



**Twelfth Annual
Conference
May 21-24, 2001
Tallahassee, Florida**



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

Florida Lake Management Society 2001

Twelfth Annual Conference Planning Committee



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Florida Lake Management Society Proceedings

Table of Contents

[Note: This file was recreated from original documents for publication on the FLMS website, the table of contents was not updated so page numbers may be slightly different from what is listed below.]

Final Conference Program -----	1 - 8
--------------------------------	-------

Workshop Program Session 1

Track 1 – Topics of Interest for Citizens, Volunteers and Professionals

Okeehoopkee, An Introduction to the Disappearing Waters, or the Karst Lakes of Leon County - Sean McGlynn, McGlynn Laboratories -----	11 - 12
Biological Control of Aquatic Weeds – Charles O’Brien, Florida A&M University -----	13
Involving K-12 Teachers and Students in Monitoring Water Quality Paul Ruscher, Florida State University -----	13 - 14
Track 2 – Stormwater BMPs - Harvey Harper, Environmental Research & Design, Inc. -----	14
Track 3 – STORET Training – Patrick Detscher, Linda Clemens, Ray Malloy & Gerold Morrison, DEP -----	15
Track 4 - Aquatic Plant Identification – Kathy Burks, DEP -----	16

Workshop Session 2

Track 1 – Volunteer Monitoring Programs: Current Status in Florida Julie Terrell, Florida LAKEWATCH -----	19
Track 2 – Sediment & Erosion Control - Dan Dewiest ,DEP Wayne Toothman and Tom Ballentine, Leon County -----	19
Track 3 – Changes in Florida’s Quality Assurance Program for Sample Collection and Laboratory Analysis – Michael Blizzard, DEP -----	20
Track 4 - Bioassessment Training for the Lake Condition Index Julie Riley, Lori Wolfe & Ashley O’Neal – DEP -----	20

Workshop Session 3

Track 1 – Volunteer Monitoring Programs: Current Status in Florida Julie Terrell, Florida LAKEWATCH -----	23
Track 2 – National Pollutant Discharge Elimination System	
Privatization of Florida’s NPDES Stormwater Program - Michael Bateman, Berryman & Henigar -----	23 - 24
Strategies for Implementing NPDES Phase II Stormwater Management Techniques Timothy Kelly and Walter Reigner, BCI Engineers & Scientists, Inc. -----	25

Track 3 – Environmental Statistics - Harvey Harper, Environmental Research & Design, Inc. -----	25
 Track 4 – Characterization of Algae Blooms	
Chlorophyll and Other Means of Algae Identification – Sean McGlynn, McGlynn Laboratories, Inc. -----	26 - 27
QA & QC for Algal IDs - Elizabeth Miller, DEP -----	28
Advantages and Limitations of Measuring Chlorophyll in Environmental Water using <i>In Vivo</i> Fluorescence - Ron Chandler, YSI -----	28
 Workshop Session 4	
Track 1 – Aquascaping for Improved Water Quality and Habitat -Kevin Songer, Environmental Management Systems and Geoff Brown, University of Florida Extension -----	31
Track 2 – Hands-on Opportunity to Learn More About the GLOBE Program for Teaching Scientific Skills to K-12 Students - Paul Ruscher, Florida State University -----	31
 Citizen Session - Conserving Our Area Lakes through This Decade and Beyond	
Local Lake Management Issues, Actions and Needs - Curtis Watkins, City of Tallahassee -----	35
A Statistical Analysis of Water Quality Data for the Lakes of Leon County Craig Diamond, Leon County -----	35 -36
Lake Hall: The Cleanest Lake in Leon County – Thomas Deck, McGlynn Laboratories, Inc. -----	36
 Plenary Program Session 1 - Florida Springs	
Florida Springs: Past, Present and Future – James A. Stevenson, DEP -----	39
Impacts From Groundwater Demands upon Spring Flows to the Wekiva River ----- Brian McGurk, SJRWMD	40 - 41
Nitrate-Nitrogen in the Suwannee River – H. David Hornsby, SRWMD -----	42
Examination and Prediction of Nitrate Loading and Response in the Surface Water/Ground Water System in the Lower St. Marks/Wakulla Rivers - Angela R. Chelette, NFWFMD -----	43
 Plenary Program Session 2 - Karst Influences on Lakes	
Characterizing Interactions between Groundwater & Surface Water in Mantled Karst Using Chemical & Isotopic Tracers – Brian Katz, US Geological Survey -----	47
Long Term Response of Sinkhole Lakes to Stormwater Runoff: Blue-green Algae Blooms and Deterioration of Secondary Production in Lake Jackson - R. J. Livingston, Florida State University -----	48 - 49
The Disappearance of Lake Jackson, A Karst Basin Lake Tom Scott, Florida Geological Survey -----	50 - 51
Modeling the Hydrodynamics of Karstic Closed Lake Systems, Lake Jackson Will Evans, Florida Geological Survey -----	52

