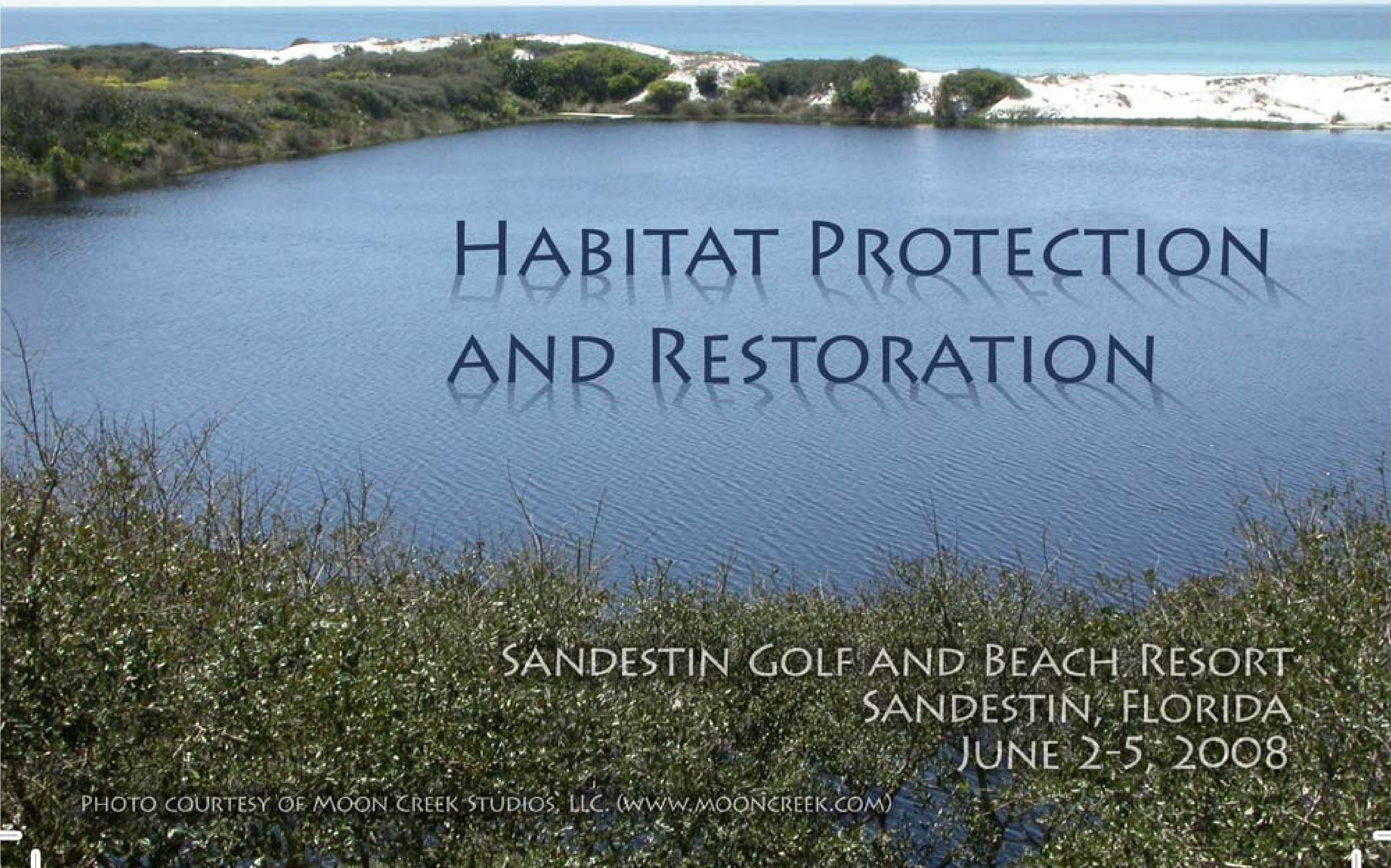
FLMS

NALMS

The 19th Annual

Florida Lake Management Society and the North American Lake Management Society Southeast Regional Conference



Habitat Protection and Restoration

Sandestin Golf and Beach Resort
Sandestin, Florida
June 2-5, 2008

Photo courtesy of Moon Creek Studios, LLC. (www.mooncreek.com)

19th ANNUAL CONFERENCE OF THE FLORIDA LAKE MANAGEMENT SOCIETY & THE NORTH AMERICAN LAKE MANAGEMENT SOCIETY SOUTHEAST REGIONAL CONFERENCE

PROGRAM & PROCEEDINGS

"Habitat Protection and Restoration"

June 2-5, 2008

Sandestin Golf and Beach Resort
Sandestin, Florida

MISSION STATEMENT

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

TABLE OF CONTENTS

The 2008 FLMS Conference is Brought to You with Assistance from the Following Sponsors:

Gold Sponsors

Choctawhatchee Basin Alliance

MACTEC Engineering and Consulting, Inc.

St. Johns River Water Management District

Break Sponsors

Environmental Consulting & Technology, Inc. (ECT)

BCI Engineers and Scientists

Raffle and Door Prize Sponsors

Two Oak Ventures, Inc.

Choctawhatchee Basin Alliance

Legendary, Inc.

Okaloosa-Walton College Foundation, Inc.

Okaloosa-Walton College Raiders Club

South Walton Tourist Development Council

Eglin Golf Course

2008 CONFERENCE COMMITTEE

Conference Chair
Sean McGlynn
McGlynn Laboratories, Inc.

FLMS President
Clell Ford
Highlands County

Program and Proceedings
Mike Coveney
St. Johns River Water Management District

Exhibitors
Shailesh Patel
Dredging & Marine Consultants, LLC

Todd Olson
Aquatic Vegetation Control, Inc.

Sponsors
Chuck Hanlon
South Florida Water Management District

Workshops
Shannon Carter-Wetzel
Seminole County – Stormwater Division

Awards
Clell Ford
Highlands County

AV Coordinator
Dean Dobberfuhl
St. Johns River Water Management District

Web Master
Erich Marzolf
St. Johns River Water Management District

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

Florida Lake Management Society
ATTN: Maryanne Utegg
P.O. Box 950701
Lake Mary, FL 32795-0701

E-mail: flmshome@aol.com

Web Address: www.flms.net

Florida Lake Management Society

2007-08 Officers and Board of Directors

President
Clell Ford
Highlands County Natural Resources Department

Vice-President
Shailesh Patel
Dredging and Marine Consultants, LLC

Treasurer
Michael Perry
Lake County Water Authority

Secretary
Shannon Carter-Wetzel
Seminole County

Administrative Assistant
Maryann Utegg

Past President
John Burns
MACTEC Engineering & Consulting, Inc.

Directors

Mike Coveney
St. Johns River Water Management District

Dean Dobberfuhl
St. Johns River Water Management District

Kelli Hammer-Levy
Pinellas County Dept. of Environmental Management.

Chuck Hanlon
South Florida Water Management District

Dharmen Setaram
United Phosphorus, Inc.

Ann Shortelle
MACTEC Engineering & Consulting, Inc.

Julie Terrell
Choctawhatchee Basin Alliance/Okaloosa-Walton College

Steve Weinsier
Allstate Resource Management, Inc.

Chapter Representatives

Shannon Carter-Wetzel (Central Chapter) & Director
Seminole County Water Quality Section

Kelli Hammer-Levy (SW Chapter) & Director
Pinellas County Dept. of Environmental Management.

Todd Olson (SE Chapter)
Aquatic Vegetation Control, Inc.

Sean McGlynn (NW Chapter)
McGlynn Laboratories, Inc.

John Burns (NE Chapter)
MACTEC Engineering & Consulting, Inc.

<u>AWARDS</u>

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.

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

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

> Odum (1993), Tom Crisman (1994), Marty Wanielista (1995), Karl Havens (1999), Claire Schelske (2000), and Betty Rushton (2003) – not awarded in 2004, 2005, 2006, or 2007.

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

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

The Richard Coleman Aquatic Resources Award is given to a professional who has worked to restore, protect, and/or advance our understanding of Florida's aquatic resources. This award is named in honor of Richard Coleman who was a founder and first president of FLMA and, prior to his death, worked tirelessly to protect and restore aquatic resources throughout the State of Florida.

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

The Marjorie Stoneman Douglas Award is given to individuals in the media who report on aquatic resource issues. This award is named in honor of Marjorie Stoneman Douglas who authored the book, “Everglades River of Grass”, founded the Friends of the Everglades, and who has been environmentally active in South Florida.

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

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

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

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

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

SPONSORS

Gold Sponsor

CBA

CHOCTAWHATCHEE BASIN ALLIANCE

OWC

Gold Sponsor

MACTEC Engineering and Consulting, Inc.

MACTEC

engineering and constructing a better tomorrow

Gold Sponsor
St. Johns River Water Management District
Break Sponsor **BCI Engineers & Scientists, Inc.**

Break Sponsor

Environmental Consulting & Technology, Inc. - ECT

ECT
Environmental Consulting & Technology, Inc.

Door and Raffle Prize Sponsors

Two Oak Ventures, Inc.

Choctawhatchee Basin Alliance

Legendary, Inc.

Okaloosa-Walton College Foundation, Inc.

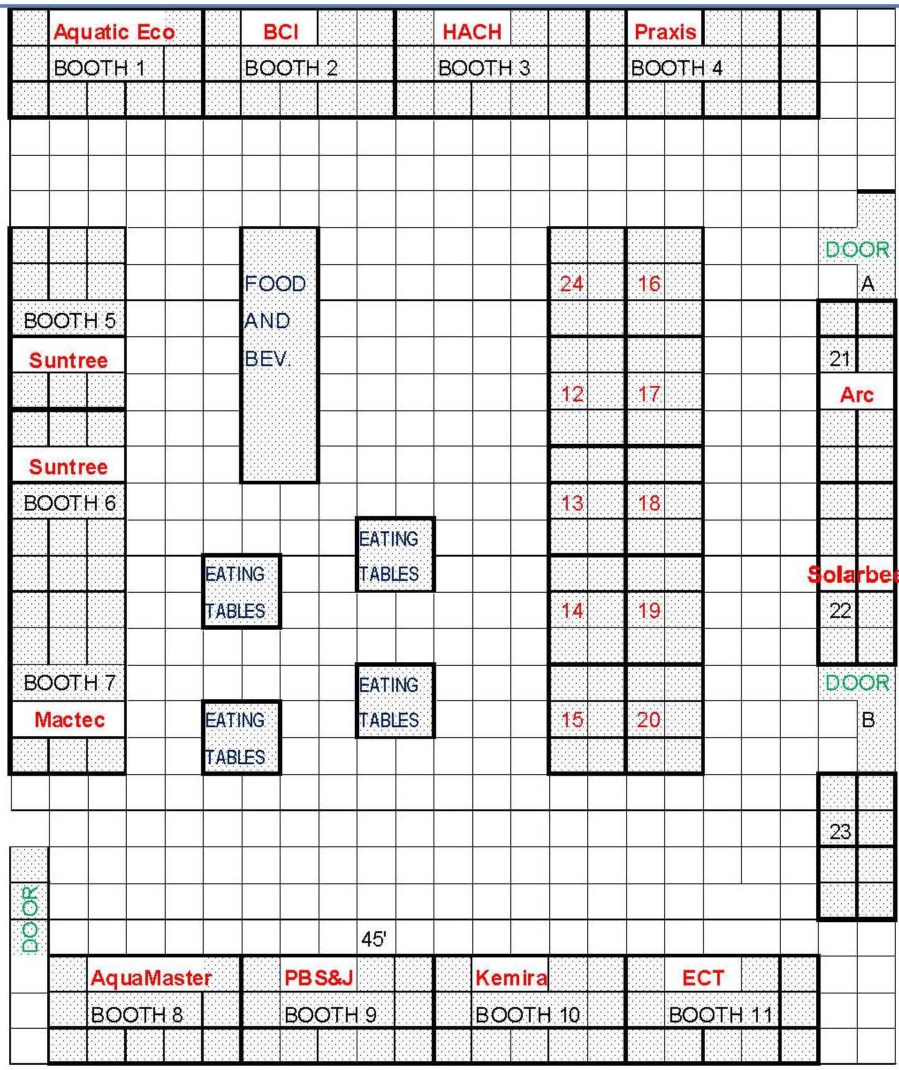
Okaloosa-Walton College Raiders Club

South Walton Tourist Development Council

Eglin Golf Course

EXHIBITORS

Floor Plan



#1- Aquatic Eco System
#2- BCI Engineers & Scientists
#3- Hach Environmental
#4- Praxis Software
#5- Suntree Technologies
#6- Suntree Technologies
#7- Mactec Engineering & Consulting
#8- AquaMaster
#9- PBS&J
#10- Kemira Water
#11- Environmental Consulting & Technology
#12- Dredging & Marine Consultants
#13- Applied Polymenr Systems
#14- Aquatic Vegetation Control
#15- AMJ Equipment
#16- GreenWater Lab
#17- Sygenta
#18- Sweetwater Tech.
#19- ERD
#20- CBA
#21- Arc Survey
#22- Solarbee Inc.
#23- SNF
#24- United Phosphorus

Applied Polymer Systems

Applied Polymer Systems is the originator and manufacturer of Floc Log and Silt Stop products. Our innovative blends of polyacrylamide based products are used for the following: erosion control, soil stabilization, water clarification, stormwater treatment, demucking, pond and lake clarification treatment systems, pond and lake construction, and reduction of turbidity and nutrient levels. APS products are non-toxic, site specific and biodegradable. All APS products are made with NSF Standard 60 Drinking Water Additives and have undergone and passed EPA/600/4-90/027F Acute 48-hr & EPA/600/4-91/002 7 day chronic testing.

Seva Iwinski
Applied Polymer Systems
678-494-5998

AquaMaster Fountains and Aerators

AquaMaster is a worldwide industry leader in the design, manufacture, and distribution of equipment and products for the care and improvement of aquatic environments. AquaMasters' product line consists of high quality Fountains, Aeration Systems, and Natural Bioaugmentation products for ponds and lakes. A worldwide authorized distribution network provides excellent localized sales and service functions. Whether it's aesthetic enhancement or water quality improvement, AquaMaster has the products to fit the need.

Bill Morgan
National Sales Manager
AquaMaster Fountains & Aerators
800 693-3144 Cell: 352 601-3488
bill@aquamasterfountains.com

Aquatic Eco-Systems, Inc.

Aquatic Eco-Systems, Inc., founded in 1978, is the largest source of lake aeration systems, fountains and related products in the world. Get everything you need from AquaticEco.com or our 450-page print catalog. Our in-house staff of fisheries biologists, lake specialists and technicians provides professional aeration system sizing, installation, product recommendations and repair/troubleshooting services. Visit TheLakeExperts.com for an in-depth resource of lake management tools and tactics.

Matt Rayl
MattR@AquaticEco.com
2395 Apopka Blvd.
Apopka, FL 32703
Tel: 407-886-3939
Fax: 407-886-1304

Aquatic Vegetation Control, Inc. (AVC)

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

Todd Olson
Aquatic Vegetation Control, Inc.
P.O. Box 10845
Riviera Beach, FL 33419
561-845-5525 or 800-327-8745
Fax 561-845-5374
Email: tolson@avcaquatic.com

avcaquatic.com

Arc Surveying & Mapping, Inc.

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

John F. Sawyer, VP
5202 San Juan Avenue
Jacksonville, FL
Phone: 904-384-8377 Fax: 904-384-8377
Email: SwyPtr@aol.com

BCI Engineers & Scientists, Inc.

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

Stephanie Dasher
sdasher@bcieng.com &
Walt Reigner
wreigner@bcieng.com
2000 E. Edgewood Drive Suite 215
Lakeland, FL 33803
Tel: (863) 667-2345
Fax: (863) 667-2662

Choctawhatchee Basin Alliance

The Choctawhatchee Basin Alliance (CBA) is an organization committed to sustaining and providing optimum utilization of the Choctawhatchee Basin watershed. Under the auspices of Okaloosa-Walton College, the Choctawhatchee Basin Alliance provides opportunities for citizens, educators, and technical experts to promote the health of the Choctawhatchee Basin watershed. The three cornerstones of the Alliance are Awareness, Involvement and Collaboration. Please browse our website (http://www.basinalliance.org) for information about CBA Projects, Restoration Activities, Research Studies and volunteer opportunities.

Dredging & Marine Consultants

Dredging & Marine Consultants, LLC (DMC) is an Engineering firm located in Port Orange, Florida. DMC offers environmental and engineering services with qualified and experienced professionals in the following disciplines:

- **Sediment Removal Engineering & Planning**
- **Shoreline Erosion Stabilization & Protection**
- **Coastal Engineering**
- **Marine & Waterfront Structures**
- **Public & Private Infrastructure Design**
- **Site Development, Dredging & Marine Construction Inspection & Monitoring**
- **Wetland Delineation & Habitat Restoration Consulting**
- **Ecological & Water Quality Monitoring**
- **Environmental & Agency Permit Processing (Local, State & Federal)**
- **Civil Site Development Engineering (Residential, Commercial, & Industrial Site Design)**
- **Stormwater Management**

We work for both the public and private sectors. 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 the 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.

Contact: **Shailesh K. Patel, M.Sc., CPSSc.**
5889 S. Williamson Blvd., Suite 1407
Port Orange, FL 32128
Phone: 386/304-6505 Fax: 386/304-6506
Email: spatel@dmces.com

Environmental Consulting & Technology, Inc. - ECT

Environmental Consulting & Technology, Inc. (ECT), is a professional engineering and scientific services firm headquartered in Gainesville, Florida, with more than 210 personnel in 14 offices. These offices are located in Gainesville, New Smyrna Beach, Orlando, Jacksonville, Melbourne, Tampa, Fort Lauderdale, Tallahassee, and Fort Myers, Florida; Ann Arbor, Brighton, Detroit, and Clinton Township, Michigan; and New Castle, Delaware. ECT personnel have completed hundreds of water-related projects in Florida, which have resulted in a wealth of experience in all phases of engineering, sampling/monitoring, permitting, and planning. This experience has been gained from numerous projects involving studies of lakes, streams, spring and estuarine areas; evaluation of existing surface and stormwater systems and components; collection, analysis, and evaluation of water quality data; modeling and evaluation of urban and rural water resources using various in-house computer models; use of a GIS for mapping and cataloging of data; determination of basin and sub-basin watershed characteristics; development of pollutant loadings; wetland delineation and permitting, and design and development of mitigation systems; fishery studies; determination of water level impacts on ecological systems; identification of BMPs; evaluation of point and nonpoint sources; engineering evaluation and design of stormwater collection and distribution systems; implementation of comprehensive water quality monitoring systems; soil sampling; biological sampling; hydrologic/hydraulic modeling; hydric soil determinations; data management; development of TMDLs; preparation of grant applications and other documents to obtain funding for capital improvements; development of master stormwater plans for governmental agencies; and updating master stormwater plans on a continuing basis. ECT's key personnel have served as expert witnesses on many water resource engineering and permitting projects.

ECT
Environmental Consulting & Technology, Inc.

Dr. Larry Danek ldanek@ectinc.com
3701 NW 98th Street
Gainesville, FL 32608
Tel (352) 332-0444
Fax: (352) 332-6722

Ron Edenfield redenfield@ectinc.com
4100 Center Point Dr., Suite 112
Ft. Myers, FL 33916
Tel: (239) 277-0003
Fax: (23) 277-1211

Environmental Research & Design, Inc. (ERD)

erd.org

ERD
Water Quality Engineering

Harvey H. Harper, Ph.D., P.E. – President
3419 Trentwood Blvd., Suite 102
Orlando, FL 32812
Phone: 407/855-9465
Fax: 407/826-0419
Email: hharper@erd.org

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.

Kemira Water

Kemira Water is a leading global provider of inorganic coagulants and organic flocculants to select industries and agriculture, with more than 50 production plants and 30 subsidiaries worldwide. It offers customized solutions for water treatment, sludge treatment, odor control, soil erosion and nutrient reduction for municipal, industrial and Agricultural facilities.

Kemira Water supplies products and services for high density livestock operations, Lake Remediation, and associated industries to provide services and systems for waste, air, water and soil management controls. We work with processes and companies to provide the tools which benefit the environment. Our products and services will control phosphorous, odor and limit algal growth. Through these processes, we benefit the Agricultural community and can significantly impact the health of lakes, rivers and streams.

Kemira Water is a subsidiary of Kemira Oyj based in Helsinki, Finland. Kemira operates on all continents, in 40 countries.

Kemiron and Kemira are on the web at kemiron.com and kemira.com.

Cheryl Harmon cheryl.harmon@kermira.com
Vic Johnson
Tom Clark
3211 Clinton Pky. Ct. #1
Lawrence, Kansas 60047
Tel: (800) 879-6353
Fax: (785) 842-3150

MACTEC Engineering and Consulting, Inc.

MACTEC Engineering and Consulting, Inc. (MACTEC) is a nationwide engineering and environmental consulting firm with specialists in over 50 scientific and engineering disciplines. Our core business is engineering for environmental, water resources, transportation, and construction projects as well as a wide range of environmental services such as risk assessment and toxicology, environmental compliance, remediation, permitting and modeling; water quality modeling and nutrient management, watershed planning and management; wetland , stream and lake restorations; stormwater management; BMPS, design and retrofit; and TMDL determinations. MACTEC is currently ranked in the top 5% of Engineering News Record's Top 500 Design Firms, ranked one of the top Southeast design firms by Southeast Construction, and 3rd among 75 firms in the Annual Design Survey.

Ann B. Shortelle abshortelle@mactec.com
John W. Burns jwburns@mactec.com
William A. Tucker watucker@mactec.com
MACTEC Engineering and Consulting, Inc.
404 SW 140th Terrace
Newberry, FL 32669
Ph: 352-333-2623
Fax: 352-333-6622

engineering and constructing a better tomorrow

PBS&J

PBS&J is a leader in Florida and throughout the US for lake, stream and ecological restoration and water resources engineering. PBS&J, with a staff of over 1000 scientists, engineers and support staff in offices throughout the state, provides a wide variety of services including water and nutrient budget assessments, water quality monitoring, water quality modeling, sediment transport and removal evaluation and design, GIS watershed analyses, watershed management planning, stormwater master planning, wetland restoration and shoreline stabilization, fisheries management, public education and involvement, NPDES permitting, TMDLs, BMAPs, stormwater retrofit, non-structural stormwater source reduction and development of enhanced stormwater treatment regulations and operation and maintenance practices.

Doug Robison derobison@pbsj.com
5300 W. Cypress Street, Suite 200
Tampa, FL. 33607
pbsj.com

PRAXSOFT

PraxSoft provides the protection you need to locate, manage and maintain your assets.

Using a unique combination of innovative RFID and wireless sensor network technology along with the most appropriate, cost-effective communications, PraxSoft has developed a unique system for the collection and display of environmental, hydrological and asset data.

PraxSoft specializes in real-time data collection, integration and delivery. Headquartered in Orlando, Florida, PraxSoft has nearly 1,000 customers in commercial and government industries. PraxSoft is a woman-owned small business certified as an 8(a) by the U.S. Small Business Administration.

Rhonda Copley
Praxis Software
Phone: 407-903-9970
Cell: 407-754-7010
Fax: 407-354-2132
Praxsoft.com

SNF Environmental

SNF is the world's leading producer of water soluble polymers. These polymers serve as coagulants and flocculants to industrial and municipal applications. Used to accelerate liquid-solid separation, SNF polymers work quickly and efficiently to thicken and dewater dredge material in any operation or environment. As a supplier of solution, emulsion and powder polymer products, SNF has the most complete product line in the market. SNF is also the only polymer manufacturer that designs and builds polymer mixing and application systems internally. SNF is the complete supplier to any application, providing technical assistance, a broad product line and superior application systems.

Scott Ramey
shramey@snfhc.com
1 Chemical Plant Road
Riceboro, GA 31323
Tel: (912) 880-8016
Fax: (912) 880-8022

Mike Chancey
tmchancey@snfhc.com
6534 Bristol Oaks Drive
Lakeland, FL 33811
Tel: (863) 899-0890
Fax: (863) 647-5860

SolarBee, Inc.

SolarBee, Inc. of Dickinson, North Dakota, has become the global leader for providing sustainable water quality in any size lake or reservoir. SolarBee high-flow long distance circulators have reduced the negative effects of excess nutrients in the water column and sediment, without chemicals or grid power, in more than 250 lakes nationwide. SolarBees eliminate harmful algae blooms, can reduce or eliminate many invasive weeds, operate silently, and require no ongoing maintenance. With an influence of up to 25 acres per machine, SolarBees are an eco-friendly and cost-effective tool for lake restoration.

Michael Lipparelli
Southeast US Regional Manager
SolarBee Reservoir Circulators
42000 Mango Street
Eustis FL 32736-9676
877-868-6713 (toll-free)
240-525-7584 (fax)
Michael@SolarBee.com
www.SolarBee.com

Circulating the World's Water

SUNTREE TECHNOLOGIES, Inc.

Suntree Technologies **has developed a complete line of products and services to meet the needs of engineers, contractors, and municipalities. The ability of municipalities to retrofit existing stormwater structures with our products saves taxpayer funds, and brings local watershed management within specification quickly. Innovation in the development of stormwater related products and dedication to our client's needs are hallmarks of** ***Suntree Technologies. Suntree Technologies*** **products and services meet, and even exceed, NPDES permitting and TDML requirements for environmental protection.**

Exhibitor: Tom Happel and Carol Happel
798 Clearlake Road, Suite # 2,
Cocoa, FL 32922
321-637-7552 Fax: 321-637-7554
happel@suntreetech.com

SWEETWATER TECHNOLOGY

teemarkcorp.com

SWEETWATER TECHNOLOGY, Div. Of TeeMark Corp offers large-scale alum applications to lakes for the reduction of phosphorus and algae control. We use a specially designed barge that can carry half a tank truck of material and distributes it with computer controlled accuracy. We also build continuous injection systems for streams, ponds and stormwater and we do watersheds applications by helicopter.

Thomas & Elinor Eberhardt
teemark@aitkin.com
1132 Air Park Drive
Aitkin, MN 56431
Tel: (218) 927-2200
Fax: (218) 927-2333

Syngenta

Syngenta is the industry leader in creating dependable pest management solutions for professional markets. Our expertise helps guide customers toward solutions in: Turf, Ornamentals, Aquatics and Pest Management.

syngentaprofessionalproducts.com

Greg Reynolds
Greg.reynolds@syngenta.com
Syngenta Professional Products
10228 Meadow Crossing Dr.
Tampa, FL 33647
Tel: (9123) 390-9284
Fax: (813) 907-6539

United Phosphorus, Inc.

Responsible approach to aquatic habitat management. UPI offers products that selectively control nuisance aquatic plant species with minimal impact to the environment.

Dharmen Setaram
13180 Lake Shore Grove Dr.
Water Garden, FL 34787
Tel: (407) 296-6399 Fax: (407) 574-4566
Dharmen.setaram@uniphos.com

AMJ Environmental / YSI / SonTek

YSI/AMJ Environmental is your Complete Source for remote environmental monitoring systems. Since 1948, YSI has been a leader in designing and manufacturing field instrumentation for our customers to improve the quality of the data they collect in increasingly efficient and dependable ways. From concept to deployment, we offer total solutions for water quality & velocity monitoring needs; including, telemetry, vertical & spatial profiling, installation, and customization. As an employee owned company, YSI is deeply committed to the worldwide challenge for creative and innovative technology that will contribute to the sustainability of the World's water resources. We look forward to working with you. www.YSI.com

Matt Previte
AMJ Environmental / YSI / SonTek
SE Regional Manager, US
O: 863-680-1823
M: 863-370-2604
mprevite@ysi.com

Brian Bendis
AMJ Environmental / YSI / SonTek
221 14th Ave. So.
St. Petersberg, FL 33701
Tel: (813) 758-0719
bbendis@amjequipment.com

FLMS & NALMS thanks all Exhibitors & Sponsors for their contribution to this conference!

SCHEDULE

19th ANNUAL FLORIDA LAKE MANAGEMENT SOCIETY CONFERENCE & 2008 NALMS SOUTHEAST REGIONAL CONFERENCE

Conference Theme: Habitat Protection and Restoration

Sandestin Golf and Beach Resort, Sandestin FL
June 2-5, 2008

FINAL PROGRAM

MONDAY - JUNE 2, 2008

7:00 am	Exhibitor Set-Up (Grand Ballroom C-D)
8:00 am-5:00 pm	Check-In and Registration (Grand Foyer)
8:15-11:45 am	**Workshop 1:** (**Cancelled)**
8:15-11:45 am	**Workshop 2: Practical Strategies for Emerging Microbial Contaminants (Fecal Coliforms and Harmful Algal Blooms)** (Terrace II). John Burns and Ann Shortelle, Ph.D., MACTEC Engineering and Consulting, Inc.
8:15-11:45 am	**Workshop 3: Using Florida's Water Birds to Monitor Wetland Restoration Success** (Bayview Room). Jim Peterson and Pam Bowen, St. Johns River Water Management District.
8:15-11:45 am	**Workshop 4: Shoreline Enhancement and Stabilization** (Terrace III). Shannon Carter Wetzel, Seminole County Public Works, and Seva Iwinski, Applied Polymer Systems, Inc.
9:30-10:00 am	**REFRESHMENT BREAK**
12:00-1:00 pm	**LUNCH (provided with full-day Workshop registration, Bayside Ballroom E)**
1:15-4:45 pm	**Workshop 5: Aquatic Plant Identification and Monitoring** (Bayside Ballroom). Matt Phillips, FDEP.
1:15-4:45 pm	**Workshop 6: Planning a Dredging Project** (Terrace I). Shailesh Patel, Dredging & Marine Consultants.
1:15-4:45 pm	**Workshop 7: Lake Watershed Planning Using Web-Based and Open Source Spatial Tools** (Terrace II). Jim Griffin, Ph.D., U. South Florida – FCCDR.
1:15-4:45 pm	**Workshop 8: Unique Aquatic Habitats in the Panhandle: Coastal Dune Lakes (includes field trip)** (Bayview Room). Julie Terrell, Choctawhatchee Basin Alliance, Okaloosa-Walton College and Mark Hoyer, U. Florida, LakeWatch.
1:15-4:45 pm	**Workshop 9: TMDL Implementation & BMAPs: Where to Begin** (Terrace III). Jennifer Gihring, Florida Department of Environmental Protection.
3:00-3:30 pm	**REFRESHMENT BREAK**

TUESDAY - JUNE 3, 2008

8:00 am-4:00 pm	Check-In and Registration (Grand Foyer)	
7:00 am-8:30am	Breakfast (Bayside Ballroom E-F)	
9:00-9:20 am	Opening Remarks: (Grand Ballroom A-B)	Clell Ford – FLMS President Ken Wagner – NALMS Past-President Seán McGlynn – FLMS Conference Chair Mike Coveney - FLMS Program Chair

Session 1: Lake and Reservoir Management Part 1 (Grand Ballroom A-B)
Moderator: Mike Coveney

9:00-9:20 am	**Opening Remarks**
9:20-9:40 am	**Is N the nutrient to control if it's growth limiting? The case for Moses Lake** - Gene Welch
9:40-10:00 am	**Lake Okeechobee: Regional Sulfate Source, Sink, or Reservoir?** – Paul V. McCormick and R. Thomas James
10:00-10:20 am	**Determinants of Water Quality in the Ocklawaha Chain-Of-Lakes** – Rolland Fulton, Walt Godwin and Brian Sparks
10:20-10:40 am	**When the Data Lie – Limitations of the TSI Statistic** – Harvey H. Harper
10:40-11:10 am	**Break**

Session 2: Integrated Watershed Management Part 1 (Grand Ballroom A-B)
Moderator: Dean Campbell

11:10-11:30 am	**Will Increased Reliance on Reuse Further Impair Our Waterways?** – Erich Marzolf
11:30-11:50 am	**Agricultural BMP's to Protect Water Quality** – Vic Johnson
11:50-12:10 pm	**The Application of Individual Sewage Disposal Systems (ISDS) Mapping to Lake Management** – David Eilers, Jim Griffin and Grant Harley
12:10-12:30 pm	**Ken Wagner (NALMS Past-President) – NALMS Welcome and Update**
12:30-2:00 pm	**Lunch (provided, Bayside Ballroom E-F)**

TUESDAY – JUNE 3, 2008 (Continued)

Session 3A: Fish, Benthos and Lake Food Webs (Grand Ballroom A)
Moderator: Michael Hill

2:00-2:20 pm	**Relationships between Burrowing Mayfly Nymphs and Low Dissolved Oxygen Occurrences in Eleven Tennessee Valley Authority Reservoirs** – Susan B. Malone and Tyler F. Baker
2:20-2:40 pm	**Fish Community composition in Tussock-Forming Aquatic Macrophytes at Two South Florida Lakes** – Bunch, A.J., M. S. Allen and D.C. Gwinn
2:40-3:00 pm	**An Rx for Florida Apple Snails in Central and South Florida Lakes** – Philip C. Darby
3:00-3:20 pm	**The Potential for Aquaculture to Support the Recovery of Apple Snail Populations in Florida Wetlands and Lakes** – Rachael L. Pierce, Philip C. Darby, Amber L. Shawl and Megan Davis
3:20-3:40 pm	**The Distribution and Occurrence of Native and Introduced Treefrogs at Morris Bridge Wellfield/Flatwoods Park, Hillsborough County, Florida Using PVC Pipe Refugia** – Aaron J. Harding, Kym Rouse Campbell and Todd S. Campbell
3:40-5:00 pm	**BREAK & POSTER SESSION (Grand Foyer)**

Session 3B: Lake and Reservoir Management Part 2 (Grand Ballroom B)
Moderator: Shannon Carter Wetzel

2:00-2:20 p.m.	**Dewatering Methodologies for Dredged Sediments** – Gene Medley, Leon Seale, Carolyn Farmer and Sherry Brandt-Williams
2:20-2:40 p.m.	**Construction of an Off-Line Nutrient Reduction Facility to Improve Water Quality Downstream of Lake Apopka** – Lance M. Lumbard, Ronald L. Hart, Sandi Hanlon-Breuer and Harvey Harper
2:40-3:00 p.m.	**The Continuing Search for the Smoking Gun on Istokpoga: Littoral, Pelagic and Canal Nutrient Conditions** – Clell Ford and Erin McCarta
3:00-3:20 p.m.	**The Enigma of Lake Blue: Where is This Stuff Coming From?** – Erin McCarta and Clell Ford
3:20-3:40 p.m.	**Use of Wireless Sensor Nodes to Provide Continuous Data for Pollutant Studies and TMDL Compliance** – Rhonda L. Copley and Kevin D. McCann

Session 4: Posters (Grand Foyer)
Moderator: Ann Shortelle
3:40-5:00 pm

A Novel Approach to Coliform Reduction in a Drinking Water Source – William Frazier

Impacts of Shallow Lake Dredging on Water Quality – Larry Battoe, Sherry Brandt-Williams, Ann Shortelle and Melissa Warren

Dissolved Oxygen Dynamics in Tussock-Forming Aquatic Macrophytes – Aaron J. Bunch and M. S. Allen

Posters (continued)

Community Cooperation to Control Exotic and Invasive Plant Species on the Coastal Dune Lakes of Walton County, Florida – Sarah Kalinoski

Seagrass Restoration – A Roadmap for Success – Whitney Stambaugh

Sediment Contamination in the Lower St. Johns River Basin, Florida: A Graphical Representation – John C. Higman, Courtney Hart, Jennifer Seerdan-Tallerico, Suzanne Baird and Dean Campbell

A Stormwater Management Plan; Collection, Organization, Options, and Prioritization (COOP) Project for the St. Andrew Bay Watershed – Jon M. Henning, Charles Yautz, Michael Brim and Danielle Honour

Reuse Water in the Middle St. Johns River Basin Watershed – Sherry Brandt-Williams and Robert Godfrey

Restoration of a Spring-Fed Pond: A Love-Your-Lake Success Story – H.R. Hammers, A.B. Shortelle and David Mandrella

The Design and Implementation of a New "One Atlas" Water Atlas for Volusia County and the City of Tallahassee and Leon County – Keith Bornhorst, Ron Chandler, Jim Griffin, Richard Hammond, Kevin Kerrigan, Jodi Pratch, Shawn Landry and Jason Scolaro

Trends in Limitation of Pelagic Algal Production in Lake Okeechobee, Florida – Karen Donnelly

Determining Nitrogen and Phosphorus Concentration Targets to Meet a Trophic State Index Goal for Lochloosa Lake – Jian J. Di and Erich Marzolf

Results of the First Two Years of Comprehensive Lake Assessments in Hillsborough County Florida – J. Griffin, D. Eilers and G.L Harley

5:00-6:00 pm **FLMS Chapter meeting and NALMS SE meeting (Grand Ballroom A or B)**

6:00-8:00 pm **Exhibitors' Social (Grand Ballroom C-D)**

WEDNESDAY - JUNE 4, 2008

8:00 am-3:00 pm	Check-In and Registration (Grand Foyer)
7:00 am-8:15 am	Breakfast (Bayside Ballroom E-F)

Session 5A: Managing Lake Jesup – A Shallow, Hypereutrophic Central Florida Lake (Grand Ballroom A)
Moderator: Sherry Brandt-Williams

8:20-8:40 am	**Approach to Sediment Dewatering in the Lake Jesup Restoration Project** – Michael Hodges
8:40-9:00 am	**Comparing Phytoplankton Data Pre- and Post- Removal of Wastewater Effluent** – Sherry Brandt-Williams and May Lehmensiek
9:00-9:20 am	**Relationships Between Lake Jesup's Phytoplankton and Zooplankton** – Sherry Brandt-Williams, John Huynh and May Lehmensiek
9:20-9:40 am	**What Happened to All the Fish? A Fisheries Overview of Lake Jesup** – Earl Lundy
9:40-10:00 am	**Biological Criteria in the Jesup Basin – Tributaries versus the Lake** – Marianne Pluchino and Gloria Eby
10:00-10:20 am	**Assessment of N2-Fixation in Lakes Jesup and Monroe, Florida** – Leonard J. Scinto, Serge Thomas, William Anderson, Makoto Ikenaga, Chris Sinigalliano and Sherry Brandt-Williams
10:20-10:50	**Break**

Session 5B: Integrated Watershed Management Part 2 (Grand Ballroom B)
Moderator: Seán McGlynn

8:20-8:40 am	**Lake St. Clair Regional Monitoring Project Water Quality Assessment** – Annette DeMaria and James W. Ridgway
8:40-9:00 am	**Winter Haven Chain of Lakes Pre-BMAP Assessment; An Interpretative Synthesis of Existing Information** – D.A. Tomasko and P. J. Latham
9:00-9:20 am	**Monitoring Storm Water Runoff with Automated Portable Refrigerated Sampler Systems** – Gary Dalbec, Larry J. Danek and Jian Di
9:20-9:40 am	**An Evaluation of the Performance of Best Management Practices (BMP's) for the Removal of Microbial Contaminants** – Brandon Jarvis, A. B. Shortelle and C.A. Stroehlen
9:40-10:00 am	**St. Clair River – Lake St. Clair – Detroit River Drinking Water Protection Network** – Annette DeMaria
10:00-10:20 am	**Implementation of TMDL/BMAP Process in the Lake Hunter Watershed, WBID 1543a, Polk County, Florida** – Chandy John, Mark Schwartz, Ken Ying and John Kiefer

WEDNESDAY – JUNE 4, 2008 (Continued)

Session 6A: Water Wars – Managing Water Quantity in Times of Shortage (Grand Ballroom A)
Moderator: Ken Wagner

10:50-11:10 am	**Water Wars: On the Eastern Front** – Ken Wagner
11:10-11:30 am	**Establishing Minimum Levels for Lentic Systems in the Southwest Florida Water Management District** – Douglas Leeper, Martin H. Kelly, Lisa A. Henningsen and Richard D. Gant
11:30-11:50 am	**Establishing Minimum Flows for Lotic Systems in the Southwest Florida Water Management District** – Douglas Leeper, Martin H. Kelly, Adam B. Munson, Jonathan B.T. Morales and Jason L. Hood
11:50-12:10 pm	**Reservoir Management amidst Epic Droughts in the Southeast: Balancing Competing Needs and Limited Resources** – Douglas C. Otto Jr.
12:10-2:10 pm	**Banquet Lunch / FLMS Annual Meeting (Bayside Ballroom E-F)**

