretation tools. To this end, indices relating macroinvertebrate community composition to a sediment hazard index were developed.

Figure 1. Study Area.



Sixteen macroinvertebrate metrics were used to characterize benthic communities (Table 1). These metrics were tested for Spearman's rank correlation to a hazard index (HI) based on sediment threshold effects concentrations (TEC) applicable to Florida (MacDonald et al. 1996; MacDonald et al. 2000). HI was calculated by summing the ratios of the concentrations of contaminants measured for a given sample to the applicable TEC value for that substance (Durrel et al. 2004). Correlations for total number of taxa (N_{taxa}), number of chironomid taxa, Shannon-Wiener diversity index, and an augmented Florida index (AFI) to HI were significant for lakes data. Composite Benthic Sediment Quality Indices (CBSI) were developed and tested for all lake sites. Metrics were combined to optimize correlation to the hazard index for each data set. The highest correlation to HI for lakes was found for $\text{CBSI} = 2\text{AFI} + N_{\text{taxa}}$.

Table 1. Candidate Metrics Screened for Correlation with the TEC-Based Hazard Index.

Total Organism Abundance	Percent Chironomidae
Total Number of Taxa	Percent Tubificidae
Shannon-Wiener Species Diversity	Percent Mollusks
Pielou's Evenness	Percent Amphipoda
Augmented Florida Index (AFI)	% Filter /Collector Feeding Guild
Percent Dominant Taxon (excluding Chaoborus spp.)	% Gatherer/Collector Feeding Guild
Total Number of Chironomid Taxa	Percent Scraper Feeding Guild
Total No. Ephemeroptera, Trichoptera, Odonata Taxa	Percent Shredder Feeding Guild
Total Organism Abundance	Percent Chironomidae

Means for CBSI corresponding to low, medium, and high sediment hazard risk were compared using one-way analysis of variance (ANOVA). ANOVA was used to identify values of the index that indicated sediment hazard levels of concern. CBSI values corresponding to low HI risk were classed as “good” – CBSI values corresponding to medium to high HI risk were assigned to the “poor” category. The poor CBSI range was defined as zero to less than the mean CBSI value corresponding to medium HI (identified by ANOVA) plus one standard deviation unit, rounded to the nearest integer. The good CBSI range was defined as greater than or equal to the poor CBSI maximum value.

The Ocklawaha River chain was used as a test case to refine methods of index calculation, because many sites were sampled in these lakes along a known gradient of contamination. Using the method of averaging CBSI values for each lake (for which multiple sites were sampled) resulted in the best correlation with the hazard index. A preliminary analysis of classification error rates was performed using source data to assess index performance. Type I and Type II error rates were below 25 percent in all cases. Additional data not used in creation of the index will be required to verify these error rates and validate the index.

CBSI are easy to calculate, involve minimal statistical assumptions, and are based on a clear linear relationship to the hazard index. CBSI and other similar indices may be useful screening tools for determining which sites should be sampled for sediment contaminants and toxicity.

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EFFECTS OF INTRODUCED GROUNDWATER ON WATER CHEMISTRY AND FISH ASSEMBLAGES IN CENTRAL FLORIDA LAKES

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Water levels in central Florida lakes have declined since the 1960s as a result of drought conditions, diverted rainwater runoff, and increased groundwater withdrawals. In an effort to maintain water levels in lakes near Tampa, the Southwest Florida Water Management District (SWFWMD) issued permits allowing landowners to pump water from limestone aquifers into lakes. We assessed effects of groundwater augmentation on limnological variables and fish assemblages in seven Florida lakes. Lakes investigated included Clear, Goose and Loyce in Pasco County, Dan, Saddleback and Sunset in Hillsborough County, and Mountain in Polk County. Pumping data were obtained from unpublished SWFWMD reports, limnological variables were collected from lakes and wells supplying groundwater, and fish populations were sampled by electrofishing.

Pumping reduced lake level fluctuation, and pumping volumes could replace the volume of water in a lake multiple times (0.24 to 3.28 times/year) in a single year. Well water had higher mean total alkalinity (189 mg/L as CaCO₃) and total phosphorus concentrations (48.3 µg/L), and lower concentrations of total nitrogen (503 µg/L) and chlorides (5.73 mg/L) than lake water samples (91.7 mg/L as CaCO₃, 14.6 µg/L, 641 µg/L, and 10.6 mg/L respectively). Original lake water samples collected prior to augmentation indicated similar patterns. Current lake water samples had a higher mean pH (7.56), total alkalinity concentration (91.7 mg/L as CaCO₃), total phosphorus (14.6 µg/L) and Secchi depth (2.44 m), and lower mean color (32.1 Pt-Co units) and chlorophyll concentration (12.7 µg/L) than historical ranges (5.5 to 6.9, 6.00 to 36.0 mg/L as CaCO₃, 5.00 µg/L, 0.8 m, 40.0 to 90.0 Pt-Co units, and 28.0 µg/L respectively). Current lake water samples also had lower mean nitrogen concentrations and higher mean chloride concentrations than historical means.

Historical fish population studies did not exist on these lakes, therefore data from the augmented lakes were compared to 36 nonaugmented lakes in Florida. The mean values for catch per unit effort (CPUE) (3.85 fish/minute), species richness (8.57 species) and biomass of harvestable fishes (58.9 grams/minute) were lower in augmented lakes than the means in nonaugmented lakes (7.45 fish/minute, 10.4 species, and 208 grams/minute; respectively). Halfmoon Lake, sampled before and after augmentation, also displayed declines in CPUE and species richness following augmentation. However, significant multiple linear regressions ($p < 0.05$) of fish population parameters versus limnological characteristics for augmented and nonaugmented lakes combined indicated that fish population responses of augmented lakes were similar to nonaugmented lakes with similar limnological characteristics.

Canonical correspondence analysis (CCA), a multivariate analysis, was used to examine the relationship between the abundance of individual fish species, as determined by catch per unit effort, in the lakes in which they were captured, and the measured limnological characteristics. A majority of fish species and nonaugmented lakes were correlated with environmental gradients of axis one, whereas augmented lakes were more related to the environmental gradients of axis two, indicating that augmented lakes were more characteristic of having high total alkalinity and Secchi depth, and low chloride and phosphorus concentrations. Cluster analysis with these four variables further demonstrated the similarities in limnological characteristics among augmented lakes. Joint plots of the CCA indicated a high probability of a low abundance of individual species in augmented lakes compared to a majority of nonaugmented lakes.

One of the augmented lakes, Sunset Lake, had much lower pumping rates (9.97×10^4 m³) than the other augmented lakes (range = 3.19×10^5 m³ to 2.67×10^6 m³), and exhibited less of a shift in limnological variables from historical values, as well as had fish population characteristics more closely resembling those of nonaugmented lakes in the joint plot of the CCA. Therefore, reduced volumes of groundwater introduction could reduce the alteration of limnological and fish population characteristics.

Central Florida lakes with groundwater introduction are characterized by limnological variables resembling aquifer water and shifts in fish community variables. However, augmentation allows for lakes to be utilized for boating, swimming and other recreational activities that might not be possible with the pumping of groundwater. It also allows for lake and wetland hydrology to be maintained and fish and wildlife habitat to be provided. Therefore, more natural water level fluctuation regimes and possible reductions in total pumpage are recommended to maintain water in the lake, while reducing the alteration of limnological and fish population characteristics.

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TMDL BIOASSESSMENT SAMPLING OF BENTHIC MACROINVERTEBRATES FOR LAKE JESUP AND LAKE SEMINARY IN SEMINOLE COUNTY

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Purpose, Scope and Objectives

Section 303 (d) of the Clean Water Act (CWA) requires States within the United States to submit lists of water bodies that fail to meet state water quality standards (termed, impaired waters). TMDLs (Total Maximum Daily Load) are criteria established for these waters to categorize the extent of impairment and to further allow for evaluation of restoration efforts as intended by the CWA. The United States Environmental Protection Agency (USEPA) requires TMDLs to be developed where other pollution regulations are not sufficient to protect water quality. TMDLs assess the potential effects on water quality, biological communities and their habitat. It provides a quantitative analysis of waterbodies; whether it is parameter specific (dissolved oxygen, fecal coliform, turbidity, nutrients) or the assessment of a biological component (bioassessments). The mission of TMDLs is to provide accurate ecological information to enable legally defensible environmental decisions (Frydenborg 2001).

The objective of this study was to obtain a thorough characterization of the benthic macroinvertebrate community in two study lakes in Seminole County as part of a biological assessment that targets waters for TMDLs in eutrophic systems. For comparative purposes, benthic macroinvertebrates were collected in eutrophic (Lake Jesup) and oligotrophic (Lake Seminary) freshwater lakes in Seminole County to further understand the dynamics of macroinvertebrates in impaired and unimpaired water bodies. This study evaluated the TMDL protocol and the use of the benthic community in the TMDL process to characterize the trophic state and subsequent changes in trophic state due to restoration and water quality improvement.

Methods

Lake Seminary, located in Maitland, Seminole County, is classified as an oligotrophic lake surrounded by a low-density residential community. This solution basin covers a surface area of 55.1 acres and has a mean depth of 14 ft. and maximum depth of 30 ft.

Lake Jesup is one of the largest and most eutrophic lakes in Seminole County. It is associated with the St. Johns River as a large, tributary lake to that river system. Lake Jesup has a surface area of 8,120 acres, extending over a flood plain of 16,000 acres (SJRWMD 2002). Eutrophication has been extensive in the past several decades due to effluent discharges from WWTPs, urban and agricultural runoff, shoreline development, roadway drainage, and inlet channel modifications at its confluence to the St. Johns River. Presently, Lake Jesup is listed on the State of Florida's TMDL draft-verified list for impaired waters.

Benthic communities within the two study lakes were sampled using identical methodologies (Conventional). In addition, within Lake Seminary, two different methodologies were used for comparison (LCI and Conventional). Benthic macroinvertebrate sampling was conducted on the same week of the same month for each lake from January to December 2002. Each benthic macroinvertebrate sample was identified to the lowest possible taxon (genus and species) and enumerated.

The Conventional Method for sampling benthos, a traditional style of sampling, utilized a bottom grab sample. A tall Ekman grab measuring 15.2 x 15.2 x 30 cm (6"x 6"x 9") and capacity volume of 5,300 ml was used to collect two pooled bottom samples per station. The samples were sieved through a #30 US mesh (mesh opening: 595 μ m) sieve bucket to removed fine sands, silts and organic debris. The abundance of the organisms was expressed as number of organisms/m².

The LCI method (Lake Condition Index) was developed by the Florida Department of Environmental Protection (FDEP) and has been designated statewide as the standard method for rapid bioassessments of lake benthic communities. As in the Conventional Method, the tall-form Ekman grab and #30 mesh sieve bucket are used to collect bottom samples. Organisms sampled for the LCI, are evaluated to obtain a value that expresses the biological integrity on a scale ranging from Very Poor to Very Good. The protocol of FDEP's LCI method was used to sample benthos from Lake Seminary.

Results and Discussion

Data collected from Lake Seminary from January through December 2002 was used for comparison of the Conventional and LCI methods of collecting benthos. Numerical values of eight metrics were compared between the two different sampling methodologies: % EOT, Total EOT (Ephemeroptera-Odonata-Trichoptera), % Diptera, Total Diptera, Hulbert's Lake Condition Index (tolerance measure), Shannon-Weiner Diversity Index ($H' = - \sum p_i \ln p_i$), Taxa Richness, and Number of Organisms/m².

Abundance using the Conventional Method was calculated as mean of the three stations in Lake Seminary to compare to the abundance derived using the LCI method. Upon analysis of each metric category between the two methods, 2002 data infers that the LCI sampling method is comparable to the Conventional method. Monthly benthic sampling using both methods provided similar results and is continuous for each metric, each month sampled in 2002.

A closer look into the methods demonstrates more fluctuations in the Conventional method for the x-axis suggesting this method provides a more complete assessment of organisms present due to the lack of subsampling, resulting in more sensitive taxa (EOTs) represented and less dominant taxa (Dipteras), thus elevating presence and abundance. Deducing that prior to 100 organisms being collected (per protocol) less Dipterans allowed for more sensitive taxa. Ephemeroptera-Odonata-Trichoptera (EOT) data discloses that between the two methods, 66.66% of the time the Conventional Method was higher than the LCI method, suggesting that the Conventional Method allows for more sensitive taxa to be collected and represented in the sample community.

To further analyze the dynamics of macroinvertebrates in an impaired and unimpaired waterbody, 3 metrics were numerically compared between the different lakes using the Conventional Method: Shannon-Weiner Diversity Index ($H' = - \sum p_i \ln p_i$), Taxa Richness, and Number of Organisms/m². Values for the Conventional Method were calculated as a mean of the three stations. Abundance (# organisms/m²) within Lake Jesup was predominantly Dipterans and Oligochetas, further indicating a shift in percent composition of taxa in a eutrophic system. Wetzel (1983) stated that as lakes become more eutrophic, a shift occurs in the percentage composition of two dominant benthic groups, with a decrease in the dipteran chironomid larvae and an increase in the more tolerant oligochaete worms (e.g., tubificids). This shift is represented in the biological composition in Lake Jesup.

Summary

The results of this study serve to demonstrate the effective use of benthic macroinvertebrates for TMDL bioassessments. Comparative methodology between the LCI and Conventional methods indicate that the LCI is a valid cost-effective method when compared to the Conventional Method, and that the Conventional Method is an effective tool when a more comprehensive benthic study is needed as it depicts a more realistic scenario of seasonal variation and accounts for more of the sensitive, intolerant taxa. Furthermore, such biological monitoring and analysis of trend assessment aids in the implementation of anthropogenic controls that target waters for TMDLs in suspect systems.

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**FACTORS AFFECTING TOTAL COLIFORM
AND *ESCHERICHIA COLI* (*E. coli*) BACTERIAL COUNTS AT 30
LAKES IN HILLSBOROUGH COUNTY, FLORIDA**

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The degree of bacterial contamination of 30 lakes in Hillsborough County Florida were studied using total coliform and *E. coli* counts as indicators. The State of Florida has established bacterial standards for acceptable levels of total and fecal coliform bacteria allowed in public waters, to which the data were compared to evaluate degree of contamination. Bacterial contamination as indicated by *E. coli* counts was not a widespread problem for the population of Hillsborough County lakes in this study. Out of 3,530 *E. coli* samples, only 1.4% of the samples exceeded the Florida Administrative Code standard. The incidence of bacterial contamination as indicated by total coliform counts (24%) was higher, but human health concerns are limited to skin rashes and ear infections through water contact activities such as swimming because of the low occurrence of high *E. coli* counts.

There was more variability in the total coliform and *E. coli* counts between lakes (18 and 19%, respectively) and dates (11 and 13% respectively) sampled than stations (3%), which was not significant. Thus, future studies should concentrate on sampling more lakes over time than sampling fewer lakes intensively over shorter time if the goal of the study is to determine the status of a population of lakes.

High total coliform counts may occur during wet versus dry periods ($p = 0.01$), however high *E. coli* counts were not explained by seasonal differences as defined by wet and dry periods ($p = 0.34$). High total coliform and *E. coli* counts at the study lakes were not explained by varying levels of aquatic macrophyte abundance, or by varying degrees of urban development indicated by road density. Total coliform and *E. coli* counts were negatively correlated with lake size ($r = -0.37$ and $r = -0.53$, respectively) and positively correlated with mean aquatic bird abundance ($r = 0.37$ and $r = 0.78$, respectively). In addition, mean depth ($r = -0.41$), lake trophic status as assessed by mean chlorophyll concentration ($r = 0.40$), total nitrogen concentration ($r = 0.40$), and Secchi depth ($r = -0.36$) were correlated with *E. coli* counts. Although sources of fecal contamination are usually thought to be human in origin (problems with sewer or septic systems), aquatic birds seem to be a very important source for bacteria in Florida lakes that should not be overlooked during bacterial contamination investigations.