Two Rivers, The Karst Lakes of Leon County, and the Floridan Aquifer, Water Quality Dynamics in Times of Drought – Sean E. McGlynn, McGlynn Lab -----	53 - 54
Poster Session 1 - A Remote Sensing and GIS Study of Long Term Water Mass Balance of Lake Jackson - Stephen Kish, Florida State University -----	55
Plenary Program Session 3 – Policy and Science Updates for a Variety of Critical Environmental Issues	
The Relationship between the Flow Regime of the Apalachicola River and Management of Reservoirs in the Entire Watershed – Steve Leitman, NFWMD -----	59
Interstate Issues Regarding Water Quality in the Ochlockonee River - Kevin Pope, Leon County -----	60 - 61
Mercury in Florida’s Environment – Tom Atkeson, DEP -----	62
The Everglades Forever Act: An Environmental Success Story - Frank Nearhoof, DEP -----	63 - 64
Policy Issues Associated with the Restoration of Lake Okeechobee - Jerry Brooks, DEP -----	65
Plenary Program Session 4 – Lake Okeechobee	
Potential for SAV Recovery in Lake Okeechobee After Years of High Lake Stage and Hurricane Irene – Matthew C. Harwell, SFWMD -----	69
The Effects of Shading on Morphometric and Meristic Characteristics of Wild Celery, <i>Vallisneria americana</i> , Transplants from Lake Okeechobee - Jim Grimshaw, SFWMD -----	70
Integrating GIS and GPS to Create a High Resolution Map of Submerged Aquatic Vegetation, Lake Okeechobee – Mark Brady, SFWMD -----	71
The Influence of a Lake Drawdown on <i>Chara</i> Abundance in Lake Okeechobee Andy J. Rodusky, SFWMD -----	72
Nutrient Enrichment and Light Gradient Bioassays as a Technique for Assessing Spatial and Temporal Distribution of Limiting Factors Affecting Phytoplankton Growth in Lake Okeechobee Bruce Sharfstein, SFWMD -----	73
Plenary Program Session 5 – Aquatic Plant Management	
Status of the Aquatic Plant Maintenance Program In Florida Public Waters - Judy Ludlow, DEP -----	77
Nutrient Dynamics Associated with Aquatic Plant Management in Lake Istokpoga Jennifer Brunty, Highlands County SWCD-----	78
Using Prescribed Fire for Aquatic Plant Management in Florida - Matthew V. Phillips, DEP -----	79
Post-Burn Assessment of Bald Cypress (<i>Taxodium distichum</i>) on Lake Miccosukee Jess M. Van Dyke, DEP -----	80
Torpedograss (<i>Panicum repens</i>) Management in Lake Okeechobee - Chuck Hanlon, SFWMD -----	81

Plenary Program Session 6 – Macrophytes and Macroinvertebrates as Biological Indicators of Water Quality and Ecosystem Health

Bioassessment of Lakes Using a Systematic Visual Survey of Macrophytes Russ Frydenborg, DEP -----	85
Trophic State Indicators and Plant Biomass in Florida Lakes Roger Bachmann, University of Florida -----	86
High Resolution Gas Chromatography (HRGC) Method for the Analysis of Some Widely Used Chlorinated Pesticides and PCBs in Plant Tissues - Rao Kode, DEP -----	87 - 88
Aquatic Insects of Florida and Water Quality – Manuel L. Pesacador, Florida A & M University -----	89
Macroinvertebrate Community Structure and Response to Marsh Dry-out in a Subtropical Constructed Wetland – Michelle Lajti, SFWMD -----	90
Poster Session 2: Blue Green Algal Exposure, Drinking Water and Primary Liver Cancer John Burns, Cyanolab – Presenting for Lora Fleming, University of Miami -----	91