Session 6B: Modeling for Reservoir Water Quality Management (Grand Ballroom B)
Moderator: Richard J. Ruane

10:50-11:10 am	**Development of Bubble Plume Modeling Capability for Reservoir Water Quality Management** – Gary E. Hauser, James A. Parsly and Mark H. Mobley
11:10-11:30 am	**Bubble Plume Mixing for Reservoir Water Quality Management and the Control of Blue-Green Algae** – Samuel S. Stone and Mark H. Mobley
11:30-11:50 am	**Model Assessment of Reservoir Management to Improve In-Lake Water Quality and Reservoir Releases** – Andy Sawyer and Richard J. Ruane
11:50-12:10 pm	**Applications of the Discrete-Bubble Model for Hydropower Aeration Systems** – Richard J. Ruane, Daniel F. McGinnis and Paul J. Wolff

Session 7A: Choctawhatchee Basin (Grand Ballroom A)
Moderator: Allison Beauregard

2:10-2:30 pm	**Changes in Land-Use and Water Chemistry within the Choctawhatchee Bay Area** – Jenny L. Kellogg and Mark V. Hoyer
2:30-2:50 pm	**Spatial differences and Temporal Changes in Water Chemistry of the Choctawhatchee Estuary System** – Julia B. Terrell
2:50-3:10 pm	**Hydrology of Coastal Dune Lakes in Walton County, FL** – J.W. Jawitz and J. H. Bhadha
3:10-3:30 pm	**Living Shoreline Projects in Choctawhatchee Bay** – Alison McDowell
3:30-4:00 pm	**BREAK**

WEDNESDAY – JUNE 4, 2008 (Continued)

Session 7B: Vegetation Management and Restoration (Grand Ballroom B)
Moderator: Kym R. Campbell

2:10-2:30 pm	**The Demonstration Project on Hydrilla and Hygrophila in the Upper Kissimmee Chain of Lakes** – Tina M. Bond, Eleanor C. Foerste, and Kimberly Lawrence
2:30-2:50 pm	**Integration of Herbicide and Grass Carp for Hydrilla Control in Lake Conway** – Bruce V. Jaggers
2:50-3:10 pm	**The Florida Lake Vegetation Index: Development and Thresholds Part 1** – Leska S. Fore, Russel Frydenborg, Nia Wellendorf, Julie Espy, Tom Frick, David Whiting, Joy Jackson and Jessica Patronis
3:10-3:30 pm	**The Florida Lake Vegetation Index: Development and Thresholds Part 2**

Session 8A: Dissolved Oxygen in Blackwater Systems (Grand Ballroom A)
Moderator: Lawrence Keenan

4:00-4:20 pm	**Spatial and Seasonal Variation of Sediment Oxygen Demand in a Chain of Lakes in the Upper St. Johns River, Florida** – F. D. Dierberg, M. M. Fisher, N. Larsen and T. Auter
4:20-4:40 pm	**Primary Production in Blackwater River-Run Lakes** – Millard M. Fisher, Steven J. Miller, Lawrence W. Keenan and Angelique M. Keppler
4:40-5:00 pm	**Chronic and Acute Hypoxia in the Upper St. Johns River** – Lawrence W. Keenan, Millard M. Fisher, Steven J. Miller and Angelique M. Keppler
5:00-5:30 P.M.	**FLMS Board Meeting (Grand Ballroom A)**

Session 8B: Cyanobacteria (Grand Ballroom B)
Moderator: John Burns

4:00-4:20 P.M.	**A Statewide Assessment of the Toxic Algal (Microcystin) Threat in Florida Lakes** – Dana L. Bigham, D.E. Canfield, Jr. and M.V. Hoyer
4:20-4:40 P.M.	**A Success Story – Controlling a Lyngbya Woolei Outbreak in High Point, NC** – William Frazier
4:40-5:00 P.M.	**Inhibition of Cyanobacterial Harmful Algal Blooms: Targeting Quiescent, Stagnant Waters with Long-Distance Circulation (LDC)** – Michael Lipparelli, Christopher Knud-Hansen and H Kenneth Hudnell

THURSDAY - JUNE 5, 2008

7:00 am-8:15 am	Breakfast (Bayview Room)
10:30 am-12:00 noon	Exhibitor Breakdown

Session 9A: Boating Impacts on Lake Lure NC (Grand Ballroom A)

Moderator: Barbara Wiggins

8:20-8:40 am — **Boating Impacts at Lake Lure, NC: Background and Questionnaire Survey** – Russell Pitts, Barbara Wiggins and Ken Wagner

8:40-9:00 am — **Boating Impacts at Lake Lure, NC: Carrying Capacity and Implications of Boat Observation Data** – Barbara Wiggins, Ken Wagner and Russell Pitts

9:00-9:20 am — **Boating Impacts at Lake Lure, NC: Boating Management Framework** – Ken Wagner, Barbara Wiggins and Russell Pitts

9:20-9:40 am — **Boating Impacts at Lake Lure, NC: A Permitting System for Progressive Tracking and Control** – Russell Pitts, Barbara Wiggins and Ken Wagner

9:40-10:10 am — **MORNING BREAK**

Session 9B: Springs and Rivers (Grand Ballroom B)

Moderator: Clell Ford

8:20-8:40 A.M. — **Nutrient Loading of Select Springs in the Suwannee River Basin: A Ten-Year Study** – R. Jason Dickey and Robbie McKinney

8:40-9:00 A.M. — **Kelley Branch Steephead Stream Restoration, Apalachicola River (Liberty County, FL)** – Michael J. Hill

9:00-9:20 A.M. — **The Effects of the Input of Groundwater on the Water Quality and Benthic Macroinvertebrate Community of the Withlacoochee River, Madison County, Florida** – Kym Rouse Campbell and Meg Andronaco

9:20-9:40 A.M. — **Long-Term Trends in Benthic Macroinvertebrate Communities in the Upper Suwannee River** – Robbie McKinney and R. Jason Dickey

Session 10: Ecology of Aquatic Vegetation (Grand Ballroom A-B)

Moderator: Dean Dobberfuhl

10:10-10:30 am — **An Evaluation of Tree Health and Tree Mortality in Forested Hardwood Wetlands Following Changes in Watershed Land Use** – Jennifer L. Brunty

10:30-10:50 am — **Life Cycle of a Tape Grass (Vallisneria Americana) Bed** – Jennifer J. Sagan

10:50-11:10 am — **Light Requirements of Four Species of Native Submerged Macrophytes Occurring in Florida Lakes** – Margaret S. Hopson-Fernandes, Edward J. Philips, Ben Koopman and Carlos A. Fernandes

11:10-11:30 am — **Periphyton Community-Host Associations and Nutrient Storage Following Lake Stage Fluctuations in Subtropical Lake Okeechobee, USA** – Andrew J. Rodusky

11:30-11:45 am — **Concluding Remarks:** Shailesh Patel, FLMS President 2008-09

SESSION 1

LAKE & RESERVOIR MANAGEMENT PART 1

IS N THE NUTRIENT TO CONTROL IF IT'S GROWTH LIMITING? THE CASE FOR MOSES LAKE

Gene Welch, Tetra Tech, Inc., Seattle

Low ratios of N:P in situ usually indicate N limitation and the ratios of soluble N:P decline as eutrophication proceeds for several reasons. So does this mean that the nutrient to control is N in order to improve lake quality? Or is P the one despite in situ growth limitation by N? There are no lakes where N only control was tried, but many where P only (or mostly) were successful (Cooke et al., 2005). The goal recommended from examination of 18 European cases was: biomass begins to decline only after SRP declines to < 10 μg/L and controlling N would show minimum benefit due to N fixation (Sas et al., 1989). Moreover, reducing inflow N, relative to P, may promote dominance of Cyanobacteria (Schlinder, 1977).

As a case in point, Moses Lake in eastern Washington was hypereutrophic in the 1960s prior to routinely adding large quantities of low-nutrient Columbia River water and switching to spray from rill irrigation in surrounding farmland. Beginning in 1977, dilution water was systematically diverted through lower Crab Creek into Moses Lake via a canal during spring and early summer. Except for 1984, dilution water was consistently added to the lake, at an average of 170 X 10^6 m^3 per year, which is 110% of the lake volume (Welch et al., 1992). The rate of input was generally greater in the 1990s. Data from Lower Parker Horn and South Lake sampling stations are used to indicate conditions during May-September in half the lake primarily affected by dilution and from lower Crab Creek during April-September to represent inflow of dilution water mixed with normal flow containing background nutrient levels.

While dilution water was low in both NO_3 and SRP, the high NO_3 levels in the background inflow caused the dilution water addition to greatly raise the inflow NO_3-N:SRP ratio to 50 or more from about 20, amounting to a preferential input reduction in P over N. As a result, average summer (May-Sept) lake TP and SRP, along with chl, steadily declined to about 70% of pre-dilution levels. Despite the reduced SRP and increased NO_3-N:SRP ratio in the inflow, the in-lake NO_3-N:SRP ratio remained at low N-limiting levels.

In-lake bioassays conducted in 1970 showed that algal biomass, dominated by Cyanobacteria, was stimulated by the addition of NO_3. That was not surprising since NO_3-N:SRP ratios were around 1 during the bioassays (Buckley, 1971; Welch et al., 1972).

The in lake TN:TP ratio remained rather constant at about the level in cells (8-12), probably because two of the dominant algae are N-fixers. Fixation tends to restore the N:P ratio in lakes enriched with P more than N, e.g., as in wastewater (Hutchinson, 1970; Schindler, 1977). Thus, the relationship between biomass and N was as good as with P in Moses Lake.

Despite persistent growth limitation by N in situ, dilution and spray irrigation lowered in-flow P relatively more than N, which resulted in lowered lake TP that ultimately lowered algal biomass. Both forms of in-flow P declined while N forms remained high, except for 2001, when they declined as well. Therefore, to reduce algal biomass in eutrophic lakes, where N-fixing Cyanobacteria dominate, P is the nutrient to control in the inflow, despite short-term in situ limitation by N!

Buckley, J. A. (1971). "Effects of low nutrient dilution water and mixing on the growth of nuisance algae". MS Thesis, University of Washington, 116 pp.

Cooke, G.D., E.B. Welch, S.A. Peterson and S.A. Nichols. (2005). "Restoration and Management of Lakes and Reservoirs". 3rd Ed., CRC Press, Inc., Boca Raton, FL.

Hutchinson, G.E. (1970). "The Biosphere". Sci. Amer. 223:44-53.

Sas, H. (1989). "Lake Restoration by Reduction of Nutrient Loading: Expectations, Experiences and Extrapolations". Academia-Verlag Richarz, St. Augustin.

Schlindler, D.W. (1977). "Evolution of phosphorus limitation in lakes". Science 195:260-262.

Welch, E.B., J.A. Buckley and R.M. Bush. (1972). "Dilution as an algal bloom contro". J. Water Poll. Cont. Fed. 44:2245-2265.

Welch, E.B., R.P. Barbiero, D. Bouchard and C.A. Jones. 1992. "Lake trophic state change and constant algal composition following dilution and diversion". Ecol. Engr. 1:173-197.

Notes

LAKE OKEECHOBEE: REGIONAL SULFATE SOURCE, SINK, OR RESERVOIR?

Paul V. McCormick and R. Thomas James
South Florida Water Management District
West Palm Beach, Florida

Sulfate is emerging as an important contaminant in the Florida Everglades because of its role in regulating the mercury (Hg) methylation process. The Everglades is exposed to high atmospheric loads of elemental Hg. Once deposited in the wetland soils, this Hg is converted to a highly toxic and bioavailable form, methyl-Hg, by naturally occurring sulfate-reducing bacteria. The activity of these bacteria and, therefore, the rate of Hg methylation are closely related to the availability of sulfate. Canal waters discharged into the Everglades contain sulfate at levels as much as >100-fold above background for this wetland. Sulfate in these waters may originate from both natural and anthropogenic sources. However, no detailed sulfate budget yet exists for the larger watershed.

Lake Okeechobee is a major hydrologic feature in the Kissimmee-Okeechobee-Everglades (KOE) watershed, and previous research has revealed the lake's role as a source, sink, and transformer for different elements. We analyzed available data on sulfate in Lake Okeechobee and its tributaries and calculated a sulfate budget for the lake to assess the significance of this water body in the watershed's sulfate budget for the period 1974-2006.

Potential sulfate sources to the lake include groundwater discharge, atmospheric deposition, and tributary inflows. Groundwater across portions of south Florida is naturally high in sulfate and is considered a potentially important sulfate source in some areas. Direct groundwater discharges to the lake have not been quantified, but the lake's chloride budget indicates that they are minimal. Therefore, we assumed that sulfate inputs from groundwater were negligible. Precipitation accounts for approximately half of the water entering the lake. Available data on rainfall sulfate concentrations and dry deposition rates in south Florida were used to estimate an average atmospheric deposition rate of sulfate to the lake of approximately 2000 mt/year. By contrast, annual surface-water inputs varied between 34,000 and 161,000 mt during the period of record and, thus, contributed most of the sulfate entering the lake.

In-lake sulfate concentrations are sensitive to changes in surface-water inputs, again supporting the importance of the watershed as the primary sulfate source to the lake. Fluctuations in annual in-lake concentrations are significantly correlated with changes in inflow concentrations ($r^2 = 0.363$, $p < 0.001$, Pearson coefficient) and loads ($r^2 = 0.332$, $p < 0.001$, Pearson coefficient). This relationship is due primarily to variation in loading rates from the Everglades Agricultural Area (EAA), which discharges water that is especially high in sulfate. Discharges from the EAA have declined since the early 1980s, and this trend is associated with a corresponding decline in lake sulfate concentrations.

Sulfate budget calculations for the lake indicate negligible internal sulfate inputs or losses. However, in-lake sulfate concentrations average 12.4 ppm higher than inflow concentrations. This 39% discrepancy can be explained by evaporative losses of lake water, which exceed rainfall by nearly the same amount. The lack of significant internal losses is consistent with the general oxic condition of the lake's sediments, which would not be expected to support sulfate reduction. The residence time for sulfate in the lake is 2.6 years, which is similar to that for the conservative ion chloride. This short residence time coupled with the lack of internal transformation or storage contributes to the sensitivity of in-lake sulfate concentrations to external loading.

Our analyses indicate that Lake Okeechobee is neither a significant source nor sink for sulfate within the KOE watershed. Rather, the lake functions primarily as a temporary reservoir for and concentrator of sulfate supplied from the watershed. If future management actions are deemed necessary to reduce sulfate loads within the watershed, these reductions should quickly be reflected in a decline in lake sulfate concentrations.

NOTES

DETERMINANTS OF WATER QUALITY IN THE OCKLAWAHA CHAIN-OF-LAKES

Rolland Fulton, Walt Godwin, and Brian Sparks
St. Johns River Water Management District
Palatka, FL

St. Johns River Water Management District is implementing a comprehensive lake and watershed restoration program in the Upper Ocklawaha River basin to manage water quality and habitat for fish and wildlife, including restoration of wetland habitat in former agricultural areas to reduce external phosphorus loading, operation of a marsh flow-way to remove particulate phosphorus from lake water, and harvesting of gizzard shad. In this presentation, we evaluate causes for temporal changes in water quality in lakes Griffin, Beauclair, and Dora. Wetland restoration in the Lake Griffin and Lake Apopka basins has substantially reduced external nutrient loading to these lakes. We also examined water quality changes related to droughts in 2001 and 2007 in eight basin lakes, four of which are not directly affected by District restoration programs.

Relationships were determined between water quality and changes in external nutrient loading, gizzard shad population size (only Lake Griffin), rainfall, morphologic (mean depth, surface area, dynamic ratio), and hydrologic (water residence time) factors. For all three lakes, phosphorus concentrations were correlated with predicted concentrations by the OECD phosphorus model, although actual concentrations tended to exceed model predictions. For Lake Griffin, total phosphorus concentrations were strongly correlated with external phosphorus loading and estimated shad population size. A multiple regression equation incorporating these two factors accounted for 94% of the observed variability in annual phosphorus concentrations in Lake Griffin. Total nitrogen concentrations were weakly related to estimated external nitrogen loading, but were correlated with external phosphorus loading and shad population size. Secchi depth, chlorophyll-*a*, and total suspended solids were strongly related to nutrient concentrations. There were no significant relationships of nutrient concentrations or other water quality parameters with rainfall, or with morphologic or hydrologic factors.

Nutrient concentrations in Lake Beauclair and, to a lesser degree Lake Dora, were more strongly related to inflow concentrations than to external loads. In both lakes, other water quality parameters were more strongly related to nitrogen concentrations than to phosphorus concentrations. Phosphorus concentrations were unrelated to rainfall, morphologic factors, or hydrologic factors in either lake. However, morphologic and hydrologic factors were related to nitrogen concentrations, chlorophyll-*a*, and Secchi depth in Lake Beauclair, but only to Secchi depth in Lake Dora.

The basin lakes showed inconsistent water quality responses to the 2001 drought, probably in part because District restoration projects were significantly reducing external nutrient loading to some of the lakes during this period. However, during the 2007 drought water quality deteriorated to some degree in all the lakes except for Lake Weir. Lake Weir has the greatest mean depth and smallest dynamic ratio (lake surface area divided by mean depth, an index of potential for sediment resuspension). The magnitude of water quality deterioration during the 2007 drought was significantly correlated with dynamic ratios of the lakes.

References

Fulton, R.S. III, Schluter, C., Keller, T.A., Nagid, S., Godwin, W., Smith, D., Clapp, D., Karama, A. and Richmond, J. (2004). "Pollutant Load Reduction Goals for seven major lakes in the upper Ocklawaha River basin." Technical Publication SJ2004-5, St. Johns River Water Management District, Palatka, FL. http://www.sjrwmd.com/programs/outreach/pubs/techpubs/pdfs/TP/SJ2004-5.pdf

Fulton, R.S. III and Smith, D. (2008). "Development of phosphorus load reduction goals for seven lakes in the Upper Ocklawaha River Basin, Florida." Lake and Reservoir Management (in press).

NOTES

WHEN THE DATA LIE – LIMITATIONS OF THE TSI STATISTIC

Harvey H. Harper, Ph.D., P.E.
Environmental Research & Design, Inc.
3419 Trentwood Blvd., Suite 102
Orlando, FL 32812
Phone: 407-855-9465
Email: hharper@erd.org

The trophic state of a lake is related to the total weight of living biomass in the water body at a specific time and provides a measure of the biological response to forcing factors, such as nutrient additions. The concept of a Trophic State Index (TSI) was developed by Carlson (1977) as a statistic to numerically define common lake trophic states, such as oligotrophic, mesotrophic and eutrophic, in a manner which is not subject to the biases of the observer. The TSI statistic has become one of the most commonly used methods of defining water quality in lakes and is used as the basis of defining water quality impairment.

The TSI statistic is often misused, and even when properly applied, may not accurately represent the biomass within the lake. The TSI of a lake is often calculated by combining TSI calculations obtained from measurements of chlorophyll, Secchi disk depth, and total P. Since trophic state is a measure of algal biomass, chlorophyll data alone should be used to calculate the TSI value. Although Secchi disk and total P are often related to chlorophyll, they are inferior estimates of algal biomass and should only be used when chlorophyll data are unavailable. However, inter-relationships between TSI variables can be useful in understanding a lake.

Even if properly applied, TSI values may not accurately describe the trophic status of a water body. Lakes classified as either oligotrophic or mesotrophic, based on TSI value, may exhibit strong stratification and persistent hypolimnetic hypoxia, both of which are indicators of eutrophic conditions. Potential methods of improving the accuracy and usefulness of TSI values will be discussed.

NOTES

SESSION 2

INTEGRATED WATERSHED MANAGEMENT
PART 1

WILL INCREASED RELIANCE ON REUSE FURTHER IMPAIR OUR WATERWAYS?

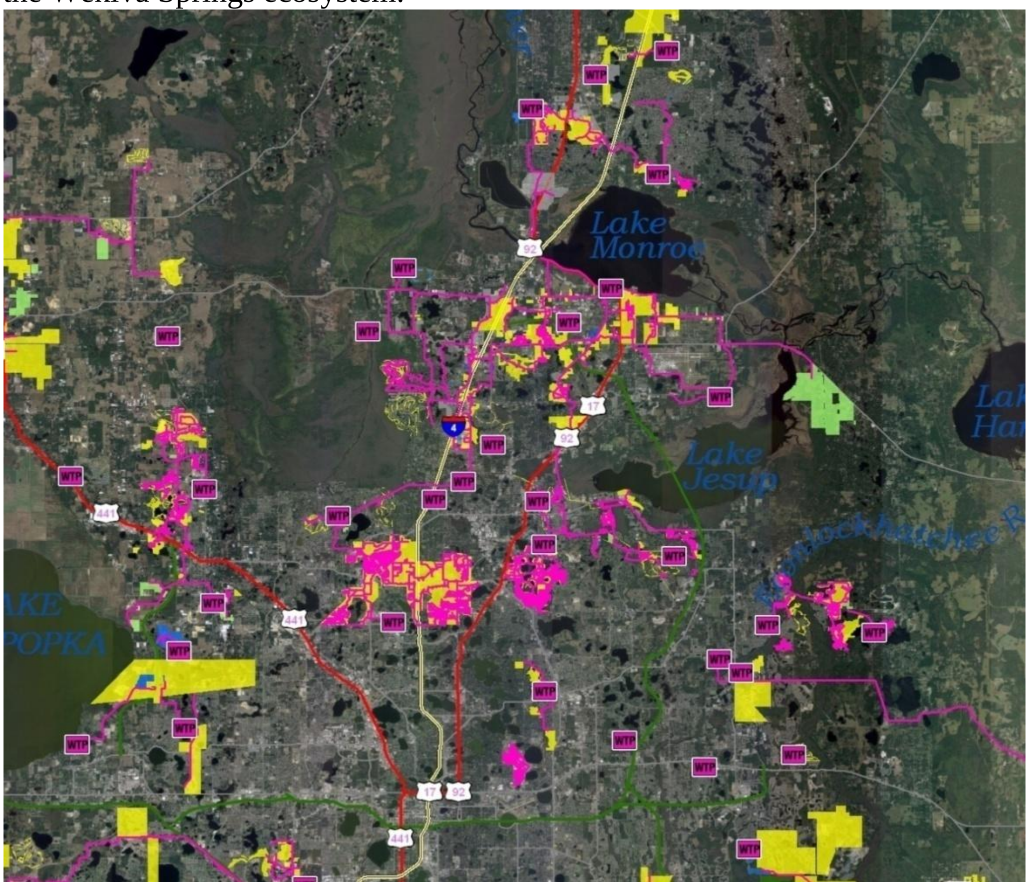
Erich R. Marzolf, Ph.D.
Water Resources Dept./Environmental Sciences Div.
St. Johns River Water Management District
Palatka, FL

Groundwater supplies have reached their sustainable limit in large areas of Florida, or will reach these limits in the very near future. Water supply utilities in these areas are moving rapidly to decide which alternative sources they intend to develop to offset the lack of additional groundwater supplies. One rapidly expanding alternative source is reuse, the practice of using wastewater treatment plant (WWTP) effluent or reclaimed water for a variety of non-potable uses, but primarily outdoor irrigation. Differences in treatment efficiency between WWTPs result in a wide range of nutrient concentrations distributed via reclaimed water. While the areas re-plumbed with purple pipe to receive reuse are well documented (Figure 1), this information is often not being incorporated into watershed nutrient loading models. This omission is problematic for a variety of reasons. First, it is essential to evaluate all loading sources when addressing nutrient impairment. Only when all loads are evaluated can equitable load reductions be allocated, as in a Total Maximum Daily Load (TMDL) process. If a loading source has not been quantified, the calculated load reductions will likely be insufficient to reverse the nutrient impairment and the load reduction efforts will likely have been inequitably allocated. Second, while water conservation messages are increasingly common, messages discussing the nutrient implications of reuse irrigation are not developed. Thus, uninformed homeowners could be applying unnecessary and excessive fertilizer to their yards. Over fertilization of turf and expanding reuse systems could contribute significant nutrient loads to waterbodies, including nutrient-impaired waterbodies with existing TMDL programs. Therefore, quantification of reuse nutrient loads is an essential step for both load reduction allocation and effective fertilizer offset strategies.

Nutrient concentration data from FDEP's Wastewater Facility Regulation (WAFR) database for plants discharging to reuse systems within the St. Johns River Water Management District (SJRWMD) from 2002 to 2006 were analyzed. Mean monthly total phosphorus concentrations from WWTPs ranged from 0.04 to 2.4 mg P/L, while total nitrogen ranged from 0.23 to 38.7 mg N/L. These concentrations are sufficiently high that many plants provided total phosphorus loading in excess of recommendations for turf (FDACS 2008), assuming that irrigation followed the SJRWMD's watering rules. However, a minority (~35%) of WWTPs monitor nutrients on a monthly or more frequent basis and do so as a result of permit conditions associated with their ability to seasonally discharge to surface waters. It is these WWTPs which have implemented the additional treatment to reduce their concentrations. Most WWTPs (~65%) do not have permit provisions to seasonally discharge to surface waters and are less likely to have invested in the advanced treatment and do not have the requirement to regularly monitor nutrient concentrations. Therefore, these plants are likely to discharge concentrations greater than those most often reported in the WAFR database. In addition, in contrast to potable water, the SJRWMD's conservation rules do not apply to reclaimed water, increasing the potential for additional irrigation and associated nutrient loading.

Reuse conserves high quality groundwater for potable uses and reduces larger nutrient load point sources, however this occurs via redistributing the water and nutrients back to watersheds which may have previously not received the nutrient loads. Thus, the resulting nutrient input to these watersheds has the potential to create or exacerbate nutrient impairment in other systems. Additional efforts are required to ensure ongoing alternative water supply development and the long standing national and state priority to restore nutrient-impaired waterbodies are accomplished in a compatible manner.

Figure 1. Map of portion of central Florida showing the reuse distribution network (purple lines and shading) in relation to nutrient-impaired ecosystems of Lakes Jesup and Apopka and the Wekiva Springs ecosystem.



References

Florida Department of Agriculture and Consumer Services. 2008. Florida Consumer Fertilizer Task Force Final Report. 34 pp. http://consensus.fsu.edu/Fertilizer-Task-Force/pdfs2/Fertilizer_Task_Force_Final_Report11408-3.pdf

---

NOTES

AGRICULTURAL BMP'S TO PROTECT WATER QUALITY

Vic Johnson
Marketing Development Specialist
Kemira Water Solutions,Inc
808 East Main Street
Lakeland,Fl 33801

In many watersheds, agriculture can be a major contributor to water quality degradation. Run-off and leaching from Livestock facilities, cash crop fields and grazing lands can contribute to poor water quality in an entire watershed.

Many agricultural producers have instituted Best Management Practices designed to decrease or completely eliminate nutrient releases and odors from their facilities. These practices normally employ a combination of chemical and mechanical steps to sequester nutrients and control odors. Other practices bind soil particulates while conserving water.

This presentation will briefly outline the practices and methodologies currently employed by successful agricultural producers. Process flows, costs and results will be presented in a case study format.

NOTES

THE APPLICATION OF INDIVIDUAL SEWAGE DISPOSAL SYSTEM (ISDS) MAPPING TO LAKE MANAGEMENT.

David Eilers, *Jim Griffin*, *Grant Harley*, USF-FCCDR, 3650 4202 E. Fowler Ave., HMS 301, Tampa FL 33620, 813-974-1068, griffin@arch.usf.edu

Background

Lakes are normally the low spot in a landscape and as such they receive both surface and surficial water that carries soluble and particulate components. Individual Sewage Disposal System (ISDS) contribute to the dissolved and particulate load of these surface and subsurface flows and consequently contribute to the chemical and biological constituents entering a lake. Knowing the location of an ISDS is therefore important to fully understanding the pollution potential posed by surface and subsurface runoff to lakes in a watershed. ISDS installations are permitted in Florida by the Florida Department of Health (FDOH); however, permit records are not necessarily an accurate method of locating an active ISDS on a land parcel. USF-FCCDR originally created an ISDS parcels map in 2002. This map, although useful, had many false positive and false negative errors. Recently we have developed a model that better estimates the likelihood the a parcel contains an ISDS based on FDOH permit records, utility billing records, the distance of a parcel from a sewage main and the position of the parcel relative to a urban service area. We have implemented the model as a map theme on the Water Atlas Web and developed automatic methods for database updates. We have also designed a hot spot analysis (HSA) theme and associated tools to assist lake managers to assess the potential of ISDS pollutants entering a lake.

Database Design and Visualization

The ISDS database and the HSA visualization employ classic spatial (ESRI geodatabase) design. The ISDS database approach recognizes that a complete and accurate septic tank layer (ISDS layer) cannot be constructed from the Department of Health permit records alone. This is because: (1) the records were only kept for more recent ISDS permits; (2) errors may exist in the records and (3) DOH may not always update their records when a parcel, with an ISDS permit, connects to a wastewater utility. For these and other reasons, the ISDS conceptual design is based on determining the potential of a parcel containing at least one ISDS. To determine this, the geodatabase asks the following spatial questions:

1. What was the Septic Tank Status determined to be from the original (2002) analysis?
2. Does the DOH have a record of a septic tank existing on the parcel from prior installation and maintenance records?
3. Does the parcel currently receive water service but not sewer service?
4. Is the parcel within the proximity of the known wastewater infrastructure?
5. Is the parcel located within the current boundaries of the Urban Service Area?

These are all yes/no questions and except for question 2 the answer values are 1/0. The DOH data is weighted so that it dominates the calculations and it has a value of 3/0.

For hotspot analysis, we have selected the Inverse Distance Weighted (IDW) spatial interpolation tool to create ISDS hot spots for the analysis. IDW is a method of interpolation that estimates cell values by averaging the values of sample data points in the neighborhood of each processing cell. The closer a point is to the center of the cell being estimated, the more influence, or weight; it has in the averaging process. This method assumes that the variable being mapped decreases in influence with distance from its sampled location. In using IDW we assume that the chemicals moving through the soil will reduce in concentration with distance due to spatial dilution and ion exchange. IDW is therefore a good way to estimate the point source affect of a septic tank. Also, it is estimated that most septic tank pollutants will have almost no affect on a water source if the source is greater than 200 ft from the tank (given that no direct flow exists).[1] Thus by setting a search radius of 200 feet we are limiting the estimated radius of movement to that distance.

Figure 1 is an example of the ArcMap display employing the type of analysis and visualization that is the basis for the Hotspot Analysis (HSA). These data correlate with recent findings from a Microbiological Source Tracking date collection conducted as part of the Hillsborough River Basin Management Action Plan effort.

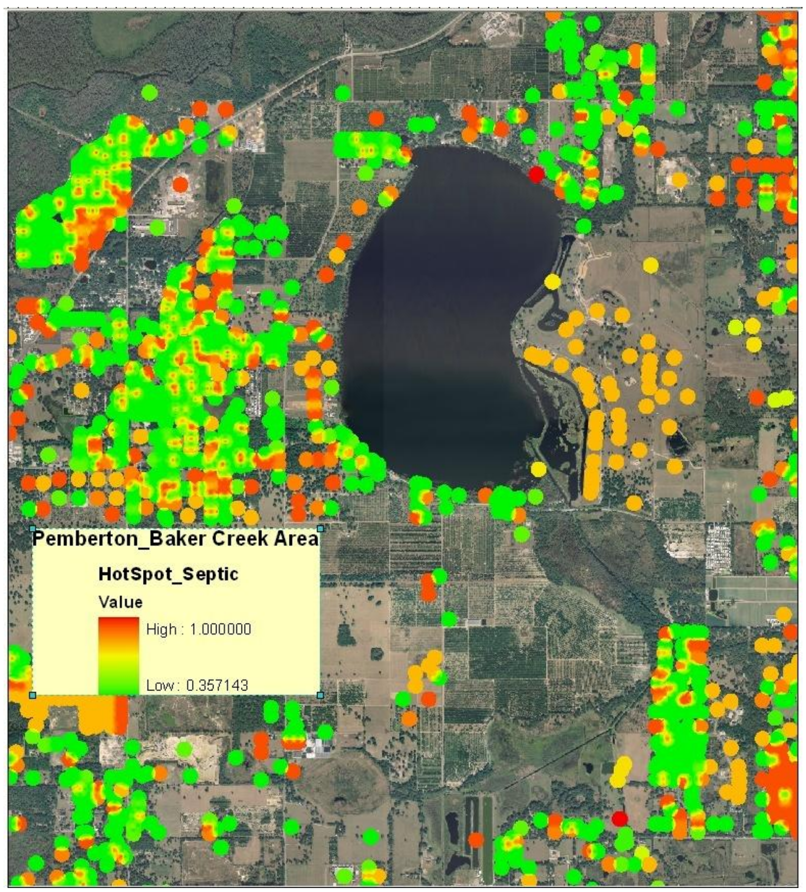


Figure 1. Septic (ISDS) Hot Spot map for the Lake Thonotosassa drainage basin in Hillsborough County Florida

[1] Informal communication

SESSION 3A

FISH, BENTHOS & LAKE FOOD WEBS

RELATIONSHIPS BETWEEN BURROWING MAYFLY NYPMHS AND LOW DISSOLVED OXYGEN OCCURENCES IN ELEVEN TENNESSEE VALLEY AUTHORITY RESERVOIRS

Susan B. Malone[1] *and Tyler F. Baker*[2]

Tennessee Valley Authority, Aquatic Monitoring & Management, 1101 Market Street, Chattanooga, TN 37402
[1](423) 876-4179, smalone@tva.gov
[2](423) 876-6733, tfbaker@tva.gov

Tennessee Valley Authority (TVA) has used consistent methods to monitor benthic fauna and dissolved oxygen (DO) conditions in Tennessee Valley reservoirs since 1994. Analysis focused on a group of 11 Valley reservoirs - nine mainstem Tennessee River reservoirs and two tributary reservoirs that are functionally and operationally similar with relatively short retention times - in which burrowing mayfly nymphs (*Hexagenia* spp., Ephemeroptera: Ephemeridae) are important components of the benthic fauna in depositional zones. These reservoirs occasionally experience thermal stratification and lower DO concentrations, particularly during late spring when TVA is filling tributary reservoirs to summer pool levels for recreation. Stratification that does occur is typically destabilized when flows are increased progressively in June, July, and August. During extended periods of drought, effects of reduced flows/discharge on water quality have resulted in sustained periods of low DO concentrations for several reservoirs. Relationships between *Hexagenia* densities and low DO occurrences were analyzed using TVA's long-term (1994-2006) data set. DO measurements were collected monthly April – September, the period of greatest potential for thermal stratification and lower DO concentrations. *Hexagenia* densities were determined from samples collected during fall (September – December) of each year and ranged from 0 to 410 nymphs/ m^2. Densities were low or undetectable in Forebay and Embayment areas where a percentage of the bottom length was exposed to periods of low DO (< 2 mg/L) during summer. Densities were highest in Forebay and Transition areas that historically have not been prone to low DO occurrences.

NOTES

FISH COMMUNITY COMPOSITION IN TUSSOCK-FORMING AQUATIC MACROPHYTES AT TWO SOUTH FLORIDA LAKES

Bunch, A. J.[1], M. S. Allen[2], and D. C. Gwinn[3]. University of Florida. 7922 NW 71st St., Gainesville, FL 32653. 352-392-9617. [1]ajbunch@ufl.edu; [2]msal@ufl.edu; [3]dgwinn@ufl.edu

Stabilization of lake levels due to altered hydrology in Florida lakes can exacerbate the formation of dense vegetation mats (i.e., tussocks) in littoral zones. Anoxia and hyperthermia associated with tussocks can provide quality habitat for small-bodied fishes utilizing the oxygen-rich surface layer, but reduce habitat for species that depend on oxygen within the water column. We sampled tussock-forming macrophyte species (i.e., cattail *Typha* spp., pickerelweed *Pontedaria cordata*, and torpedograss *Panicum repens*) at varying coverage levels (i.e., percent area coverage; 50-64%, 65-79%, and 80-95%) using enclosure samplers (i.e., block net, Wegener ring, and throw trap) dosed with rotenone at Lakes Istokpoga (2006) and Kissimmee (2007). Fish densities (number/m2) shifted with macrophyte types for various fish groups. For example, stress-tolerant fish, comprised mostly of poeciliids and cyprinodontids, were found at higher densities (37.6/m^2) in torpedograss (an invasive exotic species) than other macrophytes. Conversely, stress-moderate fish were most abundant in cattail (3.7/m^2) and had the lowest density in torpedograss (1.2/m^2). Aquatic macrophyte structural complexity, which affects prey abundance and predator avoidance likely drive differences in fish densities in this study. It is important to evaluate differences in fish densities between macrophyte species and coverage levels in order to make informed management decisions.

NOTES

AN R_X FOR FLORIDA APPLE SNAILS IN CENTRAL AND SOUTH FLORIDA LAKES

Philip C. Darby

Dept. of Biology
University of West Florida
11000 University Parkway
Pensacola, FL 32514
(850) 474-2647
pdarby@uwf.edu

For 13 years we have studied the Florida apple snail (*Pomacea paludosa*) and considered its potential as an indicator species reflecting water and habitat management in wetlands and lakes. We have found that their demography (density, survival and recruitment rates) can be tied to multiple aspects of hydrology (dry down timing and duration, and high water events) and habitat structure (substrate type, plant species and their abundances). As in any assessment of a 'cure' for a biological problem, in this case how to 'get the water [as well as the habitat] right', sufficient data must be collected to ensure efficacy of any treatment. At this point in time, we believe we have accumulated sufficiently detailed information to propose an R_x for apple snails in lake littoral zone habitats. We have identified specific plant assemblages associated with the highest snail densities. Substrate consolidation, in conjunction with the return of submerged macrophytes, has played a role in the recent resurgence of snails on Lake Kissimmee. Data from both lab and field studies helped identify specific hydrologic windows that enhance survival and recruitment largely based on the timing and duration of drying events. We also have data on the impacts of untimely high water events, including specific water depths associated with delays and overall suppression of egg cluster production. As needed for any R_x, considerations of risk and uncertainty, as well as the need for routine 'check ups', will be discussed.

NOTES

THE POTENTIAL FOR AQUACULTURE TO SUPPORT THE RECOVERY OF APPLE SNAIL POPULATIONS IN FLORIDA WETLANDS AND LAKES

Rachael L. Pierce[1], *Philip C. Darby* [2], *Amber L. Shawl*[3], *Megan Davis*[3]

[1] South Florida Water Management District, 1480-9 Skees Rd. West Palm Beach, FL 33411, (561) 681-2500 x4570. rapierce@sfwmd.gov
[2] University of West Florida, 11000 University Parkway, Pensacola, FL 32514, (850) 474-2647. pdarby@uwf.edu
[3] Harbor Branch Oceanographic Institute at Florida Atlantic University, 5600 US 1 North Fort Pierce, FL 34946, (772) 465-2400 x578. ashawl@hboi.fau.edu

The Florida apple snail (*Pomacea paludosa* Say) is a critical component of Florida freshwater lakes and wetlands, serving as prey to many aquatic and avian predators, including the endangered Snail Kite (*Rostrahmus socialibilis*). The snail kite utilizes a network of freshwater wetlands and lakes that are influenced by natural hydrologic cycles as well as water management. In the last eight years, habitat quality and snail availability has been substantially reduced, contributing to the decline of the kite population. Natural reestablishment of wild snail populations to support kite foraging may take many years. The South Florida Water Management District (SFWMD), in cooperation with Harbor Branch Oceanographic Institute (HBOI), has implemented a pilot level study to explore the possibility of raising snails via aquaculture in order to speed up the recovery of decimated snail populations through restocking. HBOI has successfully raised snails hatched from eggs collected in the field, and they have produced two generations of cultured snails. Hatch success, egg size, survival and other measures of snail viability are being assessed and will be compared to data from field studies. In addition, questions regarding genetics and how to scale up the culture to levels applicable to restoring large marsh areas will be discussed. A pilot level release is planned for spring 2008, in which the efficacy of a restocking effort will be examined. The snail culture project will be discussed in the context of other SFWMD approaches to restoring habitat quality and hydrologic conditions to support the recovery of snails and their predators.