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POSTER SESSION

ACUTE TOXICITY OF ALUM AND SODIUM ALUMINATE TO *PIMEPHALES PROMELAS* AND *CYPRINELLA LEEDSI*

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Acute toxicity tests were conducted at MACTEC Engineering and Consulting, Inc., Toxicology Laboratory, to compare the acute effects of chemical treatments of lake water for the reduction of phosphorus. Laboratory testing was performed as a predictor of treatment at Eustis Muck Farm, Florida. The tests were conducted with the vertebrate species *Pimephales promelas*, fathead minnow, and the bannerfin shiner, *Cyprinella leedsii*. Tests were conducted following the EPA methodology, *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*, EPA-821-R-02-012, October 2002. The effect criterion in the acute tests was mortality.

P. promelas were exposed to various combinations of chemicals ($\text{Ca}(\text{OH})_2$, sodium aluminate 38%, sodium aluminate 45%, and alum), which were added either simultaneously or in stages to simulate actual lake application methods:

- $\text{Ca}(\text{OH})_2$ with alum added 24 hours later.
- $\text{Ca}(\text{OH})_2$ and alum added simultaneously.
- Alum and sodium aluminate added simultaneously.
- Control 1: Eustis lake water.
- Control 2: Moderately hard water.

The most significant difference in pH measurements occurred in the simultaneous $\text{Ca}(\text{OH})_2$ and alum treatment. Before the amendment was added the pH was 7.9, and two hours after amendment, the pH had decreased to 4.7. At the conclusion of the test period, the pH was 6.8 in the simultaneous $\text{Ca}(\text{OH})_2$ and alum treatment. The simultaneous alum and sodium aluminate treatment yielded a minimal change in pH, from 7.9 to 7.6, and the pH stayed in this range for the remainder of the test.

After 48 hours of exposure, survival of *P. promelas* was 100 percent in all test treatments and controls. The timing and addition of chemicals had no effect on the survival of the vertebrate, *P. promelas*.

In follow-up to the above toxicity test, a second test was conducted in an effort to determine the dose rate of alum and sodium aluminate for Eustis Muck Farm. *C. leedsii* were exposed to ratio treatments of alum and sodium aluminate (15:1, 20:1, 25:1, and 30:1). Water quality parameters (temperature, pH, dissolved oxygen) were measured before the amendment was added, and after the amendment was added. The pH values (after 24 hours) decreased slightly in all treatments, 0.3 (15:1, 20:1 and 25:1 treatments) to 0.5 (30:1 treatment). After 96 hours of exposure to the various treatments, survival for *C. leedsii* was 100 percent in the controls and all treatment exposures, except the 30:1 exposure, survival was 97.5 percent. The test results reflect no significant difference in mortality of *C. leedsii* among treatments tested.

Subsequent to the toxicity tests conducted at various ratios with *C. leedsii*, a third toxicity test was conducted using the 30:1 ratio only. Water quality parameters (temperature, pH, dissolved oxygen) were monitored before the amendment was added, and after the amendment was added. Immediately after the amendment was added, pH decreased from 7.8 to 6.8. One hour after the amendment was added, the pH decreased to 6.5. Approximately 24 hours after the amendment was added the pH increased to 7.4, and remained in the range of 7.2 to 7.9 for the remainder of the test period. After 96 hours of exposure, survival for *C. leedsii* was 100 percent in the control, and ranged from 90 to 100 percent in the 30:1 treatment (with the removal of an outlier).

In conclusion, no significant effect on mortality was observed for *P. promelas* or *C. leedsii*, in the simultaneous alum and sodium aluminate treatment. These results support the use of amendments, alum and sodium aluminate, for phosphorus removal at Eustis Muck Farm, without adverse acute effects to fish.

References

United States Environmental Protection Agency. (2002). *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*, 5th Edition, EPA-821-R-02-012, U.S. Environmental Protection Agency, Office of Water, Washington, DC.

NOTES:

**EVALUATING EFFECTS OF "GRUBBING"
LYNGBYA SPP. ON NON-ALGAL SUBMERGED AQUATIC
VEGETATION (SAV) IN KINGS BAY
(CITRUS COUNTY), FLORIDA.**

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Located approximately 60 miles north of Tampa, Florida, in Citrus County, Kings Bay is a first magnitude spring system that forms a 600-acre embayment and headwater of Crystal River. The bay's unique ecological attributes support numerous wildlife species and economically important recreational activities. Declining water clarity and displacement of native aquatic macrophytes by nuisance exotic macrophytes and filamentous algae currently impact Kings Bay. As the agency responsible for nuisance plant control in Kings Bay, Citrus County's Aquatic Plant Services program began (circa 1997) removing benthic mats of the filamentous alga, *Lyngbya* spp., with mechanical harvesters. This process known as "grubbing" utilizes mechanical harvesters outfitted with dull blades to lift and remove algal mats found along the bay bottom in winter. These benthic mats rise to the surface of the water column during spring and summer; forming floating obstructive mats which are subsequently removed with traditionally outfitted mechanical harvesters in a method known as "skimming". The County anecdotally reports a reduction in annual skimming activities since the initiation of grubbing. However, public concerns over the perceived impacts of grubbing to non-algal submerged aquatic vegetation (SAV) have been repeatedly expressed to local and state governmental agencies. Therefore, this evaluation was initiated to assess the status of non-algal SAV and filamentous algae as a measure of grubbing impacts to SAV in Kings Bay.

Staff from Citrus County, Florida Department of Environmental Protection, Florida Fish and Wildlife Conservation Commission and the Southwest Florida Water Management District assessed the status of non-algal SAV and filamentous algae in three geographical regions (North, East and South) in Kings Bay. Within each region, areal coverage (Braun-Blanquet index of vegetative abundance) and occurrence values for non-algal SAV and filamentous algae were recorded within two 0.25m² quadrats (each sub-divided into four square sections) at 30 randomly selected sites. A total of 88 sites, equally distributed between areas that were grubbed with mechanical harvesters and those that were not (control sites), were sampled for the evaluation. At each site, areal coverage of each taxon was estimated, using a modified Braun-Blanquet index, for both total SAV (with *Lyngbya* spp.) and non-algal SAV (without *Lyngbya* spp.). Four Braun-Blanquet classes were recognized as follows: BB2 = less than 25%, BB3 = 25-50%, BB4 = 50-75% and BB5 = greater than 75%. Occurrence values were recorded for each SAV (algal and non-algal) species within the subdivided quadrats and ranged from zero (absent in all four quarters) to four (present in four quarters). Statistical comparisons of the pooled data for the grubbed and control areas were preceded by tests of normal distribution. Comparisons of means and standard deviations for parametric data were calculated with t-tests (p-value of 0.05) and F-tests (p-value of 0.05), respectively. A Mann-Whitney (Wilcoxon) W test was used to compare the medians of non-parametric data.

Results indicated that mean areal coverages of total and non-algal SAV were not significantly different between grubbed and control sites in either the North or South regions. In these regions, areal cover of non-algal SAV was assigned a mean value of BB2 in both grubbed and control sites. Presence of *Lyngbya* spp. increased mean Braun-Blanquet values for total SAV in the grubbed sites of the North (value = BB4) and South (value = BB3) regions. In contrast, total SAV in the control sites of the North and South regions were equivalent to the mean values of BB3 and BB2, respectively. Although both grubbed and control sites in the East region were assigned a mean Braun-Blanquet value of BB4 for total SAV cover, a significant difference (grubbed>control, p-value of 0.01) between the two areas was detected. Variation between the non-algal SAV Braun-Blanquet values of the grubbed and control sites in the East region did not support a statistical comparison. Mean occurrence values for *Vallisneria americana*, *Myriophyllum spicatum*, and *Lyngbya* spp. were not significantly different between grubbed and control sites, or not analyzed (insufficient variation in values), in the East and South regions. However, a significant difference (grubbed>control, p-value of 0.004) in mean occurrence values for *Vallisneria americana* was recorded in the North region. The less frequent occurrence of *Vallisneria americana* in the northern control sites may be linked to the significantly (p-value of 0.005) deeper water depths and proximity to the tidally influenced waters of Crystal River. In all regions there was no significant difference in species richness of non-algal species between the grubbed and control areas.

Comparison of mean Braun-Blanquet coverage and occurrence values, for total and non-algal SAV, between grubbed and control sites indicates that grubbing with mechanical harvesters does not significantly impact non-algal SAV species in Kings Bay. However, data from this evaluation also demonstrate that grubbing does not significantly reduce presence of the target algal species, *Lyngbya* spp. A repeat evaluation during late summer would provide information on the impact of winter grubbing on actively growing non-algal species in Kings Bay.

References

Braun Blanquet, J. (1965). Plant sociology: the study of plant communities. Authorized English translation of Pflanzensozologie 1932. Translated, revised, and edited by George D. Fuller and Henry S. Conard, 1st ed. McGraw-Hill, New York.

NOTES:

SESSION 4A

**MANAGEMENT OF
EXTERNAL INPUTS**

BROADWAY OUTFALL STORMWATER RETROFIT PROJECT

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The project is a retrofit installed to reduce the amount of pollution discharged to the Hillsborough River by using a Continuous Deflective Separation (CDS) unit and a constructed linear marsh at a major storm sewer outfall. The CDS technology is designed to remove gross pollutants such as litter, leaves, twigs, sand and pavement residue from storm runoff. According to the company, the device is non-blocking and non-mechanical and is capable of capturing 95 to 100% of waterborne litter. An EPA/FDEP 319(h) grant has provided the funds to determine how well the system removes pollutants before they are discharged to the Hillsborough River. Specifically, the project measures: 1) how much and what kind of gross solids (>64microns) are collected by the CDS unit, 2) the concentration of constituents in the flow stream for the suspended and dissolved particles (< 64 microns), 3) the accumulation of pollutants in the sediments, 4) the characterization of the macroinvertebrates in the sediments, and 5) the hydrology of the system including storm flow, base flow and rainfall. The summary presented here reports the results of the first year of monitoring.

The drainage basin that discharges through the Broadway Outfall storm sewer is approximately 132.4 acres in size and includes a 30.6-acre high intensity commercial district immediately upstream from the site. The remainder of the watershed includes multi-family and residential land uses as well as a golf course and major urban thoroughfares. As part of the Broadway Outfall Stormwater Retrofit Project a Model PSW100_60 (32 cfs capacity) Continuous Deflective Separation (CDS) unit was installed in series with an excavated sediment sump followed by a shallow linear marsh system, extending approximately 500 feet downstream from the unit.

Summary of Results

- Rainfall was above average for the year with 75 inches falling from November 2002 through October 2003. Most of the excess can be explained by the 16.16 inches that fell in December 2002, a usually dry month. Average rainfall for the region is 52 inches
- Often even small storms less than 0.25 inches have some flow that bypasses the CDS unit, but on an annual basis only 27 percent of flow does not pass through the CDS unit
- Water levels indicate that greater than 25 percent of all base flow is attributed to a daily pulse of water that was discharged into the storm drain system between 14:00 and 17:00 each day.
- The runoff coefficient for the drainage basin using preliminary calculations is 0.34 typical for an urban area that is 35 to 50 percent impervious.
- Water quality data indicate that the CDS unit is only minimally effective for reducing the suspended and dissolved constituents routinely measured in stormwater studies
- Poor removal of pollutants by the pond may be the result of its small size.
- Most of the gross solids are transported to the CDS unit during February through July and consists of 55 to 75 percent leaves.

- The CDS unit is effective in removing gross solids and 413 cubic feet were removed during the first year of the study.
- Large quantities of potentially damaging pollutants were removed in the gross solids including toxic levels of Polycyclic Aromatic Hydrocarbons (PAHs)(Table 1).
- The CDS unit effectively collects particle sizes much smaller than the screen size of 2400 um.
- Data suggest that the gross solid samples with the most leaves (particle size>850 um) had the highest concentrations of nitrogen and possibly PAHs. Larger particle sizes had more organic matter and the smaller particle sizes appear to have more metals (Table 1).
- Concentrations measured in the soils at the pipe outfall before construction of the retrofit were similar to concentrations removed by the CDS unit. The reduced concentrations immediately downstream indicate that the open ditch, sunlight and microorganisms may have been successful in reducing the concentrations.

Table 1. Chemical Analysis of the gross solids collected by the CDS unit for year one.

	SAMPLE A			SAMPLE B				Total for		Total for
Particle size	>850 uM	<850 uM		>850 uM	850-425	<425 uM		Each Clean-Out		Year
Sieve Size	>#20	<#20	Total A	>#20	#20-40	<#40 uM	Total B	April-03	July-03	
RATIOS =====>	0.75	0.25	1.00	0.45	0.25	0.30	1.00	0.56	0.44	1.00
Amount (ft ³)								231	182	
CALCULATIONS FOR PAHs (ug/kg)										
Acenaphthene	1100	560	965	750	260	150	448	706	520	624
Anthracene	1800	2000	1,850	2700	780	420	1,536	1,693	1,360	1,546
Benzo (a) anthracene	13000	25000	16,000	15000	12000	7300	11,940	13,970	8,200	11,431
Benzo (a) pyrene	16000	33000	20,250	16000	14000	11000	14,000	17,125	9,400	13,726
Benzo (b) fluoranthene	24000	46000	29,500	21000	18000	13000	17,850	23,675	15,200	19,946
Benzo (g,h,i) perylene	10000	23000	13,250	9600	8700	7600	8,775	11,013	5,400	8,543
Benzo (k) fluoranthene	21000	42000	26,250	18000	15000	13000	15,750	21,000	5,400	14,136
Chrysene	26000	47000	31,250	24000	19000	14000	19,750	25,500	11,800	19,472
Fluoranthene	42000	61000	46,750	39000	28000	19000	30,250	38,500	24,000	32,120
Fluorene	1300	760	1,165	1300	400	230	754	960	740	863
Indeno (d,2,3l,-cd) pyrene	14000	28000	17,500	12000	11000	9700	11,060	14,280	6,600	10,901
Phenanthrene	23000	20000	22,250	21000	10000	6000	13,750	18,000	10,800	14,832
Pyrene	39000	60000	44,250	38000	28000	18000	29,500	36,875	18,400	28,746
TOTAL PAH (ug/kg)	232,200	388,320	271,230	218,350	165,140	119,400	175,363	223,296	117,820	176,887
METALS (mg/kg)										
COPPER	57.3	132	76	26.7	14.2	50.6	26	51	10	33.04
LEAD	17.1	76.4	32	5	29.9	14.2	14	23	14	18.94
ZINC	190	479	262	89.2	59.5	77.6	78	170	87	133.65
NUTRIENTS & ORGANIC MATTER										
TOC	25.8	8.3	21	30.9	3.8	2.2	18	20	5.5	na
O.M.(%)	45	14.4	37	53.9	6.63	3.88	32	35	6.32	22
TKN (mg/kg)	7060	5320	6,625	9520	1370	1120	5,818	6,221	1120	3,977
TP (mg/kg)	1060	985	1,041	784	881	446	767	904	600	770
Bulk Density (g/cm3)									0.53	

Conclusions

The CDS unit is effective for removing gross solids from the storm water flow stream, but is less successful in removing the dissolved and suspended constituents typically measured with automatic samplers in most stormwater studies. During the first year of the study the CDS unit removed 413 cubic feet of gross solids including toxic levels of Polycyclic Aromatic Hydrocarbons (PAHs). The CDS unit effectively removed polluted material that would have caused long-term detrimental effects by re-suspension of bottom sediments, leaching out of sequestered pollutants, smothering of benthic habitat and other problems associated with sediment transport.

A copy of the complete report is available upon request to: betty.rushton@swfwmd.state.fl.us

NOTES:

CONSTRUCTION AND EVALUATION OF THE McINTOSH PARK ENHANCED STORMWATER TREATMENT WETLAND

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Introduction

This paper describes the evolution of the conceptual design, final design, and the planned BMP evaluation of a new type of stormwater treatment wetland. The project concept was first presented at the 2001 FLMS Conference in Tallahassee as a merging of wetland habitat restoration concepts and the treatment of stormwater for water quality purposes. In the last three years, the concept has advanced through first phase construction to the point where the Southwest Florida Water Management District, City of Plant City, and Hillsborough County are ready to begin the construction of final phases of the project.



Figure 1. Initial McIntosh Park Wetland Plan.