Plenary Program Session 7 – Phosphorus

Influence of Dry Out and Re-flooding of Organic Soils on Phosphorus Retention within Wetland Mesocosms – Christy A. Combs, SFWMD -----	95 - 96
Comparison of Sediment Accretion and Phosphorus Storage Between Stormwater Treatment Area 1 West (STA – 1W) Cell 1 and the STA – 1W Test Cells - Jana Newman, SFWMD -----	97 - 98
Phosphorus Binding in Nutrient Management and Nutrient Interception Christopher B. Lind, General Chemical Corporation -----	99
Management Implications of Revised Hydrologic and Nutrient Budgets for the Winter Park Chain-of-Lakes – Harvey H. Harper, Environmental Research and Design, Inc. -----	100
Nutrient Management of Nitrate Rich (Phosphorus Limited) Lakes on the Lake Wales Ridge Keith V. Kolasa, SWFWMD -----	101 - 102

Plenary Program Session 8 – Sediments

Historic Sedimentation of Mercury, Nitrogen and Phosphorus in Lake Barco William M. Landing, Florida State University -----	105 - 106
Recent Sediment History of Lake Jackson – J.F. Donoghue, Florida State University -----	107
Lake Carlton Sediment Pesticide Study – Kate Himel, DEP -----	108
Development and Use of Sediment Assessment Techniques in Freshwater Sediments of Florida Thomas L. Seal, DEP -----	109
Use of Liquefied Activated Carbon for Bio-digestion of Organic Lake Bottom Sediments Larry D. Madrid, Madrid Engineering Group, Inc. -----	110

Plenary Program Session 9 – Lake Restoration

The Application of Restoration Ecology to a Lake and Wetland Restoration Project James C. Griffin, SWFWMD -----	113 - 114
Management and Restoration Initiatives in the Sand Hill Lakes of Northwest Florida Paul Thorpe, NFWFMD -----	115 - 116
Selective Removal of Grass Carp from Lake Silver Using Rotenone Kevin D. McCann, City of Orlando -----	117
Restoring Lake Munson – Larry N. Schwartz, Camp, Dresser and McKee, Inc. -----	118
Preliminary Design for the Restoration of Lake Panasoffkee and Enhancement of Lake Restoration Efforts by Access Canal Dredging – Mohamed Alawi - Parsons, Brinckerhoff, Quade & Douglas ----	119 - 120

Plenary Program Session 10 – Habitat and Wildlife

Apalachicola River Low Water Study – Tom Frick, DEP -----	123
Investigations of Mortality and Reproductive Failure of Alligators in Lake Griffin James Perran Ross, Florida Museum of Natural History -----	124
A Wildlife Hybridization Problem in Florida: Feral Mallards and the Florida Mottled Duck Ronald R. Bielefeld, Florida Fish and Wildlife Commission -----	125
Population Structure, Abundance, and Community Composition of Turtles at Lake Jackson: Implications for Management and Lake Food Webs - Matthew J. Aresco, Florida State University	126 - 127
Effect of Dredging Lake Sediments on Populations of Aquatic Salamanders (<i>Amphiuma and Siren</i>) Margaret S. Gunzburger, Florida State University -----	128 - 129

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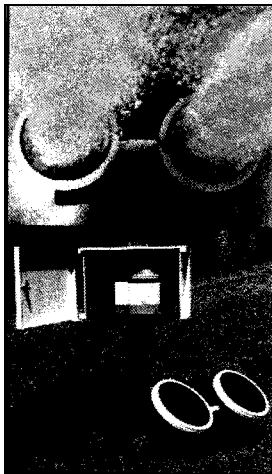