NOTES

THE DISTRIBUTION AND OCCURRENCE OF NATIVE AND INTRODUCED TREEFROGS AT MORRIS BRIDGE WELLFIELD/FLATWOODS PARK, HILLSBOROUGH COUNTY, FLORIDA USING PVC PIPE REFUGIA

Aaron J. Harding, Kym Rouse Campbell, and Todd S. Campbell
Biological Research Associates, a Division of ENTRIX, Inc. and Department of Biology, University of Tampa, Tallahassee, Riverview, and Tampa, FL

The native range of the Cuban treefrog (*Osteopilus septentrionalis*) includes Cuba, the Bahamas, and the Cayman islands (Meshaka 2001). Cuban treefrogs affect native treefrog species through competition and predation (Smith 2005). The Cuban treefrog was first identified in the Florida Keys and has been established in Florida proper since about 1951 (Barbour 1931, Schwartz 1952). Populations of Cuban treefrogs were established at the Morris Bridge Wellfield (MBWF), located in North-Central Hillsborough County, Florida, between 2001 and 2004 (Guzy et al. 2006). The wellfield is managed and operated by Tampa Bay Water on lands owned by the Southwest Florida Water Management District. The 4,000-acre wellfield is also a public recreation park, Flatwoods Wilderness Park, that is managed by Hillsborough County. The three most common native treefrog species in Flatwoods Park include the green treefrog (*Hyla cinerea*), the pinewoods treefrog (*Hyla femoralis*), and the squirrel treefrog (*Hyla squirella*). The use of PVC pipe refugia is a well-documented method used in the monitoring and passive trapping of hylid treefrogs (Boughton et al. 2000).

The three main questions of the study were: (1) what is the distribution of Cuban and native treefrogs in Flatwoods Park?; (2) were there seasonal differences in their distribution?; and (3) did the presence of the Cuban treefrog affect native treefrogs? The study took place between June 2005 and September 2007, and we studied 24 wetlands. These 24 wetlands included three freshwater marshes, nine cypress wetlands, five borrow pits, and seven riverine wetlands. Ten 5.1-cm PVC pipes were placed at ten-meter intervals along the edge of each of the 24 wetlands. The numbers and types of treefrogs observed in each pipe were recorded during monitoring events.

Even though this study was observational in nature, much information was gained regarding the occurrence, distribution, and population trends of native and Cuban treefrogs at the MBWF/Flatwoods Park. During the study, 7,237 observations were documented, which included 4,089 observations of Cuban treefrogs, 1,530 observations of squirrel treefrogs, 945 observations of pinewoods treefrogs, and 673 observations of green treefrogs. Overall, Cuban treefrogs were observed most frequently at 17 of the 24 wetlands. Squirrel treefrogs were observed most frequently at five of the 24 wetlands, while pinewoods treefrogs were observed most frequently at two of the 24 wetlands. Interestingly, either squirrel or pinewoods treefrogs were observed most frequently over the course of the study at four of the seven wetlands located adjacent to the residential development along the northern boundary of the wellfield/park, suggesting that the Cuban treefrog invasion may not have originated from the residential subdivisions.

For marshes, there was no significant difference ($p > 0.05$) in proportional observations for the four treefrog species. Observations of Cuban treefrogs in cypress wetlands were significantly higher ($p < 0.05$) than those for green and pinewoods treefrogs. For riverine wetlands and borrow pits, Cuban treefrog proportional observation were significantly higher ($p < 0.05$) than those for green, pinewoods, and squirrel treefrogs. While Cuban treefrogs were the most frequently observed species at all types of wetlands, their observations were highest at borrow pits, suggesting their preference for created and disturbed wetlands.

Regardless of season, Cuban treefrogs were the most frequently observed species. In addition, treefrog observations were significantly higher ($p < 0.05$) during the dry seasons (October through May), as compared to the wet seasons (June through September). This suggests that the pipes provide hiding places and a more suitable moisture regime during the dry, cold, non-breeding season as compared to the warm, wet, breeding season.

With the exception of one pipe at one borrow pit, treefrogs were observed at least once in all 240 pipes in this study. Similar to previous studies (Boughton et al. 2000), this investigation demonstrated that PVC pipes were highly effective and efficient at trapping treefrogs. There was a significant negative correlation (Pearson = -0.2193, $p = 0.0006$) between the observations of native treefrogs in pipes and the observations of Cuban treefrogs, suggesting that the presence of a Cuban treefrog in a pipe affected the presence of native treefrogs.

References

Barbour, T. (1931) "Another introduced frog in North America." Copeia 1931:140.

Boughton, R.C., J. Staiger, and R. Franz. (2000) "Use of PVC pipe refugia as a sampling technique for hylid treefrogs." American Midland Naturalist 144:168-177.

Guzy, J.C., T.S. Campbell, and K.R. Campbell (2006) "Effects of hydrological alterations on frog and toad populations at Morris Bridge Wellfield, Hillsborough County, Florida." Florida Scientist 69:276-287.

Meshaka, W.E., Jr. (2001) "The Cuban Treefrog: Life History of a Successful Colonizing Species." University Press of Florida, Gainesville, FL.

Schwartz, A. (1952) "*Hyla septentrionalis* Duméril and Bibron on the Florida mainland." Copeia 1952:117-118.

Smith, K.G. (2005) "An exploratory assessment of Cuban treefrog (*Osteopilus septentrionalis*) tadpoles as predators of native and nonindigenous tadpoles in Florida." Amphibia-Reptilia 23:571-575.

NOTES

SESSION 3B

LAKE AND RESERVOIR MANAGEMENT
Part 2

DEWATERING METHODOLOGIES FOR DREDGED SEDIMENTS

Gene Medley, *Leon Seale*, *Carolyn Farmer*
BCI Engineers & Scientists, Inc- Jupiter, Florida

Sherry Brandt-Williams
St. Johns River Water Management District - Palatka, Florida

The removal of nutrient-rich organic sediments from lakes, rivers and estuaries has been identified as an effective management technique for improving water quality and wildlife habitat (Cook et al. 2005). Nutrient budget analyses on many lakes, including Lake Okeechobee, indicate that the control of internal cycling of nutrients from the sediments to the water column must compliment external loading reductions to meet water quality goals within a reasonable time period (Steinman et al. 1999). Sediment removal from lakes has been utilized to increase lake depth for navigation or water quality improvements, to control nutrients, to remove toxic contaminants and to control rooted aquatic vegetation.

There are three general methods for removing sediments from lakes. The first involves a lake drawdown followed by the scraping and removal of sediments using earth moving equipment. This technique is limited by the ability to provide an extended period of drawdown, and by the limitations of the earthmoving equipment to work in deep deposits of soft sediments. The second method involves using a barge mounted dragline or backhoe to remove the sediments which are loaded onto a second barge for transport to shore. This method is often used for small navigation or contaminant removal projects and is limited by the slow rate of removal and the potential for contamination of the water column. The third method of sediment removal is hydraulic dredging. This method uses barge mounted pumps attached to a cutter or suction head to suck the target sediment off the bottom. The sediments, along with a large amount of entrained water (dilution factor ≈ 1.5 to 4) are then transported by pipeline to a disposal area. The dewatering and final disposal of these sediments constitutes a major design effort and often represents the greatest fraction of the total project costs.

Although lake sediments can vary among lakes, the dredge material produced during a typical dredging project in Florida lakes can be physically separated at the dewatering site. The material includes large debris (>5 cm), fine sand, gyttja (fine-grained, nutrient-rich organic mud) and water. Separating these materials can expedite the dewatering process and facilitate the polishing of the return water (water collected from the disposal area and returned to the lake). There are currently a variety of technologies available for dewatering dredged sediments. The selection of a method is driven by pump rates, the physical/chemical characteristics of the dredged material, return water quality requirements, available land for dewatering and disposal, and by budget constraints. The dewatering methodologies can be grouped into 5 categories:

- Passive, which refers to reliance on natural evaporation and drainage to remove moisture;
- Chemical aids, including polymers and coagulants which aggregate smaller particles together to form larger composite particles using various physical and chemical interactions;

- Physical, in which two or more components of a system are separated based on physical properties or characteristics of the materials;
- Mechanical, which requires the input of energy to squeeze, press, or draw water from the hydrated material; and,
- Integrated systems, which use combinations of chemical, physical and mechanical methods to achieve rapid segregation and dewatering of dredged sediments.

Hydraulic dredging in urban environments or at sites where the disposal area is limited may require the use of integrated dewatering systems. Integrated systems can produce a highly dewatered product that can be trucked from the dewatering facility to a remote site(s). Integrated systems were first tested on a large scale in 1997 at Lake Hollingsworth in Lakeland, Florida. The process used bar screens (large debris removal), hydrocyclones (sand separation), polyacrylic polymers (flocculation), rotary screens and settling ponds (floc/water separation) to dewater approximately 3 million cubic yards of highly organic sediments from the lake. The dewatered material was eventually used for improved pasture and golf course construction. The experience gained from the Lake Hollingsworth project was used to design an integrated dewatering system for Lake Maggiore in St. Petersburg, Florida. In addition to the use of hydrocyclones and polymers, this system incorporated a conventional thickener and belt presses to produced a cake-like material that ranged in solids content (by weight) from 25% to 35%. The dewatered material was stacked and loaded directly onto trucks for final disposal and reuse within the City. The entire processing facility occupied an area of approximately 4 acres.

The unit cost for the different dewatering methods will be dependent on the volume and characteristics of the sediments, the availability and cost of land, and treatment levels required for return water. Passive methods will require large tracts of land which can be unusable for extended periods of time. Integrated systems required an extensive array of equipment, chemicals and energy inputs. Developing a cost effective dewatering plan requires an understanding of the sediment characteristics, dredging rates, spoil site availability, and environmental permitting requirements.

References

BCI Engineers & Scientists, Inc. 2007. Rapid Dewatering Techniques for Dredged Lake Sediments. Report to the St. Johns River Water Management District. Contract No. SK940AA.

Cook D.C., E.B. Welch, S.A. Peterson, and S.A. Nichols. 2005. Restoration and Management of Lakes and Reservoirs, Third Edition. CRC Press, Boca Raton, FL.

Steinman, A.D., K.E. Havens, N.G. Aumen, R.T. James K.R. Jin, J. Zhang, B.H. Rosen. 1999. Phosporus in Lake Okeechobee: Sources, Sinks, and Strategies. In Phosphorus Biogeochemistry in Subtropical Ecosystems. Eds. K.R.Reddy, G.A. O'Connor and C.L. Schelske. Lewis Publishers: Boca Raton, FL.

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

Lance M. Lumbard, Ronald L. Hart and Sandi Hanlon-Breuer
Lake County Water Authority; Tavares, FL

Harvey Harper
Environmental Research and Design, Inc; Orlando, FL

Lake Apopka is a shallow 125-km^2 (30,888-acre) hypereutrophic lake located at the headwaters of the Harris Chain of Lakes northwest of Orlando, Florida. Intensive agricultural activity along the north shore of Lake Apopka began in the 1940s and ended in the 1990s as a result of legislative action. Nutrient loading from these historic agricultural activities remains the primary cause of water quality problems within Lake Apopka and the rest of the Harris Chain and is the focus of the Florida Department of Environmental Protection's (FDEP) Total Maximum Daily Load (TMDL) program (FDEP, 2007). The Lake County Water Authority's (LCWA) Offline Nutrient Reduction Facility (NuRF) has been specifically designed to assist FDEP and other agencies in their efforts to achieve the TMDL goals for more than 93 km^2 (22,980 acres) of impaired lakes downstream of Lake Apopka.

The Apopka-Beauclair Canal Lock and Dam was completed in 1953 and currently serves as a means of stage regulation and boating navigation to and from Lake Apopka. The controlled nature of the canal provides a unique opportunity to treat Lake Apopka discharge as a pollution point source and apply off-line alum (aluminum sulfate) injection technology to remove up to two-thirds of the total phosphorus (TP) contained in the treatment stream. The Apopka-Beauclair Canal contributes as much as 89% of the TP load to Lake Beauclair (Fulton, 1995).

Once completed, control structures within the NuRF will become the primary means of stage regulation for Lake Apopka (Figure 1). The NuRF will then be capable of treating discharges up to 300 cfs making it the largest alum treatment facility in the world designed specifically for TP removal. Navigation will not be affected and the existing dam will remain in place for additional flood conveyance.

The decision to construct the NuRF required more than six years of evaluation, planning permitting and data analysis and the cooperative efforts of many agencies. During this time, the St. John's River Water Management District (SJRWMD) has continued its restoration efforts to reduce nutrient loading from the 30,000-acre North Shore area of Lake Apopka. While some success has been realized, it is clear that the NuRF will be necessary during the lengthy restoration process to meet the required total phosphorus (TP) concentrations in Lakes Beauclair, Dora, Eustis and Griffin (Table 1). Achieving the TP goals for these lakes is also expected to improve other water quality parameters such as transparency and the overall health of the macroinvertebrate community as measured by the Lake Condition Index (LCI) (see Table 1).

Figure 1. NuRF Schematic

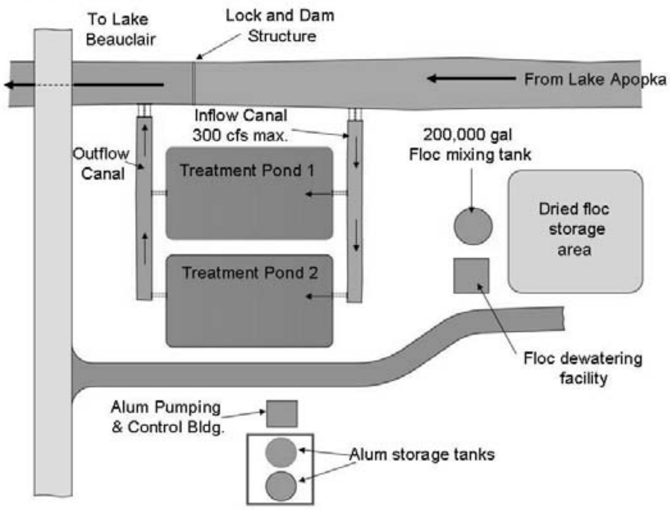


Table 1. Water Quality / LCI Data

Lake	TP TMDL (ppb)	Current TP* (ppb)	LCI**
Apopka	55	167	N/A
Beauclair	32	101	very poor
Dora	31	61	poor
Eustis	25	61	poor
Griffin	32	62	poor

* May 2007 – April 2008 SJRWMD data
** 2006 LCWA data

The Lake County Water Authority is currently constructing the $7.272 million NuRF in cooperation with the FDEP and the SJRWMD. Upon completion in January 2009, the 50-acre facility will operate at the discretion of the LCWA Board of Trustees until the restoration efforts of the SJRWMD have successfully and consistently achieved the TMDL goals for Lake Beauclair and the lake is delisted by FDEP without the assistance of the NuRF.

References

Florida Department of Environmental Protection (2007). Basin Management Action Plan for the Implementation of Total Maximum Daily Loads Developed by the Florida Department of Environmental Protection for the Upper Ocklawaha River Basin. Division of Water Resource Management, Bureau of Watershed Management, Tallahassee, FL.

Fulton, Rolland S., III. (1995). External nutrient budget and trophic state modeling for lakes in the Upper Ocklawaha River Basin. *Technical Publication SJ95-6*, St. Johns River Water Management District, Palatka, FL.

NOTES

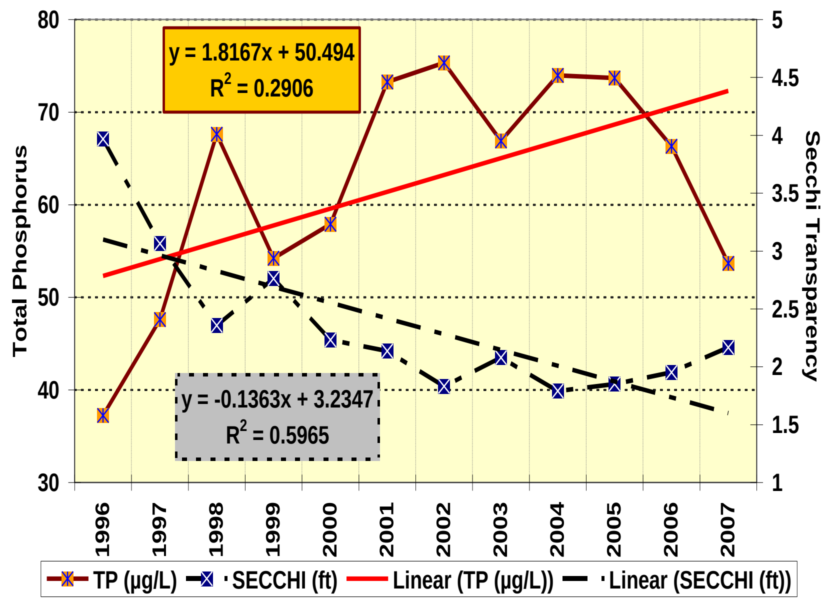
THE CONTINUING SEARCH FOR THE SMOKING GUN ON ISTOKPOGA: LITTORAL, PELAGIC AND CANAL NUTRIENT CONDITIONS.

Clell Ford and *Erin McCarta* Highlands County Natural Resources Department, 4505 George Blvd. Sebring, Florida 33875-5837, cford@hcbcc.org, emccarta@hcbcc.org

SITE DESCRIPTION, GOALS & OBJECTIVES

Lake Istokpoga, the 5th largest lake in Florida at 11,200 hectares, drains a 159,000 hectare watershed in Central Florida's Lake Wales Ridge. Lake outflows ultimately end 50 kilometers southwest in Lake Okeechobee. Istokpoga has an average depth of 1.5 m (max depth 3.5m) which when combined with the lake's large fetch makes stratification rare. Two creeks flow to Istokpoga, Arbuckle Creek (75% of the watershed from the north) and Josephine Creek (the remaining watershed from the west). Historic water quality in Istokpoga has shown a steady increase in nutrient concentrations, though the 2006 – 2007 drought has substantially improved phosphorus levels (SFWMD DBHydro data, unpublished, Florida LAKEWATCH 2007, Fig 1). FDEP has included Lake Istokpoga on its verified list of impaired waters for nutrients (FDEP, 2006). The three-fold increase in nutrient loading both into and out of Istokpoga since 2001, confounded by a reservoir-style regulation schedule helped put Istokpoga on track for TMDL development by the end of 2008. At the same time, riparian areas that are not the subject of standard evaluations, have not been studied. However, these areas may represent a significant source of nutrients or other impairing factors to Istokpoga, some of which may result more from natural conditions such as watershed soils, or the natural decay of native vegetation. Areas of interest include agricultural, commercial, residential, recreational and natural land uses. Possible sources of impact include improperly maintained septic systems, excessive fertilizer use, stormwater runoff, groundwater discharges and riparian agriculture.

Fig 1. Lake Istokpoga annual average TP and Secchi Transparency (each point represents 30 to 70 samples - LAKEWATCH data)



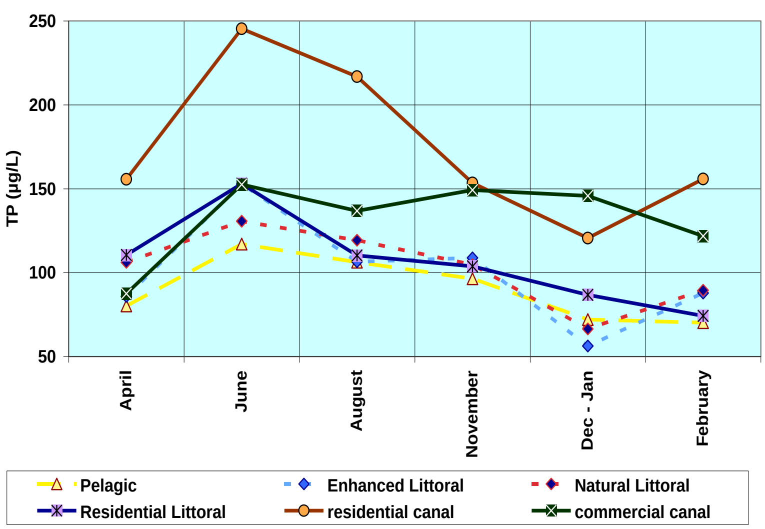
METHODS

This project focused on specific riparian land use impacts relative to excess nutrients and bacteria to the lake. Seasonal changes in lake levels, stream flows, and residential population were included in this qualitative assessment. Forty-two sample sites were sampled bi-monthly for one year; sites chosen represented open pelagic zones, residential littoral and canal areas, commercial marinas on canals, natural littoral zones, and enhanced or managed littoral zones. Standard field parameters were recorded at each site. Surface grab samples were collected and analyzed for chemical (nutrients, major ions and metals), physical (alkalinity, hardness, color, turbidity, total suspended solids) and biological (cholorphyll, enterococci bacteria and fecal coliform bacteria) parameters. This presentation compares the relative contribution from littoral and canal sites with pelagic conditions.

KEY FINDINGS

Results showed that Arbuckle Creek remains the overwhelming source of nutrients to the lake, with both pelagic and littoral zones reflecting influence of Arbuckle Creek. Results confirmed that phosphorus concentrations are statistically significantly higher in the northern portion of the lake than the south (0.1 mg/L vs 0.082 mg/L, $p<0.021$); however, this statistical difference was much stronger for silica from north to south (2.66 mg/L vs 1.64 mg/L, $p<0.001$), suggesting that in-lake sources for pelagic zone phosphorus do not exist for conserved a-biotic components of the water column. No statistically significant difference was observed for other conserved major ion species (Cl, K, Mn or Na). Canal systems clearly behave very differently from the littoral and pelagic areas, with phosphorus levels much higher than for the natural and open waters of the lake, but seasonal impacts from human activities have no statistically notable affect on nutrient levels (Fig 2). Key factors for improving in-lake and downstream water quality include the usual: Enforcing current wetland protection rules, improving water level fluctuation, maintaining septic systems, reducing fertilizer use and maintaining revegetated areas. However, without a concerted effort to reduce nutrient input from upstream, and without a natural water level fluctuation regime, nutrient loading and organic matter production in the lake will continue the negative impact on the Istokpoga ecosystem and Lake Okeechobee. The results of this study are being used for development of management strategies including a watershed management master plan for Lake Istokpoga.

Fig 2. Average TP values for all sites by category (canal averages are represented by solid lines).



NOTES

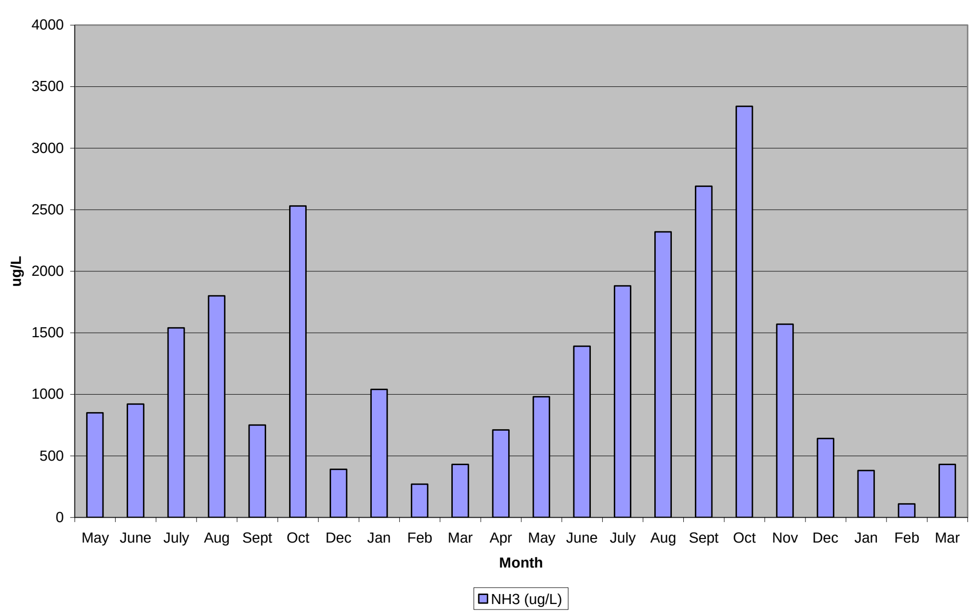
THE ENIGMA OF LAKE BLUE: WHERE'S THIS STUFF COMING FROM?
"Houston – We have a problem!"

Erin McCarta
Clell Ford
Highlands County Natural Resources
Sebring, FL

Lake Blue is a 15-acre ridge-type lake that lies in the southern portion of the Lake Wales Ridge. According to local residents, the lake was crystal clear in years past. However, since at least 2000, nutrient levels have supported seasonal noxious algae blooms that routinely leave the lake the same color as the surrounding yards. This abrupt change in the lake triggered an intensive investigation of not only the water in the lake, but also seepage and groundwater conditions in the watershed. Meteorological conditions are also being monitored by a remote weather station on site.

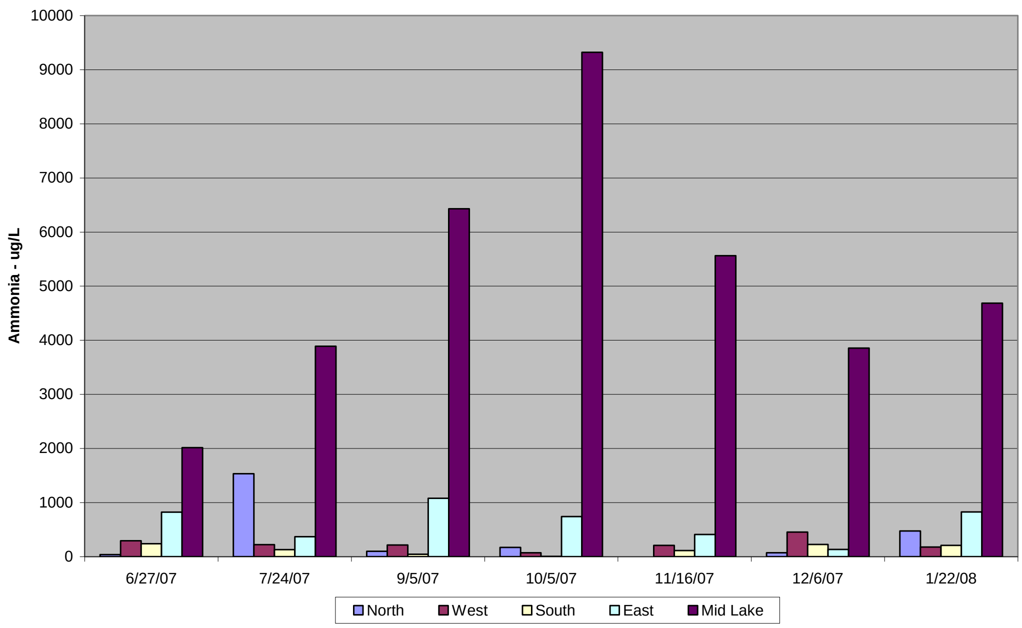
Results show that the lake goes through a large seasonal swing in water quality, with very high (2.55 mg/l, avg.) ammonia levels developing in deep anoxic water during the summer (Figure 1). Ammonia levels in the deep waters of the lake are consistently high, while at other areas in the lake those numbers are negligible. In the groundwater, ammonia is elevated at the East Well and to some extent also at the West well. Nitrate levels show very different patterns, with large values (7.16 mg/l, avg.) recorded for the south monitoring well while nitrate remains largely undetected throughout the lake itself.

Figure 1: Lake Blue Deep Water Site, Ammonia Concentration



Six months of seepage data also shows somewhat staggering results. Ammonia concentrations measured at the mid-lake seepage meter also seem to follow a well-defined seasonal trend (Figure 2). Similar to the groundwater results, Nitrate concentrations measured at the south and east seepage meters are consistently elevated.

Figure 2: Lake Blue Seepage Meter Data, Ammonia concentration 2007 - 2008



These unexpected results have provided for a possible explanation that the nitrogen entering the water system (lake) in the form of nitrate is being used for anaerobic respiration during the summer, producing the elevated ammonia levels in the lake, but during the well-mixed winter, nitrate levels do not keep pace.

Activity within Lake Blue's small watershed has been predominated over the past 65+ years by citrus farming, where all the soils are high permeability sands. The high concentration of nitrogen in the lake is most likely the result of legacy nutrients, from years of elevated nitrogen-laden fertilizer use. Even though concentrations of phosphorus have been found to be quite low, due to the extremely elevated nitrogen content, very small amounts of P are triggering large, long-lasting algae blooms. By implementing Best Management Practices (BMP's) to reduce phosphorus loading from the watershed, the health of the lake will likely improve.

NOTES

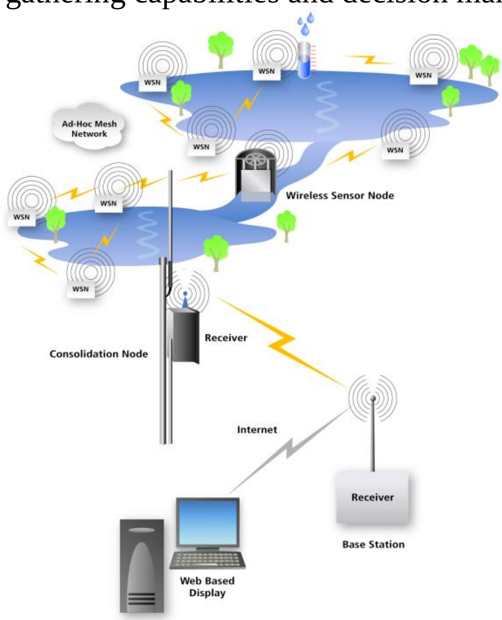
USE OF WIRELESS SENSOR NODES TO PROVIDE CONTINUOUS DATA FOR POLLUTANT STUDIES AND TDML COMPLIANCE

Rhonda L. Copley, Kevin D. McCann
PraxSoft, Inc., and City of Orlando Stormwater Utility Bureau
Orlando, FL

Environmental and weather data from site-specific locations can be limited—especially during severe weather and man-made incidents. New technologies like wireless sensor nodes (WSNs) can make even continuous monitoring affordable and effective.

Wireless Sensor Nodes are embedded devices used to gather information about their environment, do simple computations and transmit these data. They generally have sensors that monitor specific parameters and are able to pre-process and receive/send data. In some cases, the nodes can even control other remote devices such as gates, timers and contact closures.

Each wireless sensor node is made up of a microprocessor, sensors, a low-power radio and software to communicate with each other and the outside world. They have built-in intelligence to collect, communicate and analyze data about their surroundings and the environment to improve data gathering capabilities and decision making.



Autonomous sets of wireless sensor nodes are known as Wireless Sensor Networks. In lake and storm water applications these nodes gather real-time and long-term data about their environment such as water level, temperature and rainfall and communicate this data through adjacent or nearby nodes in an ad hoc fashion. This unique communications scheme allows the scattering of low-power nodes throughout a lake or watershed to provide optimal spatial coverage without expensive installation or communications costs. The nodes can transmit/receive data and find the best path back to the Base Station through one or more Consolidation Nodes. Reach back from the Consolidation nodes to the Base Station or Server can be achieved via several long-range legacy communication methods like licensed or unlicensed telemetry and satellite or cellular links. This enables total asset monitoring.

The City of Orlando employs a WSN network consisting of sensors that collect continuous lake elevations and rainfall data at sixty-seven City lakes. Besides being used for advanced warnings and hydraulic evaluation of flood conditions the data is used for pollutant studies and TMDL compliance determinations. Flow data is then used with water quality monitoring data to accurately establish the amount of pollutants; such as phosphorus, which are being discharged. For example, the headwaters for Howell Creek which outfalls to Lake Jessup, begin at Spring Lake and flow out of the City of Orlando through a canal between Lake Rowena and Lake Sue. Pollutant load modeling used in the development of the Lake Jessup TMDL indicates that the City of Orlando is contributing 688 kg/year of phosphorus to Lake Jessup. The City contends that the phosphorus loading estimate is inaccurate due to the type and assumptions used for pollutant load modeling. A stage discharge curve has been developed for the Lake Rowena outfall canal and will be used with continuous elevation data and concentration data to accurately determine our phosphorus contribution to Howell Creek. Prior to installation of elevation sensors only very rough approximations of flow could be estimated because the data consisted of monthly gage board readings, which do not typically reflect the short duration, but large flows, associated with storm events.

Empirical pollutant loading data is also being collected at the City outfalls to other impaired waters such as Little Wekiva River and Shingle Creek, using these wireless sensor nodes. Another use of the rainfall and elevation sensors will be the determination of watershed runoff coefficients by measuring changes in lake elevation for various measured rain events. All of these measurements are critical parameters for accurate diagnostic studies, TMDL development and documentation of reductions in pollutant loading to impaired waters.

Notes

SESSION 4

POSTER SESSION

A NOVEL APPROACH TO COLIFORM REDUCTION IN A DRINKING WATER SOURCE

William Frazier, Manager
Water Quality Lab and Pretreatment
Public Services Department
City of High Point, NC

Since the late 1990's we noted a trend of increasing coliform in our source drinking water supply lakes. It had reached a point where many of the streams across the watershed had been listed in the 303(d) assessments as severely impaired for fecal coliform. In addition, tests performed at the water plant indicated total bacteriological content was reaching levels that might be threatening to exceed treatment design criteria.

A variety of sources were found. Many were due to aging infrastructure. Improvements were made but coliform levels did not improve to the degree expected. Using DNA technologies, many probable source organisms were identified but they did not provide the information we expected. The greatest contributing source remained unidentified and was persistently increasing.

Here experience and empirical observation replaced absolute science. A resident flock of Canadian geese had been establishing and expanding itself on both water supply lakes over the past several years. Due to favorable conditions, one of the two lakes had 800 to 1000 individuals occupying the 800-acre lake.

Control measures available through wildlife resource, waterfowl agencies and humane societies were used with no apparent effect on the geese or coliform levels. Attending a NC Lake Management Society Conference, we stumbled onto an unconventional approach that had not been considered. Commercial ventures were offering a service to control geese using border collies to "herd" them off the lakes. Testimonials and field observation proved this was a viable approach to be considered.

Evolution has programmed geese to fear predators like fox, coyote and wolves. Through the millennia, survival in the geese's favored niche relied upon avoiding areas they even think these animals may be "hunting". Dog breeds with the overall body profile of a border collie trigger this natural instinct because, while coloration does not match, the breed's silhouette matches that of a goose's most feared predator.

This became very important as investigation proceeded because the public areas favored by the geese exposed them to other dog breeds and circumstances. While they do avoid them, they do not invoke the same level of avoidance as the herding breeds. In addition to the body profile of the border collies and other related breeds, their intensity and stalking habit exhibited when they work, something professional dog handlers call "the eye", further triggers the geese's primal survival behaviors. They seem to react at a level implying if it looks like a fox, coyote or wolf and stalks like a fox coyote or wolf, it will eat me like a fox, coyote or wolf. The result is they will leave the area as soon as possible.

We spent another year contacting commercial vendors only to find out the cost of this unexplored option for water suppliers was prohibitive. There was no research to indicate this remediation technique would yield the results we sought. The author investigated acquiring a dog from one of the vendor/trainers and, again a professionally trained dog was too expensive.

The author found a dog Australian Sheppard mix for adoption through the local humane society living at a nearby animal hospital. Its future was in question because of its age and several failed adoptions. Upon meeting the dog, the author noted its strong herding instincts, tied it to adoption failure records and made the decision to try to let the dog work on its own instincts without training.

The first time the dog was allowed to see the geese, it seemed to know exactly what to do. While we admit many errors we were not aware of then, the geese did not return to this favorite feeding and roosting location for almost three weeks. After a few more weeks of randomly letting the dog "play", the geese continued to avoid problem areas and raw water bacteriological counts began to drop off. After one season, the effectiveness of the dog was obvious by simply observing the absence of geese and we hired a professional handler with trained dogs.

Analyzing the effectiveness and applicability of this solution is complicated. First, geese have to be the source of the coliform contamination. Second, the habitat is the key issue. Geese occupy areas because they offer favorable food, nesting, protection and no native predators. If their location is not close enough to provide effective control of coliform in a drinking water intake, dogs may not be the complete answer. Fear of encounters between dogs and the public need to be evaluated. A reputable handler gives this extra attention in selecting and training the dogs he will use in this application.

The benefits are clear and supported by data. While it is an additional ongoing cost, if coliform is from the geese, it is less expensive than study, design and construction of engineered controls. It offers a very positive pro-wildlife, non-destructive solution. When combined with available hatch controls, it does not take but a couple of years to reduce the population to acceptable levels. Reducing the threat of bacteriological contaminants from breaking through treatment is obvious and remediation opportunities to improve streams classifications on 303(d) lists are an unequalled plus. At this time, the lake is being evaluated for removal from the list of impaired waters.

References:

The Proceedings of NC Lake Management Society Annual Meeting, Raleigh NC (May 2003).

The Geese Police, Howell, NJ, (866) NO-GEESE

Goosemasters, Kent Kuykendall, Ramseur, NC (336) 653-4100

NOTES

IMPACTS OF SHALLOW LAKE DREDGING ON WATER QUALITY

Larry Battoe[1], *Sherry Brandt-Williams*[1], *Ann Shortelle*[2], *Melissa Warren*

1. St. Johns River Water Management District, 4049 Reid Street, Palatka, FL 32177; email addresses: lbattoe@sjrwmd.com; sbrandt@sjrwmd.com
2. MACTEC, 404 SW 140th Terrace, Newberry, FL 32669; email address: abshortelle@mactec.com

Many of central Florida's shallow lakes received untreated or minimally treated wastewater prior to 1983, stimulating accumulation of large amounts of organic sediments and a switch from rooted, submerged vegetation to dominance of algal communities. When this point-source was eliminated water quality improved, but, with increasing nutrient loads from developing watersheds, thick layers of soft, flocculent sediment remained as an overlay on previously vegetated lake bottoms and water quality did not improve enough to satisfy conditions under the Impaired Water Rule.

Many stakeholders in the lake's recovery process believed that the sediments were the major problem and wanted to dredge back to hard packed lake bottoms. These projects have produced mixed results dependent upon a long list of confounding factors – amount of sediment removed, quantity of external nutrient loads, sediment characteristics, lake morphology and disposition and dewatering of removed sediments, for example.

This poster presents an inventory of dredging case studies and reviews dredging impacts immediately following completion of dredging and the long-term success of these projects five to 20 years after dredging.

NOTES

DISSOLVED OXYGEN DYNAMICS IN TUSSOCK-FORMING AQUATIC MACROPHYTES

Bunch, A. J.[1], and M. S. Allen[2]. University of Florida. 7922 NW 71st St., Gainesville, FL 32653. 352-392-9617. [1]ajbunch@ufl.edu; [2]msal@ufl.edu

Stabilization of lake levels due to altered hydrology exacerbates the rate at which dense vegetation mats (i.e., tussocks) form. Tussocks affect water quality (e.g., dissolved oxygen and temperature) and substrate (i.e., accumulation of organic material), and thus, may affect fish community composition. We identified spatial and temporal trends in dissolved oxygen (DO) with respect to tussock-forming macrophyte species (i.e., cattail, pickerelweed, water primrose, smartweed, and torpedograss) and coverage levels (i.e., percent area coverage; 50-64%, 65-79%, and 80-95%) at Lakes Istokpoga and Kissimmee, Florida. In dense vegetated habitats, DO tended to be hypoxic during night and morning hours with an increase in DO during the afternoon, but the magnitude of the increase was influenced by macrophyte species and/or coverage levels. Some habitats exhibited anoxia throughout the diel DO profile. Poeciliids and cyprinodontids (88% of total catch) dominated the fish community in tussock habitats during fish collections. These fish are more adapted to environmental extremes (i.e., hypoxia/anoxia and hyperthermia) than centrarchids, which only contributed 7% to total catch. Management strategies to limit tussock formation will decrease the extent and longevity of hypoxia/anoxia and create habitats that can maximize the diversity of fish communities and increase abundance of species that support fisheries.