Evolution of Concept

The Enhanced Stormwater Treatment Wetland (ESTW) concept is a new approach for treatment wetlands and merges a number of stormwater Best Management Practice (BMP) approaches into a single treatment train. The design emerged over several years of discussion and evaluation of the initial, rather simple wetland design shown in Figure 1 to the final design shown in Figure 2. The design changes were initially implemented to remove the projected rise in normal pool elevation and the associated off-site impacts. However, the design engineers

(Professional Engineering Consultants, Inc. and Environmental Research & Design, Inc.) took advantage of the necessary changes in design to significantly improve and enhance the stormwater wetland system. A second element that was added was an Alum Injection and Floc Management System. Pollution load removal modeling of the new design indicates that the project should be able to meet the pollution removal goal of 80% input phosphorus load.

ESTW Design

As shown in Figure 2, the ESTW Design has five primary elements: (1) sediment removal pond; (2) shallow wetland system; (3) deep-water wetlands within the shallow wetland system; (4) alum treatment system; and (5) alum floc management system. Each element of the design has specific wetland habitat and pollution removal roles. The key to the design is the degree that these two roles complement each other. The project area encompasses approximately 100 acres and will treat runoff from a 6500-acre contributing watershed.

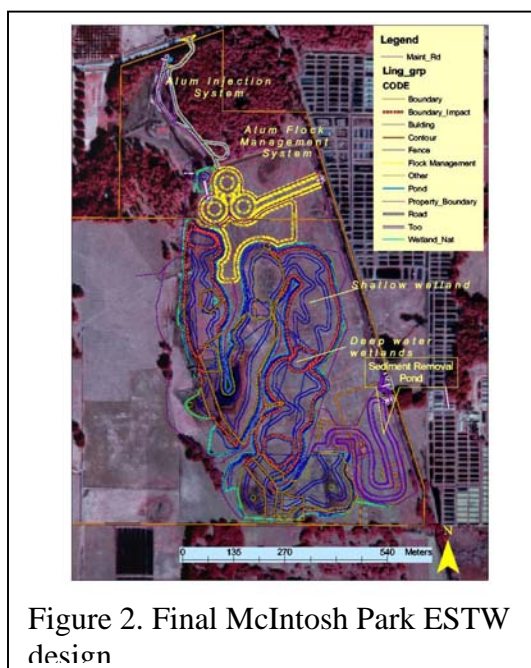


Figure 2. Final McIntosh Park ESTW design

An important element of the overall project is the BMP evaluation element. This element was planned from project concept. Consequently, monitoring well, soil core, and water quality sampling are being carried out and planned for each phase of the project. The goal of the BMP evaluation is to provide adequate data to determine the overall effectiveness of the project and to determine any on- or off-site impacts on wetland habitat or quality caused by the project. This second element is important because the project will employ alum for water quality "finishing" and recent FDEP interest in alum makes these types of data valuable. Details of the soil-sampling element can be found in a companion paper recently published in the Journal of Soil Science¹.

¹ Sigua, G.C.; Griffin, J.C.; Kang, W.; and Coleman, S.W. (2004). Wetland Conversion to Beef Cattle Pasture: Changes in Soil Properties. *J Soils & Sediments* 4 (1): 4-10.

LAKE TARPON SURFICIAL GROUNDWATER NUTRIENT STUDY

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Lake Tarpon is a 2600 acre lake located in the northeast corner of Pinellas County. The county is highly urbanized with most of the growth in the 1990's occurring in the northern third of the county including those areas around the lake. Water quality concerns lead to completion of a basin management plan for Lake Tarpon in 1998. Another concern was the impact of more than 1000 septic tanks in the lake basin. Numerous studies of the relationship between the water quality of Lake Tarpon and flow patterns of the surficial and Upper Floridan aquifers have been conducted since 1954. None of the studies addressed the nutrient input of the surficial aquifer immediately around the lake in sufficient detail to separate septic tank impacts from other sources. Pinellas County and the Southwest Florida Water Management District entered into a cooperative funding agreement to assess groundwater nutrient loading to Lake Tarpon. The objectives of the project included:

- Establish a shallow ground-water monitoring network around the lake for long term monitoring of surficial aquifer flux to the lake,
- Develop a ground-water flow net and nutrient flux model to provide updated nutrient flux estimates to the lake,
- Assess the nutrient load from existing septic tanks and evaluate the potential nutrient load reduction to the lake by replacing those septic tanks with central sewer.

The installation of 24 monitoring wells took place in 2002 at key locations around the lakes perimeter. These 24 wells plus 7 existing monitoring wells formed the monitoring network for this study. The spacing of the wells provided sufficient distribution for forming a segmented monitoring fence with adequate coverage for determining flux and nutrients to the lake using a nutrient flux model. Water samples were collected in the wet and dry season of 2002 from the 31 monitoring wells and analyzed for various constituents including nutrients. Results of the nutrient analyses were then used to select 17 wells for nitrogen isotope analysis.

Lithologic log data analyzed during the monitoring well installation indicated that the surficial sediments were predominantly characterized by fine to very fine-grained sands with variable amounts of silt, organics and clay. Hydraulic conductivity of the surficial aquifer was determined from pumping tests utilizing the slug test methodology at 21 of the 31 monitoring wells. Values obtained from these tests ranged from 2.5 to 33 feet/day, and averaged 11.3 feet/day. These values were developed for use in the nutrient flux model.

Water-quality analyses indicated that organic nitrogen species were minor parts of total nitrogen concentrations. Nitrate and/or ammonia constituted most of total nitrogen values. Nitrate concentrations ranged from 0.01 to 12.3 mg/l with concentrations greater than 1.0 mg/l detected in 11 of 31 wells. Ammonia concentrations ranged from 0.01 to 7.07 mg/l. Ammonia concentrations greater than 1.0 mg/l were detected in 9 of 31 wells.

Total nitrogen, ammonia or nitrate concentrations could not be directly related to land use. Nitrogen isotope analysis suggests two different groups of wells. The first trend consists of samples with light isotopic concentrations and higher nitrate values suggesting fertilizer as the dominant nitrogen source. The second trend shows enriched heavy isotopic values with increasing concentrations of either nitrate or ammonia. This suggests impacts from organic waste effluent from septic tanks or spray irrigation of treated effluent.

The analysis from the nutrient-loading model shows that the average total nitrogen loading ranges between 21 and 27 pounds per day. Approximately 70 to 78 percent of the total loading is contributed from areas surrounding three of the monitoring wells. These three wells are in both sewered and unsewered areas. The isotope sampling data suggests fertilizer as the source of nitrogen. The largest contributor of nitrogen identified as septic tank or reclaimed water comes from a well located near a septic tank within a golf course that is irrigated with reclaimed water. Preliminary metal and nutrient data suggest that the septic tank has a larger influence on nutrient concentrations than reclaimed water. Nitrogen isotope data further indicates that the nitrogen loading in wells located on the unsewered northwest side of Lake Tarpon is due primarily to fertilizers rather than septic tanks or reclaimed water.

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**COMPARATIVE REMOVAL EFFICIENCIES OF
CDS AND TST UNITS FOR REMOVAL OF PHOSPHORUS
IN LAKE OKEECHOBEE TRIBUTARIES**

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Lettuce Creek is within Nubbin Slough Basin, northeast of Lake Okeechobee, and discharges to the lake through the L-63S Canal. Historical water quality monitoring, conducted by the South Florida Water Management District (District), suggests that Lettuce Creek may be a significant source of sediment and particulate loading to the L-63S Canal, particularly under high flow conditions. From 2000-2004, a demonstration project was conducted in Lettuce Creek, just upstream of the point of discharge into the L-63S Canal, to evaluate the phosphorus reduction benefits which can be realized by removal of tributary sediment loads. Two sediment removal technologies were evaluated during this study, including Continuous Deflective Separation (CDS) and Tributary Sediment Trap (TST). Construction and installation of the CDS and TST units was conducted from February -April 2002. The units were constructed side-by-side, adjacent to Lettuce Creek, with a single 30-inch CMP intake pipe extending into Lettuce Creek. A series of structures and valves were also installed to split and regulate the flow discharging through the two units. Efficiency testing for the CDS and TST units was conducted from October 2002-November 2003 at inflow rates of 1, 5, and 11 cfs.

Flow rates in Lettuce Creek from November 1, 2002-December 1, 2003 were highly variable, depending primarily upon rainfall conditions. The vast majority of flow rates observed in Lettuce Creek were approximately 10 cfs or less. However, short-term increases in discharge rates to approximately 100 cfs were observed on two separate occasions and 475 cfs on one occasion. Bulk water samples were collected from Lettuce Creek during low flow and high flow conditions to evaluate the characteristics of sediment particles contained in water samples from the creek. Under low flow conditions, approximately 50% of the sediment particles had a diameter of less than 11 μm . These particles are primarily organic in nature and characterized by an elevated phosphorus concentration and an extremely low settling velocity ($\sim 10^{-6}$ m/s). Under high flow conditions, approximately one-third of the particle sizes are less than 11 μm , with an additional one-third comprised of fine sand in the 100-140 μm range. This fine sand consists primarily of inert particles with a low phosphorus content and relatively rapid settling velocity. Increases in flow rates in Lettuce Creek were found to be positively correlated with orthophosphorus and total phosphorus concentrations, although no significant correlations were observed between flow rate and TSS, turbidity, or nitrogen species.

Concentrations of phosphorus species in Lettuce Creek were found to be highly variable, with measured concentrations of organic phosphorus, particulate phosphorus, and total phosphorus covering several orders of magnitude between minimum and maximum values. On an average basis, approximately 61% of the mean total phosphorus concentration of 898 $\mu\text{g/l}$ is comprised of dissolved orthophosphorus, with 16% comprised of dissolved organic phosphorus, and 23% contributed by particulate phosphorus.

No significant removal of phosphorus species or TSS was observed in the CDS unit during operation at 1, 5, or 11 cfs. During operation at 1 cfs, the mass of total phosphorus increased by approximately 4% during migration through the CDS unit, with a net increase of 3% during operation at 5 cfs and a net reduction of 5% during operation at 11 cfs. Similar removal efficiencies were also observed in the TST unit. During operation at 1 cfs, the input mass of total phosphorus increased by approximately 1%, with a 1% removal at 5 cfs and a 1% increase at 11 cfs.

During a 207-day period of operation, the CDS unit collected 766.2 kg of dry solids which contained 0.14% total phosphorus and 0.44% total nitrogen. On an average basis, the CDS unit exhibited a mean TSS removal of 0.76 mg/l, with a mean total phosphorus removal of 1.1 $\mu\text{g/l}$ and a mean total nitrogen removal of 3.4 $\mu\text{g/l}$. Over a 193-day operational period, the TST unit removed 408.8 kg of dry solids which contained 0.14% total phosphorus and 0.14% total nitrogen. On an average basis, the TST unit removed 0.57 mg/l of TSS, 0.79 $\mu\text{g/l}$ of total phosphorus, and 0.77 $\mu\text{g/l}$ of total nitrogen. Based on an approximate construction cost of \$116,684, the 20-year life-cycle cost for mass removal in the CDS unit is approximately \$4.32/kg of dry solids, \$2992/kg of total phosphorus, and \$977/kg of total nitrogen. Based on an approximate construction cost of \$71,216 for the TST unit, the 20-year life-cycle cost for mass removal is approximately \$4.61/kg of dry solids, \$3343/kg of total phosphorus, and \$3407/kg of total nitrogen.

The inability of the solids separation units to remove phosphorus or suspended solids from Lettuce Creek inflow is attributed to two factors. First, a substantial number of fish accumulated within the two units due to the open connection with Lettuce Creek. Although numerous attempts were made to control and remove the fish populations, inputs of waste products from both dead and living fish are thought to have contributed to the poor removal efficiencies. Second, the small diameter particles discharging into Lettuce Creek are too small to be removed effectively by solids separation technologies. Although each of the two units is capable of removing sand and larger particles, particulate phosphorus in Lettuce Creek is associated with particles which can easily pass through the CDS and TST units.

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SESSION 4B

GOVERNMENTAL INITIATIVES

WATERATLAS.ORG: THE USE OF THE INTERNET IN RECRUITING VOLUNTEERS

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With over 7,800 lakes in the State of Florida, many of which do not provide public access, reaching volunteers to participate in lake management activities can be a daunting process. However, the use of the internet can help to reach those people with an interest in participating in lake management activities. The purpose of this presentation is to show how internet-based systems, such as the Water Atlas (www.wateratlas.org), can provide a necessary link between citizens and the agencies responsible for environmental management in helping to recruit volunteers.

As internet technology becomes more prevalent, many public and non-profit agencies are beginning to use it as a tool to not only provide information to the public, but to recruit volunteers. This recruitment strategy is an example “interactivity,” which can be defined as a website user being able to send information to the hosts of the site, in addition to accessing information provided on the site (Gilbert 1997). Those people who come to a specific website are self-identifying themselves as potential supporters or participants. Ellis writes that “This unique ability to ‘discover’ new people willing to align with a cause often surprises organizers by turning up previously-unknown volunteers across the street as well as across the globe” (Ellis 2003). Organizations have had varying levels of success in recruiting volunteers through the internet. Surveys of organizations using the internet as a recruitment tool have found “that while individual non-profits have had limited success in recruiting volunteers online, agencies and umbrella organizations indicate growing success” (Spencer 2002). This difference might be attributed to the ability for umbrellas organizations to reach a wider audience.

The Water Atlas websites, currently available in nine Florida counties, are an example of interactive websites where people can find scientific data, documents and other information related to a specific water resource, as well as fill out forms to communicate with the agencies responsible for water resource management. In regard to lake management, citizens can find out if the water resource is currently being monitored, learn about volunteer opportunities and fill out an online form where they can express their interest in volunteering. These forms are then directed to the people within the governmental agencies who are responsible for the volunteer programs.

This use of internet technology to recruit volunteers has been successful for the Water Atlas program. All forms submitted through the website are tracked by USF. For this presentation, we examined the statistics for the number of volunteer interest forms submitted for all Water Atlas websites during the calendar years of 2002 and 2003. The Water Atlas program received 38 volunteer forms in 2002 and 62 volunteer forms in 2003. Through the use of the Water Atlas, volunteer monitoring programs can connect with interested citizens who they might not otherwise be able to easily reach. Likewise, citizens can learn about the monitoring program and almost effortlessly express their interest in participating.

Some of the participating counties in the Water Atlas program have stated that a few of the benefits of recruiting through the internet are that the website has provided them with links to citizens who are willing to call in monthly lake and river readings, sample the water quality and become involved in lake restoration efforts. One problem that does arise from recruiting volunteers over the internet is that people can volunteer their service at any time; however, there is not always a specific project or opportunity in which to include that volunteer. If there is not an immediate need for the volunteer, then that person might lose interest in participating in volunteer efforts. Also, when a county has a specific activity for which they need volunteers, just waiting for people to offer their help through the website will not necessarily provide them with enough volunteers. In the future, it is likely that more and more citizens will be accessing the internet to find out information about water resources. Therefore, efforts should be made to refine the use of interactive technology in recruiting volunteers for lake management activities so that it can meet its full potential.

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NOTES:

**CLEAN LAKES INITIATIVE:
A START TO EXCELLENCE IN LAKE STEWARDSHIP**

Ronald Novy
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Clean, healthy lakes are very important to Central Florida's ecology and its citizens. In order to promote good lake stewardship, the Orange County Environmental Protection Division (EPD) has implemented a "Clean Lakes Initiative" to assist citizen groups and individuals in protecting Orange County lakes through education and volunteer cooperation.

Poor water quality and loss of habitat are two of the biggest problems impacting Orange County lakes. Degraded water quality is generally caused by surface-contaminated runoff from parking lots, rooftops, roads, and poor storm water management practices associated with urbanization. Lakeshore erosion, bank instability, loss of wetlands, and the lack of shoreline buffers also contribute to reducing water quality and loss of habitat. This slow degradation leads to an eventual decrease in fish and wildlife populations and can diminish the recreational opportunities and overall lake aesthetics enjoyed by our citizens.

The Clean Lakes Initiative highlights opportunities for citizens of all ages, from apartment dweller to lakefront property owner, to participate in preserving local lake ecology. Some of the programs key components are assistance in implementing:

- MSBU/MSTU (Municipal Service Benefit/Taxing Unit)
- Adopt-a- Lake/WAV Water Monitoring Program
- Storm Drain Labeling
- Educational Programs Seminars
- Community Workshops
- Florida Yards and Neighborhoods, Florida Friendly Landscaping
- Clean Lakes Incentive Program

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THE TMDL PROCESS: A LOCAL GOVERNMENT'S PERSPECTIVE

Kim Ornberg, PE

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In the beginning...