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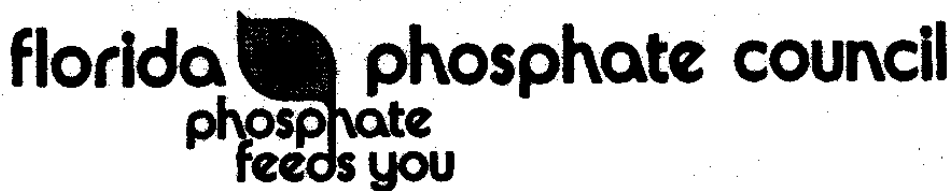
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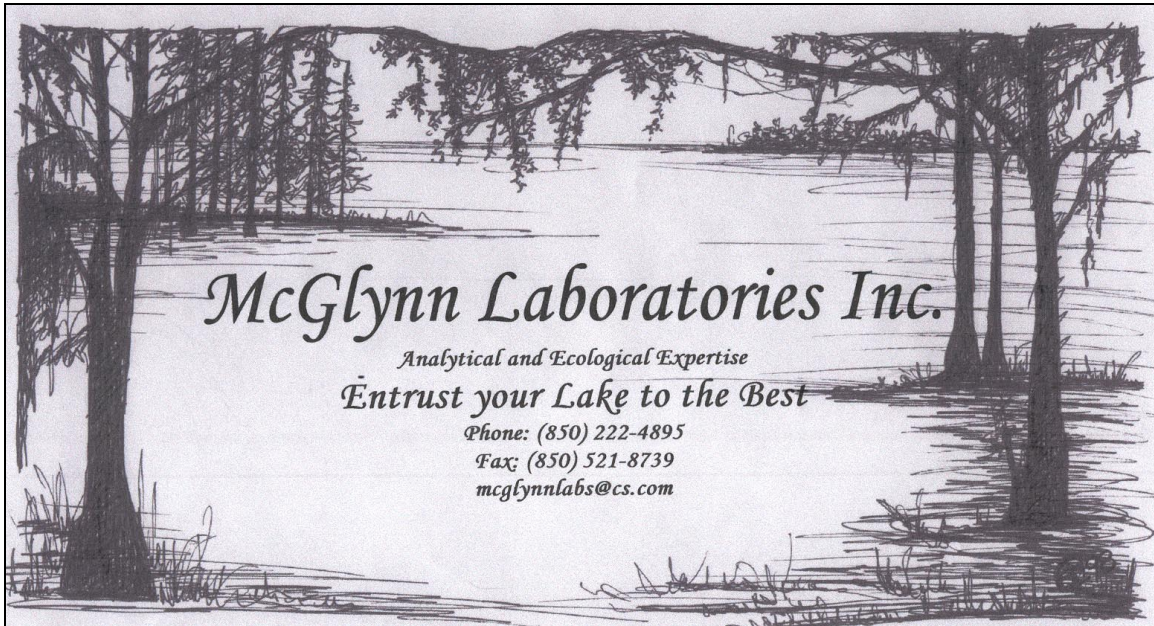
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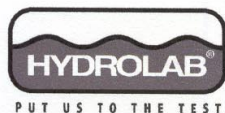
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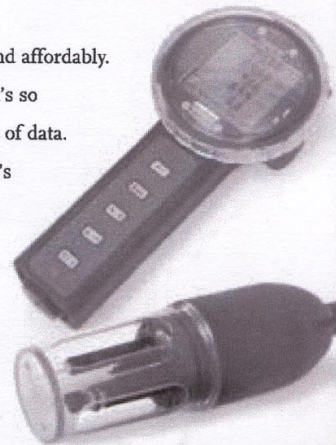
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Final Program
Florida Lake Management Society Twelfth Annual Conference
May 21-24, 2001 Tallahassee, Florida

Monday May 21

7:30 a.m. – 2:20 p.m. **Conference Registration** - Turnbull Center for Professional Development

7:30 a.m. – 8:30 a.m. **Breakfast** – Fireside Lounge Turnbull Center

Please note that separate registration is required for the workshops. The cost is \$35 for the entire day. All sessions, all tracks, breaks and lunch are included.