NOTES

COMMUNITY COOPERATION TO CONTROL EXOTIC AND INVASIVE PLANT SPECIES ON THE COASTAL DUNE LAKES OF WALTON COUNTY, FLORIDA

Sarah Kalinoski
Choctawhatchee Basin Alliance
Niceville, FL 32578

Coastal dune lakes are unique water resources known to exist only in the panhandle of Florida, the coasts of South Carolina and Oregon, as well as Madagascar, New Zealand, and Australia. They are generally found within two miles of the coast, and they are typically shallow and irregularly shaped. Their water is composed of both fresh and salt water obtained from groundwater seepage (in both directions, from the uplands and from the gulf), heavy rain, and storm surges. The coastal dune lakes of South Walton County, Florida are marked by their intermittent exchange with the Gulf of Mexico. Due to their dynamic character, these lakes support a unique collection of plant and animal species.

This project involves removal of exotic and/or invasive species that have propagated on the Walton County dune lakes due to anthropogenic activities, followed by re-vegetation with native wetland species for reestablishment of the historical native ecosystem. The project will provide better habitat for many native plant and animal species, which will also reduce storm threats to these species. Ecosystem reestablishment will allow the local human community to obtain a better understanding of the sensitive and fragile natural community to which we belong as well. Citizen participation in the restoration process—from exotic identification and removal to planting of natives and monitoring afterward—will be instrumental both in public education and in project completion.

The project begins with extensive education and outreach, whereby the Choctawhatchee Basin Alliance (CBA) and other local scientists teach high school students how to identify exotic and/or invasive species in their communities and how to use handheld GPS units in order to map them. Students learn the significance of native versus exotic and invasive species, and they also increase their knowledge of the special ecosystems that we have in our area. Once students are trained, they are then exposed to environmental fieldwork as they apply their knowledge by marking exotic and invasive plant species along the shoreline of one or more of our coastal dune lakes. The data they collect on the lakes is then translated onto maps as the students are introduced to GIS applications. CBA and the Florida Department of Environmental Protection will use these maps to develop and implement a control plan. Eventually local citizens (hopefully including homeowners along the lake and the high school students originally involved) will re-plant the shoreline with native plants, learning more about stabilization and ecosystem function.

To date, CBA and its partners have mapped five of the fifteen coastal dune lakes in Walton County. The exotic and/or invasive species that appear most prevalent on the dune lakes include but are not limited to: torpedo grass (*Panicum repens*), alligator weed (*Alternanthera philoxeroides*), Chinese tallow (*Sapium sebiferum*), cat-tail (*Typha latifolia*), and *Phragmites australis*. Partners on this project include but are not limited to: CBA, Walton County, Florida Department of Environmental Protection (FLDEP), South Walton High School (SWHS), Okaloosa-Walton Collegiate High School, University of Florida Institute of Food and

Agricultural Sciences (UF/IFAS), Walton County 4-H, Coastal Dune Lakes Advisory Board (CDLAB), South Walton Community Council (SWCC), West Florida Regional Planning Council, United States Fish & Wildlife Service (USFWS).

References

Florida LAKEWATCH (2007). "A Beginner's Guide to Water Management: Aquatic Plants in Florida Lakes." University of Florida/Institute of Food and Agricultural Sciences. Gainesville, FL.

Minchinton, T.E., Simpson, J.C., Bertness, M.D. (2006). "Mechanisms of exclusion of native coastal marsh plants by an invasive grass." Journal of Ecology 94, 342-354.

Schooler, S., Yeates, A., Wilson, J.R.U., Julien, M.H. (2006). "Herbivory, mowing, and herbicides differently affect production and nutrient allocation of *Alternanthera philoxeroides*." Aquatic Botany 86, 62-68.

Wilson, J.R.U., Yeates, A., Schooler, S., Julien, M.H. (2007). "Rapid response to shoot removal by the invasive wetland plant, alligator weed (*Alternanthera philoxeroides*)." Environmental and Experimental Botany 60, 20-25.

NOTES

SEAGRASS RESTORATION – A ROADMAP FOR SUCCESS

Whitney Stambaugh
ENSR
St. Petersburg, FL

There are approximately four categories for seagrass restoration methods. These categories include hand planting, deployed frame units, mechanical planting, and seeding. This non-comprehensive literature review analyzed eleven methods within these four categories for seagrass restoration. The goal of this analysis was to find which method or combined methods resulted in the highest survival rate for a restoration plot, and which was the most cost effective.

Most state agencies require 85% coverage of a designated mitigation plot within three years of planting. The difficulty with this requirement is that recovery typically takes longer than three years. Therefore, achieving maximum survival rate is of the utmost importance. There are various ways in which to increase the survival rate of planted seagrass beds, including but not limited to, the timing of planting, the planting method, site selection, and donor bed selection.

Our review of the literature indicates that hand planting in combination with burlap bag seeding would ensure the highest survival rate for *Zostera marina* and *Thalassia testudirium*. The methods used can also be translated for other seagrass species with certain modifications. Based upon published results this method will result in the quickest recovery time, the highest survival rate, as well as being the most cost effective. A useful addition to this method that may increase survival of the seagrass restoration bed is the use of bird roosting stakes to increase fertilization in the area.

Items to be considered for maximum survival in addition to planting methods are: region specific timing of harvesting and planting, site selection based on mean low water mark, and minimum turbidity for high levels of light attenuation. The restoration plot should be planted in accordance with seasons of the area. Timing of planting is directly related to a shift in water temperature. For example, along the Northeast coast of the United States, it is considered better to plant in early to mid fall. Harvesting of donor plants is also season specific, dependent on water temperature. Donor bed selection should resemble the restoration site as closely as possible in terms of water depth, wave action, water temperature, and salinity. This produces the highest likelihood of survival.

References

Austin, Shaun. A Comparative Analysis of Submarine Cable Installation Methods In Northern Puget Sound, Washington. Journal of Marine Environmental Engineering. 2004. Vol. 7. Pg. 173-183.

Bell, Susan. Evaluation of Seagrass Planting and Monitoring Techniques: Implications for Assessing Restoration Success and Habitat Equivalency. Restoration Ecology. 2007. Pg. 1-10.

Fishman, James. A Comparative Test of Mechanized and Manual Transplanting of Eelgrass, *Zostera marina*, in Chesapeake Bay. Restoration Ecology. Vol. 12, No. 2. Pg. 214-219.

Harwell, Matthew. Eelgrass (Zostera marina L.) seed protection for field experiments And implications for large-scale restoration. Aquatic Botany. May 1999. Vol. 64, Issue 1. Pg 51-61.

Kenworthy, W. Judson. A Comparison of Two Methods for Enhancing the Recovery Of Seagrasses into Propellor Scars: Mechanical Injection of a Nutrient and Growth Hormone Solution vs. Defecation by Roosting Seabirds. Center for Coastal Fisheries and Habitat Research. NOAA. 2000.

Orth, Robert. A rapid and simple method for transplanting eelgrass using single, Unanchored shoots. Aquatic Botany. May 1999. Vol. 64, Issue 1. Pg 77-85.

Phillips, Ronald. Transplantation of Seagrasses, with Special Emphasis on Eelgrass. Aquaculture. 1974. Vol. 4. Pg. 161-176.

Pickerell, Christopher. Buoy-deployed seeding: Demonstration of a new eelgrass (Zostera marina L.) planting method. Ecological Engineering. 2005. Vol. 25. Pg. 127-136.

Thom, Ronald. Adaptively Addressing Uncertainty in Estuarine and Near Coastal Restoration Projects. Journal of Coastal Research. 2005. Vol. 40, Pg. 94-108.

NOTES

SEDIMENT CONTAMINATION IN THE LOWER ST. JOHNS RIVER BASIN, FLORIDA: A GRAPHICAL REPRESENTATION.

John C. Higman, Courtney Hart, Jennifer Seerdan-Tallerico, Suzanne Baird and Dean Campbell.

Water Resources Department, Environmental Sciences Division
St. Johns River Water Management District, Palatka, FL 32178-1429

A sediment assessment survey of the lower St. Johns River and tributaries was made by the St. Johns River Water Management District (District) over a period of seven years (1996 – 2003). The District collected and analyzed over 200 sediment samples from this downstream segment of the St. Johns River and tributaries to determine which contaminants were present in the riverbed sediment, their locations and concentrations. Analytical results provided a preliminary screening-level assessment for 20 trace metal and over 100 organic contaminants. Results were tabulated and graphed to identify potential contaminants of concern, determine the spatial extent of these contaminants, and facilitate the comparison of contaminant levels and distributions among areas of the river.

Preliminary screening-level assessment results indicated highly variable contaminant concentrations in this 100 mile segment of the St. Johns River. All major classes of contaminants were found and the potential contaminants of concern included, but are not limited to mercury, chromium, arsenic, cadmium, lead, polynuclear aromatic hydrocarbons, polychlorinated biphenyls and pesticides (DDT and degradation products). The downstream area, surrounded by the City of Jacksonville, was clearly the most contaminated part of St. Johns River. Elevated concentrations were also found upstream near Rice Creek, and contaminant profiles indicated local sources. Typically, tributaries had higher contaminant concentrations than the river main stem, and the Cedar and Ortega rivers were the most contaminated.

NOTES

A STORMWATER MANAGEMENT PLAN; COLLECTION, ORGANIZATION, OPTIONS, AND PRIORITIZATION (COOP) PROJECT FOR THE ST. ANDREW BAY WATERSHED

Jon M. Hemming[1,2], Charles Yautz[1], Michael Brim[1], Danielle Honour[3]

[1]Friends of St. Andrew Bay-FSAB (formerly St. Andrew Bay Environmental Study Team-BEST), Panama City, Florida 32401
[2]U.S. Fish and Wildlife Service, Panama City, Florida 32405
[3]Camp, Dresser and McKee Inc. (CDM), Maitland, Florida 32751

The St. Andrew Bay watershed system is a nationally significant estuary found in the Florida panhandle. It hosts extremely high biodiversity in the bay itself, as well as in the entire watershed. This project was designed to address the management of stormwater, the largest threat to this system's health, throughout the watershed. Because this watershed is located almost entirely within one county, Bay County, it represents opportunities to apply holistic stormwater management for a coastal bay.

In collaboration with local governmental partners, the following objectives have been defined as needs for nonpoint source pollution management in the St. Andrew Bay watershed: 1) evaluate the hydrologic connectivity of the St. Andrew Bay watershed; 2) estimate loading to the bay system from various hydrologic routes; 3) identify and quantify sources of loading; 4) provide recommendations for reducing or eliminating urban enhanced loading; 5) prioritize potential implementation activities for greatest benefit and largest economy; 6) and provide monitoring and maintenance recommendations for stormwater management actions and features.

The evaluation has focused on drainage basins – not political jurisdictions – and known or likely future growth patterns over the next 20 years.

NOTES

REUSE WATER IN THE MIDDLE ST JOHNS RIVER BASIN WATERSHED

Sherry Brandt-Williams and Robert Godfrey

Sherry Brandt-Williams, Ph.D., SJRWMD. Water Resources, Environmental Sciences, Palatka, FL, sbrandt@sjrwmd.com
Robert Godfrey, Gannet-Fleming: GeoDecisions, Tampa, FL, rgodfrey@sjrwmd.com

Reclaimed water in the state of Florida has extremely high phosphorus concentrations (~0.5 to > 5 mg/L TP), because requirements of state statutes do not provide effluent concentration limits for most treatment plants. While this may be acceptable for drinking water, TP concentrations in this range are harmful to rivers and lakes because the increased nutrient availability favors algal growth, shading out healthier submerged aquatic vegetation. Additionally, there is no legislated limit to the amount of reclaimed water that can be used, as long as it is available. Using Lake Jesup as one example of the TP loading to the state's waters demonstrates that watering residential lawns using the recommended schedule and volume results in substantial nutrient loading to the lake. Applications of one inch two times a week in areas within the Jesup watershed with reclaimed water infrastructure have a potential runoff of approximately five MT TP/yr into Lake Jesup, an impaired water body in the MSJRB. This is almost 60% of the load reduction required under the current TMDL for Lake Jesup.

Reclaimed water is also used extensively in other areas of the Middle St. Johns River Basin (MSJRB) with the Orlando area CONSERV II program being one of the largest reclaimed water programs in the world and beginning in the early '80s. In the current climate of heated debate about water supply, not just in the SJRWMD, the use of reclaimed water for irrigation is an important component in ensuring viable water supply to constantly growing populations. However, because of the potential for over fertilization (resulting from a combination of use of reclaimed water in addition to regular lawn fertilization or just reuse water alone with insufficient treatment at the source), recommended applications should be reevaluated and consumers educated about potential overuse. Further, wastewater treatment plants (WWTP) should be encouraged to improve secondary treatment of effluent so that nutrient loads within watersheds receiving reclaimed water are better able to manage loads to water bodies needing protection.

We present the actual flows and concentrations from the contributing WWTPs to each area currently using reclaimed water for irrigation for the entire Middle St. Johns River basin. Quantitative scenarios are provided that demonstrate better management of this resource so that it becomes a valuable cost saver for residents, rather than an environmental hazard to surface waters.

NOTES

RESTORATION OF A SPRING-FED POND: A LOVE-YOUR-LAKE SUCCESS STORY

H. R. Hammers *and A. B. Shortelle*, Ph.D., MACTEC Engineering and Consulting Inc. Newberry, FL 32669
David Mandrella, Clay County Parks and Recreation, Camp Chowenwaw Park, Green Cove Springs, FL 32043

Camp Chowenwaw is a 150-acre park that Clay County purchased last year from the Girl Scouts. The Scouts operated the camp for more than 70 years before deciding to relocate due to encroaching development. The county plans to offer activities such as camping, kayaking, canoeing, swimming, fishing and a trail system through the wetlands. The State Park received a Love your lake Cost-Share Grant from the Florida Lake Management Society (FLMS), to restore the modified, spring-fed pond that had once been a swimming/fishing hole during the Girl Scout days. The County Park had significant plans to transform this pond into an "ecological laboratory" where children can participate in tours, demonstrations, and hands-on environmental learning activities. Engineers and Scientists from MACTEC Environmental Engineering and Consulting, Inc. (MACTEC), donated their services for the restoration design, and the restoration goal was achieved. The maintenance plan included the creation of a gradual slope into the pond that would make it readily accessible to the public, the construction of a stationary platform on the opposite side of the gradual slope, and the removal of invasive plants and the establishment of beneficial native plants including: *Vallisneria* (tape grass), *Potamogeton illinoensis* (Illinois pondweed), *Sagittaria sp*.(duck potato), *Nuphar luteum* (spatterdock), *Iris virginica shrevei* (blue flag iris), and *Canna flaccida* (yellow canna).

NOTES

THE DESIGN AND IMPLEMENTATION OF A NEW "ONE ATLAS" WATER ATLAS FOR VOLUSIA COUNTY AND THE CITY OF TALLAHASSEE AND LEON COUNTY

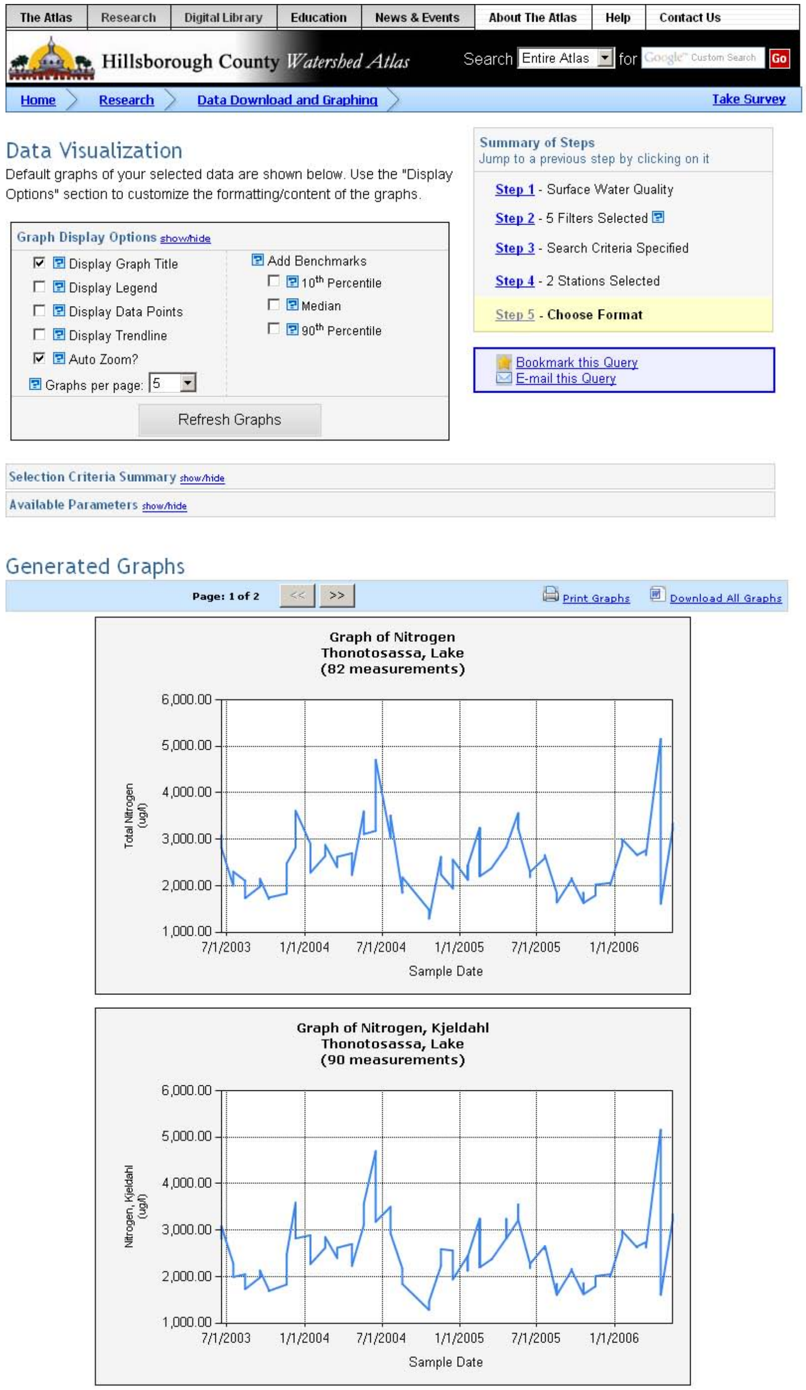
Keith Bornhorst, Ron Chandler, Jim Griffin, Richard Hammond, Kevin Kerrigan, Jodi Pratch, Shawn Landry, Jason Scolaro, USF-FCCDR, 3650 4202 E. Fowler Ave., HMS 301, Tampa FL 33620, 813-974-1068, griffin@arch.usf.edu

For years the Florida Center for Community Design and Research has been working on a water atlas web and database design that would allow the management of multiple water atlas websites through a single database and a single unified code base. We have achieved this dream with the implementation of our new "One Atlas" design. The first new water atlas websites to be implemented under this design schema are the Volusia and Tallahassee and Leon County Water Atlas websites. These websites feature a new query based data download system with multiple data filters and various report options, a data mapper for the management and display of near real-time spatial and parametric data, a query based digital library with hundreds of water resource related volumes, a large waterbody and topic search that allows rapid access to all water resource pages and a new advanced geographic system map application that is fully integrated with all water resource pages. The One Atlas design now allows users access to all water atlas websites from any other website and with the addition of the growing Florida Atlas of Lakes is becoming the single source for lake, river, and pond and near shore water resource information.

The new One Atlas design also allows the Florida Center to significantly reduce the work necessary to update a single website. This is accomplished by allowing a single update to either the database or code base to be made available to all atlas websites without any duplicative entry or programming. This feature also allows all websites to take advantage of design efforts that were sponsored by a single partner and it makes the sharing of efforts between sponsors much more effective.

Figure 1 shows the new One Atlas front page. Our design goal for this page was to allow a used to access all major Water Atlas components and features within 3 key strokes and to be able to see at a glance what the atlas provides. Figure 2 shows the new functionality available in the data download. Please visit the new development site for our City of Tallahassee and Leon County and Volusia County sites at (http://dev.tlc.wateratlas.usf.edu and http://dev.volusia.wateratlas.usf.edu.

Figure 2. One Atlas Front Page


The Atlas
Research
Digital Library
Education
News & Events
About The Atlas
Help
Contact Us
Hillsborough County Watershed Atlas
Search Entire Atlas for
Go
Home
Research
Data Download and Graphing
Take Survey
Data Visualization
Default graphs of your selected data are shown below. Use the "Display Options" section to customize the formatting/content of the graphs.
Graph Display Options show/hide
Display Graph Title
Display Legend
Display Data Points
Display Trendline
Auto Zoom?
Graphs per page: 5
Add Benchmarks
10th Percentile
Median
90th Percentile
Refresh Graphs
Summary of Steps
Jump to a previous step by clicking on it
Step 1 - Surface Water Quality
Step 2 - 5 Filters Selected
Step 3 - Search Criteria Specified
Step 4 - 2 Stations Selected
Step 5 - Choose Format
Bookmark this Query
E-mail this Query
Selection Criteria Summary show/hide
Available Parameters show/hide
Generated Graphs
Page: 1 of 2
Print Graphs
Download All Graphs
Graph of Nitrogen
Thonotosassa, Lake
(82 measurements)
6,000.00
5,000.00
4,000.00
3,000.00
2,000.00
1,000.00
Total Nitrogen (ug/l)
7/1/2003
1/1/2004
7/1/2004
1/1/2005
7/1/2005
1/1/2006
Sample Date
Graph of Nitrogen, Kjeldahl
Thonotosassa, Lake
(90 measurements)
6,000.00
5,000.00
4,000.00
3,000.00
2,000.00
1,000.00
Nitrogen, Kjeldahl (ug/l)
7/1/2003
1/1/2004
7/1/2004
1/1/2005
7/1/2005
1/1/2006
Sample Date

TRENDS IN LIMITATION OF PELAGIC ALGAL PRODUCTION IN LAKE OKEECHOBEE, FLORIDA

Karen Donnelly
South Florida Water Management District
3301 Gun Club Road, West Palm Beach FL 33416
(561) 681-2500 ext. 4568
kdonnell@sfwmd.gov

Bioassay experiments have been conducted since 1994 on the factors limiting phytoplankton production in Lake Okeechobee, Florida. This shallow, eutrophic lake is subject to large algal blooms, especially in the summer months. These blooms are regulated by high phosphorus loading and turbidity generated from sediment resuspension. Integrated samples of the water column have been collected quarterly from five stations around the lake, including pelagic, nearshore, and Fish Eating Bay sites. Aliquots of each sample are exposed to nutrient (nitrogen, phosphorus, nitrogen + phosphorus) and light gradients, with relative algal growth measured over time. Analysis of the limitation studies can help assess trends in importance of nutrient and light availability for algal blooms in the zones of the lake prone to water column blooms. In 2002 a decision tree model was developed to determine whether water quality data could be used in place of lengthy bioassays. Data from 2002-2004 were used to validate the model, with varying degrees of success, dependent on the limitation factor (light or specific nutrient). The lake is predominantly light limited, followed by nitrogen (N and N+P) limitation. While the model was successful at predicting whether light or nutrient limitation dominates (84%), it was less accurate in specifying which nutrient set was limiting (60%). This model will be tested with the subsequent data to verify if it continues to work in this system.

NOTES

DETERMINING NITROGEN AND PHOSPHORUS CONCENTRATION TARGETS TO MEET A TROPHIC STATE INDEX GOAL FOR LOCHLOOSA LAKE

Jian J. Di and Erich Marzolf
Water Resources Dept. / Environmental Sciences Div.
St. Johns River Water Management District, Palatka, FL 32178-1429

Lochloosa Lake covers about 8900 acres in eastern Alachua County, Florida. It is an eutrophic lake with average concentrations of 2119 μg/L, 70 μg/L, and 57 μg/L for total nitrogen (TN), total phosphorus (TP), and chlorophyll-a (Chla), respectively. Average annual Trophic State Indices (TSIs) over the past couple decades have varied from 22 to 93 with an average of 67. Based on the Impaired Waters Rule, a mean annual TSI of 60 is the impairment threshold for lakes with color greater than 40 platinum cobalt units, unless paleolimnological information indicates the lake was naturally more eutrophic. Based upon this rule, a TSI of 60 can be used as a restoration goal for impaired lakes in Florida. TSIs are calculated using different equations depending upon the nutrient limitation conditions in the lake (Huber et al. 1982). For nutrient-balanced lakes, the TSI is based on the average TN, TP and Chla concentrations. Thus an overall TSI of 60 can be obtained by many TN, TP and Chla concentration combinations, eg. 20, 1239, 68 or 30, 680, 45 (μg/L Chla, TN, TP respectively). However, nutrient impaired lakes require specific TN and TP load reductions as part of Total Maximum Daily Load (TMDL) program.

The purpose of this presentation is to present an objective and unambiguous nutrient concentration target setting method that is based upon a TSI of 60 as the restoration goal for Lochloosa Lake. The majority of the data used in this determination was collected by the St. Johns River Water Management District since 1995. Another restoration target assumption was that a nutrient balanced condition is desirable, therefore only the data with a TN/TP ratio between 10 and 30 were used to calculate TSIs using the equations for a co-limited condition (Huber et al. 1982). Simple linear regression models that describe the relationships between TSI and TN, TSI and TP, as well as TSI and Chla were determined using RPOC GLM of Statistical Analysis System (SAS). Target TN, TP and Chla concentrations were determined using these regression models by selecting a TSI of 60. The determined targets were 1318, 54 and 21 μg/L for TN, TP and Chla, respectively.

A variety of approaches have been used in published TMDLs throughout Florida. For Lake Jesup in Seminole County (Gao 2005) and Orange Lake in Alachua County (Gao and Gilbert 2003) the target nutrient and Chla concentrations were determined through a three-step process. First, lake TP and TN concentrations were estimated using an eutrophication model, such as the Bathtub model. Second, a target Chla concentration was determined using empirical TP-Chla models found in the literature (Huber et al. 1982, Johns and Bachman 1976). Third, a TSI was calculated using the TN, TP and Chla concentrations predicted by the models. This process was repeated until the target TSI was achieved. Since the Chla concentration contributes 50% of the final TSI score, in many cases the generalized TP-Chla model cannot appropriately characterize the TP-Chla relationship for a specific lake. For example, the TP-Chla empirical equation developed by Huber et al. (1982) for co-limited lakes was used to determine the Chla concentration for the final targeted TSI in the Lake Jesup TMDL. However the result from the Huber equation substantially under-estimated the Chla concentration for a given TP concentration in Lake Jesup. For example, a TP concentration of 94 µg/L the Huber equation predicts a Chla concentration of 30.5 µg/L in contrast to an empirical prediction of 73.5 µg/L. The probability a Chla concentration of 30.5 µg/L with a TP concentration of 94 µg/L is small for Lake Jesup. This ambiguity would appear to reduce the likelihood that the lake will achieve the restoration goal of a TSI of 65. Situations such as this suggest lake-specific data rather than generic empirical relationships are more likely to be useful in determining realistic restoration targets, even when based upon TSIs.

References

Johns, J. R. and R. W. Bachman Jr. 1976. Prediction of phosphorus and chlorophyll levels in lakes. J. of Water Pollution Control Federation 48, 2178-2182.

Huber W. C., P. L. Brezonic, J. P. Heaney, R. E. Dickinson, S. D. Preston, D. S. Dwornik, and M. A. DeMaio. 1982. A Classification of Florida Lakes. Final report to DER. Report ENV-05-82-1.

Gao X., and D. Gilbert, 2003. Total Maximum Daily Load for Orange Lake, Alachua County, Florida. Division of Water Resource Management, Bureau of Watershed Management, FDEP.

Gao X., 2005. Nutrient and Un-ionized Ammonia TMDLs for Lake Jesup. Division of Water Resource Management, Bureau of Watershed Management, FDEP.

NOTES

RESULTS OF THE FIRST TWO YEARS OF COMPREHENSIVE LAKE ASSESSMENTS IN HILLSBOROUGH COUNTY FLORIDA

Griffin, J., Eilers, D., and Harley, G.L., USF-FCCDR, 3650 4202 E. Fowler Ave., HMS 301, Tampa FL 33620, 813-974-1068, griffin@arch.usf.edu

Typical lake assessments include methods to determine lake morphology (bathymetry and shoreline mapping), biology (plant biology) and lake water chemistry (water column chemistry). Technologies that improve both the efficiency and effectiveness of lake assessment are useful when attempting to carry out these field assessments in a short time period and with limited personnel. We now use personal digital assistants (PDAs) in the field to collect and manage the variety of data collected during the typical lake assessment. Since May 2006, the University of South Florida used PDAs to collect and store lake bathymetry, lake water chemistry, and vegetation abundance and type (Figure 1). Recently, a similar application was made for a graduate thesis research effort in central Florida terrestrial caves (Figure 2). In this study, a graduate student uploaded ArcPad 7.1 onto a Dell Axim PDA for field data collection. This poster presentation discusses the many field applications of these technologies and our plans to improve our lake assessments in 2008 through the use of spatial data collection with mobile GIS software and how field data collection procedures developed for the 2008 lake assessment project were used in the field of cave and karst science to aid in the conservation and restoration of dry, terrestrial caverns.

Fig.1. David Eilers uses a PDA to collect vegetation data during a lake assessment in Hillsborough County, FL.

Fig.2. Grant Harley uses PDA during cave inventory, Citrus County, FL.

SESSION 5A

MANAGING LAKE JESUP – A SHALLOW, HYPEREUTROPHIC CENTRAL FLORIDA LAKE

APPROACH TO SEDIMENT DEWATERING IN THE LAKE JESUP RESTORATION PROJECT

Michael Hodges
President & CEO, Genesis Fluid Solutions, 6660 Delmonico Drive, Suite 242-D, Colorado Springs, CO 80919; Tel: (719) 332-7447; Fax: (719) 332-7447

The use of relatively new, rapid, dredged sediment dewatering technology may provide an alternative to the negative impacts of sediment disposal in and near wetlands.

Laboratory tests using sediment and water samples from Lake Jesup indicate that the solids in the dredge discharge flow would settle naturally at a very slow rate and leave a yellow and turbid supernatant. For example, after six hours of natural settling time, the solids interface had only dropped from 2,000 ml (@5.8% solids) to 1,730 ml (6.7% solids), and the supernatant turbidity was 153 NTU. This suggests that dewatering the sediment in a traditional, confined disposal facility would result in long settling times before the supernatant water would be clean enough to discharge, and even longer times for the sediment at the bottom of the basin to dewater.

A rapid dewatering system is being evaluated that can handle hydraulic dredge flows between 2,500 and 5,000 gpm and result in 150-250 cubic yards per hour of dewatered solids, depending on the rate and percent solids of the dredge flow. The resulting sediment could be dewatered to retain less than 50% moisture content and could be stacked for removal, trucking or possible reuse options. The resulting dredge return water would be returned to the lake as clear, containing less than 30 ppm total suspended solids. Initial lab testing identified at least one liquid cationic polymer that could work very effectively on specific sediments found in Lake Jesup in conjunction with the rapid dewatering technology. Expected reduction in dredge sediment dewatering time frames and footprints using a rapid dewatering process will be discussed for the two, proposed Jesup projects: (1) The tract at the neck of the lake and (2) 80% of the lake as a whole.

NOTES

COMPARING PHYTOPLANKTON DATA PRE- AND POST- REMOVAL OF WASTEWATER EFFLUENT

Sherry Brandt-Williams, Ph.D., SJRWMD. Water Resources, Environmental Sciences,Palatka, FL, sbrandt@sjrwmd.com

May Lehmensiek, BCI. Lakeland, FL, mlehmensiek@sjrwmd.com

Lake Jesup is a 10,660-acre lake in the Middle St. Johns River Basin in Central Florida. The lake's watershed is highly urbanized and several tributaries deliver untreated stormwater from these areas into the lake. Lake Jesup and its tributaries received effluent from wastewater treatment plants through the 1970's, and an EPA study during that time found TP concentrations in the lake ranging from 0.485 – 0.500 mg/l. Lake Jesup no longer receives direct wastewater effluent, and the average TP concentration has significantly dropped (average of 0.166 mg/l from 1991 to 2002). Lake Jesup had a median annual TSI of 82 from 1991 to 2002, showing little change over that period. However, long-term averages often mask important dynamics occurring within a lake influenced by changing external loads.

In this study, we compare phytoplankton data from three different years spanning the last 34 years (1973, 1995, and 2006) to examine how changes in water quality affect the phytoplankton community. Phytoplankton are useful indicators for water quality because they integrate ecosystem health over time and space and therefore are a good ecological measure of the success of restoration efforts. The 1973 data showed a high phytoplankton density with 27,670 algal units/ ml. Bacillariophyceae dominated the phytoplankton community and the dominant Bacillariophyceae was *Fragilaria,* a genus associated with eutrophic lakes. By 1995, the phytoplankton density was much lower, with 4341 algal units/ ml, and 4 algal groups contributing about evenly to the composition (Cyanobacteria, Chlorophyta, Cryptophyta, and Bacillariophyceae). This dramatic change in phytoplankton was accompanied by a similar increase in water clarity and decreases in TP concentrations and TN:TP ratios. However, the phytoplankton density in 2006 was twice as high as the density in 1973 (58,372 algal units/ml) and was dominated by Cyanobacteria, which are indicative of colored, hypereutrophic lakes. This change was accompanied by a dramatic increase in watershed development and a small but significant increase in TP concentration.

These dynamics indicate that improvements in wastewater treatment were successful in improving water quality in Lake Jesup by 1995, but that subsequent population growth and changes in land use in the watershed lead to changes in water quality by 2006 that favor toxic algal blooms and a constantly increasing reservoir of soft sediments. The change in dominant genera between the 1973 and 2006 data indicate some interesting interactions between phytoplankton and water quality, many of which are presented and interpreted.

NOTES

RELATIONSHIPS BETWEEN LAKE JESUP'S PHYTOPLANKTON AND ZOOPLANKTON

Sherry Brandt-Williams, Ph.D., St. Johns River Water Management District. Water Resources, Environmental Sciences, Palatka, FL, sbrandt@sjrwmd.com

Top-down control of phytoplankton biomass using cascading effects through trophic levels has been discussed and used as a lake management technique for about two decades. For example, encouraging larger Cladoceran (mostly Daphnia) populations appears to limit phytoplankton populations through herbivory. This approach appears to be more effective in deeper, temperate lakes than shallow lakes, and there is considerable debate over efficacy in eutrophic versus oligotrophic waters. In Florida, the smaller size of Daphnia spp. appears to be one factor which limits the effectiveness of top-down control of phytoplankton. Further, other relationships between zooplankton, phytoplankton, water chemistry and trophic state appear to be different between subtropical, shallow colored lakes versus temperate lakes, but there have been few studies to determine potential management options in shallow subtropical lakes.

Lake Jesup is a large, shallow, hypereutrophic lake in central Florida. The St. Johns River Water Management District now has 6 years of phyto- and zooplankton data in Lake Jesup, along with water chemistry and hydrologic data. Several significant relationships between zooplankton and key water quality parameters are evident in the data. Rotifera, which may have limited management value, exhibit strong positive correlations with chlorophyll and Cyanophyta ($R = 0.66$, $p < 0.0001$ and $R=0.62$, $P < 0.0001$). Cladocera have significant positive relationships with both PO_4 concentration and lake stage ($R=0.50$ and $R=0.67$, both $p<0.0001$). However, the Cladoceran population is small most of the time. More complete analysis of relationships between genus, phylum and important species of phytoplankton, zooplankton, water chemistry and trophic state are presented along with time-series to demonstrate interactions that might be enhanced for management options. Implications for future lake management are discussed.

NOTES

WHAT HAPPENED TO ALL THE FISH?
A FISHERIES OVERVIEW OF LAKE JESUP

Earl Lundy
Florida Fish and Wildlife Conservation Commission
De Leon Springs, FL

Lake Jesup is a shallow, highly eutrophic central Florida lake with a surface area of 4,050 ha. Due to the nature of the lake and the poor water quality, fish kills have been frequent over the past decade. The lake's fish community is dominated by rough fish, and the largemouth bass (*Micropterus salmoides*) population is small in comparison to other lakes in the St. Johns River (Holder et. al 2007). Lake Jesup does support sizeable black crappie (*Pomoxis nigromaculatus*) and sunfish (*Lepomis spp.*) fisheries. A limited catfish (*Ictalurus spp*.) fishery also exists. Data indicate a system with a preponderance of rough fishes, notably Florida gar (*Lepisosteus platyrhinchus*), bowfin (*Amia calva*) and gizzard shad (*Dorosoma cepedianum*). In contrast, the fish community of Lake Monroe, a nearby lake of similar area (4,430 ha) in the St. Johns River, has a greater preponderance of largemouth bass and sunfishes and lower numbers of rough fishes.

Lake Jesup has very little submerged aquatic vegetation, and much of the littoral vegetation is not considered preferred fish habitat. The thick organic mud layer that covers much of the bottom of Lake Jesup limits possible habitat for sportfish reproduction. Species richness in the lake is low in comparison to other lakes, and catch per unit effort data indicate reduced littoral populations of fishes. The poor water quality, along with lack of suitable habitat for sport fishes, has lead to a lake that has a poor reputation with many area anglers and sportsmen. Lake Monroe, in contrast, has a more varied plant community, much greater amounts of submerged aquatic vegetation, and higher overall water quality. As such, fishing pressure on Lake Monroe is higher.

Community electrofishing sampling was performed on Lake Jesup in December 2006, and November 2007, while Lake Monroe community sampling occurred in November 2006 and November 2007. Spring electrofishing sampling of largemouth bass was performed on Lake Jesup in April 2007 and April 2008, and in Lake Monroe in February 2007 and in February 2008. Sample locations were determined by plotting the lake perimeters with ArcGIS, plotting sampling points at 750-m intervals, and converting the points to latitude and longitude data. These data were then downloaded to a handheld global positioning system (GPS) receiver using the DNRGarmin program from the Minnesota Department of Natural Resources (DNR). Sample sites were randomly chosen from these pre-designated sampling points, as per the current draft of the FWC Standardized Sampling Manual (Bonvechio 2006). Community samples were collected using 10-minute multi-species transects. Largemouth bass sampling consisted of 15-minute transects using the individual species design. Fishery data were gathered using access-point creels spanning January through May of 2006 and 2007.

Degradation of Lake Jesup has lead to an overall decline in the fish community. Monitoring of the fish community of the lake is recommended to ascertain the overall stability of the present community, and to detect the effects of perturbations on the fish community of Lake Jesup. Additionally, consideration should be given as to the possibility of restoration or other habitat manipulations on Lake Jesup, and their possible benefits to the lake's fisheries.

References

Bonvechio, K., ed. 2006. Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute Freshwater Research Section. Standardized Sampling Manual.

Holder, J., R. Hyle, and E. Lundy. 2007. Annual Performance Report, Fiscal Year 2005-2006. Lower St. Johns River Resource Development. Florida Fish & Wildlife Conservation Commission, Tallahassee, FL, USA.

NOTES

BIOLOGICAL CRITERIA IN THE JESUP BASIN – TRIBUTARIES VERSUS THE LAKE

Marianne Pluchino and Gloria Eby
Seminole County, FL

Typically water quality data is used almost exclusively to assess conditions in Florida's lakes. Inventories of benthic fauna are increasingly important in the development of criteria used to evaluate the biological and chemical conditions of streams and rivers and may soon gain more acceptance in lakes as well. Biological indicator species are environmental gauges that provide a signal of the biological condition in a watershed. Using bioindicators as an early warning of pollution or degradation in an ecosystem can help sustain critical resources. Their decline may indicate a disturbance in the ecosystem while an abundance of a single species or species mutations can indicate specific conditions such as low oxygen. Some species depend on a frequent disturbance, while others cannot tolerate any disturbance. Benthic fauna are particularly important because they cannot easily leave an area when problems occur.