Seminole County is located in the middle St. Johns River Basin, just north of Orlando. It is bounded on the north and east borders by the St. Johns River and on the western border by the Wekiva River. It is predominantly identified as a Group 2 basin by FDEP's TMDL rotating basin schedule, with a very small portion (southeast corner) that falls within the Group 3 basin boundary (upper St. Johns River Basin).

After seeing many presentations and articles over a few years' time by Eric Livingston, his staff, and others about the impending TMDL program, we decided that rather than waiting for it to come to us, we would try to gear up, be proactive, and try to help FDEP with this process. We went into the process with the attitude that we wanted an accurate list of impaired water bodies used to develop TMDL, not with the attitude of having every one of them removed from the list. We made this proactive decision based on several factors. First, we knew that it was inevitable that the TMDL program was coming our way. Second, we knew that, because of the consent agreement and other legal issues, the state was working with a very restricted time frame with which to develop and implement the program; and also, as virtually all government agencies operate, FDEP's staff and resources for this major undertaking were very limited. Finally, once we comprehended the enormity of the project which the state's small staff had been tasked to complete we asked ourselves, who better than us to provide the state with input and insight about surface water quality data and the other related information they needed to complete their TMDL goals in our area? The state staff, with whom we have developed a very good working relationship over the past several years, was doing a great job with the process, but could use some additional help to develop a more accurate product. We decided that it would be in our own best interest to provide the state with the needed local insight that they did not have the time nor funding to provide themselves. We then began to take the necessary steps that would allow us to be proactive, which included briefing our county commissioners and county manager on the impending TMDL process. This then enabled us to start securing additional funding in conjunction with our NPDES MS4 program. We in turn were able to hire a consultant to assist our staff with the process.

Our adventure, thus far...

Phase 1 – Data Review

It is vitally important for the whole process that the state begins with a good set of data. We therefore began by making sure that our own water quality data was uploaded into STORET, the federal database that FDEP uses. While not a simple task, it is a very important one! Next, we obtained a copy of and reviewed the database and made sure that our data was included and

accurate (because of our deep confidence in the STORET database system). We also did a thorough review of the other data in the database, especially the Legacy STORET data. The Legacy data is much older data, and consequently has not always been properly collected, entered or quality controlled. We were only looking for blatantly obvious erroneous data, such as negative values or values that were orders of magnitude higher than all of the rest, which could have been caused by conversion error, etc. We also plotted out all of the sample sites so that we could review them for spatial accuracy. We found that many samples were located in incorrect WBID (waterbody identifications), which was due mostly to inaccurate input into STORET. This was especially true, once again, with the Legacy STORET data. We found that there was a very large group of different sample sites (~45) that were positioned in the exact same spatial location, which happened to be at about the center of the county. We summarized all of the water quality and spatial errors that we had found and provided corrected information, where applicable, to the state. They reviewed this and incorporated the revisions we had identified.

Phase 2 – Strategic Monitoring

Additional samples were required to fill in the data gaps for some of the waterbodies that had been identified as potentially impaired. We offered, and subsequently provided, our staff's assistance in collection (and analysis by a NELAC certified analytical laboratory) of some of these additional samples.

As each iteration of the Planning List was published, we compared the results of each IWR run with our own analysis. We reviewed the raw data from the database repeatedly, since new data was continually being uploaded at each iteration. We also looked at all of the actual WBID delineations, and proposed some revised boundaries. At each iteration, we summarized our findings and/or discrepancies and submitted them to the state. We then conducted teleconferences with FDEP staff to discuss the discrepancies each time. These teleconferences were vital in allowing an open dialogue to more thoroughly discuss the issues. It also allowed the state to request any additional information that they might need in order to further consider our requests. Through this process, we were successful in having several of the inaccurate or incorrect impairments within our jurisdiction removed from the list. We were not able to have all of the impairments removed from the list that we felt were incorrect, but this was due mostly to our own inability to provide the state with enough evidence to justify removal to both the EPA and environmental groups, which are closely scrutinizing the process. Fortunately, none of the impairments in question are listed as "high priority," so we are continuing to collect additional data that should affect their removal from the list, when re-analyzed. We have also begun collecting data on lower priority listed waterbodies that had not previously been in the County's monitoring program. As a result, we will feel confident about the data accuracy and subsequent impairment status of each of these waterbodies.

Phase 3 – Data Analysis and TMDL Development

We are currently providing local assistance and coordination with both the TMDL model development and stakeholder process. We have coordinated several technical meetings with local municipal staff and state staff to identify the state's TMDL modeling plan of action and data needs, as well as identify information that is available from the different municipalities. This information includes basin studies (H&H modeling), hydrologic data with or without

corresponding water quality data (actual pollutant load data), pollutant load estimates/models, meteorological data, etc. Some of this information is currently being analyzed by FDEP and will likely be used as a preliminary modeling/assessment tool. In terms of the coordination and assistance with the local stakeholder process, we have provided the names of local stakeholders and identified appropriate meeting locations.

This is where we are in the current and ongoing process. We are continuing to work cooperatively with the state to provide as much assistance as we can, because we feel strongly that the end product will be better and more accurate with our positive interaction throughout the process.

My advice to you...

- Don't stick your head in the sand – it is coming whether you like it or not!
- Take a positive proactive approach and get involved in the process.
- Educate or brief your local officials on the process, so they know what's coming.
- Develop a good working relationship with FDEP.
- Get your data into STORET, whatever it takes!
- Thoroughly review the data and assessments at each step of the process.
- Provide FDEP with all of the local information that you can identify.
- If you do not have the expertise and/or time to dedicate to the process, contract with a reputable consultant that can serve as an extension of your staff and will assist you with the process.

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SESSION 5A

USE OF COAGULANTS FOR WATER QUALITY IMPROVEMENT AND LAKE MANAGEMENT

**EXPERIENCES IN COAGULANTS FOR MANURE
TREATMENT AND PHOSPHORUS RUNOFF CONTROL:
EVALUATIONS OF SYSTEMS FOR SMALL
AND LARGE CAFO OPERATIONS**

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Confined Animal Feeding Operations (CAFO) generated 128 billion pounds (58 billion kg) of manure in 1997; 1.4 billion pounds of which (0.65 billion kg) were phosphorus. Manure phosphorus is largely soluble or readily available to runoff events exacerbating eutrophication of surface waters. Florida is a highly agricultural state that ranks 16th in broiler chicken production, 11th in egg production, 4th in horses, 14th in dairy cattle, 12th in beef cattle, 33rd in pigs, 6th in catfish, and has significant numbers of other conventional and exotic livestock.

Over the past eighteen months use research projects have looked at the applicability of various wastewater and solids handling equipment options with chemical precipitation and flocculation for nutrient reduction. Originally the use of aluminum sulfate as a poultry litter amendment demonstrated 80% reduction in soluble reactive phosphorus (SRP) as well as the environmental benefits in ammonia and particulate emission control, soluble metal and TOC reductions in runoff. Mortality reduction, condemnation reduction, ventilation savings, improved feed conversion, animal welfare issue improvement, and worker safety all contribute to positive agronomic benefits to “incentivize” the projects. Moving into larger animals and liquid waste systems required more sophisticated equipment and additional chemical options to enhance dewatering and provide odor control. The aims of the treatment were reductions in SRP, clarification of water to provide the farmer with reuse options, and remove any nitrogen. Costs had to be in a range where the farmer could afford the technology, and the technologies had to be both durable and simple enough to withstand the rigors of farm service.

Bench scale tests were conducted to determine appropriate additions of aluminum sulfate (alum), ferric sulfate (LFS), aluminum chloride, and aluminum chlorohydrate (ACH) needed to obtain the requisite SRP reductions in the farmer’s nutrient management plan (NMP) or an arbitrary target of 80%¹ if no NMP was in force. Polymeric flocculants of various molecular weights and charge characteristics were then tested to determine the enhancement they provide in dewatering and clarification of the coagulated alum/LFS tests. Usually cationic polyacrylamide emulsion type products provided the best treatment. Field analytical equipment such as Hach® spectrophotometers and the like were used to determine clarity, SRP, total Nitrogen, Sulfide, etc. Best tests were used to set up dosage on full-scale programs.

¹ The 80% target is that used in several states’ NRCS practice standards in which a farmer adding alum to achieve 80% SRP reduction in poultry facilities can apply for Environmental Quality Incentive Program (EQIP) matching funds.

Dairy waste successes perhaps have the most pertinent data relative to the FLMS experience in local watersheds. In dissolved air flotation systems (DAF) the use of alum and polymers or LFS and polymers have produced “ginger ale” colored effluent from raw flushed manure. In these cases the fiber in the manure has been recovered, and the effluent from the recovery systems is treated by injection of alum and polymer into a manure feed line pressureized with air. The release of pressure causes bubbles that float the treated floc to the surface for removal. Clean water is decanted off and the floated solids are either land applied or otherwise treated. Three different vendors of fiber recovery systems and DAF clarifiers were tested full-scale. SRP removal ran from 80% to >95%; Total Suspended Solids (TSS) removal ran from 90-95%; and Total Nitrogen removal ran from 40-50%. Costs averaged \$0.06 per cow per day to \$0.15 per cow per day—acceptable costs.

Some systems use belt filter presses to dewater the manure. In these systems, LFS or alum and polymers can produce a drier solid material than a DAF. The penalty often is a dirtier liquid fraction and higher O&M costs. These are weighed against the cost of solids disposal. These system easily average over 80% SRP, TSS and 30% TN removal. Costs for these systems will run in the \$0.15-\$0.20 per cow per day.

Recent developments in using geotextile dewatering bags are showing excellent clarity and nutrient removal at very competitive costs. These bags² have been used for decades for beach erosion control, dredge spoil containment, hazardous waste containment, municipal waste and paper waste treatment. These are pumped with the chemically treated waste and allowed to dewater. The bag is its own containment system and filtration system. In treating swine and dairy lagoons, and fresh flush waste these systems run <\$0.005/gallon treated. Small dairies are looking at around \$500-600 per bag plus \$5-10/day in chemical for four to six months waste holding. Removal rates on large swine lagoon cleanout were >97% SRP removal, >50% TN removal and up to 90% removal of heavy metals.

The bag and manure can be disposed of as one unit in a landfill or energy recovery system (both will burn at high temperatures). Or, the dried manure can be removed and land applied or composted, and the bag cab be reused as road base on the farm (same material as road bedding).

The control of SRP, TN and other contaminants from CAFO manure and lagoons can be technically effective as well as cost effective with simple and “farmer friendly” treatment technology. Existing or closed lagoons can be cleaned quickly and watershed impacts immediately reduced.

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² Geotube® a product of Miratech Division of Ten Cate Nicolon

THE FEASIBILITY OF USING SODIUM ALUMINATE WITH ALUM FOR NUTRIENT CONTROL AT EUSTIS MUCK FARM

Maria L. Jones, Brad Uhlmann, and Ann B. Shortelle,
MACTEC, Inc. - Newberry, FL

Victoria R. Hoge and Walt Godwin
St. Johns River Water Management District - Palatka, FL

MACTEC Engineering and Consulting, Inc. performed a series of tests at our laboratory in Gainesville, Florida to assist the SJRWMD determine the appropriate combination of amendments to be applied at the Eustis Muck Farm in order to lower the levels of phosphorus in the water column prior to dewatering activities. These tests were performed in three phases. The purpose of Phase I tests was to determine whether the application of sodium aluminate as a buffer instead of hydrated lime was a feasible alternative. The purpose of Phase II tests was to determine the appropriate ratio of amendments (ratio of alum to sodium aluminate). The purpose of Phase III tests was to narrow in on the appropriate ratio as well as determine whether the additional aluminum may result in unacceptable toxicity in the environment.

The combination of alum and sodium aluminate has been previously used successfully to inhibit the diffusion of phosphorus from lake sediments into the water column (Sweetwater Technology Corp.). This has been done by creating a layer of aluminum hydroxide flocs over the sediments. For the treatment of lake sediments, the pH of the lake was maintained unchanged. The removal of phosphorus from the water column has been successfully accomplished using a combination of alum and hydrated lime. When alum hydrolyzes it forms $\text{Al}(\text{OH})_3$ flocs that bind dissolved phosphorus and settle to the bottom, while hydrated lime buffers the system in order to maintain the pH within a reasonable range. Sodium aluminate is an excellent buffer and at the same time contributes significantly to the total concentration of $\text{Al}(\text{OH})_3$ required for P deactivation. Our tests were conducted to demonstrate that if sodium aluminate is used instead of hydrated lime there can be a significant savings in the amount of amendments used to treat Florida surface waters.

All the tests performed were designed using water collected from the Eustis Muck Farm impoundment and with the target final aluminum concentration of 18 mg Al^{3+} per liter recommended in a previous study of the waters at Eustis Muck Farm performed by ERD (2003). This concentration of Al^{3+} was sufficient to lower the phosphorus concentration from levels of over 2400 $\mu\text{g/L}$ to the target concentration of 50 – 100 $\mu\text{g/L}$.

The Phase I tests verified the efficacy of the alum/lime dosage recommended by ERD, and compare it to the performance of alum and sodium aluminate, completely buffering the system to maintain an unchanged pH.

Phase I Tests		[P] µg/L	Amendments added (as mg of Al ³⁺)	pH measurements			
				Initial	2 hours	20 hours	44 hours
Beaker #1	Control - Lake water	2410	None	7.87	7.8	7.7	7.7
Beaker #2	Alum/Lime	28	Alum: 18 / Lime: 16 mg Ca(OH) ₂	7.83	5.8	6	6.8
Beaker #3	Alum/sodium aluminate	462	Alum: 7.54 / So-Al: 10.33	7.75	7.7	7.6	7.6
Beaker #4	Alum/sodium aluminate	692	Alum: 10.6 / So-Al: 7.26	--	--	--	7.1

The results indicated that efficient P removal is subject to pH, and that a pH range between 5.5 to 6.5 was optimal. The less efficient P removal of Beaker #4 compared to Beaker #3 was attributed to sampling error which included some floc.

Phase II tests were performed using different volumetric ratios of alum to sodium aluminate, while maintaining the total Al³⁺ concentration at 18 mg/L. Various ratios were tested between 3:1 and 60:1 (alum to sodium aluminate). PH measurements were taken at one minute, one hour and 24 hours after the addition of amendments. The tests with ratios between 10:1 and 30:1 gave pH measurements within the target range one hour after the addition of amendments. Results for the tests between 3:1 and 30:1 ratio are shown below.

Phase II Tests		Amendments added		[P] µg/L	pH measurements		
Ratio		Alum (mg Al3+)	So- Al (mg Al3+)		1 minute	1 hour	24 hours
3:1		1.54	2.06	462	7.47	7.45	7.63
5:1		1.99	1.61	-	6.88	7.00	7.21
10:1		2.57	1.03	-	6.36	6.43	6.88
15:1		2.84	0.76	97	6.14	6.03	6.69
20:1		3.00	0.60	-	5.96	6.09	6.55
25:1		3.10	0.50	-	5.87	5.87	6.43
30:1		3.18	0.42	42	5.85	5.76	6.38

Only three test ratios were submitted for P analysis: the 3:1 ratio was chosen since it is the ratio at which the pH remained unchanged, and the 15:1 and 30:1 were chosen to bracket what was estimated to be the optimum ratio. The ratio of 20:1 was determined to be optimum based on the pH (not dropping significantly below 6.0) and the P concentration estimated to be approximately 70 µg/L.

Phase III tests were performed to refine the ratio recommended for treatment of the Eustis Muck Farm, and to determine whether dissolved aluminum would be expected to be present at potentially harmful concentrations during the application of amendments. The following ratios were tested: 15:1, 20:1, 25:1 and 30:1.