8:30 a.m. – 10:00 a.m. **Workshops (Session 1)** – Turnbull Center for Professional Development

Track 1 – Topics of Interest for Citizens, Volunteers and Professionals

Okeehoopkee, An Introduction To The Disappearing Waters, Or The Karst
Lakes Of Leon County - Sean McGlynn - McGlynn Laboratories

Biological Control of Aquatic Weeds – Charles O’Brien
Florida A&M University

Involving K-12 Teachers and Students in Monitoring Water Quality
Paul Ruscher – Florida State University

Track 2 – Stormwater BMPs - Harvey Harper - Environmental Research &
Design, Inc.

Track 3 – STORET Training – Patrick Detscher, Linda Clemens,
Ray Malloy & Gerold Morrison - DEP

Track 4 - Aquatic Plant Identification – Kathy Burks - DEP

10:00 a.m. – 10:20 a.m. **Break** – Fireside Lounge Turnbull Center (Refreshments Provided)

10:20 a.m. – 11:50 a.m. **Workshops (Session 2)** – Turnbull Center for Professional Development

Track 1 – Volunteer Monitoring Programs: Current Status in Florida
Coordinator: Julie Terrell - Florida LAKEWATCH

Track 2 – Sediment & Erosion Control - Dan Dewiest – DEP, Wayne Toothman
and
Tom Ballentine - Leon County

Track 3 – 10:20 a.m. – 11:00 a.m. STORET Training (cont. from session 1)

11:00 a.m. – 11:50 a.m. Changes in Florida’s Quality Assurance Program for
Sample Collection and Laboratory Analysis – Michael Blizzard - DEP

Track 4 - Bioassessment Training for the Lake Condition Index
Julie Riley, Lori Wolfe & Ashley O’Neal - DEP

11:50 a.m. - 12:50 p.m. **Lunch (Provided)** – Dining Room Turnbull Center

- 12:50 p.m. – 2:20 p.m. **Workshops (Session 3)** – Turnbull Center for Professional Development
- Track 1 – Volunteer Monitoring Programs: Current Status in Florida
Coordinator: Julie Terrell - Florida LAKEWATCH
- Track 2 – National Pollutant Discharge Elimination System
- Moderator: Phil Coram
- Privatization of Florida’s NPDES Stormwater Program - Michael Bateman Berryman & Henigar
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Timothy Kelly and Walter Reigner - BCI Engineers & Scientists
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- Track 4 – Characterization of Algae Blooms
- Moderator: Carlos Fernandez – Hillsborough County
- Chlorophyll and Other Means of Algae Identification – Sean McGlynn
McGlynn Laboratories, Inc.
- QA & QC for Algal IDs - Elizabeth Miller – DEP
- Advantages and Limitations of Measuring Chlorophyll in Environmental Water using *In Vivo* Fluorescence - Ron Chandler – YSI
- 2:20 p.m. – 2:50 p.m. **Break** – Fireside Lounge Turnbull Center (Refreshments Provided)
- Please note that Workshop Session 4 and the Citizen’s Session that follow run concurrent with the Field Trip and Dinner. You must choose between them.*
- 2:50 p.m. – 4:30 p.m. **Workshop (Session 4)** – Turnbull Center for Professional Development
- Track 1 – Aquascaping for Improved Water Quality and Habitat
Kevin Songer – Environmental Management Systems,
Geoff Brown - University of Florida Extension/Leon and Wakulla Counties
- Track 2 – Hands-on Opportunity to Learn More About the GLOBE Program for Teaching Scientific Skills to K-12 Students - Paul Ruscher - Florida State University
- 3:15 p.m. – 10:00 p.m. **Field Trip and Dinner** - Depart from Doubletree Hotel
Lake Munson, Karst Plain, Wakulla Springs (*Please note: Separate Registration Required - Cost is \$30.00*)
- 7:00 p.m. – 8:30 p.m. **Citizen Session - Conserving Our Area Lakes through This Decade and Beyond** (No Charge) Turnbull Center for Professional Development
- Moderator: Curtis Watkins - City of Tallahassee

Local Lake Management Issues, Actions and Needs - Curtis Watkins
City of Tallahassee

A Statistical Analysis of Water Quality Data for the Lakes of Leon County
Craig Diamond – Leon County

Lake Hall: The Cleanest Lake in Leon County – Thomas Deck
McGlynn Laboratories, Inc.