Biological data is being collected in Lake Jesup and its tributaries by Seminole County. A difference between tributary and lake species and abundance has been noted for the Lake Jesup basin. Current inventories are presented, the relationship between tributaries and lake examined and potential use of this data in managing Lake Jesup's water quality is discussed.

NOTES

ASSESSMENT OF N2-FIXATION IN LAKES JESUP AND MONROE, FLORIDA

Leonard J. Scinto, Southeast Environmental Research Center, Florida International University (SERC/FIU), 11200 SW 8th Street, Miami, FL 33199. 305-348-1965, scintol@fiu.edu

Serge Thomas, Florida Gulf Coast University, 10501 FGCU BLVD. S, Fort Meyers, FL 33965. 239-590-7184, sethomas@fgcu.edu

William Anderson, (SERC/FIU), 305-348-2693, andersow@fiu.edu.

Makoto Ikenaga, (SERC/FIU), 305-348-2828, ikenagamakoto@yahoo.co.jp

Chris Sinigalliano, National Oceanic and Atmospheric Administration, Atlantic Oceanographic and Meteorologic Laboratory, 4301 Rickenbacher Causeway Miami FL 33149, 305-361-4384, Christopher.sinigalliano@noaa.gov.

Sherry Brandt-Williams, Water Resources Department, St. John's River Water Management District, 4049 Reid St. Palatka, FL 32177. 386-329-4292, sbrandt@sjrwmd.com.

We estimated the annual within-lake N_2-fixation rates of Lakes Jesup and Monroe, FL, to improve the ability of the SJRWMD to manage their watersheds. Specific objectives included: estimation of the annual TN loading from N_2-fixation, determination of seasonal and daily variation in N_2-fixation, correlation between fixation rates and biophysicochemical measures (Gross Primary Production, Chl a , etc.), identification of algal groups by photosynthesis-based inferences (PhytoPAM), and molecular identification of N_2-fixing organisms and their level of gene expression. Lakes were sampled every 7 weeks for one year. The N_2-fixation rates (by acetylene reduction) were generally greater in L. Jesup than in L. Monroe except during 2 of the 8 events. Day N_2-fixation rates were greater than nighttime diurnal incubations. Fixation rates may be influenced biotic activity as the GPP and respiration in L. Jesup were ≈ 3 times higher than in L. Monroe. Total Chl a varied seasonally but was generally greater in L. Jesup being > 200 ug L^{-1} most of the year. Chl a in L. Monroe showed some peaks (up to 255 ug L^{-1}) but usually averaged ≈ 20 ug L^{-1}. The L. Jesup algal community was consistently dominated by cyanobacteria (95%) with some green algal (5%). Preliminary DGGE analysis of DNA and RNA suggests one type of cyanobacteria dominate L. Jesup. The algal community in L. Monroe generally contains approximately 40% cyanobacteria, 30% greens, and 18% diatoms except for a bloom where 80% was cyanobacteria. DGGE analysis suggests that the dominant cyanobacteria varied seasonally.

NOTES

SESSION 5B

INTEGRATED WATERSHED MANAGEMENT PART 2

LAKE ST. CLAIR REGIONAL MONITORING PROJECT WATER QUALITY ASSESSMENT

Annette DeMaria, Staff Engineer, Environmental Consulting & Technology, Inc.[1]
James W. Ridgway, P.E., Vice President, Environmental Consulting & Technology, Inc. [2]

The Lake St. Clair watershed, a 1,900 square mile urbanized drainage area populated by 1.8 million people in southeast Michigan, has been impacted by numerous point and non-point source discharges. In order assess the nature, degree and extent of the water quality problems in the Lake and its tributaries, there was a desire to give this multi-jurisdictional watershed a "physical" that would include monitoring for various physical, hydrological, biological and chemical parameters during wet and dry weather conditions. Once $2.5 million were obtained from Michigan's unclaimed bottle deposit fund, this desire was realized with the formation of the Lake St. Clair Regional Monitoring Project.

The Project's monitoring results revealed that elevated *E. coli* concentrations (wet weather median values up to 3,600 cfu/100mL) found in newly urbanized areas were just as high as those found in older areas. This was surprising since illicit discharges are often associated with areas that have older sanitary and storm water infrastructure, which can often lead to sewage infiltrating to storm sewers. In addition, median phosphorus levels were found as high as 0.6 mg/L in tributary streams with the sources being split between storm water runoff and wastewater treatment plant effluent.

The results of this effort are being disseminated to the state and municipalities, in order to focus storm water pollution prevention efforts that are required under the industrial and municipal sections of the National Pollutant Discharge Elimination System permit program authorized by the Clean Water Act.

[1] 44315 Groesbeck Highway Clinton Township, MI 48036. Phone: 586-465-2583. Email: ademaria@ectinc.com

[2] 719 Griswold Street Suite 1040 Detroit, MI 48226. Phone: 313-963-6600. Email: jridgway@ectinc.com

---

NOTES

WINTER HAVEN CHAIN OF LAKES PRE-BMAP ASSESSMENT: AN INTERPRETATIVE SYNTHESIS OF EXISTING INFORMATION

D.A. Tomasko and P.J. Latham
PBS&J
5300 W. Cypress Street
Tampa, FL 33607
813.281.8346
DATomasko@pbsj.com

The Winter Haven Chain of Lakes watershed is located in north-central Polk County. The Winter Haven Chain of Lakes (WHCL) is generally divided into the Northern Chain, consisting of 5 lakes, and the Southern Chain, consisting of 16 lakes. In the WHCL system, FDEP, Polk County, the City of Winter Haven and the District have completed, or are currently working on, a number of projects that seek to address water supply, flood control, water quality, and the maintenance of natural systems. While many of the lakes in the WHCL have fairly good water quality, Lakes Shipp, Conine and Haines have had annual TSI values in excess of 70. Nitrogen concentrations from Lakes Jessie and Shipp have included samples with TN concentrations in excess of event mean concentration (EMC) values for TN commonly used in stormwater loading. As such, an excess of TN could be associated with unrecognized point sources, sediment resuspension, inputs of groundwater with high levels of nitrate, and potential nitrogen fixation by blue-green algae. An additional topic related to TMDLs and B-MAPs for the WHCL is that of the role of tannins in moderating algal growth. As there have been significant losses of wetlands coverage in the watershed of the WHCL, it is possible that there has been a significant decrease in tannin levels. If nutrient loads can be "tempered" by wetland-associated tannin levels, this could have significant impacts on the B-MAP development and implementation processes for the WHCL

NOTES

MONITORING STORMWATER RUNOFF WITH AUTOMATED PORTABLE REFRIGERATED SAMPLER SYSTEMS

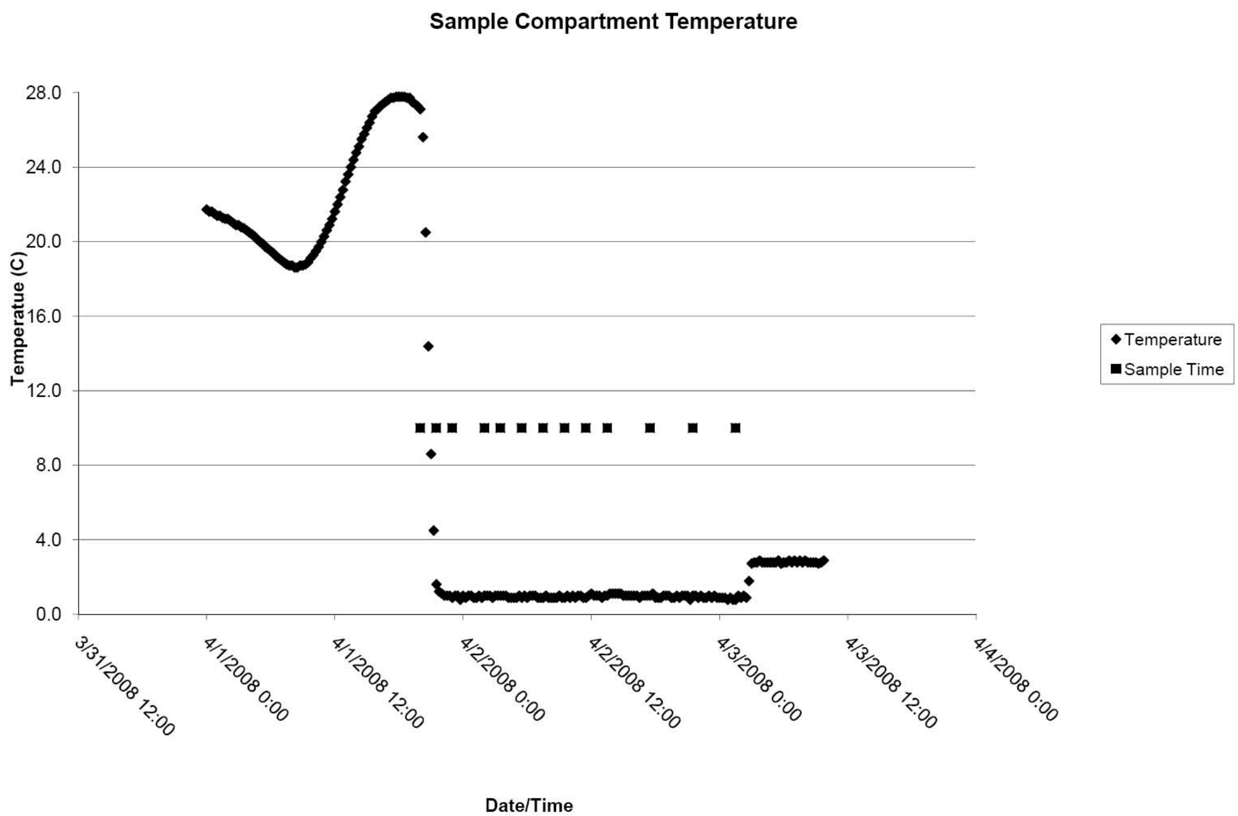
Gary Dalbec, *Larry J. Danek, Ph D,* Environmental Consulting & Technology, Inc.,
Gainesville, Florida
Jian Di, St. Johns River Water Management District,
Palatka, Florida

Environmental Consulting & Technology, Inc. (ECT) is conducting a stormwater runoff monitoring project for the St. Johns River Water Management District (SJRWMD) on four tributary creeks draining to Newnans Lake, including Hatchett Creek and Little Hatchett Creek, and one creek (Lochloosa Creek) draining to Lake Lochloosa in Alachua County. The purpose of the project is to collect stormwater runoff data for input to district watershed models to predict nutrient loading to the lakes for the development of Pollutant Load Reduction Goals (PLRGs). Project monitoring consists of measuring rainfall, creek current velocity and level, as well as collection of water quality samples for analyses of ammonia, total Kjeldahl nitrogen (TKN), orthophosphate, total phosphorus, and total organic carbon (TOC) during 15 storm events. Additionally, samples are collected during periods of baseflow to evaluate the differences in nutrient loading between baseflow and storm runoff conditions.

Storm monitoring is being done with an automated sampling system consisting of an Isco® Avalanche portable refrigerated sampler interfaced with a Model 674 “tipping bucket” rain gage, and a Doppler current velocity sensor and pressure transducer for water level measurements. In addition to sample collection, the sampler also provides data logging capabilities for the interfaced equipment and sample collection and refrigeration data. The current velocity and water level data are used in conjunction with either stream cross-section measurements or culvert dimensions to calculate discharge rates, which can ultimately be used for pollutant load determinations. The programmable sampler is battery powered and collects 14 discrete samples in a refrigerated compartment that complies with sample chilling (4^{o} Celsius [C]) preservation requirements of the Quality Assurance Rule 62-160, Florida Administrative Code (F.A.C.) and Code of Federal Regulations (CFR) Title 40 Part 136. Figure 1 displays temperature data logged from a sampler refrigeration compartment leading to and during a storm sampling episode for the project. Also shown are sample collection points during the sampling event.

The sampler is activated by a prescribed combination of rainfall and water level rises, and the project manager is notified by cell phone modem that sampling has initiated. Water samples are automatically collected at fixed intervals along the hydrograph that were predetermined based on individual drainage basin characteristics. Electronic data such as rainfall, water level, stream velocity, and sample collection times are recorded by the unit’s data logger and can be interrogated in the field to determine which key water samples along the hydrograph should be retained for analysis.

All sites are remotely located, which provides logistical challenges such as equipment security, access, holding times, maintenance of a continuous power supply, and reliable cellular service. Despite the logistical challenges, the system has proven to be a reasonably reliable sampling alternative that greatly reduces the labor costs typically associated with stormwater sampling.



NOTES

AN EVALUATION OF THE PERFORMANCE OF BEST MANAGEMENT PRACTICES (BMPS) FOR THE REMOVAL OF MICROBIAL CONTAMINANTS

B. M. Jarvis, A. B. Shortelle. Ph.D. and C. A. Stroehlen, P.E. MACTEC Engineering and Consulting, Newberry, Fl.

The State of Florida currently lists 26 of 28 basins as having at least one waterbody that is impaired by fecal coliform. An additional 313 waterbody segments in the state have fecal coliform TMDL limits planned for development within the next 14 years. Storm water is increasingly recognized as an important contributor of high bacterial concentrations in Florida lakes and streams, and effective management strategies are needed to mitigate this growing problem. Studies performed throughout the U.S. have shown that Best Management Practices (BMPs) have been used to attempt to reduce bacterial concentrations in runoff entering local waterbodies. A number of BMP strategies, including both structural and non-structural practices, have been used for this purpose with varying levels of success. Understanding of treatment performance in the removal of bacterial contaminants, however, is hindered by limited post-construction performance data for a variety of BMPs and site-specific conditions. Assessments of BMP performance have found that removal efficiencies vary under a wide range of conditions, including regional variations in climate and physical BMP design. An evaluation of the factors affecting bacterial contaminant removal in current BMP design techniques was performed to prioritize effective strategies for future BMP applications.

NOTES

ST. CLAIR RIVER – LAKE ST. CLAIR – DETROIT RIVER DRINKING WATER PROJECTION NETWORK

Annette DeMaria, Staff Engineer
Environmental Consulting & Technology, Inc.
44315 Groesbeck Hwy. Clinton Township, Michigan 48036

The overall goal of St. Clair River-Lake St. Clair-Detroit River Drinking Water Protection Network is to protect drinking water from chemical releases and other threats to public health along the Lake Huron to Lake Erie corridor by instituting real-time water quality monitoring. This corridor, which runs between Canada and the State of Michigan, has been subject to over 700 chemical spills during the past 15 years (IJC 2006).

The two main project tasks are:

1. Install, operate and maintain water quality monitoring instrumentation (multiparameter sondes, organic carbon analyzers, fluorometers, and gas chromatograph/mass spectrometers) at 13 water treatment plants (WTPs) along the corridor; and

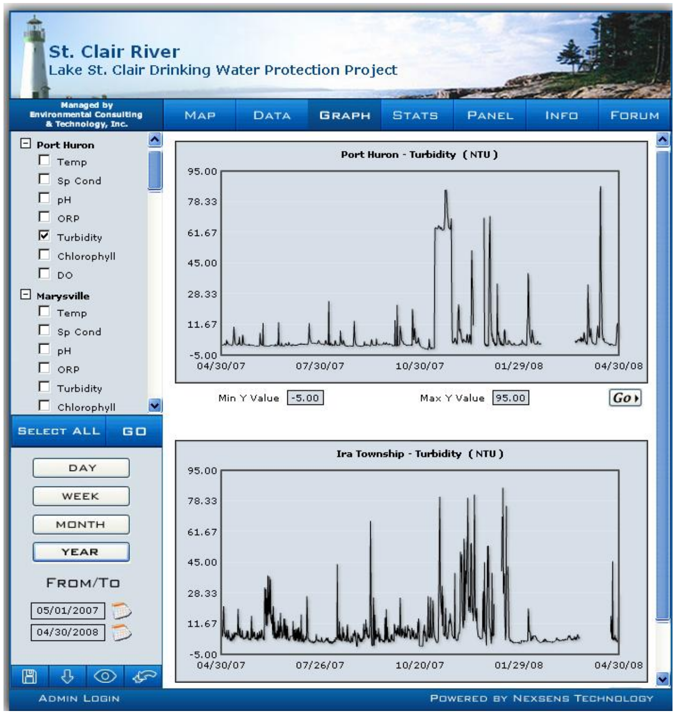
2. Implement a data management and communication system which will store and display the project monitoring data (on a near real-time basis) and notify water treatment plant operators when serious threats to water quality are present.

The water quality monitoring equipment was installed in 2007 to monitor the raw water at each WTP based on the flow characteristics and potential hazards in the corridor. Installation required the design and placement of dedicated sample intake lines at three of the WTPs. These sample lines were fed through each WTP's intake pipe with the help of SCUBA divers. One intake is almost a mile in length, which provided quite a challenge for the engineer and contractor.

The instruments and sensors allow for the quick detection of potential contaminants on a near real-time basis. The multiparameter probes are collecting the following parameters on a 15 minute interval: turbidity, pH, temperature, specific conductivity, oxidation reduction potential, dissolved oxygen and chlorophyll. These parameters may be used as indicators of chemical and sewage spills to the corridor. The fluorometers are collecting total aromatic hydrocarbon data and are calibrated to diesel fuel to aid in determining the presence of petroleum products in the raw water. The total organic carbon (TOC) analyzers are measuring the amount of organic matter in the raw water which may indicated the presence of untreated sewage in the raw water. A secondary benefit of having this water quality data is that it will aid WTP operators in determining the appropriate treatment processes and chemical dosages for the raw water.

The GC/MSs are programmed to report concentrations of 28 volatile organic compounds (VOCs) in the raw water. The minimum reliable value for most of the VOCs is 0.1 microgram per liter, which, in most cases, is far below the maximum contaminant level set by the U.S. EPA and State of Michigan for the finished water. The GC/MSs were original programmed to provide readings every 30 minutes, but several technical problems were encountered with the units. Currently, the project manager is working with the manufacturer to determine the cause of the problems, so that a new operational protocol can be developed and employed.

All four instruments are wired to a data logger located at each plant where the data is transmitted via the internet to a remote computer server. The server compiles data from all of the monitoring sites and transmits it to all project stakeholders via the internet. The data is displayed on a password protected website to view and download by the WTP operators.



Website Display of Monitoring Data

The data management system software compares the concentration of each parameter to preset threshold values. When a threshold value is exceeded, an alert is sent the appropriate WTP operator(s). Alerts are sent as emails and/or text messages based on the preference of the operators. Once notified, the operators can make treatment and operational decisions at the WTP to ensure that the raw water is properly treated.

Several challenges lay ahead for this project. Sustainable funding for the project has not yet been secured; the current project funding is provided by several state and federal grants and is not institutionalized in the WTPs' budgets. A permanent organizational structure has not been formalized, which is needed to maintain and grow the established network. Typical pollutant concentrations in the corridor are not well understood at this time due to insufficient background data. After a year or more of data collection, the alert levels will be adjusted to reduce the number of false alarms to the operators.

Successful implementation of the project will lead to quicker identification of pollutants, prompter notification of partners regarding the presence and identity of water contaminants, faster implementation of actions to protect the public from exposure to chemicals, and hopefully fewer chemical spills in the corridor.

International Joint Commission (IJC) "Spills in the Great Lakes Basin with a Special Focus on the St. Clair-Detroit River Corridor." July 2006.

NOTES:

IMPLEMENTATION OF TMDL/BMAP PROCESS IN THE LAKE HUNTER WATERSHED, WBID 1543A, POLK COUNTY, FLORIDA

Chandy John Ph.D[*]*., Mark Schwartz, P.E., Ken Ying, Ph.D., John Kiefer, P.E.*
BCI Engineers & Scientists, Inc., Lakeland, Florida 33803.

An assessment of Lake Hunter was carried out in 2001 as part of the Florida Department of Environmental Protection's (FDEP) watershed management approach for restoring and protecting water resources and addressing Total Maximum Daily Load (TMDL) Program requirements. Lake Hunter was verified as impaired for nutrients and was placed on the Verified List of Impaired Waters for the Hillsborough River Basin in May 2004, because its Trophic State Index (TSI) was persistently above the state's threshold value of 60, averaging 80 from 1991 through 2002. Elevated TSI values are associated with the growth of blue-green algae and low dissolved oxygen (DO) content, and can result in conditions that are unfavorable for fish and other wildlife.

TMDLs must be developed and implemented for impaired waters in Florida, unless the impairment is documented as naturally occurring condition that cannot be abated by a TMDL, or unless a management plan is implemented to correct the problem. A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet the waterbody's designated uses. Lake Hunter is a Class III waterbody with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife.

This paper reviews the 2004 TMDL developed for Lake Hunter, describing historical and current conditions, the lake's hydrology and water quality, and the nutrient TMDL and pollutant loading and provides conclusions and recommendations for implementation of a Basin Management Action Plan (BMAP) to restore and protect the lake's water quality.

NOTES

SESSION 6A

WATER WARS - MANAGING WATER QUANTITY IN TIMES OF SHORTAGE

WATER WARS: ON THE EASTERN FRONT

Ken Wagner, Ph.D., CLM, NALMS Past President
ENSR Water Resources Manager. P.O. Box 506, Willington, CT 06279. 860-429-5323-222,
kwagner@ensr.aecom.com

As Mark Twain said, "Whiskey is for drinkin', water is for fightin'." Most of us in the east were educated about the battles over water in the western USA, and many assumed we would never be in that situation as a simple matter of supply and demand. But the days of water wars have arrived, and are complicated in the east by the governing body of law, based on riparian rights. Prior appropriations, or "first in time, first in right", governs western water law. In the east, riparian rights guarantee water to anyone with access to a waterbody, including via groundwater. This presentation will discuss examples from NJ, CT, PA, FL, GA and AL in eastern water resource management and associated regulatory and legal contexts. Key lessons include:

- A water budget is like a household budget; if you don't live within your means, you get in trouble. Interbasin transfers are like loans, but in water management they often go unpaid.
- Reservoirs are like banks; they hold water for later use, except that they are leaky and uninsured. Like banks, they often don't have enough capital in them at once to satisfy all possible users. Good management is difficult yet essential.
- Reservoir construction has dropped off dramatically since about 1970 as a function of environmental laws; available water is variable at any instant in time, but the population is continually growing. If we can't increase supply, we must reduce demand.
- Climate change has induced temporal fluctuations that make water availability less dependable in the short-term; we have bust and boom dynamics, and do not have the infrastructure to mitigate this variability. Supply and demand are diverging.
- Management to satisfy all water users may not be possible, but the optimal management strategy requires flexibility, monitoring, and informed reaction. Good science is essential. Water conservation is critical, and is spawning new practices within our lifetimes.
- Ultimately, water conflicts are money conflicts; environmental issues are usually a smokescreen or tool for manipulating the system to get a desired result traceable to money.

Example 1: A New Jersey Reservoir

Constructed in 1970 in response to the drought of 1965-66, Round Valley Reservoir offered storage of 55 billion gallons of high quality water. Minimal use for supply resulted in development of an excellent fishery, swimming, picnicking and camping areas, boat concessions, and other recreational facilities. When the drought of 1980-81 struck, and the state attempted to use the water stored for that purpose, parties interested in recreational and habitat uses sued. Water supply use was limited to the upper 5 ft of a 160 ft deep lake.

Example 2: A Connecticut River

Shepaug Reservoir was built around 1920 to impound water in a fairly steep and flashy watershed (on glacial till), providing water to a CT city a substantial distance away and out of the watershed by agreement with downstream towns. In the late 1990s, downstream parties demanded that more water be released from the reservoir during summer. The sides squared off over water for people vs. water for downstream habitat, but the real conflict was property value and recreational enjoyment of wealthy downstream users vs. money for the city from water sales. The judge split the difference, making both sides unhappy. The CT Supreme Court found in favor of the city, but suggested that the state might want to look at water allocations among people and habitat on a more comprehensive basis. That effort is ongoing.

Example 3: A Pennsylvania Stream

A bottled water company uses spring water, most of which would otherwise feed the headwaters of a trout stream. PA models impact of withdrawals on habitat, and equates habitat loss to fish loss. The model showed a 5-10% impact, an allowable impact until the stream classification was changed. A decade of data showed that it was not low flows that governed fish abundance, but disruptive high flows from a developing watershed and creation/destruction of pool habitat. Data also showed that change in modeled habitat did not correlate to changes in fish abundance in this historically altered stream channel. A complicated flow management system was devised and permitted to minimize impacts, and a habitat improvement program was approved.

Example 4: Florida Minimum Flows and Water Levels

Seeking to balance human water supply need with other uses, including habitat and recreation, the Water Management Districts have sought to set minimum flows and water levels that restrict water supply uses based on the best available science. A separate presentation on that program is planned in this session.

Example 5: The Now Famous ACF System

Current litigation potential limits what can be said, but many of the lessons above are illustrated. Lake Lanier in the upper Chattahoochee River provides flood control, recreation and water supply. There are additional downstream impoundments also managed by the USACE, with valued river segments in between and additional uses such as transportation, power production, and endangered species support. The Flint River is heavily used for irrigation through adjacent wells. The two rivers meet at Lake Seminole, another USACE impoundment, and the Apalachicola River runs from there to the Gulf, supporting several endangered species and a commercial shellfishery. Under drought conditions, there is simply not enough water to support all uses to the extent that each would like, resulting in interstate conflicts. The USACE is charged with maximizing the value of reservoir level and flow management. A separate presentation on that program is planned in this session.

NOTES

ESTABLISHING MINIMUM LEVELS FOR LENTIC SYSTEMS IN THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Douglas A. Leeper, Martin H. Kelly, Lisa A. Henningsen and Richard D. Gant
Southwest Florida Water Management District
Brooksville, Florida

Florida Law requires the Southwest Florida Water Management District to establish minimum levels for lakes within its jurisdiction to prevent “significant harm” that may result from water withdrawals. To date, minimum levels have been established for 103 District lakes. Development of minimum levels involves characterization of existing withdrawal impacts, development of benchmark water level records, and identification and evaluation of significant harm/change standards. Characterization of withdrawal impacts is typically based on groundwater modeling and review of available lake stage and pumpage records. Development of benchmark water level records, *i.e.*, records that reflect the hydrologic regime that would be expected in the absence of water withdrawals, is necessary for evaluation of water-use impacts. Lack of long-term empirical water level measurements and the occurrence of water-use impacts often hinder development of benchmark records. Benchmark records are, therefore, typically developed using predictive statistical models that are based on non-impacted lake level records and rainfall. A variety of significant change standards, developed to address natural system and human-use values, are evaluated and used to identify acceptable deviations from the benchmark record that can be used to establish minimum lake levels. Minimum levels are incorporated into District Rules and used for a variety of regulatory purposes, including the permitting of consumptive water use (*i.e.*, water withdrawals). In cases where minimum levels are not being met or are not expected to be met during the next twenty years, State Law requires implementation of recovery or prevention strategies to ensure compliance with the minimum levels.

References

Dierberg, F. E. and Wagner, K. J. (2001) "A Review of “A Multiple-Parameter Approach for Establishing Minimum Levels for Category 3 Lakes of the Southwest Florida Water Management District”, June 2001 Draft by D. Leeper, M. Kelly, A. Munson, and R. Gant." Prepared for the Southwest Florida Water Management District. Brooksville, Florida.

Leeper, D. (2006) "Proposed Methodological Revisions Regarding Consideration of Structural Alterations for Establishing Category 3 Lake Minimum Levels in the Southwest Florida Water Management District, April 21, 2006 Peer-Review Draft. Southwest Florida Water Management District. Brooksville, Florida.

Leeper, D., Kelly, M., Munson, A. and Gant, R. (2001) "A Multiple-Parameter Approach for Establishing Minimum Levels for Category 3 Lakes of the Southwest Florida Water Management District, June 14, 2001 Draft." Brooksville, Florida.

Southwest Florida Water Management District. (1999) "Northern Tampa Bay Minimum Flows and Levels White Papers: White Papers Supporting the Establishment of Minimum Flows and Levels for Isolated Cypress Wetlands, Category 1 and 2 lakes, Seawater

Intrusion , Environmental Aquifer Levels and Tampa Bypass Canal, Peer-Review Final Draft, March 19, 1999." Brooksville, Florida.

Southwest Florida Water Management District. (2008) "Minimum and Guidance Levels for Crooked Lake in Polk County, Florida." Brooksville, Florida.

Wagner, K. and Dierberg, F. (2006) " A Review of "Proposed Methodological Revisions Regarding Consideration of Structural Alterations for Establishing Category 3 Lake Minimum Levels in the Southwest Florida Water Management District" by D. Leeper, 2006". Prepared for the Southwest Florida Water Management District. Brooksville, Florida.

NOTES

ESTABLISHING MINIMUM FLOWS FOR LOTIC SYSTEMS IN THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Douglas A. Leeper, Martin H. Kelly, Adam B. Munson,
Jonathan B.T. Morales and Jason L. Hood
Southwest Florida Water Management District
Brooksville, Florida

Florida Law requires the Southwest Florida Water Management District to establish minimum flows for lotic systems within its jurisdiction to prevent "significant harm" that may result from water withdrawals. To date, minimum flows have been established for 8 freshwater or estuarine river segments and 2 springs. Development of minimum flows involves characterization of existing withdrawal impacts, identification of seasonal high, medium and low flow periods or blocks, development of benchmark flow records and development of significant harm/change standards. Characterization of withdrawal impacts is based on groundwater modeling and available flow and pumping records. Seasonal flow blocks are identified to address system characteristics associated with components of the flow regime (*i.e.*, maintenance of wetted perimeter during low flow periods and inundation of floodplains during high flow periods). Benchmark water level records, *i.e.*, records that reflect the hydrologic regime expected in the absence of water withdrawals, are used along with multiple significant harm/change standards to identify block-specific percent-flow reductions that are used to identify minimum flows. The minimum flows are expressed as block-specific, allowable flow-reduction percentages, based on the daily flow measured on the previous day. Minimum flows are incorporated into District Rules and used for a variety of regulatory purposes, including the permitting of consumptive water use (*i.e.*, water withdrawals). In cases where minimum flows are not being met or are not expected to be met during the next twenty years, State Law requires implementation of recovery or prevention strategies to ensure compliance with the minimum flows.

References

Kelly, M., Munson, A., Morales, J. and Leeper, D. (2005) "Alafia River Minimum Flows and Levels – Freshwater Segment." Southwest Florida Water Management District. Brooksville, Florida.

Kelly, M., Munson, A., Morales, J. and Leeper, D. (2005) "Proposed Minimum Flows and Levels for the Middle Segment of the Peace River, from Zolfo Springs to Arcadia." Southwest Florida Water Management District. Brooksville, Florida.

Kelly, M., Munson, A., Morales, J. and Leeper, D. (2005) "Proposed Minimum Flows and Levels for the Upper Segment of the Myakka River, from Myakka City to SR 72." Southwest Florida Water Management District. Brooksville, Florida.

Kelly, M., Munson, A., Morales, J. and Leeper, D. (2007) "Proposed Minimum Flows and Levels for the Upper Segment of the Braden River, from Linger Lodge to Lorraine Road, Peer Review Draft." Southwest Florida Water Management District. Brooksville, Florida.

Munson, A., Kelly, M., Morales, J. and Leeper, D. (2007) "Proposed Minimum Flows and Levels for the Upper Segment of the Hillsborough River, from Crystal Springs to Morris Bridge, and Crystal Springs." Southwest Florida Water Management District. Brooksville, Florida.

Southwest Florida Water Management District. (2002) "Upper Peace River: an Analysis of Minimum Flows and Levels, August 25, 2002 Draft." Ecologic Evaluation Section. Brooksville, Florida.

Southwest Florida Water Management District. (2004) "Minimum Flows for the Tampa Bypass Canal, May 15, 2004 - Draft." Ecologic Evaluation Section. Brooksville, Florida.

Southwest Florida Water Management District. (2004) "The Determination of Minimum Flows for Sulphur Springs, Tampa, Florida, September 28, 2004 Draft." Resource Conservation and Development Department. Brooksville, Florida.

Southwest Florida Water Management District. (2006) "Lower Hillsborough River Low Flow Study Results and Minimum Flow Recommendation, Draft - August 31, 2006." Brooksville, Florida.

NOTES

RESERVOIR MANAGEMENT AMIDST EPIC DROUGHTS IN THE SOUTHEAST: BALANCING COMPETING NEEDS AND LIMITED RESOURCES

Douglas C. Otto, Jr, P.E., D.WRE, Chief, Hydrology and Hydraulics Branch, Mobile District, U.S. Army Corps of Engineers, 109 St. Joseph Street, Mobile, Alabama, 36602, 251-690-2718, douglas.c.otto.jr@sam.usace.army.mil

The Corps of Engineers operates ten multi-purpose reservoirs in the nearly 45,000 square miles of the southeast's Apalachicola-Chattahoochee-Flint and Alabama-Coosa-Tallapoosa River (ACT/ACF) systems. The Corps reservoirs are operated to balance a variety of authorized purposes to meet stakeholder needs including generation of hydroelectric power, navigation, water supply, water quality, fish and wildlife, and recreation. Since 2005, the southeast has experienced increasingly severe drought conditions resulting in often competing demands for scarce water between numerous diverse basin stakeholders. In particular, a decades old debate between upstream and downstream water users has simmered to the surface during 2006, 2007, and 2008. In 2006, the Corps initiated consultation with the U.S. Fish and Wildlife Service regarding Interim Reservoir Operations (IOP) from its Jim Woodruff Dam for three endangered species in the Apalachicola River; the Purple Bankclimber and Fat Three Ridged Mussels, and the Gulf of Mexico Sturgeon. Due to the unprecedented severity of the ongoing drought, in 2007 the Corps re-initiated consultation with the U.S. Fish and Wildlife Service regarding its operations from the Jim Woodruff Dam resulting in a revised drought operating plan labeled the Exceptional Drought Operation (EDO) designed to further reduce downstream flows in response to exceptional drought conditions and increasingly depleted system reservoir conditions. The ACT reservoir system essentially recovered during the winter and spring of 2007, and will likely enter the 2008 low flow/high water demand in a healthy condition. In contrast, the ACF basin, and in particular Lake Lanier near Atlanta, will likely not recover, and may enter the 2008 low flow/high demand period in the most depleted condition in its history. Following many years of impasse between the States of Alabama, Georgia, and Florida regarding the allocation of water in the ACT/ACF basins, in the absence of State agreement regarding water allocations and drought plans the Corps has recently initiated efforts to update the ACT/ACF Water Control Manuals as well as a reevaluation of its Jim Woodruff Dam Exceptional Drought Operation.

The near total reliance of Metro-Atlanta on surface water sources for its municipal and industrial water supply is examined, to include the unique challenges of geology, geography, population, and drought. Atlanta's underlying crystalline rock geology effectively eliminates development of a groundwater-based water supply. Compounding the geologic challenge is that of geography. Unlike most major American Cities, Atlanta was not founded based on its proximity to a major navigable river or harbor, but instead formed at the terminus of a rail line. While ideal for growth in the age of rail, this location placed Atlanta at the headwaters of several river basins, each capable of only a limited reliable supply of fresh water. With 30-40% of Georgia' population reliant on this limited and fragile water source, the ongoing drought which began in 2005 has strained Lake Lanier, the primary water source for Metro-Atlanta.

In addition to water supply for the Metro-Atlanta area, several other issues have created fissures between various stakeholders. The rapid growth of irrigation since 1970, particularly in the southern portion of the ACF basin has reduced flows to downstream stakeholders. In

addition, proposed new instream flow targets for waste assimilation, thermal and nuclear plant cooling, water quality, environmental, and water supply uses have added potential system constraints and demands that may not all be met during extreme drought conditions such as are ongoing in the basin.

NOTES

SESSION 6B

MODELING FOR RESERVOIR WATER QUALITY MANAGEMENT

DEVELOPMENT OF BUBBLE PLUME MODELING CAPABILITY FOR RESERVOIR WATER QUALITY MANAGEMENT

Gary E. Hauser
Loginetics, Inc.
Knoxville, TN

James A. Parsly
Private Consultant
Knoxville, TN

Mark H. Mobley
Mobley Engineering, Inc.
Norris, TN

Bubble plume modeling facilitates design of oxygen injection and bubble upwelling systems to meet environmental goals for reservoirs and their releases. A standalone bubble plume model (BUBBLE3) and interface (BPi) were developed to simulate air or oxygen plumes in various configurations (circle, line, rectangle). This plume submodel was later embedded into CE-QUAL-W2 to explore reservoir effects of and on the plume. This presentation describes the bubble plume modeling capability, verification testing, linkage with CE-QUAL-W2, and example applications.

The plume model calculates hydrodynamics and water quality along a column of rising bubbles assuming a bubble-water core with an annulus of entrained water, based on Wuest, et al (1992). The model integrates governing equations for water, momentum, heat, and dissolved and gaseous oxygen and nitrogen. It includes equations of state for pressure, water density, bubble-water mixture density, gas volume, and bubble radius. The model simulates upwelling due to gas plumes in a stratified ambient for an initial bubble size and time-variant gas flows. Bubble decompression, gas transfer, and velocity are computed as bubbles rise and exchange gases with ambient water. The model starts a new plume after each plume detrains, until a final plume reaches the surface or its bubbles dissolve completely. In the CE-QUAL-W2 linkage, entrainment of ambient water by a bubble plume is treated as layered sinks, and detraining plumes are treated as sources. A bubble plume routine was originally coded for the TVA BETTER model by Shiao (1998). This code was debugged, updated with new numerical scheme, and expanded to handle circular and rectangular plumes by Hauser (Loginetics) to produce BUBBLE3. The improved stand-alone version (BUBBLE3) was later embedded into CE-QUAL-W2 v3 by James Parsly (Consultant).

In model testing performed by Hauser (2004) after code modifications mentioned above, BUBBLE3 reproduced model results published by Wuest (1992) for oxygen injection at 13 scfm into a deep stratified reservoir at 65m depth, a case where the oxygen was completely absorbed before the plume reached the surface. BUBBLE3 reproduced Wuest model variations in these variables with depth: plume flow, plume radius, plume velocity, plume temperature, bubble radius, bubble core density. BUBBLE3 plume flow predictions were also verified against upwelling measurements by Brown, et. al. (1989) in field experiments in Upper Bear Reservoir, where air was injected at 25-50 scfm into a destratified reservoir at 22m depth, creating a strong upwelling plume that reached the surface. Results are shown in Table 1. The range of flow measurements for each air flow is from multiple methods used to measure flow. In model results, α is entrainment coefficient and Fr_0 is the densimetric Froude number used to start the bubble plume.

Table 1. Comparison of Plume Model and Field Data Upwelling Flows

Air Flow Rate (scfm)	Measured Upwell Flow (m^3/s)	Modeled Upwell Flow (m^3/s)			
		α=0.08 Fr_0=0.75	α=0.08 Fr_0=1.6	α=0.11 Fr_0=0.75	α=0.11 Fr_0=1.6
25	10.8-12	10.3	10.4	12.5	12.6
50	13-18	13.7	13.8	16.5	16.6

Good agreement exists between the stand-alone bubble plume model predictions and field data for single plumes. Field data on secondary plumes are needed to verify how plume restarts are handled in BUBBLE3. More calibration data and research are also needed to understand how best to apply the CE-QUAL-W2 model with embedded plume model.

References

Brown, R. T., J. A. Gordon, C. E. Bohac (1989). "Measurement of Upwelling Flow from Air Diffuser"; J. Environmental Engineering, Vol. 115, No. 6, December.

Shiao, M. C. (1998). personal communication; TVA Engineering Laboratory, Norris, Tennessee.

Wuest, A., N. Brooks, D. Imboden (1992). "Bubble Plume Modeling for Lake Restoration"; Water Resources Research, Vol. 28, No. 12, pp 3235-3250; December.