Phase III Tests	Amendments added (mg Al ³⁺)		Total [P]	SRP	Dissolved Al	pH			Alkalinity/mg/L	
	Alum	So- Al	mg/L	mg/L	µg/L	1 min	1 hour	24 hours	@ day 1	@ day 4
Control	0.0	0.0	1.9	1.88	55.5	7.14	7.19	7.47	81.2	92.8
15:1	14.5	3.5	0.065	0.004U	68.3	5.64	5.76	6.28	52.2	56.8
20:1	15.3	2.7	0.068	0.004U	75.3	5.51	5.62	6.07	22.04	23.2
25:1	15.8	2.2	0.052	0.004U	99.4	5.40	5.49	5.97	18.56	18.56
30:1	16.1	1.9	0.051	0.004U	92.7	5.33	5.44	5.90	17.4	24.36

U = analytical detection limit

Though results indicated little variability, the ratio of 20:1 was selected as the target for whole lake application for the following reasons: the pH remained within the target range of 5.5 to 6.5, the total P concentration was within the target range, and the dissolved Al concentration was likely to be acceptable based upon the results of companion toxicity testing and the availability of complexing agents in the site water.

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NOTES:

THE USE OF LIQUID ALUM FOR NUTRIENT CONTROL AT EUSTIS MUCK FARM

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Ann B. Shortelle, Maria L. Jones, and Brad Uhlmann
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Eustis Muck Farm has been designated as a disposal site for dredge material from canals surrounding Lake Griffin. Deposition of dredge materials in Eustis Muck Farm will raise bottom elevations and er sediments that contain pesticide residues from previous row-crop farming activities. Existing water column P concentrations were highly elevated, averaging 2,900 µg TP/L for the previous two years. Prior to disposal of il, water level in the site needed to be lowered to create storage capacity with a potential discharge of phosphorus (P) to Lake Griffin. The site covered approximately 550 acres with an average water depth of 8 feet.

The most logical action to reduce or eliminate this loading of nutrients to Lake Griffin was an application of liquid alum to precipitate phosphorus from the water column prior to dewatering the site. This method has been successfully used within the Emeraldal Marsh Conservation Area at the Lowrie Brown and Long Farms. An initial application design by Environmental Research & Design, Inc. (ERD) recommended an alum dosage of 18 mg/L and a lime dose of 16 mg/L to reduce phosphorus levels to a desired range of 50-100 µg/L while maintaining a pH above 5.5. Further investigation by MACTEC, Inc. commended using sodium aluminate as a neutralizing agent at an optimum ratio of 20:1 (alum:sodium aluminate). Sodium aluminate forms $\text{Al}(\text{OH})_3$ upon addition to water, therefore less alum is required to inactivate phosphorus.

A total of 368,883 gallons (82 tankers) of alum and 6,036 gallons (2 tankers) of sodium aluminate were applied between November 13 and November 20, 2003 by Sweetwater Technology, a division of Teemark Corporation. The final expense of the chemical application was \$278,061 or \$506 per acre. total phosphorus decreased to 64 µg TP/L immediately following application. During January 2004 the water elevation site was lowered by two feet to provide storage for the planned incoming dredge spoil.

By March 2004, concentrations had risen to 237 µg TP/L and 460 mg Al-D/L. This coincided with a pH increase to 9.14 and a rise in chlorophyll-a concentrations. During early April, these levels declined to 214 µg TP/L, 78 mg Al-D, and a pH of 7.58. A new equilibrium is likely being established during this time. The water quality results from this treatment will be compared to previous applications at two nearby sites within the Emeraldal Marsh Conservation Area.

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**EVALUATION OF AN OFF-LINE NUTRIENT
REDUCTION FACILITY TO IMPROVE WATER QUALITY
DOWNSTREAM OF LAKE APOPKA**

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Lake Apopka, located northwest of Orlando, Florida at the headwaters of the Harris Chain of Lakes, is a 125-km² hypereutrophic lake that has experienced decades of poor water quality due to external nutrient loading. About four-fifths of the lake is located within Orange County and one-fifth within Lake County. The majority of nutrient loading is attributed to muck farm discharge occurring since the early 1940's. Muck farming around Lake Apopka ceased in the mid 1990's but average total phosphorous (TP) concentration in the lake is still 145 ppb (Marzolf, 2004).

Discharge from Lake Apopka, via the Apopka-Beauclair Canal, contributes directly to the eutrophication of Lakes Beauclair, Dora and Eustis. The Florida Department of Environmental Protection (FDEP) recently placed all of these lakes on their 2003 Verified List of Impaired Waters and established a TP Total Maximum Daily Load (TMDL) for each. Reduction of phosphorous discharge from Lake Apopka appears to be the most logical step toward meeting TMDLs for most of Lake County's Harris Chain of Lakes.

Several agencies are currently working toward achievement of TMDL goals for Lake Apopka and downstream. The St. Johns River Water Management District (SJRWMD) has already initiated several projects including muck-farm acquisition, activation of a Marsh Flow-Way (MFW), and gizzard shad harvesting. These projects are expected to make significant strides toward achievement of Lake Apopka's 55 ppb TP TMDL target concentration. However, additional treatment will still be necessary to meet the TP TMDL target concentrations for Lakes Beauclair (32 ppb), Dora (31 ppb) and Eustis (25 ppb).

The Lake County Water Authority (LCWA) is also working to meet the TMDL goals established downstream of Lake Apopka. The LCWA recently commissioned two studies, titled Beauclair Canal Alum Treatment System Evaluation (2002) and Alum Treatment Feasibility Evaluation for Lake Dora and Lake Beauclair (2003), to investigate the phosphorous removal capabilities of aluminum sulfate (alum). Based on these studies, the LCWA concluded that whole-lake alum application would not be economic until loading sources to the lakes could be controlled. The LCWA also concluded that an off-line facility on the Apopka-Beauclair Canal (ABC) would be most appropriate for treatment of water discharging from Lake Apopka. Therefore, the LCWA solicited Requests for Proposals for an Off-line Nutrient Reduction Facility (NuRF).

In cooperation with the Florida Fish and Wildlife Conservation Commission, SJRWMD and FDEP, the LCWA reviewed several alternatives for the NuRF. The successful design proposal, recently awarded to Environmental Research & Design, Inc. (ERD), calls for the NuRF to be constructed using proven alum injection technology. Based on the evaluation, the NuRF could reduce total phosphorous load to Lake Beauclair by 67% or more for flows up to 300 cubic feet per second. In conjunction with the MFW, the NuRF will have the capability of reaching the TP TMDL for Lake Beauclair and will provide substantial benefits to Lake Dora and Lake Eustis as well.

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LAKE HOLLINGSWORTH ALUM TREATMENT

Harvey H. Harper, P.E.

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Gene Medley

City of Lakeland Lakes and Stormwater Division - Lakeland, FL

Lake Hollingsworth (area = 355 acres) is a highly productive, hypereutrophic lake which is an important recreational and natural resource for the City of Lakeland (City). Over the past 40 years, Lake Hollingsworth has been characterized by elevated levels of total nitrogen, total phosphorus, and chlorophyll-a and has exhibited poor water column clarity and virtually constant algal blooms. The bottom of Lake Hollingsworth accumulated a thick layer of flocculent organic sediments which is easily disturbed by wind action and is thought to contribute to the ongoing conditions of poor water quality within the lake. During 1997-2001, the City of Lakeland performed a hydraulic dredging project on Lake Hollingsworth to remove approximately 80% of the organic sediments in an attempt to increase the mean water depth within the lake and to reduce internal recycling of nutrients from the sediments into the overlying water column (post-dredging volume = 3076 ac-ft; mean depth = 8.7 ft).

When dredging activities were completed, concerns were raised that the remaining organic sediments may still have the potential to contribute nutrients to the water column of the lake. As a result, the City contracted with ERD to evaluate the characteristics of remaining sediment deposits within the lake and the feasibility of an alum application for inactivation of nutrient release from remaining sediments. The alum application is also intended to provide immediate improvement in water quality characteristics so that submerged aquatic vegetation could be established within Lake Hollingsworth to further improve long-term water quality.

Field and laboratory activities were conducted by ERD from July-August 2003 to characterize existing sediments and to evaluate water quality impacts resulting from the application of alum to the sediments and the overlying water column. A total of 36 separate core samples was collected in Lake Hollingsworth and evaluated for a wide range of physical and chemical characteristics. Shoreline sediments are comprised primarily of a fine sand, with organic muck located in central portions of the lake. Each of the core samples was carried through speciation procedures to evaluate bonding mechanisms for phosphorus within the sediments. The Chang and Jackson speciation procedure was used which allowed the speciation of sediment phosphorus into saloid-bound phosphorus (defined as the sum of soluble plus easily exchangeable sediment phosphorus), iron-bound phosphorus, aluminum-bound phosphorus, and calcium-bound phosphorus. Saloid-bound phosphorus is considered to be available under all conditions at all times. Iron-bound is relatively stable under aerobic environments, characterized by redox potentials > 200 mV (E_h), while unstable under anoxic conditions, characterized by redox potentials < 200 mV. Aluminum-bound and calcium-bound phosphorus are considered to be stable under all conditions of redox potential and natural pH conditions. Based upon the results of the sediment speciation, approximately 20% of the total sediment phosphorus within Lake Hollingsworth is potentially available for release into the overlying water column. Isopleths of available phosphorus within the sediments were developed to estimate sediment inactivation requirements and for use as a guide during inactivation procedures. Laboratory jar testing was performed to evaluate impacts on water quality characteristics from addition of alum to the water column of the lake.

Estimates of the mass of total available phosphorus within the 0-10 cm layer of the sediments in Lake Hollingsworth were generated by graphically integrating the total available phosphorus isopleths. On a mass basis, the sediments of Lake Hollingsworth contain approximately 5076 kg of available phosphorus, equal to approximately 163,747 moles of phosphorus. Based upon a molar Al:P ratio of 5:1, inactivation of phosphorus release from sediments in Lake Hollingsworth would require approximately 818,735 moles of aluminum which is equal to approximately 99,695 gallons of alum.

Application of approximately 85,500 gallons of alum, equivalent to 85% of the required sediment inactivation dose, was completed during December 2003. The application reduced water column concentrations of total phosphorus from 108 $\mu\text{g/l}$ prior to the treatment to a mean of approximately 12 $\mu\text{g/l}$ two weeks after the final application. Chlorophyll-a concentrations in the lake were reduced from a pre-treatment mean of 145 mg/m^3 to a post-treatment value of 8.6 mg/m^3 . Slow increases in total phosphorus and chlorophyll-a concentrations have been observed since the application, with concentrations of total phosphorus approximately 40 $\mu\text{g/l}$ and chlorophyll-a approximately 25 mg/m^3 six months following the application.

NOTES:

SESSION 5B

**WATERSHED EVALUATION
AND MODELING**

A GIS APPROACH TO WATERSHED NON POINT SOURCE POLLUTION LOAD MODELING

James C. Griffin

Southwest Florida Water Management District – Brooksville, FL

David T. Jones

Parsons, Inc. - Tampa, FL

Introduction

The Southwest Florida Water Management District (SWFWMD) and its consultant, Parsons Inc., are in the process of improving the existing SWFWMD non-point source pollution (NPS) load model. This model was developed cooperatively with Parson's Inc. and Hillsborough County and operates within the ArcView¹ environment to estimate pollution loads on a watershed and sub-watershed level. The model employs the United States Environmental Protection Agency's (USEPA) "Simple Method" model and customized ArcView tools to allow watershed planners to estimate pollution loads potential for various land use-soil combinations and to evaluate the pollution load reduction potential of various Best Management Practice (BMPs) facilities. SWFWMD is in the process of updating its ArcView based NPS pollution estimation model to operate in the ArcGIS 8/9 environment. This paper will discuss the general requirement; the proposed improvements to the existing model will discuss the advantage of developing a customized Geodatabase to support the model.

Background

One approach used in estimating NPS loads for a watershed plan is the event mean concentration (EMC) based NPS pollution load Simple Method. This method estimates the pollutant load based on annual rainfall, land use with its associated EMC and impervious surface values and soil type with its associated hydrologic soil group. The USEPA Simple Method normally employs a spreadsheet approach to calculate a gross load potential for each of the numerous soil-land use polygonal areas. The present SWFWMD ArcView based model is a GIS implementation of this spreadsheet approach. This method may be used, with reasonable results, for watershed planning where the primary goal is to find potential problem areas and to compare the potential pollution load between sectors. However, the method does not allow a true determination of the expected pollution load and the method does not take advantage of the full power of today's GIS software and new data gathering approaches. Finally, the pollution load model is run separately and is not necessarily coordinated with the flood protection model. Because of these shortfalls, the SWFWMD began a project to update and improve the existing model.

¹ESRI trademark

Approach

The new SWFWMD NPS pollution load model project has the goal of: (1) Moving the present ArcView model into the Arc 8/9 environment; (2) Improving spatial and temporal accuracy of rainfall data through the use of NEXRAD; (3) Improve runoff coefficient calculation by incorporating SWIM 4.5 and (4) housing the model results within a geodatabase². These goals will be met by taking advantage of the full capabilities of an Arc 8/9 data model developed as part of the project.

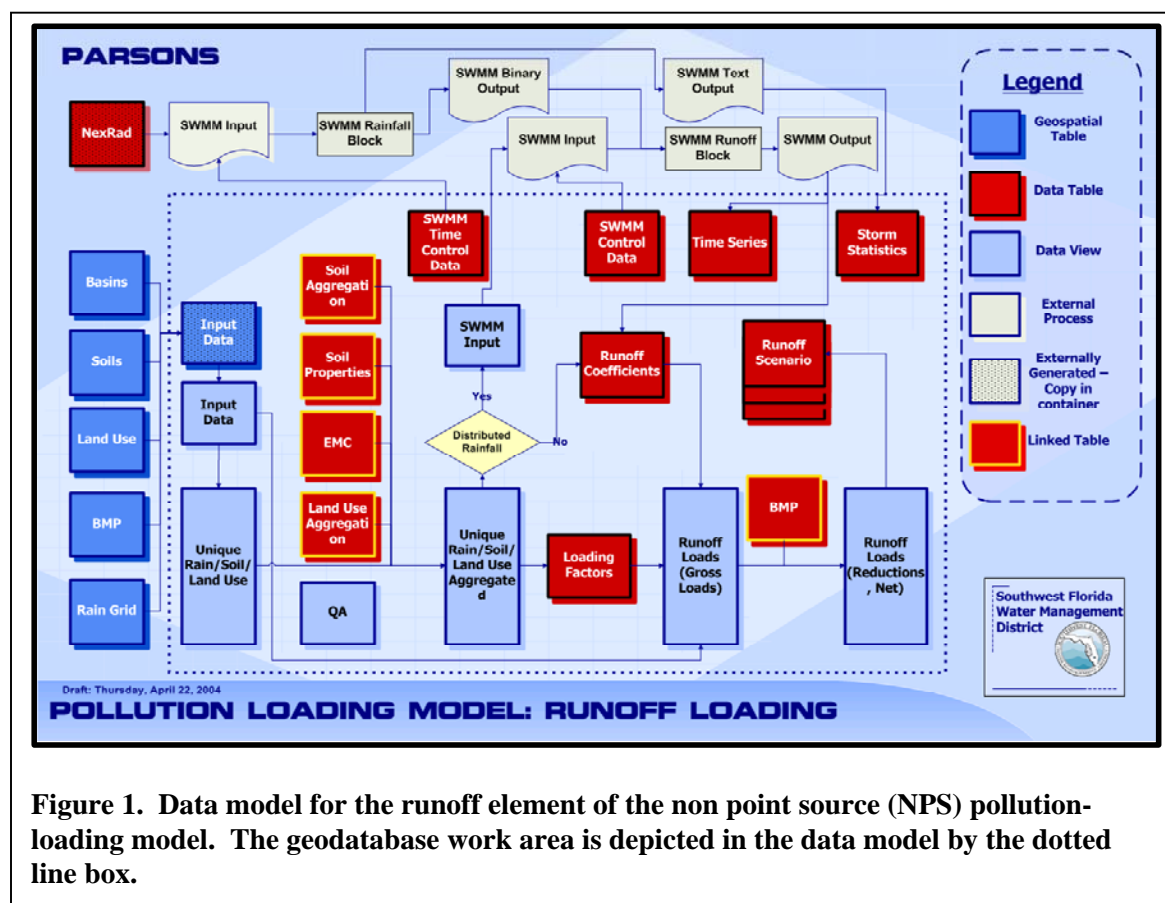


Figure 1. Data model for the runoff element of the non point source (NPS) pollution-loading model. The geodatabase work area is depicted in the data model by the dotted line box.