NOTES

BUBBLE PLUME MIXING FOR RESERVOIR WATER QUALITY MANAGEMENT AND THE CONTROL OF BLUE GREEN ALGAE

Samuel S. Stone
Peace River / Manasota Regional Water Supply Authority,
Arcadia, FL

Mark H. Mobley,
Mobley Engineering, Inc.,
Norris, TN

Introduction

At the Peace River Regional Water Supply Facility near Arcadia Florida, a bubble plume diffuser system has been recently installed to improve dissolved oxygen levels and provide widespread mixing in the reservoir to reduce algal blooms. The off-stream reservoir has a maximum depth of 26 feet, a capacity of 544 million gallons and a surface area of 85 acres. The reservoir is supplied with river water pumped from the nearby Peace River and ground water from storage wells as available. High levels of total dissolved solids, phosphates, nitrogen and conductivity are experienced in the reservoir. The reservoir was equipped with two 50- HP mechanical aerators in 1987. Historical data shows that aeration and mixing together can control algae but under some conditions, algae blooms have still occurred. When mechanical mixing is insufficient, the utility must resort to the use of chemicals to control algal blooms. Increased loads from construction storm water have caused the facility to evaluate increasing the mixing and aeration capacity in the reservoir. Additional mechanical aerators would be difficult to deploy and would result in high energy costs. Bubble plume diffusers are energy efficient, easily deployed and able to provide sufficient aeration and mixing to meet the additional demands.

Bubble Plume Design

Bubble plumes can move large quantities of water and can be designed to greatly increase mixing in a reservoir. Bubble plumes are utilized for a wide range of water quality enhancement techniques to meet environmental goals for reservoir water quality improvement. From hypolimnetic oxygen systems that use weak bubble plumes to achieve high oxygen transfer efficiencies, to upwelling systems that use strong bubble plumes to move water in the reservoir, a successful bubble plume system requires designing the plume to meet the site specific goals of the project.

The new mixing system for the Peace River Reservoir #1 was designed using a bubble plume model developed by Loginetics. The model includes bubble diameter tracking as a function of hydrostatic pressure and mass transfer. It has been verified over a wide range of applications. Using this model, a strong plume was chosen that would move water to the surface yet could be spread over a large portion of the reservoir. The plume is designed to provide DO enhancement near the sediments and enough mixing in the reservoir to inhibit the metabolic processes of algal cells by disrupting their position in the photic zone.

Diffuser System Installation

The diffusers were installed along the centerline of the north and south lobes of the reservoir with alternating sections of bubble plume and supply piping as shown in Figure 1. The diffusers are supplied by a 50 HP variable speed oil free air compressor.

Results from Initial Testing

Initial testing included a comparison of the new bubble plume system with an existing mechanical aerator after about 2 weeks with all aeration systems being off. Without any aeration, the DO in the bottom-most water in the reservoir had deteriorated to less than 2 mg/L. Operation of the bubble plume diffusers in the South lobe of the reservoir and operation of the existing mechanical aerator in the North lobe was commenced on April 21st. Both lobes recovered to nearly 6 mg/L in just a few days of operation as shown in the DO measurements presented in Figure 2.

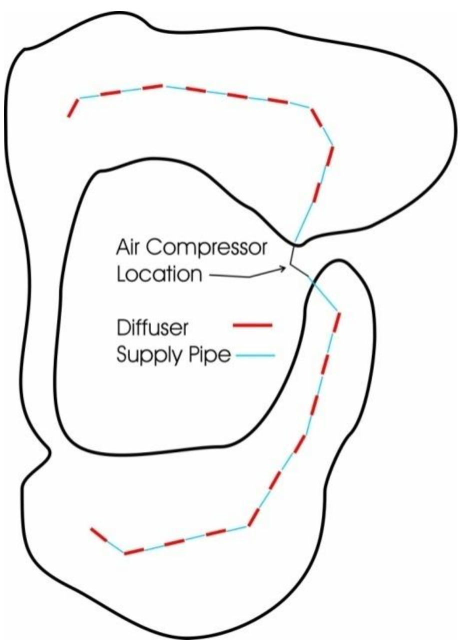


Figure 1: Diffuser Layout

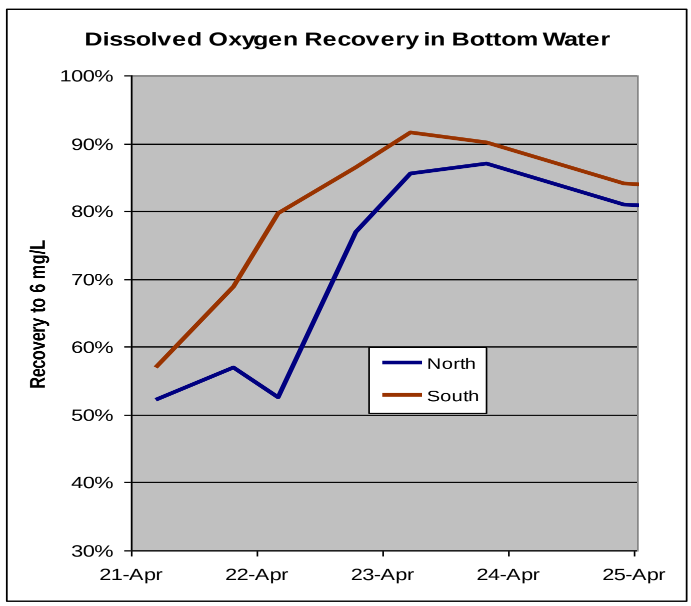


Figure 2: Initial Results

Conclusions

The new bubble plume aeration system causes strong mixing throughout the reservoir with visual water movement on the surface near the plumes. Bottom layer DO levels were increased faster with the bubble plume aeration system than with the existing mechanical system using one half the electrical power. Additional tests are planned for this summer to better define aeration and mixing design requirements for the Peace River Facility's new reservoir that is 10 times the size of the existing reservoir and currently under construction.

MODEL ASSESSMENT OF RESERVOIR MANAGEMENT TO IMPROVE IN-LAKE WATER QUALITY AND RESERVOIR RELEASES

Andy Sawyer, Reservoir Environmental Management, Inc., 900-5 Vine Street, Chattanooga, TN 37403, (423) 304-6572, remi@chatt.net
Richard J. Ruane, Reservoir Environmental Management, Inc., 900-5 Vine Street, Chattanooga, TN 37403, (423) 265-5820, jim@chatt.net

Dissolved Oxygen concentrations (DO) in the releases from Saluda Hydro are at times below the state standard, and coolwater fish habitat in the lake is reduced by low DO conditions. Analysis of nutrient sources in the watershed indicated that about 65% of the phosphorus inputs to Lake Murray come from three or more point sources. A CE-QUAL-W2 model was used to simulate the negative effect that these nutrient loads have on DO in the releases from Saluda Hydro, as well as within Lake Murray. Prior to model development, water quality data collected throughout Lake Murray and its watershed were analyzed. The results of this analysis were used as the basis for the inputs and calibration of the model. The model was calibrated for temperature, DO, algae and nutrients in the lake as well as temperature and DO in the discharges from the dam. The calibrated model was used to predict how water quality in the reservoir and its releases would respond to a reduction in phosphorus in the inflows for eight years of record having a range of operating conditions. The model predicted that less phosphorus in the inflow would result in improvement in water quality in the lake, that in turn would cause a improvement in the DO concentrations in the releases from the reservoir. The modeling also revealed changes in reservoir operations that could enhance fish habitat in the lake and in reservoir releases to a limited extent without the phosphorus reductions in the inflows to the lake.

NOTES

APPLICATIONS OF THE DISCRETE-BUBBLE MODEL FOR HYDROPOWER AERATION SYSTEMS

Richard J. Ruane, Reservoir Environmental Management, Inc, 900-5 Vine Street, Chattanooga, TN 37403 (423) 265-5820, jim@chatt.net

Daniel F. McGinnis, Surface Waters - Research and Management, Swiss Federal Institute of Aquatic Science and Technology, Eawag, CH-6047 Kastanienbaum, Switzerland

Paul J. Wolff, WolffWare Ltd., PO Box 554, Norris, TN 37828

Turbine venting is the preferred aeration approach for increasing dissolved oxygen (DO) in the releases from hydropower turbine systems. However, the performance and predictability of these systems has been a challenge to owner-operators, turbine vendors, and environmental regulatory agencies. This challenge has increased with the concern for total dissolved gases (TDG). Also, compliance under 401 Certificates for water quality has increased the need for better ways to assess the performance of these systems.

Experience with the Discrete-Bubble Model (DBM) on aeration systems used for water resource applications led the authors to develop this model for application to turbine aeration systems. The DBM has been used at 15 hydro plants for various applications: to estimate the airflow required in a draft tube to increase DO using a compressor; to estimate the DO increase at several projects where airflows were known; to provide input for the design of draft tubes for new turbine units; to predict the performance of aerating wheels using airflows provided by turbine vendors; to simulate hourly DO in the tailraces of nine hydro plants for periods of five to seven years and predict the performance of the aeration systems for attaining water quality objectives under agreements being developed under 401 Certificates; to predict DO levels for potential enhancements to turbine venting systems, i.e., the benefits of adding hub baffles to the turbines; and to develop look-up tables for power plant operators to operate turbine venting systems.

This presentation would focus on one of these applications: Osage Hydro in MO.

NOTES

SESSION 7A

CHOCTAWHATCHEE BASIN

CHANGES IN LAND-USE AND WATER CHEMISTRY WITHIN THE CHOCTAWHATCHEE BAY AREA

Jenney L. Kellogg, *Mark V. Hoyer*
Florida LAKEWATCH
University of Florida
Department of Fisheries and Aquatic Sciences
Gainesville, Florida

Background

Land use has been found to be an integrating variable that reflects human disturbance in a catchment. Land use changes can significantly impact groundwater recharge, stormwater drainage, and water chemistry changes within a watershed. The surrounding areas of Choctawhatchee Bay have experienced large population changes within the last 16 years. Walton County has increased in population 61% while Okaloosa County has increased 22.5%. With the increasing growth and land development in the area, it is important to examine any relationships between land use and water chemistry in this area. Utilizing land use maps combined with water chemistry data, we have the ability to examine the potential effects of phosphorus, nitrogen, and sediment load on aquatic systems. Recently, water quality in Choctawhatchee Bay has been perceived to be in decline. As the population has grown, land-use changes have occurred in the area. We have examined changes in land use within the watersheds surrounding Choctawhatchee Bay in relationship to changes in water chemistry within the bay.

Methods

Statistical and geographic information system (GIS) analyses were adopted in this study. Data were examined for general relationship between changes in land use and water chemistry variables between two different time periods in the Choctawhatchee Bay area.

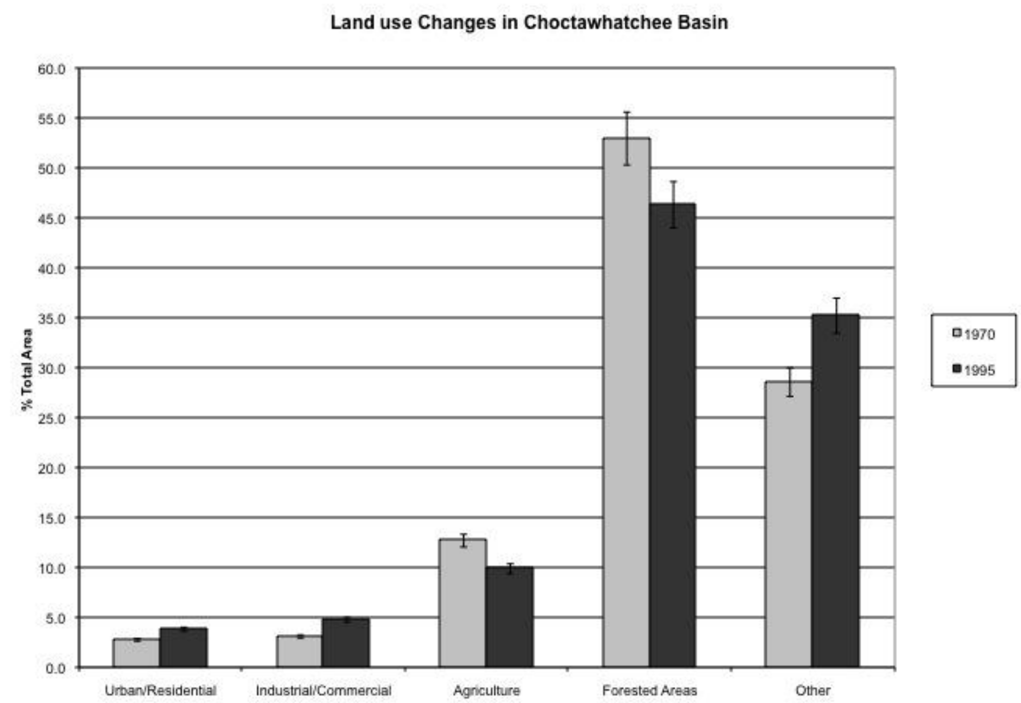
Two land use maps were acquired for the GIS analyses. A 1970 land use map was acquired from USGS. The 1970 map covered the entire state of Florida and was categorized into 23 land use groups. The other land use map (1995) was acquired from the Florida Geographic Data Library and was originally made by FLDEP. The 1995 map was categorized into 43 land use categories. Based on the available data, individual watersheds were chosen in the Choctawhatchee Bay area. A whole watershed comparison was also completed between the two time periods.

Land use categories for the two maps were reclassified into a more simplified classification scheme including: Urban/Residential, Industrial/Commercial, Agriculture, Forested Area, and Other (Bays, Estuaries, non descript areas etc.). New land use classification files were joined by object ID for each polygon in both maps.

Individual watersheds were chosen based on data availability. Spatial overlay was done using the Union function in ArcMap 9.2. This allows a comparison on land use in both maps polygon by polygon.

Results

Looking at whole watershed comparisons in land use between the two maps, there appeared to be differences between the two time periods in several categories. However, many areas that were "other" in the 1970s map may have been reclassified in the 1995 map to actual land areas. This gives the appearance of land use changes especially in the forested areas category. The changes in land use seen in the GIS comparison would need to be verified via areal photos if possible before any management decisions could be made based on these analyses. The watershed analyses indicated some significant changes in water chemistry between the two time periods, however, the same inherent error in land classification does not allow for any justified conclusions.



Implications

GIS can be a powerful tool to gather, synthesize and analyze large databases. The objective of this study was compare significant changes in land use to any changes in water chemistry parameters by watershed. The method may prove more beneficial if used with two land use maps made with same methodology, and sampled at similar scales.

NOTES

SPATIAL DIFFERENCES AND TEMPORAL CHANGES IN WATER CHEMISTRY OF THE CHOCTAWHATCHEE ESTUARY SYSTEM

Julia B. Terrell, Choctawhatchee Basin Alliance, Niceville, FL

Walton and Okaloosa Counties are not unlike other Coastal Floridian County in that they are experiencing record high population growth rates and the expected population growth rates for each county are staggering. A comprehensive evaluation of the current and historical water quality is needed. Water quality of the estuary system is evaluated first spatially along the horizontal stretch of the bay and then temporally over the 40 years of data record.

The Choctawhatchee Basin Alliance of Okaloosa-Walton College (CBA) has been coordinating monthly water sampling within the Choctawhatchee watershed for over 10 years. CBA volunteers record monthly at each station at the surface and bottom dissolved oxygen, pH, turbidity, temperature, and salinity. Water samples are also sent to the University of Florida's Florida LAKEWATCH program and analyzed for total phosphorus, total nitrogen, chlorophyll, and water clarity. LAKEWATCH also records quarterly color readings. All available water chemistry data (USEPA data collected in 1968, UWF data collected in 1975, CAAMa data collected in 1985-1987, and CBA/LAKEWATCH data collected from 1991-2007) have been joined into one data set and assigned to one of six sections based on its location (section 1 is located near the river. and section 6 is located near the east pass).

Water chemistry data spatially along the longitudinal axis are summarized in Table 1 over the 40 years of data collection. Average total phosphorus, total nitrogen, chlorophyll, color, and turbidity were highest in Section 1 (nearest the Choctawhatchee River) and gradually decreased as one travels west to Section 6. Secchi disk depth was typically lowest in Section 1 and increased as one travels west to Section 6. Temporally, water quality parameters are summarized over the 40 years of record within each section in Table 2. Seasonality exists in the sections of the bay closest to the river and is not significant in sections of the bay closer to the east pass. Walton and Okaloosa Counties are fortunate in that the historical population growth have not caused widespread water quality degradation experienced by other similarly growing areas.

The importance of long-term, routine sampling is critical for the preservation of the overall good water quality in the Choctawhatchee Bay. Groups like the Choctawhatchee Basin Alliance are providing a valuable, cost-efficient service to water resource managers throughout the State by coordinating a long-term, routine sampling program, providing outreach and education to the local community and municipal staffs on how to be good environmental stewards with the water resources, and executing localized restoration projects to help correct specific problems identified through monitoring.

Table 1. Summary of the spatial water chemistry analyses from six sections along the horizontal length of the Choctawhatchee Bay. Section 1 is located along the east side of the bay near the Choctawhatchee River. Section 6 is located along the west side of the bay near the East Pass. Small letters next to each mean represents statistically significant differences.

Section (sig)		1(a)	2(b)	3(c)	4(d)	5(e)	6(f)
Period of Record		1968 — 2007	1968 —2007	1968 — 2007	1968 — 2007	1968 — 2007	1968 — 2007
Total Phosphorus	N	208	139	208	155	142	179
(mg/L)	Mean	0.027(a)	0.018(bcdf)	0.016(bcdf)	0.016(bcdf)	0.012(e)	0.016(bcdf)
	Range	0.000 – 0.170	0.001-0,085	0.000-0.120	0.000-0.160	0.001-0.052	0.000-0.063
Total Nitrogen	N	210	138	210	157	144	181
(mg/L)	Mean	0.456(a)	0.302(b)	0.239(cdef)	0.226(cdef)	0.223(cdef)	0.233(cdef)
	Range	0.000-3.070	0.105-0.600	0.000-0.503	0.000-1.000	0.105-0.800	0.000-1.513
Chlorophyll	N	169	118	186	135	124	158
(µg/L)	Mean	6(ab)	6(ab)	3(cdef)	3(cdef)	4(cdef)	3(cdef)
	Range	0-66	1-19	0-23	0-19	1-70	0-17
Secchi	N	195	136	205	114	100	129
(m)	Mean	1.07(a)	1.53(b)	2.14(c)	2.44d(f)	3.37(e)	2.63(df)
	Range	0.10-2.7	0.36-4.27	0.65-5.79	0.00-6.17	1.07-7.92	0.83-7.00
Color	N	148	79	158	116	55	128
(PCU)	Mean	46(a)	30(b)	19(cdef)	17(cdef)	12(cdef)	15(cdef)
	Range	5-250	3-115	3-95	0-71	3-50	0-61
Turbidity	N	266	545	571	351	318	361
(NTU)	Mean	8(abe)	6(abce)	4(bcef)	5(abcef)	3(bcef)	3(cef)
	Range	0-301	0-250	0-214	0-828	0-158	0-105

Table 2. Temporal water chemistry analyses over a 40-yr period of record from 1968 to 2007.

Parameter	Section	Seasonality	Prob>F	Temporal Significance
Total Phosphorus	1	3°	0.9878	No Significant Change
Total Nitrogen	1	None	0.0148	Significant Decrease
Chlorophyll	1	6°	0.0405	Significant Increase
Secchi	1	3°	0.5333	No Significant Change
Total Phosphorus	2	2°	0.239	No Significant Change
Total Nitrogen	2	2°	0.0576	No Significant Change
Chlorophyll	2	6°	0.0421	Significant Increase
Secchi	2	4°	0.3213	No Significant Change
Total Phosphorus	3	None	0.9608	No Significant Change
Total Nitrogen	3	2°	0.1045	No Significant Change
Chlorophyll	3	None	0.899	No Significant Change
Secchi	3	None	<.0001	Significant Increase
Total Phosphorus	4	None	0.9403	No Significant Change
Total Nitrogen	4	None	0.0208	Significant Increase
Chlorophyll	4	None	0.7825	No Significant Change
Secchi	4	None	<.001	Significant Increase
Total Phosphorus	5	None	0.0012	Significant Decrease
Total Nitrogen	5	None	0.7782	No Significant Change
Chlorophyll	5	None	0.1095	No Significant Change
Secchi	5	None	0.038	Significant Increase
Total Phosphorus	6	None	0.0426	Significant Decrease
Total Nitrogen	6	None	0.4069	No Significant Change
Chlorophyll	6	None	0.8094	No Significant Change
Secchi	6	None	0.6415	No Significant Change

HYDROLOGY OF COASTAL DUNE LAKES IN WALTON COUNTY, FL

J.W. Jawitz, J.H. Bhadha
Soil and Water Science Department, University of Florida, Gainesville, FL 32611
jawitz@ufl.edu

The Choctawhatchee Basin coastal dune lakes are a unique feature of the Florida Panhandle. They are predominantly freshwater bodies, with intermittent connections to the Gulf of Mexico. Rapid residential development in the surrounding watersheds has raised concerns regarding water quality within the lakes, specifically increasing nutrient levels. This paper reports on hydrologic and water quality assessments of three of these lakes: Draper, Campbell, and Camp Creek Lakes. In addition trends in lake water quality are compared to land-use changes determined from analysis of historic aerial photos. Finally, the coastal dune lakes were used as the basis of a design project for a student team from the University of Florida competing in the US EPA People, Prosperity, and the Planet student design competition. The students proposed an educational campaign related to the hydrology of the coastal dune lakes and these results and recommendations are also discussed.

NOTES

LIVING SHORELINE PROJECTS IN CHOCTAWHATCHEE BAY

Alison McDowell
Choctawhatchee Basin Alliance
100 College Boulevard
Niceville, FL 32578
850 729-6423
Mcdowel2@owc.edu

The Choctawhatchee Basin Alliance (CBA) is committed to sustaining and providing optimum utilization of the Choctawhatchee Bay watershed. To accomplish this, CBA facilitates stakeholder partnerships and executes on-the-ground projects that promote and restore ecosystem health. Many of these projects incorporate "living shoreline" best management practices that can be replicated by public and private landowners.

This paper will offer case studies of CBA's living shoreline projects that restore and protect eroded and degraded coastal and wetland habitat and establish an educational framework that will provide for future restoration and stewardship opportunities. Specific projects include Ecosystem Restoration of Mattie Kelly Park, Stream Restoration/Stormwater Remediation at Liza Jackson Park, Shoreline Restoration/Stormwater Remediation at Cessna Park, and the Schultz Shoreline Protection/Restoration. Topics to be discussed include best management practices, partnerships, funding sources, public education and volunteer involvement. Projects described here present alternatives to hardened shorelines, as well as valuable lessons-learned for restoration practitioners.

NOTES

SESSION 7B

VEGETATION MANAGEMENT AND RESTORATION

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

Bond, Tina M. Osceola County. 1 Courthouse Square Kissimmee, FL 34741 tbon@osceola.org
Foerste, Eleanor C. UF/IFAS Osceola County Extension. 1921 Kissimmee Valley Lane, Kissimmee, FL 34744 efoe@osceola.org
Lawrence, Kimberly. Osceola County. 1 Courthouse Square Kissimmee, FL 34741. klaw@osceola.org

Osceola County was awarded a $2.881 million grant to demonstrate new herbicides, develop new technology processes or practices, or a new combination or uses of technologies, processes or practices for the purpose of proving technologically feasible and cost effective means to manage hydrilla, hygrophila and other exotic aquatic vegetation in Osceola County. The grant was awarded by US EPA with funding from October 1, 2007 until September 30, 2010. This grant provides funds to conduct and promote the coordination and acceleration of studies that address the causes, effects, extent, prevention, reduction, and elimination of water pollution.

Many drainage projects have significantly altered the natural hydrology of the central and south Florida ecosystem. The entire system is controlled by water control structures that have imposed significant hardships on the natural ecosystem. Due to the ideal climate for plant species growth, many exotics have become dominant in the ecosystem in a relatively short period of time.

Objectives

The specific objectives of the project are to evaluate the effectiveness of experimental use permit herbicides and biological controls in the treatment of hydrilla and hygrophila; to evaluate new technology processes or practices, or a new combination or uses of technologies, processes or practices for the control of hydrilla and hygrophila using small-scale field work; to implement and monitor successful practices and processes using large-scale field demonstrations; and to demonstrate the project efforts in alternative technologies, including bio-controls to manage hydrilla and hygrophila and disseminate to the public the results of the project.

Methods

Detailed methodology for each of the four elements is available for review at the project website, http://plants.ifas.ufl.edu from the Osceola County project link. Demonstrations are conducted at a variety of scales as the project advances and includes aquarium, mesocosm, pond and partial lake treatments. SePRO, a sole source provider of Mycoleptodiscus terrestris (Mt) is demonstrating the effectiveness if this contact bioherbicide, working toward commercial distribution for increased commercial access for lakes managers. Research to identify new biocontrol agents for Hydrilla is underway in east Africa in Uganda and Burundi. Scientists are working with cooperators in India to identify possible bio-control option for Hygrophila.

Key Findings

The presentation will report on progress to date as well as significant findings of interest to lakes manager.

NOTES

INTEGRATION OF HERBICIDE AND GRASS CARP FOR HYDRILLA CONTROL IN LAKE CONWAY

Bruce V. Jaggers
Florida Fish and Wildlife Conservation Commission
601 W. Woodward Ave.
Eustis FL 32726
352-742-6438
bruce.jaggers@myfwc.com

Integration of aquatic plant control methods is often promoted but seldom utilized effectively in operational aquatic plant control programs. Integration is defined as bringing parts together into a whole. A benefit of integration of aquatic plant control methods can result in less of each part being used than if one part is used alone. This paper will use an operational example (Lake Conway, Orange County, Florida) of the integration of herbicide and a bio-control (triploid grass carp) focusing on the savings realized in materials and cost versus the use of herbicide only. In 1986, 1988 and 1997/98 triploid grass carp (TGC) were stocked in Lake Conway to achieve approximate stocking rates of 1.8 TGC per metric ton of submersed vegetation and 13 TGC per metric ton of hydrilla (*Hydrilla verticillata*). In winter 2003 an application of fluridone herbicide was made targeting 4.0 parts per billion (ppb) active ingredient. Field concentrations of fluridone ranged from 1.0 to 2.5 ppb. Lakewide control of hydrilla was achieved within 12 months of the fluridone application. It is theorized that the fluridone functioned as a plant growth regulator allowing the bio-control (TGC) to achieve the hydrilla reduction. Material savings of 108 gallons fluridone and 10,542 TGC was realized by integrating. Total integrated cost was $121,540 (fluridone and TGC) while fluridone only at a target rate of 10 ppb would have cost $216,000 (2003 prices). It is theorized that integration of fluridone with TGC may be effective for control of fluridone-resistant hydrilla at fluridone concentrations of 5 to 15 ppb.

NOTES

THE FLORIDA LAKE VEGETATION INDEX: DEVELOPMENT AND THRESHOLDS

Leska S. Fore
Statistical Design, Seattle, WA

Russel Frydenborg, Nia Wellendorf, Julie Espy,
Tom Frick, David Whiting, Joy Jackson, and Jessica Patronis
Florida Department of Environmental Protection, Tallahassee, FL

The Florida Department of Environmental Protection (DEP) is required under the Clean Water Act to assess the biological condition of its streams, rivers and lakes. We developed a multimetric index, the Lake Vegetation Index (LVI), to assess the biological condition of aquatic plant communities in Florida lakes (Fore et al., 2007). For the development and testing of the LVI, aquatic plants in 95 lakes were sampled by boat during 2000–03. To validate the results for the LVI, data from an additional 63 lakes were collected in 2004. For field data collection, lakes were divided into 12 pie-shaped sections. Plant taxa lists were made for each section during a boat drive-by survey and one intensive "transect" from the shoreline to the center of the lake within that section. Submersed plants were sampled with a frodus sampler (double-sided rake on a rope) during the transect portion. One dominant or two co-dominant taxa were identified as the taxa comprising the most areal coverage of each lake section. Using the replicate data, we determined that we needed to sample four lake sections (one third of the lake) to reliably detect differences in lake condition.

A total of 48 candidate metrics based on measures of community structure, taxa richness, and percent of total taxa were calculated and tested against independent measures of human disturbance. An additional 17 metrics related to natural history attributes of the plants were derived from a national database and evaluated. Tolerant and sensitive taxa were defined based on designations made by 10 expert botanists working independently to define coefficients of conservatism (CC) scores for wetland (not lake) plants in Florida. The CC represents a species' fidelity to its ecological niche, and is used to show how sensitive a plant is to disturbance. To test metrics, we developed a human disturbance gradient (HDG) that summarized measures of water chemistry, habitat condition, intensity of land use in a 100 m buffer around the lake, and hydrologic modifications. A total of 10 metrics met the targeted values for correlation with HDG; of these ten, four were not redundant with each other and were included in the LVI: percent native taxa, percent invasive taxa as determined by the Florida Exotic Pest Plant Council, percent sensitive taxa as determined by CC scores, and the average CC of the taxon present over the largest area. LVI was highly correlated with HDG and other independent measures of human disturbance for both the development and the validation data sets (-0.68 and -0.72, Spearman's *r*). We concluded in 2005 that LVI was a reliable indicator of lake condition and had sufficient statistical precision to detect multiple levels of biological condition.

Additional LVI data were collected in 2005-2006, and a second validation was conducted in 2007 with data from 167 lakes. These data included additional CC scores for plants that did not occur in the wetland sampling and additional plant attribute data, and they reflected the 4-

section sampling method. LVI and its component metrics were, again, highly correlated with HDG (-0.71, Spearman's *r*), the WQ index, and the habitat index. All four LVI metrics showed regional differences in that northern lakes had values indicating better biological condition than southern lakes for the same level of human disturbance. Southern lakes are more vulnerable to invasion by exotics from tropical climates, since the lack of freezing temperatures allows these alien plants to obtain a firmer foothold. For this reason, percent native and percent exotic taxa were not adjusted during the metric scoring process. Percent sensitive taxa and dominant CC were adjusted because many of the sensitive plants with high CC values are not naturally found in southern lakes; therefore, expectations for these metrics should be lower and are reflected in the updated scoring rules for these metrics. The variance estimate of LVI derived from repeat visits to the same lake during two years was approximately twice the variance estimate derived from same-day repeat visits for the original analysis. For the current sampling protocol, the LVI is capable of detecting approximately 4 levels of biological condition. Two repeat visits to a lake would increase the precision of LVI and support the distinction of 6 levels of biological condition.

An essential step in the use of any biological assessment tool is the determination of threshold scores which represent healthy or impaired biological communities. EPA recommends that states use a Biological Condition Gradient (BCG) to illustrate how ecological attributes change in response to increasing levels of human disturbance (Davies and Jackson, 2006). The BCG is a conceptual model that assigns the relative health of aquatic communities into one of six categories, ranging from natural or native condition to severe changes in structure of the biotic community and major loss of ecosystem function. A panel of Florida plant experts determined thresholds for impaired and exceptional plant community condition based on the BCG model. Based on the BCG model, three categories of lake plant community biological integrity were delineated, and the LVI values observed for lakes in each category were used to define thresholds. LVI ranged from 0-100 with higher scores indicating better biological condition: Category I = 78-11, Category II = 38-77, and Category III = 0-37.

References

Davies, S.P. and S.K. Jackson. 2006. The biological condition gradient: a descriptive model for interpreting change in aquatic systems. Ecological Applications 16(4):1251-1266.

Fore, L.S., R. Frydenborg, N. Wellendorf, J. Espy, T. Frick, D. Whiting, J. Jackson, and J. Patronis. 2007. Assessing the Biological Condition of Florida Lakes: Development of the Lake Vegetation Index (LVI). Final Report to FDEP. Available: ftp://ftp.dep.state.fl.us/pub/labs/assessment/sopdoc/lvi_final07.pdf

NOTES

SESSION 8A

DISSOLVED OXYGEN IN BLACKWATER SYSTEMS

SPATIAL AND SEASONAL VARIATION OF SEDIMENT OXYGEN DEMAND IN A CHAIN OF LAKES IN THE UPPER ST. JOHNS RIVER, FLORIDA

F.E. Dierberg[a], *M. M. Fisher*[b], *N. Larsen*[a], *and T. Auter*[a]

[a] DB Environmental, Inc., 365 Gus Hipp Blvd., Rockledge, FL 32955
[b] Water Resources Group, PO Box 1978, Olympia, WA 98507

Introduction

Waters of the Upper St. Johns River have high color (200 CPU) and relatively high nutrients (0.09 mg/L and 1.5 mg/L of total phosphorus and total Kjeldahl nitrogen, respectively). The U.S. Environmental Protection Agency has established nutrient loading targets for portions of the Upper St. Johns River (Florida) because of failure to meet state water quality standards for dissolved oxygen (DO). The St. Johns River Water Management District (SJRWMD) initiated an intensive investigation into the sources and sinks of DO in the Upper St. Johns River basin that included characterization of water column respiration and primary production, sediment oxygen demand (SOD), and continuous *in situ* monitoring of DO concentrations. The objective of this study was to characterize the spatial and temporal variability of SOD in the six lakes.

Methods

Sediment cores and overlying waters were collected from six lakes in the Upper St. Johns River (Blue Cypress, Hell 'n Blazes, Sawgrass, Washington, Winder, and Poinsett) during the spring, summer, fall, and winter of 2006-07. Two coring stations were located in the larger lakes (Washington, Winder, and Poinsett), while Blue Cypress, Sawgrass and Lake Hell 'n Blazes had only one station. Triplicate cores were collected at each station. After storage at 4ºC for 48 hours in the lab, each core was decanted and refilled with oxygen-saturated site water. Incubations occurred in the dark and at ±2ºC of the *in situ* temperature. DO and temperature measurements of the overlying water within the sediment cores and the water-only control cores were performed at times 0, 2, 8-10, 24, 36, and 48 hours by a Hach Portable LDO™ dissolved oxygen meter and sensor. SOD rates were calculated by the difference in DO readings between sediment cores and control cores. Rates were adjusted for the volume of overlying water and for the surface area of the core.

Results

The SOD rates for the six lakes in the Upper St. Johns River were low, ranging from –0.01 to 1.08 g O_2/m^2-day. Variation among and within the lakes occurred seasonally. The presence of mollusks within the sediment had a pronounced effect on the SOD rate. Antecedent rainfall patterns had a secondary effect. Heavy precipitation in the watershed prior to the fall sampling resulted in some of the highest water column oxygen consumption and lowest SOD rates measured during the year for many of the lakes. Analysis of the sediments indicated detrital, muck, clay, and sand layers. Flocculent particles (frequently $\leq$ 1 cm) usually made up the surficial layer of sediment, with muck underneath.

Annual SOD rates representing the mean of the four seasons varied within a narrow range among the lakes, with Lake Washington having the highest (0.39 g O_2/m^2-day) and Lake Winder the lowest (0.26 g O_2/m^2-day). Excluding those cores containing mollusks lowered the range of annual SOD rates to 0.23 to 0.33 g O_2/m^2-day among the six lakes, a rate much lower than previously measured for the Upper St. Johns River (Roberts 1983).

Discussion

The narrow seasonal and spatial range of SOD rates may be due to frequent resuspension, mixing, and transport of sediment in the lakes. The lakes are shallow and are interconnected by the St. Johns River.

In the context of total oxygen budgets for the lakes, SOD contributed approximately 14-22% of the sum of the oxygen-consumptive processes (SOD + water column respiration and chemical oxygen demand). The results of a completed modeling effort for Lake Hell ‘n Blazes indicated the oxygen demand from all the oxygen “sinks” approximately equaled the oxygen supplied from sources (reaeration + photosynthesis). Apparently DO sources and sinks in these humic-colored lakes are closely balanced, and thus very sensitive to fluctuations in principal components of the oxygen budget.

Reference

Roberts, J.E., Jr. 1983. Dissolved Oxygen Budgets of Humic-Colored Aquatic Systems. M.S. Thesis, Florida Institute of Technology, Melbourne, FL.

NOTES

PRIMARY PRODUCTION IN BLACKWATER RIVER-RUN LAKES

Millard M. Fisher
Water Resources Group
P.O. Box 1978
Olympia, WA 98507

Steven J. Miller
Lawrence W. Keenan
Angelique M. Keppler
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32656

Introduction

The upper portion of the St. Johns River in northeast Florida is a broad expanse of wetlands feeding into a chain of lakes along the river. These lakes exhibit relatively high nutrients, low chlorophyll concentrations, and seasonal periods of dissolved oxygen depression, even anoxia. Because of these low dissolved oxygen levels, these river segments and lakes have been identified as impaired waterbodies.

The primary objective of this study was to quantify primary productivity and respiration. These measurements were quantified monthly for one year to determine seasonal patterns in primary productivity, determine differences in productivity between river segments and lakes, and to identify relationships between productivity and the observed drops in dissolved oxygen levels. This study was a major component of a larger study on dissolved oxygen dynamics in this river lake system.

Methods

Primary productivity and respiration was estimated with monthly, diurnal light and dark bottle deployments in three lakes and two river locations in this upper portion of the St. Johns River. The three lakes included in this study were Blue Cypress Lake (BCL), Lake Hell'n Blazes (HBO) and Sawgrass Lake (SGO). The two river stations were located near the inflow to Lake Hell'n Blazes (HBI) and the inflow to Sawgrass Lakes (SGI). Additionally, primary productivity was estimated using *in situ* diurnal dissolved oxygen measurements by a number of dataloggers recording dissolved oxygen and temperature every 15 minutes over a multiyear period. The two techniques produced different results based on different sets of assumptions. The techniques were compared and relative strengths and weaknesses are described.

A Stella model of dissolved oxygen dynamics was developed to investigate relationships between primary productivity, respiration, water flow, sediment oxygen demand, temperature, and wind in this system. This model allows the results from the dissolved oxygen dataloggers and the light and dark bottle measurements to be understood in context of the assumptions behind these techniques.

Results and Conclusions

Seasonal drops in dissolved oxygen concentrations are strongly coupled with storm events at the beginning of the wet season after the surrounding herbaceous wetlands are inundated by rising water levels. The dissolved oxygen depression also coincides with peaks in several water quality constituents. In this study, the light and dark bottle experiment revealed that primary productivity decreased with the observed drops in dissolved oxygen concentrations while respiration increased but remained low throughout the year. The seasonal trends in primary productivity as determined from the *in situ* data loggers was very similar to that of the light and dark bottles for all sites. However, the rates of primary productivity were higher during several months with the data loggers. The largest differences between these two methods were observed in BCL. The respiration rates determined from the *in situ* data loggers was much more dynamic throughout the year and significantly larger than that of the light and dark bottle experiment. This pattern suggests that respiration rates calculated from the datalogger measurements are more affected by external factors than are the calculated rates of primary productivity. The light and dark bottle measurements isolate the sample volume from exchanges with the atmosphere and prevent replacement or mixing with river flow. Whereas, the datalogger approach would allow external factors such as wind aeration to be counted as production or subtracted from respiration in the calculations.

The Stella model constructed was able to reproduce diurnal fluctuations in dissolved oxygen concentrations very well. The rates of productivity and respiration determined from both the *in situ* data loggers and the light and dark bottles produced very similar results when put into the model. This indicates that the productivity respiration pair is not the primary drivers of dissolved oxygen concentrations in this system. External factors most strongly affecting dissolved oxygen concentrations in the model are water flow, wind speed, and water column temperature. Large changes were observed in modeled dissolved oxygen concentrations with changes in wind speed. Additionally, altering the flow through the system resulted in significant control of dissolved oxygen in the model output. This suggests that aeration due to wind speed interactions with the water column and the rate of flow through the system have a significant impact on dissolved oxygen concentrations in the upper portion of the St. John’s River.