² At its most basic level, the geodatabase is a container for storing spatial and attribute data and the relationships that exist among them. In a geodatabase, which is a [vector](#) data format, features and their associated attributes can be structured to work together as an integrated system using rules, relationships, and topological associations. In other words, the geodatabase allows you to model the real world as simply or complexly as your needs dictate.(ESRI definition)

Figure 1 illustrates the primary components of the runoff-loading element of the model design. The complete design adds a network model, which will be covered in detail in a second paper. The current paper will focus on the structure of the above data model and will discuss the proposed application of this element of the overall model. There are many challenges to the present model effort. The first of which is to develop an approach that effectively employs the relational database design inherent in the new Arc 8/9 environment. While there are many advantages to a relational database approach, the approach requires a significant amount of design to be accomplished prior to the geodatabase design. A second challenge is the application of NEXRAD data for both spatial and temporal improvements to rainfall and runoff calculations. A third is the concept and use of EMC and BMP data and a fourth is the use of time series data and the integration of the SWIM 4.5 model.

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LAKE ISTOKPOGA AND ARBUCKLE CREEK: PROGRESS IN WATERSHED EVALUATION AND A SUMMARY OF WATER QUALITY CONCERNS

Jennifer Brunty

Highlands County Soil and Water Conservation District
Sebring, FL

Lake Istokpoga is a 28,000 acre lake located in Highlands County, a few miles upstream of the Kissimmee River and in the Lake Okeechobee watershed. Until recently, only a small percentage of Lake Istokpoga's 1554 km² watershed was officially recognized by the Comprehensive Everglades Restoration Plan (CERP) and the Lake Okeechobee Watershed Project (LOWP). Official recognition of the whole watershed, which currently crosses Water Management District boundaries, has resulted in numerous recent efforts to identify sources of phosphorus in the watershed.

Lake Istokpoga has been identified as a significant source of phosphorus to Lake Okeechobee (SFWMD, 2003), which has already been assigned a phosphorus Total Maximum Daily Load (TMDL). Between 1995 and 2005, Lake Istokpoga contributed an average of 21.1 metric tons of P per year, on average, to Lake Okeechobee, as measured at the S-68 outflow structure. Lake Okeechobee has a TMDL of 127 metric tons per year of P, 95 tons from surface water inflows.

One P source identification effort was a mass watershed survey conducted by the SFWMD during the dry and rainy seasons of 2002. Samples were collected from several dozen sites on a single day for the watersheds of each of Lake Istokpoga's primary tributaries, Arbuckle Creek, and Josephine Creek. The dry season samples were collected in April, and wet season samples were collected in July. Results of these sampling efforts indicated that there were few sources of P input in the Josephine Creek watershed (Ritter, 2003), which has historically had low levels of P at the creek mouth, averaging about 40 ppb. However, there were several areas of concern for P contribution identified by this survey in the Arbuckle Creek watershed. These sources include the wastewater treatment plant for the Avon Park Correctional Institution, three dairies, and a sod farm (Ritter, 2003). LAKEWATCH data collected from Arbuckle Creek indicate that P concentrations increase as water flows through the County. The long-term average P concentration in Arbuckle, at the inflow to Istokpoga, is 110 ppb (SFWMD data).

LAKEWATCH, Highlands County, and SFWMD data all indicate that P concentrations in Lake Istokpoga are significantly higher at the north/inflow end of the lake than at the south/outflow end of the lake (60-80 ppb versus 40-60 ppb). These data indicate that the lake is currently absorbing P from water as it moves from north to south through the lake, though this is not expected to continue indefinitely. In fact, a sediment study conducted by the University of Florida indicates that, under current conditions, the lake will only continue to absorb P for another 15 years (White et al., 2003). These and other data suggest that there is a need for immediate implementation of Best Management Practices in the Arbuckle Creek watershed.

Numerous aquatic plant control efforts are continually underway on the lake, and data indicate that these efforts also have an impact on water quality and the P concentrations in Lake Istokpoga. For example, the Florida Fish and Wildlife Conservation Commission (FFWCC) conducted a whole lake drawdown in 2001 to remove about 1300 acres of tussock that had accumulated around the lake's shoreline. At the same time, the DEP conducted a whole lake hydrilla treatment. In previous years, P levels declined as hydrilla coverage increased, until the hydrilla was treated. After treatment, P concentrations historically increased from 40 ppb to 80 ppb, until the hydrilla regrew. However, P and chlorophyll concentrations did not decline, and water clarity did not increase following the 2001 treatment.

Additional data will be gathered from an intensive study of direct P inputs to the lake, starting in October, 2003. Also, an autosampler has been installed to continuously measure P near the mouth of Arbuckle Creek as part of the LOWP.

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NOTES:

POLLUTION LOAD MODELING USING THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT'S DATA MODEL

David T. Jones

Parsons, Inc. - Tampa, FL

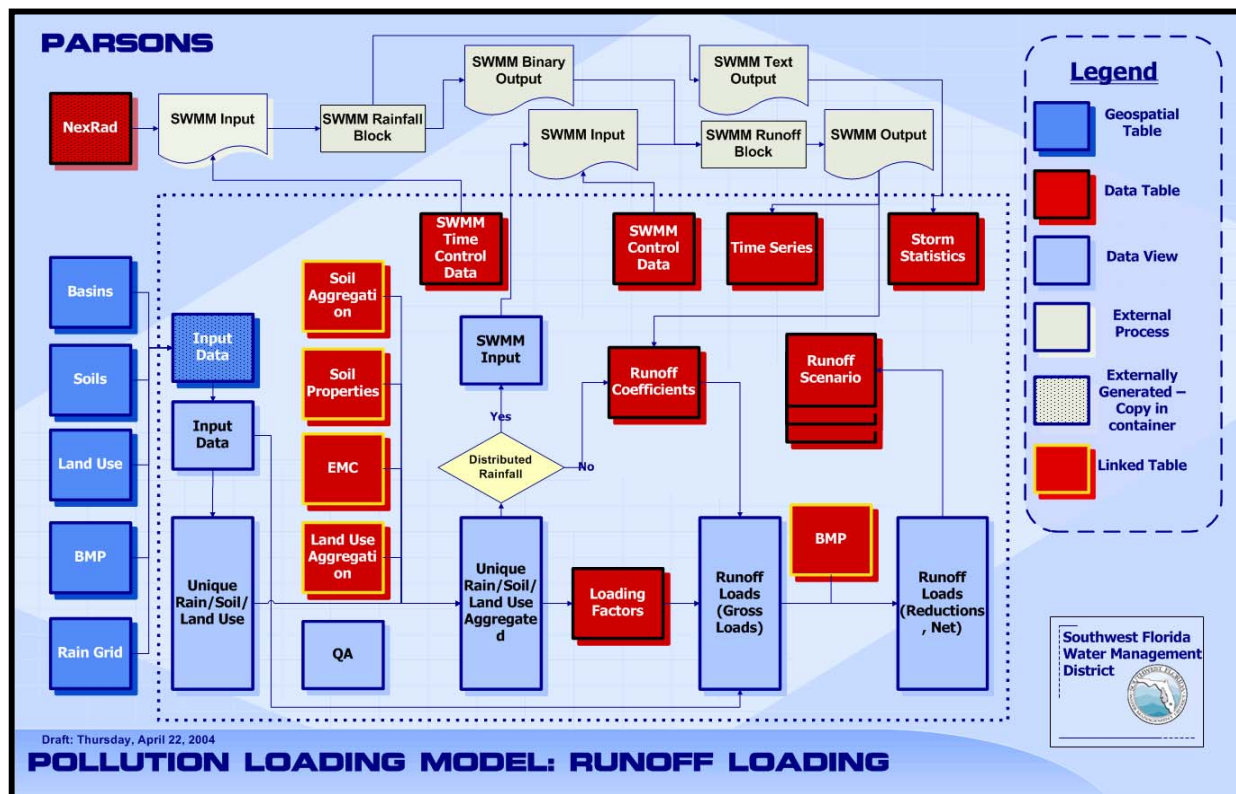
James C. Griffin

Southwest Florida Water Management District – Brooksville, FL

Introduction

The Southwest Florida Water Management District (District) is in the process of developing a data model to aid in watershed evaluation and modeling. This data model will be a customized version of the ArcHydro³ data model, tailored to suit the District's needs. This paper will discuss pollution load modeling procedures that are being developed to improve loading estimates and to take advantage of the District's data model. Data sharing and reuse is a key benefit of using a data model. Reusable procedures can be developed to prepare calculations and views of the data since the format of data within the model is uniform.

Figure 2 - Runoff Loading



³ ArcHydro, 2004. Webpage: <http://www.cwrw.utexas.edu/giswr/hydro>
University of Texas, GIS Water Resource Consortium

Loading Model

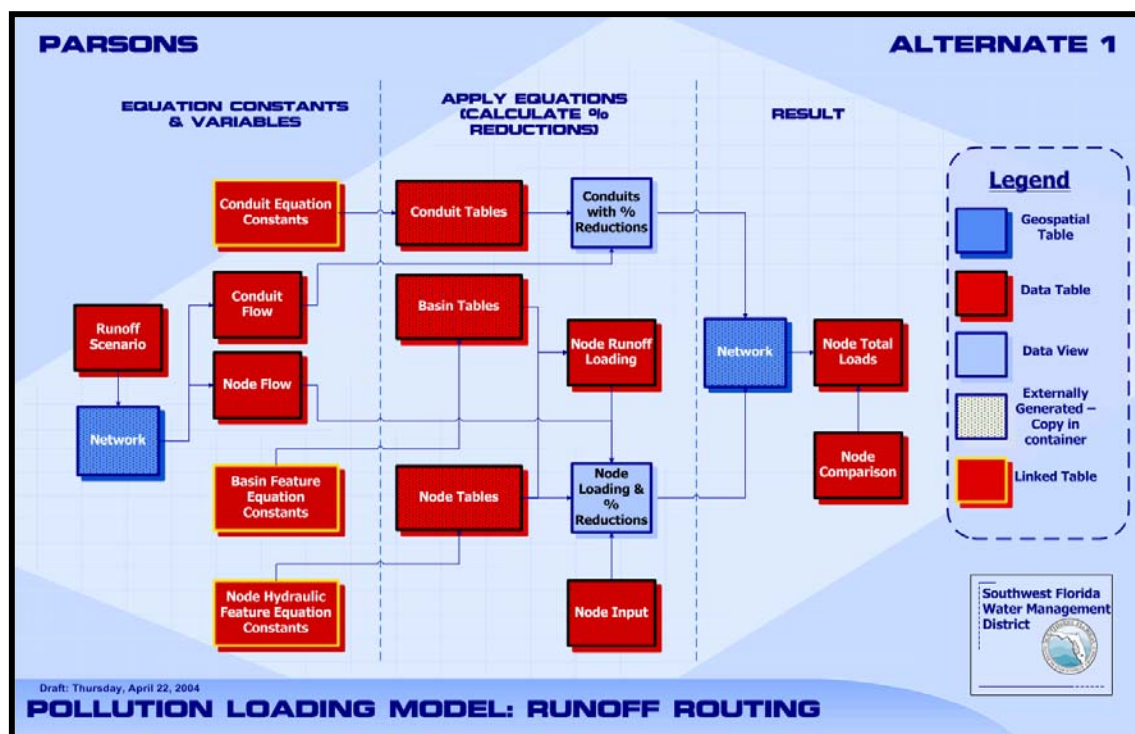
The loading model is being developed in two components –runoff loading and pollutant load routing. The diagram below (Figure 1) illustrates the conceptual design of the runoff loading component.

Principal features of the new loading model will include the ability to calculate, rather than enter as input, the “runoff coefficient” and the ability to apply spatially distributed time series rainfall data. The U.S. Environmental Protection Agency’s (EPA) Stormwater Management Model (SWMM), Version 5, will be used to implement these features. The District maintains a continuous record of rainfall on a district-wide, two-kilometer grid. These rainfall data will be used to create SWMM rainfall interface files for use in continuous runoff simulations. The results of the continuous simulations will be used to define the runoff volumes. Event mean concentrations (EMC) will then be applied to the runoff volumes to predict loads.

Load routing will be accomplished using a network model (Figure 2). The District’s data model includes a network of nodes and links that describes the drainage system. Flow and load enter or are removed from the drainage system at nodes. The details concerning how flow and load are transmitted from one location (node) to another are defined by the links. This network, of nodes and links, will be used to describe the flow and attenuation of pollutants within the system. BMP information will be applied at nodes and links based on user-defined equations. Each node will be assigned an attribute of “source” or “sink” depending on the net load that enters (source) or is removed from (sink) the drainage network at the particular node’s location. Losses may also occur along links.

These procedures will improve pollution loading estimates and subsequent decision-making concerning management actions.

Figure 3 - Pollutant Load Routing



TOOLS AND STANDARDS FOR INTEGRATING WATER RESOURCE DATA INTO GIS

Kyle Campbell and Shawn Landry

University of South Florida - Florida Center for Community Design and Research
Tampa, FL

In the past, integrating quality-assured water resource data into GIS for analysis has been a challenging task. In Florida, custodians of water resource data represent diverse entities, using different data standards and varying scales of spatial accuracy. In a typical Florida county, as many as twenty nine separate databases house water resource information from 15 different custodians. In designing and managing data for several counties through the Water Atlas program (www.wateratlas.org), the University of South Florida has developed a series of standard operating procedures and tools that facilitate the availability and use of scientific data for spatial analysis of water resources. The overall goal of these tools is to make data more readily available to the public through display on the Atlas and facilitate access for resource management professionals.

A critical step in the process is to create a sample site layer in GIS that preserves the lineage of the original spatial data from the custodial agency but is related to a reference hydrology layer through a unique ID. The unique ID is defined from a base hydrology coverage that is based on the National Hydrography Dataset (1999). A polygon feature such as a lake or pond is assigned a single ID, whereas, linear water features such as streams and rivers have multiple IDs that are assigned by a reach code. The process to match the sampling location to the appropriate water resource is a semi-automated iterative process that is performed on a quarterly basis. All of the sites are appended to a single sample site shapefile and redundant sample sites from sources such as STORET, are merged with data from local sources. A “Nearest Features Extension” in ArcGIS is performed to initially match the sample sites to the appropriate water resource. The results undergo a series of quality control procedures and sites that cannot be resolved with available reference information are sent back to the data custodians for correction. Using this approach, the Water Atlas Program in cooperation with agencies throughout Florida has matched over 7,000 individual sample sites to 1,307 named water resources using the standards of the National Hydrography Dataset (NHD) and procedures developed at USF. The advantage of this technique is that it allows all of the data that have been collected about a particular water resource to be mapped to that water resource even if the spatial information in the original data were incorrect or at a smaller scale.

To facilitate access for water resource professionals to the vast dating holdings, software tools have been designed to allow researchers to review metadata, browse data through an online mapping system developed in ArcIMS, and query and download these data for further analysis. Users can view and retrieve data either by viewing a series of standard data pages, designed primarily for the public, or use the advanced data download tools to perform spatial or statistical analysis. The ArcIMS system allows users to download a sample site shapefile, base hydrology, and associated metadata in a packaged ZIP file. Users can download water quality, hydrology or other datasets in a text file in row wise format, or in column format via MS Excel. These files are readily imported into a GIS system.

Overall, these tools benefit water resource professionals in lake management by facilitating easy access to quality assured data that can be readily incorporated into GIS or statistical software for further display and analysis. In addition, the system improves data quality for all providers by providing an independent series of quality control measures. Finally, the convenience of being able to access the necessary data for analysis in one location ensures that the best available data will be used. Future tools being developed will further improve data quality measures and will allow users to perform spatial queries to retrieve all of the published data within a geographic region such as a watershed or basin.

References

USGS (1999) "National Hydrography Dataset Fact Sheet". Reston, Va. Available online at: <http://erg.usgs.gov/isb/pubs/factsheets/fs10699.html>T.