NOTES

CHRONIC AND ACUTE HYPOXIA IN THE UPPER ST. JOHNS RIVER

Lawrence W. Keenan
lkeenan@sjrwmd.com
(386) 329-4425
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32656

Millard M. Fisher
(360) 701-5393
millardfisher@earthlink.net
Water Resources Group
P.O. Box 1978
Olympia, WA 98507

Steven .J. Miller
sjmiller@sjrwmd.com
(386) 329-4387
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32656

Angelique M. Keppler
akeppler@sjrwmd.com
(386) 312-2309
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32656

Several river segments and lakes in the upper St. Johns River basin in northeast Florida have been identified as impaired waterbodies because of low dissolved oxygen levels. A large dissolved oxygen dynamics study was instituted to address both chronically low dissolved oxygen levels and recurrent periods of hypoxia. The study includes measures of sediment oxygen demand, primary production, nutrients, biochemical oxygen demand, and a network of dissolved oxygen dataloggers, water quality sampling stations and autosamplers.

Chronically low dissolved oxygen concentrations could largely be attributed to low levels of *in situ* oxygen production and high allochthonous carbon loading. However the causes of the episodic extreme hypoxic events are not straightforward. These extreme events are strongly associated with storm events at the beginning of the wet season when water levels are rising but only after the surrounding herbaceous wetlands are inundated. The development of a hypoxic event in 2007 was anticipated based on water levels and weather forecasts. This allowed for an intensive sampling effort to be mounted which included autosamplers, daily grab samples,

dataloggers, and light and dark bottles. The dissolved oxygen depression coincides with peaks in several water quality constituents though the association does not necessarily indicate causation. Excess nutrients and excess labile carbon are the two most probable causes identified by the data. Consideration of all facets of the data collected along with observations in the field suggests a probable source and the possibility of an alternative causal or contributing mechanism.

NOTES

SESSION 8B

CYANOBACTERIA

A STATEWIDE ASSESSMENT OF THE TOXIC ALGAL (MICROCYSTIN) THREAT IN FLORIDA LAKES

Bigham, D.L., D.E. Canfield, Jr., and M.V. Hoyer
University of Florida
Gainesville, FL

Blue-green blooms are of particular concern as some strains of cyanobacteria produce the toxin microcystin (Chorus and Bartram 1999). Reported cases of livestock, wildlife, and pet fatalities have been attributed to consumption of freshwaters with high microcystin concentrations (Steyn 1943; Ashworth and Mason 1946; Carmichael 1986, 1994). In response to the reported cases of microcystin sickness and death, the World Health Organization established suggested provisional safety standards for microcystin; a drinking water standard at 1 µg/L and a recreational standard at 20 µg/L. An uncertainty factor of 1000 is associated with each of the microcystin standards.

The primary objective of this study was to complete a statewide survey of Florida lakes to identify the quantity and range of microcystins found in lakes, frequency of occurrence of varying concentrations, and seasonal patterns of microcystin concentrations. Microcystin concentrations were measured bimonthly (January-December) for 2006 for 187 lakes and results were compared to the World Health Organization (WHO) drinking water and recreational standards to provide a preliminary assessment of human risk. The ELISA kit (Abraxis LLC., product # 520011, Warminster, USA) provided the antibody-coated plate, microcystin standards, and all reagents used to determine total microcystin concentration (µg/L).

Mean microcystin concentrations ranged from non-detectable to 12 µg/L, with 29 % of the lakes containing detectable microcystin ($\geq$ 0.1 µg/L). Only 7 % of the lakes had mean microcystin concentrations above the WHO drinking water standard of 1 µg/L. None of the lakes had mean microcystin concentrations above WHO recreational standard of 20 µg/L. At any time throughout the year, microcystin concentrations can be measured at levels above 1 µg/L, but microcystin concentrations were found to increase significantly starting in May/June, with the highest concentrations occurring during September-December (F value= 8.18, p-value $<$ 0.0001; Tukey-Kramer HSD). Of the 862 individual water samples collected from the 187 Florida lakes, microcystin concentrations ranged from non-detectable (65 % of the samples) to 34 µg/L. Only 7 % of the individual samples exceeded the WHO drinking water standard, while 28 % of the samples contained detectable microcystin. Three individual water samples exceeded the WHO recreational standard from Lake Jesup (Seminole Co.) and Lake Hunter (Polk Co.).

Microcystin concentrations in Florida lakes were found to increase with cyanobacterial biomass. The chlorophyll concentrations, that corresponded to the 862 microcystin water samples, were converted to cyanobacteria total biomass (mg/L) using a Florida-specific equation developed by Canfield et al. (1985). As total cyanobacterial biomass increased, microcystin concentration increased significantly. At a total biomass of 100 mg/L, where Duarte et al. (1992) showed that cyanobacteria dominate 100 % of the phytoplankton community, microcystin values reached and surpassed concentrations of 1 µg/L.

Using total chlorophyll concentrations as the indicator of trophic state and the classification system of Forsburg and Ryding (1980), the 187 lakes were classified into trophic categories (i.e., oligotrophic to hypereutrophic). As the trophic state increased, the percentage of detectable microcystin increased. Despite the trend of increasing microcystin concentrations with increasing trophic state, only two of the lakes in this study produced water samples with microcystin concentrations above the WHO recreational standard.

Consequently, from the measured microcystin concentrations obtained during 2006, microcystin does not seem to pose the greatest toxic algae threat to Floridians at this time as lakes are typically not used for drinking water and the WHO recreational standard is seldom exceeded. However, many lake users are interested in monitoring lakes not only from a human health perspective, but especially to placate "their" fear of toxic algae. A new method for determining microcystin concentrations in water, a microcystin test strip, became available in 2007 and offers the public the ability to monitor water bodies independently. Equipped lake users could sample lakes monthly, weekly, and during observed bloom events. These frequent monitoring efforts could help develop the long-term data base and could also be entered into an on-line data base and or a website to provide an early warning system to lake users. If the early warning system were available through the University of Florida as well, it would allow this "real-time" data to act as both a research and extension tool. Creating an ALGAEWATCH program would greatly benefit and enhance the university's research, extension agents, and teaching as well as contribute to an understanding of microcystins in Florida lakes.

References

Ashworth, C.T. and M.F. Mason. 1946. Observations on the pathological changes produced by a toxic substance present in blue-green algae (*Microcystis aeruginosa*). Am. J. Pathol. 22: 369-383.

Canfield, D.E., Jr., S.B. Linda, and L.M. Hodgson. 1985. Chlorophyll-biomass-nutrient relationships for natural assemblages of Florida phytoplankton. Water Resource Bulletin 21(3): 381-391.

Carmichael, W. W. (1986). Algal Toxins. Adv. Bot. Res. 12: 47-101.

Carmichael, W. W. (1994). The Toxins of Cyanobacteria. Sci. Am. 270: 78-86.

Chorus, I. and J. Bartram. (Eds.), Toxic Cyanobacteria in Water. 1999. A Guide to Their Public Health Consequences, Monitoring, and Management. E & FN Spon. On behalf WHO, London.

Duarte, C.M., S. Agusti, D.E. Canfield, Jr. 1992. Patterns of phytoplankton community structure in Florida lakes. Limnol. Oceanogr. 37 (1): 155-161.

Forsburg, C. and S-O. Ryding. 1980. Eutrophication parameters and trophic state indices in 30 Swedish waste-receiving lakes. Arch. Hydrobiol. 89: 189-207.

Steyn, D.G. 1943. Poisoning of animals by algae on dams and pans. Farm. S. Africa 18: 489-510.

NOTES

A SUCCESS STORY – CONTROLLING A LYNGBYA WOOLEI OUTBREAK IN HIGH POINT, NC

William Frazier, Manager
Water Quality Lab and Pretreatment
Public Services Department
City of High Point, NC

In July 2000, an unexpected outbreak of the potentially toxic cyanobacterium Lyngbya woolei took over 80 percent of the City of High Point's primary raw water source in less than a month. Although there is a large body of research on the algae, its characteristics and effects, relatively little was known about how to control it.

The next 6 years have yielded a wealth of information on impacts, causes and controls. The benefits have been as unexpected as its initial outbreak.

The first task was finding resources to mitigate the algae. Academic sources were scarce and scattered. The process put us in touch with the top names in the world of cyanobacteria research. Data concerning its nature and effects were published but few resources were available on how to get rid of it. The few that were available at the time were pursued with limited success.

This piece of the puzzle was found by complete accident. It was in a fishing article in a publication of the Bass Anglers Sportsman's Society on how Dr John Rodgers and his students at Clemson University in South Carolina in partnership with commercial ventures had devised a method of assessing the controls for lyngbya in large utility lakes in Alabama. Subsequent searches, conferences and personal conversations put us in touch with his program.

The first step was to perform the Algal Challenge Test (ACT). In essence this is a toxicity test that exposes the lyngbya and water from our location to specific chemicals that have demonstrated effective control of the algae under laboratory and real-world conditions. Once the effective agent and dose, without overdosing, has been determined, these conditions are transferred to real world conditions.

This is usually performed with an airboat to keep from disturbing the mats and to provide a convenient platform for the delivery system for the recommended chemicals. The delivery system consists of a manifold with a series of weighted hoses extending below the water's surface. This applies the chemicals directly on the growing mats instead of surface applications that may not be effective since surface mats are more of a protective mechanism for this algae than its primary growth habit.

The demonstration area we chose was a highly visible and frequently used public fishing area on our primary water supply. Chemical drift and efficacy studies were performed. The results of the rehabilitation were very dramatic and have been published. References are provided below.

Secondary benefits have been unexpected and equally dramatic. In conjunction with efforts of managers in the parks and recreation department to expand fishing opportunities, several youth fishing tournaments have been staged that would have been impossible without addressing the lyngbya. Public participation and accolades have been very favorable.

Another unexpected benefit was when the City of High Point received the NC American Water Works Association – Water Environment Federation award for best tasting water at their annual conference in 2007. While control of lyngbya was not the only treatment technology applied, its impact cannot be overlooked due to the extremely noxious tastes and odors lyngbya imparts on the water; especially in the fall of the year when the award was presented.

If there is a drawback, the problem of treating the entire lake is one of funding. The expense per acre is not that great relative to the threat but there is no regulatory driver that mandates public drinking water systems address the threat as of this conference. However, there is little doubt that regulatory agencies are in the process of addressing cyanobacteria as a whole and lyngbya specifically through their Candidate Contaminant List (CCL).

There still are missing pieces of the puzzle. Too much remains undiscovered about lyngbya blooms, its triggers, supporting conditions, drivers and control options. In addition, source water protection program initiatives must recognize the threat of its continued spread, partner with applicable agencies and develop realistic educational tools translating this very complicated subject for the general public's understanding and use.

References:

O'Niell R. Tedrow[1], B. Maurice Duke[1], Louwanda Jolley[1], Wayne Chao[1], William Frazier[2], and John H. Rodgers, Jr. (May 2007) "Laboratory and field responses of *Lyngbya* sp. following exposures to copper-containing algaecides", Clemson University, South Carolina.

Dr Michael Smart, US Army Corps of Engineers, Lewisville Aquatic Ecosystem Research Facility, Lewisville, Texas.

Applied Biochemists, www.appliedbiochemists.com

NOTES

INHIBITION OF CYANOBACTERIAL HARMFUL ALGAL BLOOMS: TARGETING QUIESCENT, STAGNANT WATERS WITH LONG-DISTANCE CIRCULATION (LDC)

Michael Lipparelli, Christopher Knud-Hansen and H Kenneth Hudnell
SolarBee, Inc.
[1]Eustis, Florida; [2]Westminster, CO; [3]Chapel Hill, NC

Cyanobacterial (a.k.a., blue-green algal) populations increase exponentially under appropriate growth conditions, a process known as “blooming.” Cyanobacterial blooms produce some of the most potent toxins known, cyanotoxins, equivalent in toxicity to cobra venom. Humans are exposed to cyanotoxins through recreational activities, as well as through drinking water. Acute health effects range from gastrointestinal and flu-like illnesses to death, whereas repeated, lower-level exposures are associated with chronic conditions such as cancers and neurodegeneration.[1] Massive amounts of organic matter descend to the sediment during bloom die offs triggering aerobic decomposition processes that cause hypoxia and fish kills.[1] Because of these and other risks to human health and ecosystem sustainability, episodes of excessive cyanobacterial population growth are referred to as harmful algal blooms (HABs).

Four primary conditions are generally necessary for the occurrence of HABs: 1) high concentrations of available nutrients (i.e., soluble inorganic phosphorus and nitrogen); 2) light intensity sufficient for photosynthesis; 3) warm temperatures, and; 4) periods of low water flow rates, (i.e., quiescent or stagnant waters). Traditional approaches to HAB inhibition have focused on limiting nutrient availability. Tools to restrict nutrient availability include watershed management, phosphorus inactivation through chemical precipitation, hypolimnetic oxygenation, and dredging. Nutrient input reduction is beneficial for water quality, but is a long-term approach to HAB inhibition, particularly in lakes with significant amounts of non-point source nutrient input. Phosphorus flocculation can inhibit HABs in the short term, but requires repeated application for sustained HAB control and adversely impacts the aquatic environment.[1] Flocculation, dredging, and hypolimnetic oxygenation are expensive and cost prohibitive in large lakes. Hypolimnetic oxygenation often stimulates HABs in larger water bodies by bringing nutrient-rich water from the dark hypolimnion to the epilimnetic photic zone. The approach to HAB inhibition described here targets their need for quiescent, stagnant waters. Inhibiting HABs can be accomplished without adverse environmental impact via sustainable, solar-powered technology.

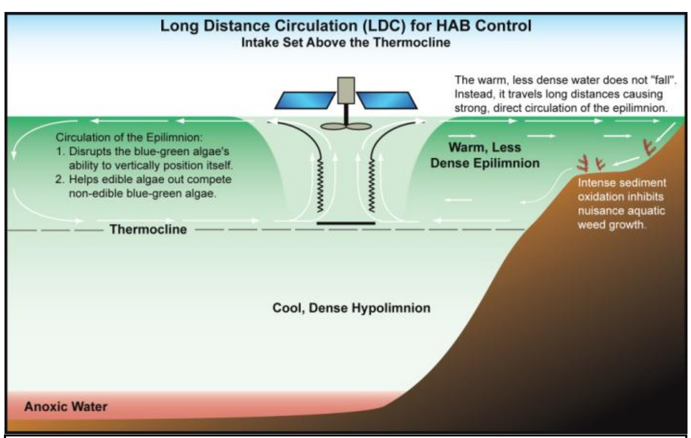


Figure 1. HAB inhibition is achieved by circulating water in the epilimnetic photic zone.

HABs prevention in small wastewater lagoons by water circulation through intense aeration is well established. The scientific basis for HAB control through circulation in lakes is described in the literature on habitat disturbance.[2-6] The current technology inhibits HABs using a solar-powered high-efficiency upflow pump mounted on a floating platform to create radial long distance circulation (LDC) of the epilimnetic photic zone. A plate suspended from the bottom of the intake hose causes water to be drawn in horizontally. Because water is in layers of different density, the intake pulls water from long distances in a near-laminar flow. Only the warm water above the thermocline is circulated, enabling a single unit to effectively circulate the water over an area of up to 35 acres (14 ha) per machine. This approach does not destratify the lake, disturb the sediment, or require land-based energy. Successful HAB inhibition has been achieved since 1998 in more than 230 water bodies (including over 80 municipal drinking water reservoirs) that range in size from less than an acre up to over ten thousand acres.

This presentation summarizes the sustainable ecological benefits realized with HAB control through LDC in several lakes nationwide during the last ten years. Documented benefits include preventing taste and odor events in raw water storage reservoirs, reducing chlorophyll *a* concentrations, increasing water clarity, and improving dissolved oxygen distribution in the water column. Furthermore, the prevention of HABs enables soluble N and P to go into edible algae that are subsequently consumed by zooplankton and fish. This not only improves the lake fishery, but also reduces organic loading to bottom waters that would otherwise experience hypolimnetic oxygen depletion. Solar-powered LDC predictably prevents toxic algae blooms without relying upon grid-based energy sources.

Reference(s)

[1]Hudnell, H. Kenneth (Ed.) (2008) Cyanobacterial Harmful Algal Blooms: State of the Science and Research Needs Series: Advances in Experimental Medicine and Biology, Vol. 619, Springer Press, New York.

[2]Donaghay, P.L. and T.R. Osborn (1997). “Towards a theory of biological-physical control of harmful algal bloom dynamics and impacts.” Limnol. Oceanogr. 42(5, part 2): 1283-1296.

[3]Huisman, J., J. Sharples, J.M. Stroom, P.M. Visser, W.E.A. Kardinaal, J.M.H. Verspagen, and B. Sommeijer (2004). “Changes in turbulent mixing shift competition for light between phytoplankton species.” Ecology 85(11): 2960-2970.

[4]Jungo, E., P.M. Visser, J. Stroom, and L.R. Mur (2001). “Artificial mixing to reduce growth of the bluegreen alga *Microcystis* in Lake Nieuwe Meer, Amsterdam: an evaluation of 7 years of experience.” Water Science and Technology: Water Supply, 1(1): 17-23.

[5]Reynolds, C.S., S.W. Wiesman, B.M. Godfrey and C. Butterwick (1983). “Some effects of artificial mixing on the dynamics of phytoplankton populations in large limnetic enclosures.” J. Phytoplankton Research, 5: 203-234.

[6]Visser, P.M. et al., (1996). “Artificial mixing prevents nuisance blooms of the cyanobacterium *Microcystis* in Lake Niewe Meer, The Netherlands.” Freshwater

NOTES

SESSION 9A

BOATING IMPACTS ON LAKE LURE NC

BOATING IMPACTS AT LAKE LURE, NC: BACKGROUND AND QUESTIONNAIRE SURVEY.

Russell Pitts, Lake Lure Marine Commission, Lake Lure, NC; *Barbara Wiggins*, CLM, Wiggins Environmental Services, Asheville, NC; *Ken Wagner*, Ph.D., CLM, NALMS Past President, ENSR Water Resources Manager, Willington, CT.

The Town of Lake Lure is evaluating options for keeping boating density at a safe level under the ever increasing pressure of recreational pursuits on the lake. A very inclusive and public process has been conducted, with decisions made based on the best possible combination of science, economics, and social acceptability.

Lake Lure was formed in 1925 and the associated community has been growing ever since, most notably in very recent years. It is a very scenic lake, with great appeal to retirees and second home owners. Growth has accelerated in recent years, creating a number of issues for the town leaders to address. The community has seen many changes, and a review of legal issues in 2005 resulted in what is called "The law of Lake Lure"; the town has recognized its responsibility in managing boating as a result. Many actions have been taken over the last decade to properly manage the lake and its users, but boating safety is still a primary concern.

The majority of boating activity appears to come from shorefront residences. Many lakefront homes have multiple boats and there are over 300 boat slips associated with private developments that abut the lake. Off-lake residents and even residents of other towns have been able purchase boat permits for Lake Lure, however, with use by off-lake parties mainly on weekends and holidays, creating peak use periods. The Town enacted a number of rules to moderate use of the lake and set boundaries on how some uses impact others. Town liability for boating accidents is a very real concern. To approach management scientifically, we need to understand use patterns and carrying capacity at Lake Lure.

Quantitative data were collected for boat use patterns through a questionnaire during the spring and summer of 2006. A 40% rate of return was achieved, and demographics of respondents appear to accurately reflect the user population. Values were obtained for types of lake uses, types of boats used, frequency and duration of use, perceived risks and conflicts, and opinions on possible boat management techniques. Crafting a publicly acceptable boat management plan represents a major challenge, and stakeholder input is considered very important. Having actual data on desired activities and use patterns was invaluable in dealing with the public at meetings, especially when there was disagreement over actual conditions that could be assessed from questionnaire results.

Carrying capacity is largely a function of the interaction between lake features and boat types. A certain number of acres are boatable, based on depth, required distance from shore for operators, and needed area for safe operation of each boat, with these values varying by boat type and engine size. Consequently, while a carrying capacity can be calculated for any one class of boat, a wide range of carrying capacities exist for the range of boat mixes that can occur on the lake. Lake Lure also has the issue of commercial uses to contend with, as there are tour boats, fishing guides, property work boats, real estate boats, and ski schools operating on the lake. Providing adequate and safe opportunity for all boating uses allowed on the lake is viewed as an important need.

Results generally confirmed informed appraisals of conditions, uses, and boating statistics, but contradicted some extreme statements made at meetings. Households average one motorboat >10 hp, about half the operators are trained, and between 10 and 20% of the homes on the lake are rented, giving access to people potentially unfamiliar with boating and Lake Lure. Safety is an issue mainly on busy summer weekends and holidays. Towing and high speed cruising are the major boat uses, but the proportion of non-motorized boats on the lake has grown steadily. Rarely are property owners present more than half the time; things could get much worse with full time occupancy. About 2/3 of all property owners purchased that property with the intent of gaining boat access to Lake Lure. Average boating density can be calculated from collected data, based on types of boats permitted and owner use statistics, and an estimate of peak values can be made.

NOTES

BOATING IMPACTS AT LAKE LURE, NC: CARRYING CAPACITY AND IMPLICATIONS OF BOAT OBSERVATION DATA.

Barbara Wiggins, CLM, Wiggins Environmental Services, Asheville, NC; *Ken Wagner*, Ph.D., CLM, NALMS Past President, ENSR Water Resources Manager, Willington, CT; and *Russell Pitts*, Lake Lure Marine Commission, Lake Lure, NC.

The survey data that was collected in the spring of 2006 provided a good basis for a management plan, but Lake Lure needed confirmation of the actual boating uses during the summer months. Quantitative data were collected for boat use patterns through direct observation during field surveys, particularly on weekends and holidays. Boats were divided into several categories and uses when observed in two-hour increments throughout daylight hours on days representing a variety of situations, including good weather weekends and holidays, good weather weekdays, and bad weather days.

The distribution of actual boating use was not even, either by use or location on the lake. The survey found that the lake was effectively split into four narrow arms, with different capacities for the number of boats that could be handled safely. The two-hour survey periods were adjusted for each arm to provide further information on whether the carrying capacity was exceeded during any of the field survey dates in 2006. The surveys also confirmed the change in boating use during rainy weather – all uses dropped except for fishing, which increased and spread out from shoreline to mid-channel activities.

The observations confirmed that the lake has no density or safety concerns when considering any of the categories of non-motorized, motorized boats < 10 HP, or fishing boats at any time of the week. No density problems were observed during sunny weekday uses with any of the categories of boating use during the summer. Density peaks were experienced for motorized >10 HP or towing boats during mid-day hours and the highest levels of activities were noted on weekends and holidays. The lake frequently exceeds the 10 acres/boat density during the mid-day hours on the weekends. This level of activity may be acceptable to the community. However, when using a 20 acres/boat capacity goal for safety concerns surrounding the towing activity of boats, there were still several days where the boating counts exceeded this level for the whole lake (Fourth of July holiday) and more specifically, the North Arm and the South Arm of the lake exceeded the capacity on several sunny weekend days during the mid-day hours. The North Arm is the longest straight stretch of open water on Lake Lure, and attracts much of the towing activities involving skiing. It is also the arm that is adjacent to a large residential/resort development. The North Arm has the most undeveloped lakefront shoreline and will be experiencing increased growth of homes and boating use in the future. The South Arm has several smaller tributary arms connecting a large density of homes and also has a lake front restaurant (the only one on the lake) that attracts traffic throughout the day.

Field surveys provided additional information based on observations. Traffic flow of the boats in the narrow arms did tend to follow a counter clockwise direction when heavier boating use was present. The heavily used North and South Arms would shift from towing activities to near shore activities (fishing, swimming, eating and sitting) when the numbers of boats present went over the 20 acres/boat level. Field staff observed that unsafe boating techniques were present at all levels of boating use and created unsafe conditions during all conditions. These unsafe drivers were particularly dangerous at the higher boating densities due to the lack of reaction time/area available to avoid these drivers.

In summary, indications from the questionnaire survey were generally supported by observational data, and refinements of carrying capacity and perceived use patterns from the questionnaire survey were made from these data. Carrying capacity estimates were generated based on apparent space needs for each boating activity, the available lake area appropriate to each use, and the mix of uses observed. Carrying capacity is sometimes exceeded on summer weekends and holidays with nice weather between the hours of 11 AM and 5 PM, mainly as a function of operation of boats >10 hp for high speed activities. There is some evidence of self regulation of larger boats, but peak densities do achieve possible danger levels, especially for untrained or inexperienced powerboat operators. Risks are low during most weekdays and any day with rainy weather. There is a need to reduce peak use of large motorboats or control activities during peak use to maintain safe conditions, but there is adequate capacity to meet boating needs when all daylight hours over the entire week are considered.

NOTES

BOATING IMPACTS AT LAKE LURE, NC: BOATING MANAGEMENT FRAMEWORK.

Ken Wagner, Ph.D., CLM, NALMS Past President, ENSR Water Resources Manager, Willington, CT*; Barbara Wiggins*, CLM, Wiggins Environmental Services, Asheville, NC; and *Russell Pitts*, Lake Lure Marine Commission, Lake Lure, NC.

There is a very wide range of potential management options that could be applied at Lake Lure. The key is to select options that represent the least intrusive and most equitable means to ensure safety to the greatest feasible degree. The objective is to maximize safety and enjoyment of the lake while providing opportunity for the range of permitted uses, with some sense of the proportional nature of use popularity. For example, towing and high speed cruising are the most popular uses, but sunset viewing from boats becomes the dominant use in the evening, and sailing is not very popular as a consequence of lake features. Non-motorized boating is increasing in popularity based on permit issuance, but can occupy different space than most high horsepower motorboats. Achieving balance is a major challenge.

Management options are divided into four major categories (Access Control, Time Zoning, Space Zoning, and Training and Behavioral Modification) plus an enforcement category that applies to all of the others. Access control limits the number of boats that can be on the lake at all, but does not prevent high peak densities; access limits that prevented high densities would produce a very low average use, denying many the use of the resource when it could be safely offered. Time and space zoning help separate uses to both maximize use and enhance safety. Training and behavioral modification are essential for safe operation during peak densities, which can exceed generally accepted safe boating levels. Enforcement is essential to any successful management system, but requires and educational focus rather than intimidation.

A considerable amount of public discussion was conducted and input was considered in developing a proposed management plan. A number of adjustments are feasible and appear appropriate based on the work done in 2006. Measures have been recommended, with phased implementation beginning in the 2007 boating season. Key aspects include a permit system with limits on boats >10 hp, education and training programs, supervision for those under age 16, a police patrol with a focus on education, a dedicated boating education and enforcement staff person, and a 75 ft distance between boats moving at more than headway speed. The permit system limits the average density to that which has historically been acceptable with limited problems, but does not prevent unsafe peak densities. The training, education and enforcement options are aimed mainly at improving safety during peak density periods. The 75 ft distance between fast-moving boats creates a density-dependent mechanism for limiting unsafe activity during peak densities, and also serves to spatially even high speed uses.

The approach is likened to a golf club. Access equates to membership, while time and space zoning equate to physical features that must be acknowledged by all members. Additional peak density controls are possible, equating to tee times on a golf course, but were not applied at Lake Lure. Training and behavioral requirements represent a code of conduct to which members must adhere. This approach allows reasonably equitable use of the resource without greatly diminishing member enjoyment of it.

The primary benefits of this plan include physical and temporal separation of some uses to maximize safety while protecting the privilege of those now holding permits, allowing only educated and trained boat operators, providing an appropriate level and focus of enforcement, and creating a density-dependent mechanism for controlling higher risk activities. The primary negative aspects of this plan are that at some future point, people will be denied a permit for a boat >10 hp on Lake Lure, and high speed activities may be limited during busy periods. Provisions for plan adjustment based on future surveys of boating patterns have been incorporated into the plan, and such surveys are recommended.

NOTES

BOATING IMPACTS AT LAKE LURE, NC:
A PERMITTING SYSTEM FOR PROGRESSIVE TRACKING AND CONTROL.

Russell Pitts, Lake Lure Marine Commission, Lake Lure, NC; *Barbara Wiggins*, CLM, Wiggins Environmental Services, Asheville, NC; and *Ken Wagner*, Ph.D., CLM, NALMS Past President, ENSR Water Resources Manager, Willington, CT.

Lake Managers around the world are facing the difficult challenge of trying to manage boat density while also attempting to maximize the full safe potential of their lake's recreational carrying capacity. Combine the ever-increasing number of lake users with the political realities of restricting lake access or lake use, and conflicts are to be expected, leading to management compromises. Lake Lure has been using a boat permitting system for over 40 years, but has found limitations in using this permit-focused approach. Upon investigating alternative options, the Town was legally advised that the any solution for managing boat density must be built upon a logical and rational basis. A solution that removed most, if not all, of the qualitative ambiguities that could be challenged by the various entities impacted by new regulation is most desirable but elusive.

One of the challenges that Lake Lure faced was the inability to regulate commercial operations on the lake with a permitting system based only on price. A half-dozen active lake businesses seemed to be consuming the lake's safe carrying capacity, although there were few data to document this use. It was determined by the local community that there was a desire to limit commercial use of the lake to 30% of the lake's total carrying capacity, with the remaining carrying capacity reserved for non-commercial, residential type uses. Establishing a ratio for commercial vs. non-commercial uses generated various practical issues, such as how to enforce ratios when there was no tool or process to measure the current usage. How should boat permits be allocated in a manner that was fair, and more importantly had a logical and rational basis that could stand up if tested in a court of law? The remainder of this abstract will describe various aspects of the computer-based solution developed for Lake Lure, which has been very successfully used for a number of years. With some further programming adjustments, this system could be applied at other lakes. The developers of Lake Lure's solution are willing to work with NALMS to make this computer-based solution available to all lake managers, but it will require some investment of time and money, which in turn will require confirmed need from other lake managers.

SUMMARY OF SOLUTION

The current solution to allocating lake resources over time provides both lake impact analysis and boat permit processing for all commercial lake operations (e.g. lake tours, fishing guides, rental boats, professional charters, etc.). It also supports boat permit processing for non-commercial boaters. All of this is achieved using a single integrated database, which includes a custom user interface composed of multiple data maintenance screens and supporting reports. The lake impact analysis is currently scoped to support only commercial boating, since this particular segment of boating operation was producing a seemingly high impact on the lake's safe carrying capacity. Additionally, the commercial segment of boat operations has predictable use patterns that can be easily modeled and tracked. The plan is to eventually expand the lake impact estimating model to support non-commercial boaters. More recently, a limit was placed on the number of permits allocated to motorboats >10 hp, as data indicated overuse by that boating sector. The impact analysis is performed using a Microsoft Excel based estimating model that employs simple arithmetic with lots of variables to account for, which ultimately calculates the acre-hour impact for each vessel. Here acre-hours are used as the measure of resource availability and use. The resource can be defined as the amount of suitable acres for the amount of time in which those acres can be used. For each use, acre-hours represent the necessary acres to safely enjoy the activity times the hours of use typically applied.

COMPONENTS OF SOLUTION

The current solution for modeling, allocating, and processing commercial and non-commercial boat permits consists of the following component:

- Lake Use Regulations – Regulations that clearly define the ordinances and fines associated to the lake commercial licensing and boat permitting process
- Lake Commercial License – Annually renewed license that is required for commercial operations that clearly depicts the number and type of boats allowed
- Commercial Boat Permit – Boat permit that ties to a commercial license
- Non-Commercial Boat Permit – Annually renewed boat permit that is tied to boat usage that is not categorized as commercial in nature
- Lake Database – Microsoft Access based database, which is used to store all commercial and non-commercial permit data
- Lake Impact Estimating Model – Microsoft Excel spreadsheet that contains parameter driven formulas for calculating lake impact for each lake commercial license request, as well as calculating cumulative impact of all lake commercial licenses across various seasons (peak, shoulder, and winter)
- <u>Non commercial boat permitting process</u> 1. Application submitted => 2. Application validated => 3. Application information loaded into database => 4. Application printed & signed by applicant = 5. Boat permit(s) granted and paperwork filed
- <u>Commercial boat permitting process</u> 1. Lake commercial license applications are submitted by Nov.1 => 2. Applications are prioritized and lake impact estimated & leveled using lake impact estimating model => 3. Estimating results presented to Marine Commission for approval/revision => 4. Lake Commercial license applications approved or disapproved & loaded into database => 5. Requests for Boat Permits => 6. Information validated & requirements confirmed = 7. Boat permit(s) granted and paperwork filed.

NOTES

SESSION 9B

SPRINGS AND RIVERS

NUTRIENT LOADING OF SELECT SPRINGS IN THE SUWANNEE RIVER BASIN: A TEN YEAR STUDY

*R. Jason Dickey**, *Robbie McKinney***
*Biological Research Associates; A division of Entrix, Inc.
Tallahassee, FL
**Suwannee River Water Management District
Live Oak, FL

Data were collected from six springs in the middle Suwannee River between 1994 and 2005 as part of the Suwannee River Water Management District's (SRWMD) Water Assessment Region Network (WARN). Water chemistry data, collected concurrently with instantaneous discharge measurements, were used to estimate annual loading (kg/yr) of key nutrients into the Suwannee River. Loading estimates were compared across springs in relation with climatic conditions and prevailing landuse.

The study focused on six first to second magnitude springs located within a 25-mile stretch of the middle Suwannee River and included: Lafayette Blue Springs (LBS010C1), Suwannee Blue Springs (SBL010C1), Telford Spring (TEL010C1), Unnamed Spring (SUW718971), Little River Spring (LRS010C1), and Ruth/Little Sulfur Spring (RLS010C1). Nutrient loading estimates were conducted for total phosphorous (TP), soluble reactive phosphorous (SRP), total nitrogen (TN), and nitrate-nitrite nitrogen (NOx). Predominant landuse within the study area ranged from silviculture and row-crop agriculture to poultry and cattle operations. Average discharge on the Suwannee River during the study period was approximately 5,700 cfs. The data record included five climatic events where river discharge exceeded 20,000 cfs.

Nutrient loading computations were modeled using FLUX (US Army Corps of Engineers 1996). FLUX incorporates six calculation techniques to extrapolate instantaneous loading estimates across a broader flow record. These include: direct mean loading, ratio estimate (flow-weighted), modified ratio estimate, first order regression, second order regression, and regression applied to individual daily flows. A notable shortcoming of this study was the lack of mean daily discharge (MDD) records at each spring, a requisite for FLUX. Indeed these data do not exist for most springs in the Florida panhandle. Instead MDD was statistically derived using USGS records on the Suwannee River. Correlation coefficients varied from 30% - 96% across the six springs; a relationship that appeared to be independent of spring size, mean discharge, or distance to the USGS gage. This in itself offered insight into the autonomous nature of similarly sized and closely (proximity) related springs.

Split-plot repeated measured ANOVA confirmed significant increases in NOx among years, after accounting for seasonal effects, at each station. Concentrations of TP, SRP, NH3, and TN remained statistically similar ($p<0.010$) among years and were therefore not considered in the loading computations. Generally NOx loading estimates were statistically similar among stations. The exception was SUW718971, which significantly expressed the greatest concentrations (mean NOx = 11.5 mg/L; $N = 46$; $p<0.001$). This was the lowest magnitude spring of those sampled (mean cfs = 4.0 cfs; $N = 23$; $p<0.005$).

Overall nutrient loading estimates were independent of spring magnitude and season. Climatic events negatively influenced loading; that is, nutrient concentrations generally decreased with increasing discharge. Multiple regression analyses were not performed but local landuse (≤ 15 mile radius of spring) appeared to be the best predictor of NOx loading. The nature of this study was purely exploratory and the intent was more focused on raising questions, rather than answering them. The Suwannee River Water Management District will continue to monitor water quality trends in area springs as a continuation of the WARN network.

References:

Walker, W.W. 1996. Simplified Procedures for Eutrophication Assessment and Prediction: User Manual. US Army Corps of Engineers. Waterways Experiment Station. Instruction Report # W-96-2. Updated April 1999.

Maceina, M. J., P. W. Bettoli, and D. R. DeVries. 1994. Use of a split-plot analysis of variance design for repeated-measures fishery data. Fisheries 19(3): 14-20.

Hornsby D. and Ceryak, R. 2000. Springs of the Aucilla, Coastal, and Waccasassa Basins in Florida. Suwannee River Water Management District. Publication No. WR00-03

NOTES

KELLEY BRANCH STEEPHEAD STREAM RESTORATION APALACHICOLA RIVER (LIBERTY COUNTY, FL)

Michael J. Hill
Florida Fish & Wildlife Conservation Commission
1338 Avondale Way
Tallahassee, FL 32317
850-251-8919 work
850-410-2842 fax
Michael.Hill@MyFWC.com

Kelley Branch is one of a few rare and biologically distinctive steephead streams located along the eastern side of Apalachicola River in Florida. The stream lies within The Nature Conservancy's (TNC) Apalachicola Bluffs and Ravines Preserve and contained both an eight hectare impoundment and an upstream road and culvert. Surveys revealed that the oligotrophic lake failed to sustain a fishery and that both structures had significantly altered biological communities within the watershed. In partnership with TNC, the Florida Fish and Wildlife Conservation Commission funded the removal of the upstream road crossing, de-watering of the lake and removal of the dam, pipe and riser system, and re-sculpturing of the lake bottom into a stream channel to restore fluvial connectivity and provide for fish passage and biological recovery throughout Kelley Branch. A channelized streambed was revealed after the lake was de-watered, which required additional planning to re-create typical stream meandering based on nearby steephead streams located within the preserve . Root wads, log vanes and other woody materials were used within the new channel to provide natural structures for long-term stabilization and recovery. Recent surveys show that resident downstream fish species have been able to successfully migrate through the newly constructed streambed and throughout Kelley Branch. The total project cost was $291,230 dollars.

NOTES

THE EFFECTS OF THE INPUT OF GROUNDWATER ON THE WATER QUALITY AND BENTHIC MACROINVERTEBRATE COMMUNITY OF THE WITHLACOOCHEE RIVER, MADISON COUNTY, FLORIDA

Kym Rouse Campbell and Meg Andronaco
Biological Research Associates, a Division of ENTRIX, Inc., and Nestlé Waters North America, Inc., Riverview and Zephyrhills, FL

There are two rivers in Florida named Withlacoochee. The northern Withlacoochee River is a major tributary of the Suwannee River and originates in Georgia, flowing approximately 70 miles before crossing into Florida. The Withlacoochee River is characterized by clear black water, high limestone banks, numerous shoals, abundant floodplain forests, and various springs. It joins the Suwannee River at Suwannee River State Park, just west of Live Oak, as it winds its way to the Gulf of Mexico. Madison Blue Spring, one of Florida's 33 First Magnitude Springs, rises at the edge of the Withlacoochee River when the river is at its normal level. When the Withlacoochee River floods, it inundates the spring by many feet and reverses the spring's flow, which causes large amounts of slightly acidic water to flow deep into the aquifer.

Since Fall 2003, water quality and the benthic macroinvertebrate community have been surveyed in the Withlacoochee River upstream and downstream of Madison Blue Spring Run as part of an ongoing monitoring program required by a Water Use Permit issued by the Suwannee River Water Management District. The monitoring program is intended to detect ecological responses to changes in spring discharge and addresses three distinct aquatic habitats: the solution channels leading to Madison Blue Spring, Madison Blue Spring Pool and Run, and the Withlacoochee River at the end of the spring run.

The following field measurements are made at each Withlacoochee River sampling site every May and November: water temperature, pH, dissolved oxygen, specific conductivity, and turbidity. A grab sample is collected and preserved as appropriate from each site and transported to the laboratory for quantitative analysis of alkalinity, calcium, chloride, potassium, magnesium, sulfate, ammonia nitrogen, nitrite nitrogen, nitrate nitrogen, orthophosphate phosphorus, total organic carbon, and color.

Every May and November, the benthic macroinvertebrate communities are sampled in the Withlacoochee River about 100 meters upstream of Madison Blue Spring Run near the State Highway 6 Bridge and in the Withlacoochee River approximately 200 meters downstream of the spring run using the Florida Department of Environmental Protection's (FDEP's) Stream Condition Index (SCI) protocol. Dipnet samples are collected along the western bank of the river by wading and reaching from the bank. One set of 20 samples is collected at each Withlacoochee River sampling site, and each set is composited in a bucket and preserved. At our laboratory, each composited benthic macroinvertebrate sample is sorted according to the FDEP's SCI protocol, and the sorted samples are sent to an expert for taxonomic identification.

The influence of the discharge of groundwater on the water chemistry of the Withlacoochee River is apparent from the differences in the water quality of the upstream and downstream sites. Levels of dissolved oxygen, chloride, color, orthophosphate phosphorus, potassium, sulfate, and total organic carbon measured in the Withlacoochee River upstream of the spring run to date have been significantly higher ($p < 0.05$) than concentrations measured downstream of the spring run. Since 2003, magnesium and nitrate nitrogen concentrations measured in the Withlacoochee River upstream of the spring run have been significantly lower ($p = 0.0001$) than levels measured in the Withlacoochee River downstream of Madison Blue Spring Run.

SCI scores for the Withlacoochee River upstream of the spring run have ranged from Good to Poor, while those for the downstream site have ranged from Fair to Very Poor. However, SCI scores for both Withlacoochee River sites have been similar to date. The number of benthic macroinvertebrate taxa found in the Withlacoochee River upstream from the spring run since Fall 2003 (Mean = 34 taxa) has been significantly higher ($p = 0.0001$) than numbers found in the downstream site (Mean = 22 taxa). At both Withlacoochee River sites, the amphipod, *Hyalella azteca* complex, and the chironomid, *Tanytarsus* sp. C, typically make up the majority of the benthic macroinvertebrate samples. Since 2003, 15 mayfly (Ephemeroptera) and 14 caddisfly (Trichoptera) taxa have been found in the Withlacoochee River upstream of the spring run, while 11 mayfly, 1 stonefly (Plecoptera), and 5 caddisfly taxa have occurred in the Withlacoochee River downstream of the spring run. High numbers of these three benthic macroinvertebrate orders typically indicates better water quality, and the differences in numbers between sites is most likely due to the input of groundwater, which naturally contains low levels of dissolved oxygen.

NOTES

LONG-TERM TRENDS IN BENTHIC MACROINVERTEBRATE COMMUNITIES IN THE UPPER SUWANNEE RIVER

Robbie McKinney, R. Jason Dickey***
*Suwannee River Water Management District
Live Oak, FL
**Biological Research Associates; a division of Entrix, Inc.
Tallahassee, FL

The Suwannee River Water Management District (SRWMD) established an ambient surface water quality monitoring network as part of the SRWMD Water Assessment Regional Network (WARN) in 1989, as a priority project of the Surface Water Improvement and Management (SWIM) program. The network's purpose is twofold: to determine the water quality status of the priority water bodies within the District, and to identify changing conditions in water quality.

Both water quality measurements and biological monitoring are included within the WARN network. One of the main focuses of the SRWMD biological monitoring includes benthic macroinvertebrates. This group of organisms has been used for many years to assess water quality. The methods used to sample them are well-established and have shown that populations of these organisms exhibit characteristic responses to various kinds of environmental stresses. The goal of this study was to determine temporal trends existing in biological indices, effects of water quality nutrient variables on biological indices, and mean differences among sites and years of collection.

Benthic macroinvertebrates are collected quarterly by the SRWMD using dip nets and/or Hester-Dendy multiplate samplers at long-term river sites. Reported macroinvertebrate data include benthic macroinvertebrate taxa richness, benthic macroinvertebrate total abundance per m^2, Shannon's Diversity Index, and Hill's Evenness for each sample replicate.

This study encompasses benthic macroinvertebrate data collected from the first quarter (October-December) of 2003 to the fourth quarter (July-September) of 2007. The area of collection for this study includes three sites in the upper Suwannee River; at Benton (station SUW010C1), near Suwannee Springs (station SUW070C1), and Ellaville (station SUW100C1). Analysis of variance (ANOVA) and correlation coefficients were used to compare means and reveal trends through time for each site in the upper Suwannee River.

Trend analysis showed correlations between time of collection and at least one of the biological indices at two of the three sites. The site SUW010C1 was the only site that showed no trend among any of the four indices through time. The site SUW070C1 presented a statistically higher mean for Shannon's Diversity Index and taxa abundance when compared with the other two sites. A statistically higher mean for three of the four biological indices existed for the year 2007 compared to 2005, a year categorized by higher precipitation in the upper Suwannee River basin.

Both total kjeldahl nitrogen and total phosphorus were also extremely important factors affecting macroinvertebrate indices. These nutrients showed varying influences on macroinvertebrate taxa richness at both SUW010C1 and SUW100C1. Abundance, Shannon's Diversity, and Hill's Evenness were also significantly influenced by these nutrients at each of the sampling sites.

Differences among the river sites give more insight into the mechanics driving macroinvetebrate indices through both time of drought and inundation in the Upper Suwannee River. The year 2007 showed that despite persistent drought conditions in the Upper Suwannee River, the macroinvertebrate community indices had fully rebounded from riverine flood conditions that occurred in 2005 as a result of seasonal storms. The SRWMD will continue to monitor trends and changes in both biological and water quality as a continuation of the WARN network.

References:

Hornsby, D., R. Mattson, T. Mirti. 2004. Surfacewater quality and biological annual report WR-04/05-02. Suwannee River Water Management District. Live Oak, FL: 234 p.

Maceina, M. J., P. W. Bettoli, and D. R. DeVries. 1994. Use of a split-plot analysis of variance design for repeated-measures fishery data. Fisheries 19(3): 14-20.

Scarsbrook M. R., I. K. G. Boothroyd, and J. M. Quinn. 2000. New Zealand's National River Water Quality Network: long-term trends in macroinvertebrate communities. New Zealand Journal of Marine and Freshwater Research 34: 289-302.

NOTES

SESSION 10

ECOLOGY OF AQUATIC VEGETATION

AN EVALUATION OF TREE HEALTH AND TREE MORTALITY IN FORESTED HARDWOOD WETLANDS FOLLOWING CHANGES IN WATERSHED LAND USE

Jennifer L. Brunty, Ph.D.
Southwest Florida Water Management District
Sarasota, FL

Overview

A common belief among those responsible for the design of surface water management systems associated with development has historically been that the more water a wetland receives, the better off the wetland will be. However, it has become apparent in recent years that some forested hardwood wetlands can suffer significant tree mortality following changes in land use in wetland watersheds. In some cases, these forested hardwood wetlands either receive runoff from a larger watershed than under historic conditions, or the wetlands are inappropriately incorporated into the design of the stormwater management system, resulting in an increased hydroperiod for the wetland. Proper design of stormwater ponds that discharge to these wetlands requires evaluation of pre-development and post-development factors to assure water levels, duration and frequency of the receiving wetland(s) hydroperiods are not adversely impacted. This presentation includes a review of four case studies of factors that were considered, or were not considered, during the Environmental Resource Permit (ERP) review process for projects that included forested hardwood wetlands with significant tree mortality post-development. While this is not an exhaustive study of the matter, some of the key items that should be considered in the ERP evaluation process are identified and discussed. The following is a general summary of some key items.

Discussion

ERP application evaluation under current Southwest Florida Water Management District (District) rules focuses primarily on changes in the flow rate of water leaving a project area rather than changes in the actual volume of water being discharged to wetlands and/or other surface waters. The criteria for evaluation of water quantity impacts to wetlands and surface waters is outlined in Section 3.2.2.4 of the District's Basis of Review document for ERP application review. While these criteria state that the designer of a surface water management system must provide reasonable assurance that adverse secondary impacts will not occur to wetland hydroperiods as a result of operation of the surface water management system, the design engineers often have difficulty providing this reasonable assurance. The expertise of most design engineers has historically focused more on the prevention of offsite flooding than preserving natural wetland hydroperiods, resulting in great difficulty in accurately modeling wetland hydrologic regimes.

In the course of designing surface water management systems associated with development, engineers may change the size of sub-basins draining to individual wetlands within a particular watershed. However, changes in the size of the watershed draining to a given wetland have the potential to result in an increased or decreased volume of water being discharged to a wetland. This potential change in volume may change the hydroperiod of a wetland, which may result in adverse secondary impacts to the wetland, including tree mortality in hardwood forested systems.

In addition, wetlands are occasionally used for attenuation of stormwater to reduce the rate of flow of water being discharged from the project area. Attenuation of stormwater in a wetland may result in an altered wetland hydroperiod, resulting in deeper water levels for longer periods than the wetland had experienced historically. Evaluation of the change in hydroperiod has typically relied upon time-stage hydrographic analysis provided by the engineering consultant, though the District is in the process of developing a continuous simulation model to be used for this purpose.

When stormwater ponds are designed to discharge to neighboring wetlands, the elevation of the outfall structure is generally set at the SHWL of the receiving wetland. In addition, a discharge structure from the wetland to an offsite waterway is typically installed, and if the control elevation is set incorrectly (i.e. too high, resulting in an extended hydroperiod) or a V-notch or orifice, in cases, is not included (i.e., preventing the wetland system from slowly releasing or "bleeding" down water from SHWL to NP), tree mortality may occur, as proved to be true in one of the case studies to be discussed.

Conclusion

A better understanding of the effects of watershed and/or hydroperiod changes on the health of forested hardwood wetlands is necessary to more effectively incorporate wetlands into surface water management systems. As the case studies of actual wetlands that have suffered tree mortality will show, review of changes in hydroperiod, setting the correct elevation of control structures, attenuation and the use of appropriate SHWL indicators is critical in the design and evaluation of proposed land use changes, through the ERP process, to provide reasonable assurance that adverse impacts to forested hardwood wetlands will not occur. The case studies covered in this presentation are intended to be expanded upon with further case studies to provide additional information for use in ERP application reviews.

NOTES

LIFE CYCLE OF A TAPE GRASS (VALLISNERIA AMERICANA) BED

Jennifer J. Sagan
BCI Engineers & Scientists, Inc.
2000 E. Edgewood Dr. Suite 215, Lakeland, FL

Purpose

Within the lower basin of the St. Johns River (LSJRB), Notheast Florida, a cyclical pattern of disappearance and resurgence of *Vallisneria americana* beds has been observed within a freshwater lake. Seasonal surveys conducted at a permanent monitoring station over a decade provided an opportunity to observe the mode and pattern of *V. americana* reestablishment at the site and as related to water quality. In addition, a propagule bank study was conducted at the site to determine density of viable *V. americana* seeds or other propagules in the sediment.

Methods

Data were collected along five fixed transects distributed within a 50-m swath of a study plot along the eastern shore of Crescent Lake. Transects were placed perpendicular to the shore starting from the shore to the outer edge of the SAV bed. At 1-m intervals along each transect, *V. americana* presence/absence and maximum canopy height were recorded. In addition, the linear cover of plant foliage was determined along the transect. Data were collected corresponding to the fall and spring seasons beginning in fall of 1997. Quarterly data were collected beginning in fall 2000 through spring 2007. On June 10, 2004, sediment cores were collected from 15 randomly chosen locations along each transect within the study plot. At each location, 4 sediment cores were obtained to a depth of 5cm using a 5 cm diameter coring device. Samples were sieved to identify any below-ground vegetative propagules. Composited sediment samples were then incubated in a growth chamber at 30 ˚C and 100 uE m^{-2} s^{-1}. Appearance of seedlings was recorded throughout a three-month period.

Results

During initial surveys in October 1997 and May 1998, there was no submerged aquatic vegetation (SAV) present at the study site. In October 1998, small *V. americana* plants (< 0.05 m) were observed within near-shore areas, extending predominantly 2 – 16 m from shore, and at low occurrence (8%). Bed length and percent occurrence increased concomitantly over a year and a half to maximum values (93 m and 89%, respectively) primarily through rhizomal expansion. Mean shoot length remained small (< 0.05 m) during the first year. Mean shoot length then doubled (0.05 m vs. 0.10 m) at nineteen months after bed reestablishment and then quadrupled (0.10 m vs. 0.45 m) within a seven month period thereafter. *V. americana* produced fruits each seasonal survey starting in spring 2000 through spring 2002 with the exception of fall 2001 and winter 2002. Bi-weekly water quality data collected at the site showed water color ranged from 800 CPU (March 1998) to 40 CPU (June 2001). A significant correlation between *V. americana* percent occurrence and decreasing color values (r_s= - 0.952, p = 0.0117) from 1998 through 2001 was found. By June 2003, the site was again denuded, corresponding to a return to normal precipitation patterns and increasing light attenuation due to high color. As water color declined, corresponding to drought conditions in 2005, *V. americana* reemerged in the bed as it did in 1998. These early stages of recolonization were clearly via seed germination as some seedlings still had the seed coat attached to the tip of the leaf blade. Seedlings at this stage had blade dimensions of approximately 0.02 m x 0.002 m (blade length x blade width). The same pattern of bed colonization through rhizomal expansion was observed as in the first resurgence. Mean density of viable *V. americana* seeds in the sediment was 356.2 m^{-2} ± 1209.2 m^{-2} (mean ± stdev). *V. americana* seedlings emerged from only three of the fifteen core samples. Total seedling density was 390.2 m^{-2} ± 1202.6. Charophyte density was 33.9 m^{-2} ± 101.6.

Conclusions

Reestablishment at the site occurred first by germination of seeds and then primarily by rhizomal expansion while maintaining a low shoot height. This pattern of growth has been seen in other sections of the LSJR during recovery. *V. americana* appears to initially allocate resources to lateral expansion throughout the bed, possibly to reduce interspecific competition and to increase access to resources. This is an important method of colonization for southern populations, and this species in general. Tuber production has not been noted in southern populations in which *V. americana* grows (Dawes and Lawrence 1989, personal observation) and while other species are capable of establishment in a new location by rooting of above-ground tissue, the leaves and reduced stem of *V. americana* do not act as propagules. *V. americana* colonization is limited to export of whole plants (Capers 2003) or seeds. Within-bed recolonization is limited to emergence from roots (Boustany et al. 2001) or through seed germination and then through rhizomal expansion. Through this study it was also possible to document that *in situ* seeds were still viable up to 32 months.

References

Boustany, R.G., Michot, T.C., Moss, R.F. (2001). Interactive effect of variable light and salinity on biomass and growth of *Vallisneria americana* in Lower St. Johns River, FL, USA. Final Report to the St. Johns River Water Management District, Palatka, Florida.

Capers, R.S. (2003). Macrophyte colonization in a freshwater tidal wetland (Lyme, CT, USA). *Aquatic Botany* 77:325-338.

Dawes, C.J., Lawrence, J.M. (1989). Allocation of energy resources in the freshwater angiosperms *Vallisneria americana* MICHX. and *Potamogeton pectinatus* L. in Florida. *Florida Scientist* 52: 58-63.

NOTES

LIGHT REQUIREMENTS OF FOUR SPECIES OF NATIVE SUBMERGED MACROPHYTES OCCURRING IN FLORIDA LAKES

Margaret S. Hopson-Fernandes[1], *Edward J. Phlips*[2], *Ben Koopman*[3], *and Carlos A. Fernandes*[4]

[1]Hillsborough Community College, Math & Sciences Division, 4001 Tampa Bay Blvd., Tampa, FL, 33614, (813) 253-7023, mhopsonfernandes@hccfl.edu
[2]University of Florida, Department of Fisheries and Aquatic Sciences, 7922 NW 71st St., P.O. Box 11060, Gainesville, FL 32653, (352) 392-9617 ext 248, phlips@ufl.edu
[3] University of Florida, Department of Environmental Engineering Sciences, 217 Black Hall, P.O. Box 116450, Gainesville, FL 32611-6450, bkoop@ufl.edu
[4]Hillsborough County Mosquito and Aquatic Weed Control, 4220 Tampa Bay Blvd., Tampa, FL 33614, (813) 554-5029, fernandesc@hillsboroughcounty.org

Introduction

Light is one of the most significant factors controlling macrophyte production in aquatic systems. Submerged macrophytes are shade plants that are adapted for survival in the highly variable underwater light environment. A review of the literature indicated considerable variation in photosynthetic capacity and light compensation points among submerged macrophyte species.

The purpose of this study was to investigate the photosynthetic photon flux density (PPFD) (µmol photons m^{-2} s^{-1}) at the sediment-water interface required for the survival and growth of vegetative propagules of four native submerged macrophyte species, *Najas guadalupensis*, *Potamogeton illinoensis*, *Vallisneria americana* and *Chara* sp. The selected species exhibit a variety of morphometries and life histories and are found commonly occurring throughout Florida. We predicted that all study species would grow at light levels of less than or equal to 3% incident irradiance at the sediment-water interface and that *V. americana* would exhibit the greatest capability for growth in low levels of light.

Materials and Methods

Shade cloth was used to establish four light treatment groups in an outdoor growth tank in south Florida. Shade cloth was used in differing numbers of layers to adjust experimental light levels from approximately 1% to 27% full sun at the air-water interface below the treatment groups. Immature vegetative propagules in a state of active physiological growth were selected for study. The experiment was repeated over three culture periods: 27 April to 14 July 2002, 21 April to 7 June 2003 and 28 June to 2 August 2003. Experiment 1 was a random design with four light treatments with three replicates per plant species per treatment. Experiments 2 and 3 were complete randomized block designs with $n = 9$ pots per plant species per light level. All macrophyte biomass data were statistically analyzed using GLM procedures (SAS Institute, Inc. 1999-2001). Significant means ($P \leq 0.05$) were separated using Tukey's HSD Test. Regression analysis was used to investigate the relationship between PPFD and macrophyte biomass. PPFD for no net growth was calculated using a modification of Equation 16.30 developed by Zar (1996) as presented in Grimshaw et. al.(2002).

Results and Discussion

The minimum PPFD at the sediment-water interface for no net growth of propagules ranged from 1.2 to 2.4% incident irradiance (10 to 140.1µmol photons m^{-2} s^{-1}). *Chara sp.* required the least PPFD for growth. All angiosperms exhibited the greatest growth capacity at low light levels during the spring culture periods. Minimum PPFD was measured for *Chara sp*. during the summer growth period. Spencer and Bowes (1990) determined that light saturation for photosynthesis ranges from 10-50% full sunlight. Several studies including Bowes et al. (1977) and Moeller (1980) determined that light compensation points (LCP) often occur at 1-3% full sunlight. A review of the literature indicates that minimum light requirements are species-specific and are affected by the length of the growing season (see Table 1).

Table 1: Selected field observations and experimental conclusions concerning the light requirements of several species of submersed macrophytes.

Observed an inter-specific variation in LCP's among four species of SAV ranging from 55 μmole photons m^{-2} s^{-1} to 15 μmole photons m^{-2} s^{-1}	VAN ET AL. 1976. Effects of light quality on growth and chlorophyll composition in *Hydrilla verticillata*. J.Aquat. Plant Manage. 15:29-31.
Estimated that an average midday irradiance of at least 250 μmole photons m^{-2} s^{-1} would be necessary for seed production	AGAMI and AGAMI 1980.
Estimated that the light level that determined the lower depth limit of plant colonization could be as much as 21% of surface light	CHAMBERS and KALFF 1987. Light and nutrients in the control of aquatic plant community structure. I. *In situ* observations. J. Ecol. 75:611-619.
Estimated that *Potamogeton perfoliatus* required > 11% of ambient irradiance for survival	GOLDSBOROUGH and KEMP. 1988. Light Responses of a Submersed Macrophyte: Implications for Survival in Turbid Waters. Ecology. 69: 1775-1786.
Observed that an average of 100 umol*m^{-2}*s^{-1} was necessary at the sediment-water interface for submersed macrophytes to survive in the tidal Potomac River	CARTER and RYBICKI. 1990. Light attenuation and submersed macrophyte distribution in the tidal Potamac River and Estuary. Estuaries 13:441-442.
Estimated that 7% of surface light or 505 mol*m^{-2} per year was needed for rooted aquatic plants to grow.	SAND-JENSEN and MADSEN. 1991. Minimum light requirements of submerged freshwater macrophytes in laboratory growth experiments. J. Ecol. 79:749-764.
Concluded that the light requirements for submersed plant growth vary widely and few of these [studies] have distinguished between requirements for plant survival and plant reproduction.	KIMBER et. al. 1995. Light availability and growth of wildcelery (*Vallisneria americana*) in upper Mississippi River backwaters. Regulated Rivers: Research and Management 11:167-174.
Determined that the PPFD for no net growth of *Vallisneria americana*, measured approximately a quarter meter from the sediment surface, was 29 μmole photons m^{-2} s^{-1} or 4.09% surface irradiance.	GRIMSHAW et. al. 2002. The effects of shading on morphometric and meristic characteristics of Wild Celery, *Vallisneria americana* MICHX., transplants from Lake Okeechobee, Florida. Arch. Hydrobiol. 155:65-81.
Calculated the minimum PPFD at the sediment-water interface for no net growth of propagules of *N. guadalupensis* was 17.5 μmole photons m^{-2} s^{-1} or 2.3% incident irradiance, for *P. illinoensis* was 18.6 μmole photons m^{-2} s^{-1} or 2.4% incident irradiance, for *V. americana* was 18.7μmole photons m^{-2} s^{-1} or 2.4% incident irradiance and for *Chara* sp. was 10 μmole photons m^{-2} s^{-1} or 1.2% incident irradiance.	THIS STUDY

In conclusion, native submerged macrophyte species vary considerably in minimum light requirement for growth and survival. These findings have significant ecological implications for submerged macrophyte communities. We believe that the results of this study will be of value to lake managers for use in the development of a more systematic approach to the establishment of diverse communities of desirable native species in restored systems.

<u>References</u>:

Contact Margaret Hopson-Fernandes for additional citation information.

PERIPHYTON COMMUNITY-HOST ASSOCIATIONS AND NUTRIENT STORAGE FOLLOWING LAKE STAGE FLUCTUATIONS IN SUBTROPICAL LAKE OKEECHOBEE, USA

Andrew J. Rodusky

Lake Okeechobee Division, South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, FL 33406, USA (phone: 561-686-8800, fax: 561-681-6310, email: arodusk@sfwmd.gov)

Periphyton biomass, community structure, nutrient content and host submerged and emergent plant taxa were monitored on a quarterly basis between August 2002 and January 2006 in the nearshore region of Lake Okeechobee. Lake stage generally was high ($\geq$ 4.5 m msl) but fluctuated during the study. All monitored submerged aquatic vegetation (SAV) beds disappeared after the passage of Hurricanes Frances and Jeanne, and *Hydrilla* was only present during 29% of the quarters. All host macrophyte and *Chara* biomass were seasonally variable and the highest periphyton biovolumes coincided with the highest mean annual areal SAV coverage. Periphyton assemblages were most separated by substrate and then season. Both epiphytic and epipelic biomass were seasonally and spatially variable ($p<0.05$), generally highest during the summer, and comprised mostly of diatoms. Epiphytic nutrient content within each host group was seasonally variable except for total carbon (TC) and total nitrogen (TN) in the *Vallisneria*-associated assemblages. In the epipelic communities, nutrient content was spatially and seasonally variable, though only marginally so for TN on a seasonal basis. Nutrient storage was always highest in epipelon and lowest in epiphytes on *Scirpus* and *Vallisneria*. Mean nearshore epiphytic total phosphorus (TP) storage (3 MT) underestimated total TP storage since *Chara*, epipelon and *Hydrilla* TP storage were not included. Periphyton TP storage capacity may become more important if the lake is managed within a lower stage envelope allowing for greater light penetration and if SAV and emergent plants regularly meet or exceed their annual coverage goals.

NOTES

PRESENTING AUTHORS CONTACT INFORMATION

CONTACT INFORMATION FOR PRESENTING AUTHORS

2008 FLMS/NALMS SE CONFERENCE

NAME	**AFFILIATION / ADDRESS**	**PHONE**	**E-MAIL**
Bigham, Dana L.	University of Florida, IFAS Gainesville, FL 32611	352-392-9617 ext. 228	dlbigham@ufl.edu
Brandt-Williams, Sherry	St. Johns River Water Management District 4049 Reid Street, Palatka, FL 32177	386-329-4292	sbrandt@sjrwmd.com
Brunty, Jennifer	Southwest Florida Water Management District Sarasota Regulation 6750 Fruitville Rd., Sarasota, FL 34240	941-377-3722 ext. 6571	Jennifer.brunty@swfwmd.state.fl.us
Bunch, A. J.	University of Florida. 7922 NW 71st St., Gainesville, FL 32653	352-392-9617	ajbunch@ufl.edu
Campbell, Kym Rouse	Biological Research Associates, a Division of ENTRIX, Inc. 3905 Crescent Park Drive, Riverview, FL 33578	813-664-4500	kcampbell@biologicalresearch.com
Copley, Rhonda L.	President Praxis Software, Inc. 4700 Millenia Blvd. Suite 175 Orlando, FL 32839	407-903-9970	Rhonda@praxsoft.com
Danek, Larry J.	Environmental Consulting & Technology, Inc., Gainesville, Florida		
Darby, Philip C.	Dept. of Biology University of West Florida 11000 University Parkway, Pensacola, FL 32514	850-474-2647	pdarby@uwf.edu
DeMaria, Annette	Staff Engineer, Environmental Consulting & Technology, Inc 44315 Groesbeck Highway Clinton Township, MI 48036	586-465-2583	ademaria@ectinc.com
Di, Jian J.	Water Resources Department St. Johns River Water Management District, Palatka, FL 32178-1429	386-329-4453	jdi@sjrwmd.com
Dickey, R. Jason	Water Resources Analyst Biological Research Associates 2420 W Lakeshore Drive Ste. 100 Tallahassee, FL 32312	850-681-9700	jdickey@biologicalresearch.com
Dierberg, Forrest E.	DB Environmental, Inc. 365 Gus Hipp Blvd., Rockledge, FL 32955	321-639-4896	woody@dbenv.com
Donnelly, Karen	South Florida Water Management District 3301 Gun Club Road, West Palm Beach FL 33416	561-681-2500 ext. 4568	kdonnell@sfwmd.gov
Eilers, D.	USF-FCCDR, 3650 4202 E. Fowler Ave., HMS 301, Tampa FL 33620	813-974-1068	
Foerste, Eleanor C.	UF/IFAS Osceola County Extension 1921 Kissimmee Valley Lane Kissimmee, FL 34744	321-697-3000	efoe@osceola.org
Ford, Clell	Highlands County Natural Resources Department 4505 George Blvd., Sebring, FL 33875-5837	863-402-6545	cford@hcbcc.org
Frazier, William	Manager Water Quality Lab and Pretreatment Public Services Department City of High Point, NC	336-883-3415	bill.frazier@highpointnc.gov
Fulton, Rolland	St. Johns River Water Management District P.O.Box 1429, Palatka, FL 32178	386-329-4361	rfulton@sjrwmd.com

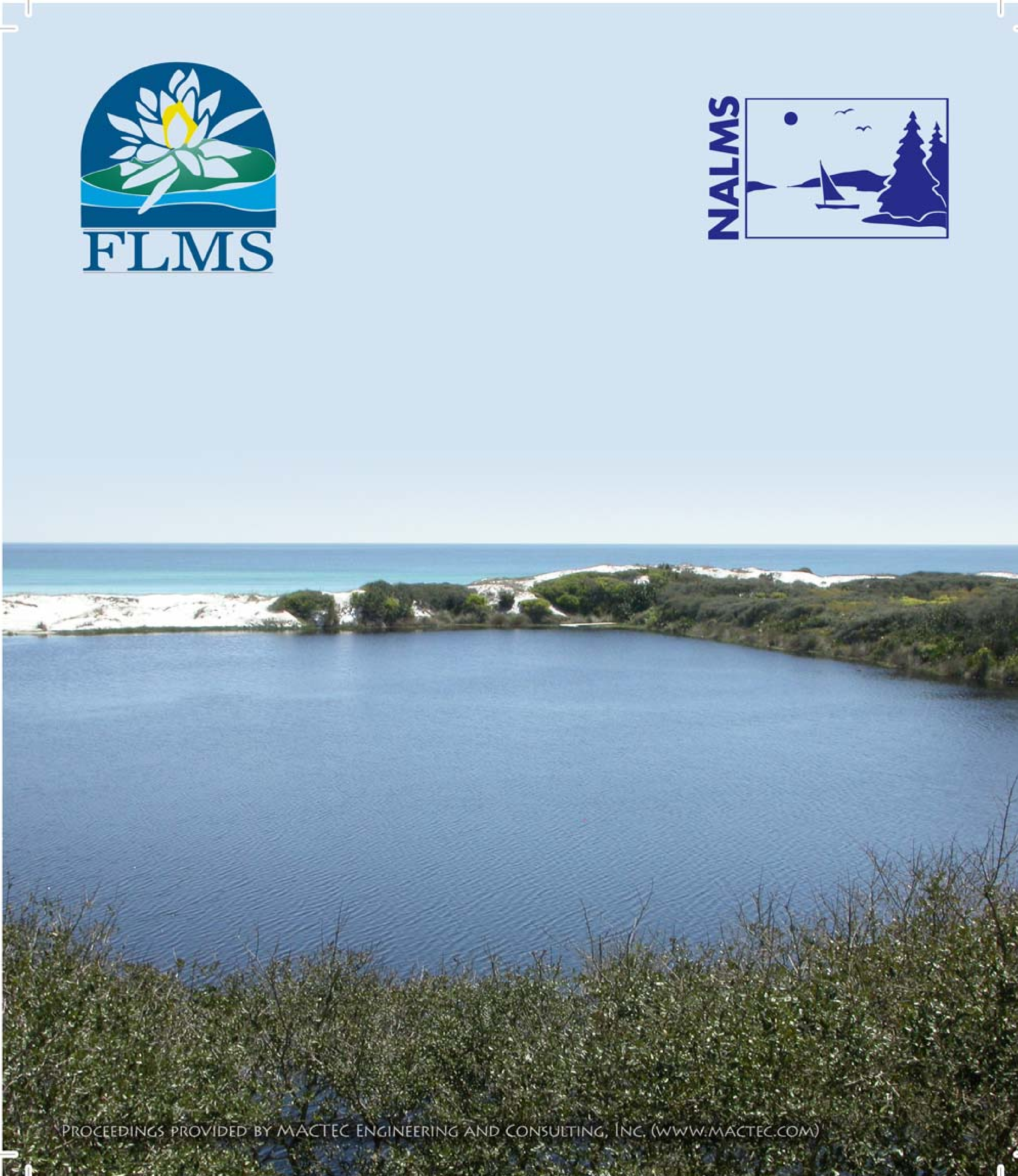
NAME	AFFILIATION / ADDRESS	PHONE	E-MAIL
Godfrey, Robert,	Gannet-Fleming: GeoDecisions Tampa, FL		rgodfrey@sjrwmd.com
Griffin, Jim	Florida Center for Community Design + Research School of Architecture and Community Design University of South Florida 4202 E. Fowler Ave., HMS 301 Tampa FL 33620	813-974-1068	griffin@arch.usf.edu
Hammers, H. R.	MACTEC Engineering & Consulting Inc. 404 SW 140th Terrace, Newberry, FL 32669	352-332-3318	hrhammers@mactec.com
Harding, Aaron J.	Biological Research Associates, a Division of ENTRIX, Inc. 2420 W. Lakeshore Drive, Suite 100 Tallahassee, FL 32312	850-681-9700	aharding@biologicalresearch.com
Harley, G.L.	USF-FCCDR 3650 4202 E. Fowler Ave., HMS 301 Tampa FL 33620	813-974-1068	Harley@arch.usf.edu
Harper, Harvey H.	Environmental Research & Design, Inc. 3419 Trentwood Blvd., Suite 102 Orlando, FL 32812	407-855-9465	hharper@erd.org
Hauser, Gary E.	Loginetics, Inc., 6009 Mont Richer Avenue, Knoxville, TN 37918	865-688-8401	gehauser@loginetics.com
Henning, Jon M.	U.S. Fish and Wildlife Service, 1601 Balboa Ave, Panama City, Florida 32405	850-769-0552 x238	Jon_Hemming@fws.gov
Higman, John C.	St. Johns River Water Management District P.O.Box 1429, Palatka, FL 32178	386-329-4385	jhigman@sjrwmd.com
Hill, Michael J.	Florida Fish and Wildlife Conservation Commission 1338 Avondale Way, Tallahassee, FL 32317	850-251-8919	Michael.hill@myfwc.com
Hodges, Michael	President & CEO, Genesis Fluid Solutions, 6660 Delmonico Drive, Suite 242-D, Colorado Springs, CO 80919	719-332-7447	
Hopson-Fernandes, Margaret S.	Hillsborough Community College, Math & Sciences Division, 4001 Tampa Bay Blvd., Tampa, FL, 33614	813-253-7023	mhopsonfernandes@hccfl.edu
Jaggers, Bruce V.	Florida Fish and Wildlife Conservation Commission 601 W. Woodward Ave., Eustis FL 32726	352-742-6438	Bruce.jaggers@myfwc.com
Jarvis, B. M.	MACTEC Engineering and Consulting, Inc., 404 SW 140th Terrace, Newberry, FL 32669	352-332-3318	bmjarvis@mactec.com
Jawitz, J.W.	Soil and Water Science Department University of Florida 2169 McCarty Hall, Gainesville, FL 32611	352-392-1951 x 203	jawitz@ufl.edu
John, Chandy	BCI Engineers & Scientists, Inc., Lakeland, Florida 33803	863-667 2345	cjohn@bcieng.com
Johnson, Vic	Marketing Development Specialist Kemira Water Solutions,Inc 808 East Main Street, Lakeland,Fl 33801	256-668-4750	vic.johnson@kemira.com
Kalinoski, Sarah	Choctawhatchee Basin Alliance Okaloosa-Walton College 100 College Boulevard East, Niceville, FL 32578	850-729-6425	kalinoss@owc.edu
Keenan, Lawrence W.	St. Johns River Water Management District P.O. Box 1429, Palatka, FL 32178	386-329-4425	lkeenan@sjrwmd.com

NAME	AFFILIATION / ADDRESS	PHONE	E-MAIL
Kellogg, Jenney L.	University of Florida Department of Fisheries and Aquatic Sciences 7922 NW 71st Street Gainesville, Florida 32653	352-870-5793	jlk@ufl.edu
Leeper, Douglas A.	Southwest Florida Water Management District, Resource Projects Department 2379 Broad Street, Brooksville, Florida 34604	1-800-423-1476 or 352-796-7211, extension 4272	doug.leeper@swfwmd.state.fl.us
Lehmensiek, May	BCI, Lakeland, FL		mlehmensiek@sjrwmd.com
Lipparelli, Michael	Southeast US Regional Manager SolarBee, Inc. 42000 Mango Street, Eustis FL 32736	877-868-6713	Michael@SolarBee.com
Lumbard, Lance M.	Lake County Water Authority 107 N. Lake Ave., Tavares, FL 32778	352-343-3777 ext. 38	lancel@lcwa.org
Lundy, Earl	Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute De Leon Springs Field Office. 5450 U.S. Highway 17 De Leon Springs, FL 32130	386-985-7827	earl.lundy@myfwc.com
Malone, Susan B.	Tennessee Valley Authority, Aquatic Monitoring & Management, 1101 Market Street, Chattanooga, TN 37402	423-876-4179	smalone@tva.gov
Marzolf, Erich R.	Water Resources Department St. Johns River Water Management District Palatka, FL 32178	386-329-4831	emarzolf@sjrwmd.com
McCann, Kevin D.	Stormwater Assistant Division Manager City of Orlando- Public Works Department Stormwater Utility Division 1030 South Woods Avenue, Orlando, FL 32805	407-246-2234 ext. 34	Kevin.McCann@cityoforlando.net
McCarta, Erin M.	Highlands County Natural Resources 4505 George Blvd., Sebring, FL 33875	863-402-6545	emccarta@hcbcc.org
McCormick, Paul V.	Lake Okeechobee Division South Florida Water Management District 3301 Gun Club Rd West Palm Beach, FL 33406	561-682-2866	pmccormi@sfwmd.gov
McDowell, Alison	Choctawhatchee Basin Alliance 100 College Boulevard Niceville, FL 32578	850 729-6423	Mcdowel2@owc.edu
McKinney, Robbie	Environmental Scientist-Biologist Water Resources Department Suwannee River Water Management District 9225 County Road 49 Live Oak, FL 32060	386-362-1001	rlm@srwmd.org
Medley, Gene	BCI Engineers & Scientists 1232 W. Indiantown Road, Suite 107 Jupiter, Florida 33458	561-741-8838	gmedley@bcieng.com
Miller, Steven J.	Water Resources Department St. Johns River Water Management District Palatka, FL 32178	386-329-4387	sjmiller@sjrwmd.com
Mobley, Mark H.	Mobley Engineering, Inc., 30 Hickory Trail, Norris, TN 37828	865-494-0600	mark@mobleyengineering.com
Otto, Douglas C. Jr.	Chief, Hydrology and Hydraulics Branch, Mobile District, U.S. Army Corps of Engineers, 109 St. Joseph Street, Mobile, Alabama, 36602	251-690-2718	douglas.c.otto.jr@sam.usace.army.mi l

NAME	AFFILIATION / ADDRESS	PHONE	E-MAIL
Pierce, Rachael L.	South Florida Water Management District, 1480-9 Skees Rd. West Palm Beach, FL 33411	561-681-2500 x4570	rapierce@sfwmd.gov
Pitts, Russell	Lake Lure Marine Commission, P.O. Box 127, Lake Lure, NC, 28746	828-625-8823	russellpitts@bellsouth.net
Pluchino, Marianne P.	Seminole County - Stormwater Senior Environmental Scientist 520 W. Lake Mary Boulevard, Suite 103 Sanford, FL 32733	407-665-5668	mpluchino@seminolecountyfl.gov
Rodusky, Andrew J.	South Florida Water Management District Lake Okeechobee Division 3301 Gun Club Road West Palm Beach, FL 33406	561-686-8800	arodusk@sfwmd.gov
Ruane, Richard J.	Reservoir Environmental Management, Inc, 900-5 Vine Street, Chattanooga, TN 37403	423-265-5820	jim@chatt.net
Sagan, Jennifer J.	BCI Engineers & Scientists, Inc. 2000 E. Edgewood Dr. Suite 215, Lakeland, FL	386-937-3922	jsagan@bcieng.com
Sawyer, Andy	Reservoir Environmental Management, Inc., 900-5 Vine Street, Chattanooga, TN 37403	423-304-6572	remi@chatt.net
Scinto, Leonard J.	Southeast Environmental Research Center, Florida International University (SERC/FIU), 11200 SW 8th Street, Miami, FL 33199	305-348-1965	scintol@fiu.edu
Stambaugh, Whitney	Natural Resources Department ENSR 9700 16st St N, St. Petersburg, FL 32716	727-577-5430 ex 58	wstambaugh@ensr.aecom.com
Stone, Samuel S.	Environmental Affairs Coordinator, Peace River / Manasota Regional Water Supply Authority, 8998 SW County Road 769, Arcadia, FL 34269	863-993-4565	sspeariv@hughes.net
Terrell, Julia B.	Director Choctawhatchee Basin Alliance Okaloosa-Walton College 100 College Boulevard, East Niceville, FL 32578	850-729-6422	terrellj@owc.edu
Tomasko, D. A.	PBS&J 5300 W. Cypress St., Tampa, FL 33607	813-281-8346	DATomasko@pbsj.com
Wagner, Ken	ENSR P.O. Box 506, Willington, CT 06279	860-429-5323	kwagner@ensr.aecom.com
Welch, Gene	Tetra Tech, Inc. 1420 5th Ave., Suite550, Seattle, WA 98101	206 728 9655	gene.welch@tetratech.com
Wellendorf, Nia	Florida Department of Environmental Protection Biology Section, MS 6515 2600 Blairstone Rd. Tallahassee, FL 32399	850-245-8190	Nijole.Wellendorf@dep.state.fl.us
Wiggins, Barbara	Wiggins Environmental Services, PO Box 18944, Asheville, NC, 28814	828-254-5644	bswiggins@bellsouth.net

FLMS

NALMS



Proceedings provided by MACTEC Engineering and Consulting, Inc. (www.mactec.com)