NOTES:

SESSION 6A

RESTORATION PROJECTS - II

**FIELD AND LABORATORY ASSESSMENTS FOR
SEDIMENT REDUCTION AND NUTRIENT CONTROL IN
RESTORING MULLET LAKE (CENTRAL FLORIDA)**

Forrest E. Dierberg and Janelle Potts

DB Environmental
Rockledge, FL

Tom Workman

St. Johns River Water Management District
Palatka, FL

Mullet Lake, a shallow (<2.0 m), 60-acre lake in central Florida, is targeted for restoration as part of a mitigation plan. Baseline data collected on the surface water and sediment indicate a eutrophic to hypereutrophic lake (chlorophyll *a* = 31-85 µg/L) containing flocculent, unconsolidated sediments that are > 0.7 m thick over most of the lake bottom. Elevated total and exchangeable nitrogen (total = 1.57-2.02%; exchangeable = 67.5-227 µg N/g) and phosphorus concentrations (total = 1490-2000 µg P/g; exchangeable = 1.79-26.0 µg P/g), and oxygen demand (0.386-0.516 mg/g/h), in the surficial sediments indicate a significant potential for internal loading to the overlying shallow water from the frequently resuspended sediment. Due to sediment internal loading and considering that nonpoint source pollution from the watershed has been eliminated, the primary focus of the restoration is on the removal or reduction of lake sediments (instead of external nutrient control) without incurring significant nutrient or oxygen demand releases to downstream waters.

We performed a laboratory study to examine the effects that sediment dry-out would have on nutrient release and oxygen demand upon reflooding under oxic and anoxic incubation conditions. Sediments were composited from 4 stations in Mullet, and air-dried in the lab to attain moisture losses of 29-34 and 62-65%. After drying, filtered Mullet Lake standing water was used to reflood the sediments for a 10-day incubation period in the dark and at room temperature (21-23° C). Subsamples from the overlying water in the treatment and control vessels were collected at times 0, 1, 3, 5, 7 and 10 days after initiation of the incubation, and analyzed for soluble reactive phosphorus (SRP), ammonium, nitrite + nitrate, and pH. Water samples for biochemical oxygen demand (BOD), total Kjeldahl nitrogen, dissolved iron, and total phosphorus were analyzed before and after the incubation.

Drying sediments to obtain moisture losses between 29 and 65% followed by reflooding yielded negligible SRP releases from top (0-10 cm) sediments under oxic and anoxic conditions. By contrast, we observed significant releases from bottom (30-40 cm) sediments, especially under anoxic conditions. This was accompanied by dissolved iron concentrations that were 218±118 µg/L, compared to only 15 ± 0µg/L and 35±22 µg/L dissolved iron concentrations for the oxic-treated bottom sediment and the anoxic-treated upper sediment, respectively. Desiccation followed by reflooding resulted in ammonium concentrations increasing significantly in the overlying water under oxic and anoxic conditions, whereas nitrite plus nitrate concentrations decreased relative to the water-only control. Soluble BOD decreased in both oxic

and anoxic incubations relative to the initial values, with more of a decrease observed under oxic conditions. These results indicate that certain sediment reduction and removal techniques (e.g., drawdown and excavation; dredging) are likely to release nutrients either within the water column of Mullet Lake or at the sediment disposal site.

NOTES:

LAKE SEMINOLE STORMWATER RETROFIT PROJECT

Jeffrey L. Herr, P.E.

Environmental Research & Design, Inc. - Orlando, FL

Jim Griffin, Ph.D.

Southwest Florida Water Management District - Brooksville, FL

Lake Seminole is a 684-acre hypereutrophic lake located in west-central Pinellas County. The lake was created in the late 1940s by the damming of the north section of Long Bayou, a brackish water segment of Boca Ciega Bay. In the late 1970s, the Seminole Bypass Canal was constructed on the east side of Lake Seminole to divert stormwater runoff from an 11 square mile watershed around the lake and directly into Long Bayou to control flooding north of Lake Seminole. In 1992, the Southwest Florida Water Management District completed the Lake Seminole Diagnostic Feasibility Study in response to public concerns over declining water quality and growth of nuisance aquatic vegetation. In 2001, Post Buckley Schuh & Jernigan (PBS&J) prepared the Lake Seminole Watershed Management Plan for Pinellas County which identified seven lake management objectives, including the reduction of pollutant and nutrient loadings from external sources and improving lake water quality. Water quality goals were established for the lake which included reducing the mean chlorophyll-a concentration to ≤ 30 mg/m³; reducing the mean TSI value to ≤ 65 ; reducing current external total phosphorus loads from the entire watershed by 50%; maintaining Class III standards for DO, pH, specific conductivity, and chloride; and obtaining 80% TSS load reduction for all permitting MSSW facilities within the watershed. The specific structural components of the Watershed Management Plan include providing alum stormwater treatment for Basins 1, 2, 3, 6, and 7; diverting alum treated Seminole Bypass Canal discharge to Lake Seminole; excavating 930,000 yards of organic sediments in the lake; and restoring priority wetland and upland habitat in and around the lake.

Lake Seminole has an area of approximately 640 acres, with water depths ranging from 2-10 feet. Approximately 3500 acres of highly urbanized watershed drain to Lake Seminole. The basins selected for alum treatment have a total watershed area of 2186 acres, or approximately 62% of the total. During 2003, mean water quality measurements in Lake Seminole were 105 mg/m³ for chlorophyll-a, 2.8 mg/l for total nitrogen, 0.11 mg/l for total phosphorus, and 0.28 m for Secchi disk depth.

The stormwater retrofit project for Lake Seminole was initiated in October 2003. The objective of the stormwater retrofit project is to reduce current external total phosphorus loads by 50%. This will be accomplished by treating the stormwater runoff from Basins 1, 2, 3, 6, and 7. To achieve a 50% annual mass load reduction for total phosphorus, the peak discharge for up to a 1.73-inch storm event must be treated. Peak discharges for this storm event range from 68-174 cfs for each of the five basins. This will result in treating approximately 2600 ac-ft of annual runoff volume each year, or 75% of the total annual runoff volume to the lake.

With the exception of Basin 3, which has an existing stormwater pond adjacent to the basin outfall, undeveloped land is unavailable adjacent to each basin outfall. The initial concept developed in the watershed management plan discussed the use of existing canals for floc settling. These canals do not have adequate volume to provide the required 3 hours of detention time at the peak design flow. Therefore, concepts for in-lake floc settling areas have been developed for Basins 1, 2, 6, and 7. The treatment of runoff from Basin 3 is proposed in an expanded existing stormwater pond. With the exception of Basin 3, alum treatment and partial floc settling would occur in each outfall ditch but would primarily occur in a settling area located in the lake adjacent to the shoreline. The floc settling areas would be initially dredged to provide the required water volume and would be periodically redredged to remove accumulated floc material. A total of approximately 148,000 yards of material would need to be dredged to create the floc settling areas. The conceptual opinion of probable construction cost to construct an off-line floc settling pond for Basin 3 and in-lake floc settling areas for Basins 1, 2, 6, and 7 is approximately \$3,700,000. The conceptual annual operation and maintenance cost for these facilities, including labor, chemicals, power, floc removal and disposal, and renewal and replacement, is approximately \$160,000.

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NOTES:

ORLANDO EASTERLY WETLANDS PROJECT: TREATMENT WETLANDS RENOVATION

Mark D. Sees

City of Orlando - Orlando Easterly Wetlands - Orlando, FL

Thomas L. Lothrop, P.E.

City of Orlando - Wastewater Division – Orlando, FL

After 15 years of effectively removing nutrients from reclaimed water, the 486 hectare, Orlando Easterly Wetlands (OEW) system has shown signs of reduced Phosphorus uptake performance. A principal reason for the reduced nutrient removal performance is the deposition of organic rich sediments in the treatment cells, which has been responsible for considerable bypassing particularly near the inflow region of the wetland. In an effort to rejuvenate the Phosphorus uptake performance of the OEW, excavation of 110 acres of treatment cells was undertaken in the fall of 2002. Approximately 0.45 meters of organic debris and soil were removed from Cells 1,3,4,7 and 8 of the OEW system

After 130,000 m³ were excavated from treatment areas, giant bulrush (*Scirpus californicus*) was replanted and the cells began receiving about 0.26 m³/s (6 MGD) of nutrient enriched water. Biweekly water quality sampling has been performed and data will be presented depicting the improvements in water quality. Changes in vegetation will also be presented.

The OEW is one of the largest and longest operating reclaimed water treatment wetlands in the world. The performance loss and the rejuvenation of Phosphorus uptake performance is of great interest to constructed wetlands managers. The problem of sediment deposition is common to all treatment wetlands and an understanding of how to rejuvenate these wetlands imperative to their success. This presentation will detail the implementation and results of the OEW's renovation techniques.

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SESSION 6B

INTRODUCTION TO TOURS

WATERSHED EDUCATION

John J. Walkinshaw

Southwest Florida Water Management District
Brooksville, FL

The Southwest Florida Water Management District recognizes the need for a comprehensive education program to raise watershed awareness and protect water resources in watersheds. Goals include: (1) helping residents and visitors understand the watershed; (2) equipping people to protect their watershed; (3) identifying specific audiences and shaping the messages and programs reach residents; (4) developing components that can be used in other watersheds; and (5) support the District's Comprehensive Watershed Management Initiative.

The Brooker Creek Watershed in northeastern Pinellas and northwestern Hillsborough counties was selected for the pilot program. Research included a pre-program public opinion survey and a series of focus group discussions. Key findings concluded that many people in the watershed are concerned about water-related issues and how those issues affect their community. Some specific findings are as follows: (1) yard appearance is important to watershed residents; (2) eighty-one percent of residents surveyed do not understand that they live in a watershed; (3) more than 55 percent of survey participants live near a water body; and (4) only 19 percent of the residents surveyed said they live in a watershed.

Based on the research, a plan was developed to implement an education program. The plan includes information on goals; key audiences and their characteristics; messages, formats, distribution mechanisms; and evaluation indicators. In addition, program components were identified including a newspaper insert, Web site, teacher training, speaker presentation, student activity packet, watershed road signs, volunteer program and special event. The program implementation is scheduled for Fall 2004.

Watershed education is also included in the District's Youth Education programming. The baseline education program includes mini-grants for hands-on water resources classroom projects; newsletters; teacher training; field trips; summer camps; and curricula. Watershed education equips teachers and students to make informed decisions. Youth watershed education utilizes education centers at Brooker Creek Preserve, Starkey Park, Cross Bar Ranch and Weedon Island. The District also utilizes the Legacy Program, which is a cooperative venture with county school boards, to develop public lands for public recreation and educational use compatible with the restoration and protection of water resources.

Watershed education is part of the Hillsborough Adopt-A-Pond program as well. The program, partially funded by the District and implemented by Hillsborough County, supports community volunteers who live near stormwater ponds to reduce pollution sources in the neighborhood, increase native plant habitat in and around the pond, reduce litter in the pond, mark neighborhood storm drains and increase the residents' understanding of stormwater runoff impacts. The District is looking for opportunities to expand this program.

The District provides funding to some local counties for the Florida Yards and Neighborhoods Program to promote greater awareness of the need to conserve water resources and reduce pollutants, and to change landscape and outdoor irrigation practices. The program includes workshops and distribution of printed materials to encourage homeowners to adopt landscape designs that save water and reduce impacts from stormwater runoff.

The District also works with partners to expand outreach. In support of District-sponsored stormwater research at the Florida Aquarium, signage has been placed explaining the benefits and best management practices for stormwater ponds. An adjacent area is used to conduct outside presentations to school groups and other interested parties. Funding has also been provided for signage along the existing Florida Water Story exhibits. The signage contains a description of Florida's various types of wetlands, full-color photos and an explanation as to how humans benefit from these water resources. Youth-oriented efforts include the importance of water quality, water conservation and habitat protection for after-school and school holiday outreach programs at Tampa Bay-area YMCAs, Boys and Girls Clubs and other non-profit, youth-based community organizations.

NOTES:

OVERVIEW OF SADDLEBROOK

Saddlebrook Staff

EDUCATIONAL TOURS

- #1: Florida Aquarium
(tour leaves at 3:30 p.m.)
- #2: Cross Bar Ranch and Brooker Creek Education Center
(tour leaves at 2:00 p.m.)
- #3: Saddlebrook Resort and Wetlands
(tour leaves at 3:00 p.m.)

SESSION 7

**LAKE ASSESSMENT
TECHNIQUES**

ASSESSING FLORIDA LAKES VIA A FLORISTIC QUALITY INDEX

Russel Frydenborg

Florida Department of Environmental Protection
Bureau of Laboratories - Tallahassee, FL

After observing water clarity and plant communities of a lake, environmental professionals often assess the health of the system based on best professional judgment. The Florida Department of Environmental Protection is developing a Floristic Quality Index method where trained staff can objectively assess human impairment in lakes based on characteristics of the vascular plant community.

The Clean Water Act charges us to protect and restore the “physical, chemical, and biological integrity” of the nation’s waters. Jim Karr, the “father of the index of bio-integrity” assessment methodology, defines biological integrity as “the ability of an aquatic ecosystem to support and maintain a balanced, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region”. Due to the unpredictable and transient nature of stormwater runoff (Florida’s number one pollution source), many environmental programs have begun to directly measure the health of the biological community, rather than relying on water quality testing alone. Biological communities are ideal impairment indicators because they are sensitive to human disturbance, integrate cumulative impacts over time, react to synergistic effects, and provide a direct evaluation of the resource condition. But because biological systems are quite complex, it is important to establish an assessment methodology that is objective and legally defensible. The general procedure to develop scientifically valid biological assessment tools includes the following steps:

1. Classify aquatic systems into meaningful units.
2. Sample target biota across a human disturbance gradient.
3. Select relevant biological attributes that provide a reliable signal about human effects.
4. Extract and interpret patterns in the data.
5. Communicate results to policy makers.

Standard Operating Procedures have been developed for carrying out the Floristic Quality Assessment to ensure a consistent and comparable level of assessment effort at all sites. First, the investigator divides the lake up into twelve units, or ‘slices of pie’ in predominately circular lakes. Next, the investigator travels via boat at a slow speed parallel to the shore and records the plant taxa observed, using the naked eye and binoculars, as appropriate. At one point in each of the 12 sampling units, the investigator establishes a 5 m wide belt transect from the shore towards the lake center and records additional emergent, floating, and submersed flora observed. Submersed plants are sampled via a standard frodus. Between the two somewhat different sampling strategies, a substantially complete list of plants for each sampling unit is developed. The dominant or co-dominant species is also recorded for each unit. Data sheets with the pre-printed names of the most common plants are utilized for convenience.

As botanists have theorized for years, the ecology of a site can be ascertained from the life history information associated with each plant present. Mark Brown, with the University of Florida Center for Wetlands, oversaw a panel of expert Florida botanists who assigned a specific score for many common lake plants. This score, called the Coefficient of Conservatism, or C of C, indicates the degree to which a given plant species exhibits ecological specialization or tolerance to human disturbance. The coefficients range from 0 to 10. A species with a high C of C would be sensitive to human-induced environmental stress, as well as have a high degree of fidelity to a narrow range of ecological conditions. Most species found in unaltered ecosystems have higher C of C scores. Conversely, a low C of C score indicates species that are found where human activity has substantially altered the system. By standardizing the sampling and interpretation framework, using the C of C and other attributes of the floral community, we can create a useful assessment tool. Collectively, this process is referred to as Floristic Quality Assessment.

With Ellen McCarron as contract manager, DEP has hired Leska Fore, nationally known bio-statistician, to calibrate the Floristic Quality Index against a quantified scale of human stress, known as the Human Disturbance Gradient or HDG. The HDG establishes environmental criteria, independent from the biology, to determine the relative degree of impairment caused by humans. The HDG consists of land use information, hydrologic measures, habitat assessment scores, and water quality data. The HDG can be used to determine which attributes of floristic community are effective discriminators of adverse human effects. These measures, known as metrics, should:

1. Provide meaningful measures of ecological structure or function.
2. Show strong and consistent correlation with human disturbance.
3. Be statistically robust, with low measurement error.
4. Represent multiple categories of biological organization.
5. Be cost-effective to measure.
6. Show responses that are not redundant with other metrics.

During the fall of 2004, it is anticipated that results from the preliminary Floristic Quality Index calibration effort will be available. This method promises to provide an additional tool for assessing lakes for a variety of environmental purposes, including ambient monitoring, quantifying lake restoration success, and Total Maximum Daily Loads.

NOTES:

DEVELOPMENT OF PHOSPHORUS LOAD REDUCTION GOALS FOR SEVEN LAKES IN THE UPPER OCKLAWAHA RIVER BASIN, FLORIDA, USA

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Pollutant Load Reduction Goals (PLRGs) are defined as estimated numeric reductions in pollutant loadings needed to preserve or restore designated uses of receiving bodies of water and maintain water quality consistent with applicable state water quality standards.

The general process used for development of PLRGs was to:

- 1) Identify the critical pollutant(s),
- 2) Estimate the existing pollutant load,
- 3) Determine the desired concentration for restoration or compliance with state water quality standards,
- 4) Determine the allowable pollutant load to reach the desired concentration, and
- 5) Determine the necessary load reductions (PLRG).

One priority area for PLRG determinations is the impaired water bodies in the Upper Ocklawaha River Basin (UORB). Surface waters within the UORB are naturally productive. However, increases in nutrient loading from intensive agriculture and urbanization have severely degraded water quality. This study developed PLRGs for phosphorus for the seven major lakes in the UORB: Beauclair, Dora, Harris-Little Harris, Eustis, Griffin, Yale, and Weir.

Phosphorus was identified as the primary pollutant of concern in the UORB lakes, due to substantial historical increases in external loading of phosphorus to the lakes, and its key role as a controlling nutrient for algal growth in lakes.

Existing external phosphorus loads for the seven lakes were estimated for the 10-year period 1991-2000. Major phosphorus sources for the lakes were tributary discharges from upstream lakes, agricultural discharges, and continued discharges from former agricultural lands undergoing restoration. The natural background phosphorus concentration for the lakes was determined through a combination of existing concentrations in reference lakes and modeling of natural background conditions in the basin. Data collected from the UORB lakes between 1998 and 2001 were analyzed to determine the relationship between phosphorus concentrations and water transparency (compensation point). Target phosphorus concentrations were established by allowing a 10% degradation from natural background water quality as outlined in F.A.C. Chapter 62-302.530. To determine the external phosphorus load required to reach the target phosphorus concentrations, we applied Vollenweider-type models to predict phosphorus concentrations in the UORB lakes. This water quality modeling supported an assumption of a directly proportional relationship between phosphorus concentrations in the lakes and external phosphorus loading.

The estimated current and recommended external total phosphorus (TP) loads for the UORB lakes are:

Lake	External Phosphorus Load (metric tons/year)			Percent reduction
	Current TP load	Target TP load	Load reduction goal	
Beauclair	21.2	3.2	18.0	85%
Dora	18.2	6.2	12.0	66%
Harris	12.7	8.7	4.0	31%
Eustis	16.2	10.4	5.8	36%
Griffin	35.6	11.9	23.7	67%
Yale	1.52	1.37	0.15	10%
Weir	1.23	1.23	0	0%

These PLRGs were prepared in response to a request from the Florida Department of Environmental Protection and the U.S. Environmental Protection Agency, for their use in development of Total Maximum Daily Loads for these water bodies. TMDLs based on these PLRGs have now been established for 6 of the lakes. Lake Weir is of lower priority for TMDL development, and TMDLs have not yet been established for that lake.

Regression analysis of relationships between phosphorus concentrations and other water quality parameters in the UORB lakes were used to predict the effects of the target phosphorus concentrations. Mean chlorophyll-*a* concentrations were predicted to decrease to 30 µg/liter or less, from existing means up to 160 µg/liter. Assuming that the compensation depth for aquatic vegetation occurs at 1% of surface illumination, we predicted that the target phosphorus concentrations could support submersed aquatic vegetation over 10 to 41% of the lake areas.

SJRWMD acquisition and wetland restoration of a large agricultural area adjacent to Lake Griffin has resulted in roughly an 80% reduction in phosphorus discharges from that area. These reductions, combined with drought conditions in the late 1990s, have resulted in estimated external phosphorus loads to Lake Griffin that were near or below the PLRG for 4 of the last 5 years. To accelerate recovery of Lake Griffin, we have been conducting harvesting of gizzard shad from the lake since 2002. The reduced external phosphorus loading and shad harvest have contributed to substantial improvements in the water quality of Lake Griffin.

NOTES:

DEVELOPMENT AND USE OF SEDIMENT ASSESSMENT TECHNIQUES IN FRESHWATER SEDIMENTS OF FLORIDA

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In healthy aquatic environments, sediments provide critical habitat for benthic organisms for feeding, spawning, incubation, and other biological processes. Direct contact with or ingestion of contaminated sediments may affect the health and behavior of these benthic organisms. In the field of environmental regulation and monitoring, the issue of sediment contamination is typically not emphasized, in part because state and federal agencies do not have enforceable standards for sediments. However, it is apparent that regulating the water column alone does not protect the entire aquatic ecosystem. For example, periodic water quality monitoring programs do not assess the cumulative impact of contaminants within aquatic ecosystems. Water column analyses can show that contaminant concentrations are below state standards, while concurrent measurement of the sediment reveals the site as contaminated. Since sediments collect contaminants, knowledge of sediment quality is important for environmental managers, especially in lake and river restoration projects and maintenance dredging projects.

Recognizing the need to answer sediment contamination questions, the Florida Department of Environmental Protection (FDEP) developed tools to assist sediment management decisions in both inland (freshwater) and coastal (estuarine-marine) waters. To assess estuarine and marine sediment quality with respect to biological effects, in 1994 FDEP published numerical sediment quality assessment guidelines (SQAGs), which were derived using a version of the weight-of-evidence approach initially developed by the National Status and Trends Program, a research arm of the National Oceanic and Atmospheric Administration. These marine-based SQAGs, which currently exist for 34 sediment contaminants, identify ranges of sediment concentrations predicted to coincide with minimal-, possible-, and probable-biological effects. Similar biological effects-based SQAGs, published by FDEP in 2003, exist for 29 contaminants found in sediments in Florida's inland (freshwater) systems.

Even though they are common sediment contaminants, all trace metals are naturally occurring; thus monitoring programs must be able to distinguish between what may be present in the environment naturally versus what has been added by human activity. Trace metals enter surface waters during the weathering of minerals, and it is now recognized that air deposition is another pathway for metals to enter aquatic systems. Many trace metals, in extremely low quantities, are essential for the biological function of organisms, but most metals cause deleterious biological effects when present in high concentrations. To identify sediments contaminated with metals such as arsenic or lead, FDEP staff has developed statistical tools based on normalization of metal concentrations to reference elements (aluminum or iron). Sites were selected for inclusion in the clean sediment database based upon their remoteness from known anthropogenic sources. Least squares regression analysis, using aluminum or iron concentration as the independent variable and the concentration of the other metal as the dependent variable, was employed to fit regression lines to the data. Using results of the regression analysis, 95 percent prediction limits were calculated. If a metal concentration falls above the upper 95 percent limit, the sample is designated as enriched in that metal.

The metal to aluminum tool requires use of a total digestion technique of the sediment, which employs hydrofluoric acid (HF), nitric acid (HNO₃), and a strong oxidizing acid, typically perchloric acid (HClO₄). The total digestion technique is necessary mainly because repeated studies have shown that recovery of many metals, especially aluminum, is low with other digestion procedures, such as EPA's total recoverable technique. An obvious weakness of this graphical tool is that it does not predict biological effects; however, when used in tandem with the SQAGs, both tools provide guidance for identifying contaminated sediment management priorities. It should be noted that the SQAGs should not be used in lieu of water quality criteria, as waste cleanup targets, or as stand-alone sediment quality criteria.

The FDEP Watershed Monitoring and Data Management (WMDM) Section, in conjunction with the Northwest Florida Water Management District, the St. Johns River Water Management District, and the Alachua County government is presently conducting a survey of lakes throughout Florida. Water and sediment samples will be collected at 300 lake sites in 2004. The FDEP Central Laboratory will perform analysis of trace metals, nutrients, and organic contaminants, and then WMDM staff will use the above sediment quality assessment tools to analyze the resulting data set.

Additional Recommended Reading:

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NOTES:

SESSION 8

TOXIC ALGAE ISSUES

CYANOBACTERIA POPULATIONS IN SEVEN CENTRAL FLORIDA LAKES

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Cyanobacteria, or blue-green algae, are the dominant component of phytoplankton communities in many nutrient enriched freshwaters, including a number of large central Florida lakes. Dense cyanobacterial populations can negatively affect recreational use in these waters as well as having adverse ecological impacts. Of particular concern are bloom-forming cyanobacteria species, many of which also have the capacity to produce toxic compounds. One such species, the filamentous, nitrogen-fixing *Cylindrospermopsis raciborskii* is known to be common in many lakes in this part of Florida (Chapman and Schelske 1997, Williams et al. 2001).

There are a number of possible goals for cyanobacteria monitoring programs. These include using certain species as biological indicators of shifts in trophic state or changes in water quality that can be used to either provide a rationale for implementing steps to improve water quality or assess the efficacy of measures already in place. Early detection of potential nuisance cyanobacteria taxa associated with blooms, taste and odor production or toxin production allows for the possibility of proactive water management techniques.

In order to evaluate the abundance of cyanobacteria in productive central Florida lakes and to determine the prevalence of potentially toxigenic species in the cyanobacteria communities of these water bodies biweekly phytoplankton samples were collected for two years beginning in September 2001 from seven lakes in this region. The lakes monitored included Lakes Apopka, Beauclair, Dora, Eustis, Griffin, Harris and Yale. Samples were collected from one open water site at each lake. Species identification and quantitative enumeration of cyanobacteria were performed on all samples and comparisons of total cyanobacteria abundance (CYANO), total numbers of potentially toxigenic cyanobacteria (PTOX) and concentration of *Cylindrospermopsis raciborskii* (CYL) were made both between lakes and between years.

Mean total CYANO was highest in both years in Lake Apopka (means of 1,361,860 units/mL and 1,136,098 units/mL in Y1 and Y2 respectively), followed by Lakes Beauclair (650,370 units/mL and 449,210 units/mL) and Dora (581,110 units/mL and 500,196 units/mL). Total CYANO numbers in Lakes Eustis, Griffin, Harris and Yale were lower (mean CYANO of <285,000 units/mL) and were not significantly different from each other in either year. The cyanobacterial community in Lake Apopka was different than that found in the other 6 lakes. In Apopka *Planktolyngbya tallingii* and *Aphanocapsa* spp. dominated while in the other lakes *Limnothrix/Pseudanabaena* spp. and *Cylindrospermopsis raciborskii* were the most abundant taxa. Total CYANO was greater in Year 1 than in Year 2 of the study in Lakes Beauclair and Harris (235,570 units/mL and 116,700 units/mL in Y1 and Y2 respectively) while no significant change was detected between years for the remaining lakes.

Mean total PTOX concentrations in Year 1 and Year 2 were higher in Lakes Beauclair (154,190 units/mL and 69,420 units/mL) and Dora (144,590 units/mL and 129,510 units/mL) than in Lake Apopka (13,550 units/mL and 1,864 units/mL). In Year 2 PTOX levels in Lakes Eustis (40,520 units/mL) and Harris (41,990 units/mL) were also greater than in Lake Apopka. PTOX numbers in Lakes Apopka, Beauclair, Griffin and Harris were higher in Year 1 than in Year 2. The most common potentially toxigenic cyanobacteria species found were *Cylindrospermopsis raciborskii* and *Microcystis* spp.

Mean CYL abundance in Lakes Beauclair (118,830 trichomes/mL) and Dora (127,020 trichomes/mL) were higher than other lakes in Year 1 while in Year 2 CYL numbers were highest in Lake Dora (112,960 trichomes/mL). Year 2 CYL concentrations were lower than Year 1 levels in Lakes Apopka (1,560 trichomes/mL vs. 12,570 trichomes/mL), Beauclair (60,475 trichomes/mL vs. 118,830 trichomes/mL), Griffin (28,390 trichomes/mL vs. 72,700 trichomes/mL) and Harris (11,145 trichomes/mL vs. 45,130 trichomes/mL). *Cylindrospermopsis raciborskii* populations tended to peak in the spring and fall, and reach their lowest levels during the winter, particularly in winter 2002-2003 in Lakes Eustis, Griffin, Harris and Yale. *C. raciborskii* was absent from Lake Apopka for nearly seven months from September 2002 to March 2003.

The decline in CYANO, PTOX and CYL from Year 1 to Year 2 in some of the study lakes is an encouraging sign that water quality in these lakes may be improving. Monitoring of these lakes is continuing which will provide additional data to determine if the observed trend is mainly a reflection of the end of a period of drought conditions or if the implementation of water quality improvement strategies is beginning to have the desired effects.

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NOTES:

**RECREATIONAL EXPOSURE TO FRESHWATER
CYANOBACTERIA IN FLORIDA LAKES:
A PROSPECTIVE EPIDEMIOLOGY STUDY**

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Case studies and anecdotal reports document a range of acute illnesses associated with exposure to cyanobacteria in recreational waters. Dermal, gastro-intestinal and respiratory symptoms are most commonly reported, as well as more serious illnesses like pneumonia, blistering of oral mucosa, and temporary loss of consciousness. Studies on the epidemiology of recreational exposure to cyanobacteria are limited and somewhat conflicting, and much uncertainty remains regarding measures of exposure, susceptibility of individuals with a history of atopic illness, and the relative contribution of cyanobacterial exotoxins to these acute illnesses.

To measure cyanobacteria levels in recreational waterbodies, exposure to cyanobacteria and the incidence of acute illness, individuals engaging in recreational activities were recruited at lakes, reservoirs and rivers affected by cyanobacteria to varying degrees; non-exposed volunteers were recruited at recreational water sites known or suspected to be largely free of cyanobacteria. Recruited individuals completed a self-administered questionnaire and were then followed up by telephone, after three days post-exposure. Preliminary analysis of the Australian component of the study has not revealed any significant difference in specific illnesses between unexposed groups and those exposed to various levels of cyanobacteria.

Inclusion into the study of subjects recruited in Florida during the 2002 summer months will be presented. The results of this work, along with clinical and laboratory-based toxicity studies, will help to determine exposure guidelines for authorities with management responsibility for recreational waters.

NOTES:

EVALUATION OF THE PRODUCTION AND TOXICITY OF *LYNGBYA* SPP. IN FLORIDA SPRINGS

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Lyngbya wollei is a freshwater, benthic, non-heterocystous cyanobacterium found in lakes, rivers, springs, and water supply reservoirs throughout the southeastern US. In Florida's springs, lakes, and coastal embayments, *Lyngbya wollei*, and a related marine analog, *L. majuscula*, are known to produce a number of bioactive compounds that affect the nervous system (e.g., saxitoxins) and act as skin irritants, potent tumor promoters, and protein kinase C activators (e.g., lyngbyatoxin and debromoaplysiatoxins). There have been sporadic reports of human illness (e.g., skin irritation, blistering, respiratory irritation, and symptoms possibly related to anaphylaxis) following recreational contact with filamentous algae in Florida springs. Many of these springs are dominated by *L. wollei*, but the etiology of the illnesses reported are unknown.

In collaboration with the Florida Department of Health and the Centers for Disease Control and Prevention, the distribution of *Lyngbya* spp. will be identified for each 1st Order Magnitude spring and analyzed for known toxins (lyngbyatoxin-a, aplysiatoxin, debromoaplysiatoxin, saxitoxin). The environmental controls on growth and potential N₂ fixation will also be identified through nutrient bioassays and acetylene reduction calibrated by ¹⁵N uptake experiments. Molecular methods will also be employed by applying polymerase chain reaction (PCR) followed by cloning and sequencing procedures to obtain unique *nifH* gene sequences from *Lyngbya* spp. at all sites. The team has extracted and characterized DNA from diverse *Lyngbya* spp. located in Guam, Australia, North Carolina, and Florida and have used sequencing data to assemble *nifH*-based phylogenetic trees. This information has been used to identify and clarify the lineage of different *Lyngbya* species/strains responsible for the recently noted expansion in Florida springs.

Preliminary data sets will be discussed in context of the environmental factors driving *Lyngbya* expansion in Florida Springs and lakes, known toxins, and potential human health risks associated with recreational contact in Florida surface waters.

NOTES:

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