Tuesday May 22

7:30 a.m. - 4:50 p.m. **Conference Registration** - Turnbull Center for Professional Development

7:30 a.m. – 8:30 a.m. **Breakfast** – Exhibit Hall Turnbull Center

8:30 a.m. – 8:50 a.m. **Welcome and Opening Remarks**
Sean McGlynn (President of Northwest Florida Chapter FLMS, Conference Chairperson)
Pam Leasure (President of Florida Lake Management Society)
Honorable Dan Winchester (Chairman of Leon County Commission)

8:50 a.m. – 10:10 a.m. **Session 1 - Florida Springs**

Moderator: Honorable Bob Rackleff – Leon County Commission

Florida Springs: Past, Present and Future – James A. Stevenson – DEP

Impacts From Groundwater Demands upon Spring Flows to the Wekiva River
Brian McGurk – SJRWMD

Nitrate-Nitrogen in the Suwannee River – H. David Hornsby – SRWMD

Examination and Prediction of Nitrate Loading and Response in the Surface Water/Ground Water System in the Lower St. Marks/Wakulla Rivers
Angela R. Chelette – NFWMD

10:10 a.m. – 10:30 a.m. **Break** – Exhibit Hall Turnbull Center (Refreshments Provided)

10:30 a.m. – 12:10 p.m. **Session 2 - Karst Influences on Lakes**

Moderator: Tyler Macmillan - NFWMD

Characterizing Interactions between Groundwater & Surface Water in Mantled Karst Using Chemical & Isotopic Tracers – Brian Katz – US Geological Survey

Long Term Response of Sinkhole Lakes to Stormwater Runoff: Blue-green Algae Blooms and Deterioration of Secondary Production in Lake Jackson
R. J. Livingston – Florida State University

The Disappearance of Lake Jackson, A Karst Basin Lake -Tom Scott
Florida Geological Survey

Modeling the Hydrodynamics of Karstic Closed Lake Systems, Lake Jackson
Will Evans – Florida Geological Survey

- Two Rivers, The Karst Lakes of Leon County, and the Floridan Aquifer, Water Quality Dynamics in Times of Drought – Sean E. McGlynn – McGlynn Lab
- 12:10 p.m. – 1:10 p.m. **Lunch (Provided) – Florida Lake Management Society Business Meeting**
Dining Room Turnbull Center
- Poster Session 1** (Location to be Announced): A Remote Sensing and GIS Study of Long Term Water Mass Balance Of Lake Jackson - Stephen Kish - Florida State University
- 1:10 p.m. – 2:50 p.m. **Session 3 – Policy and Science Updates for a Variety of Critical Environmental Issues**
- Moderator: Sandy D'Alemberte - President of Florida State University
- The Relationship between the Flow Regime of the Apalachicola River and Management of Reservoirs in the Entire Watershed – Steve Leitman - NFWMD
- Interstate Issues Regarding Water Quality in the Ochlockonee River
Kevin Pope – Leon County
- Mercury in Florida's Environment – Tom Atkeson – DEP
- The Everglades Forever Act: An Environmental Success Story
Frank Nearhoof - DEP
- Policy Issues Associated with the Restoration of Lake Okeechobee
Jerry Brooks – DEP
- 2:50 p.m. – 3:10 p.m. **Break – Exhibit Hall Turnbull Center (Refreshments Provided)**
- 3:10 p.m. – 4:50 p.m. **Session 4 – Lake Okeechobee**
- Moderator: Chuck Hanlon – SFWMD
- Potential for SAV Recovery in Lake Okeechobee After Years of High Lake Stage and Hurricane Irene – Matthew C. Harwell – SFWMD
- The Effects of Shading on Morphometric and Meristic Characteristics of Wild Celery, *Vallisneria americana*, Transplants from Lake Okeechobee
Jim Grimshaw – SFWMD
- Integrating GIS and GPS to Create a High Resolution Map of Submerged Aquatic Vegetation, Lake Okeechobee – Mark Brady – SFWMD
- The Influence of a Lake Drawdown on *Chara* Abundance in Lake Okeechobee
Andy J. Rodusky – SFWMD
- Nutrient Enrichment and Light Gradient Bioassays as a Technique for Assessing Spatial and Temporal Distribution of Limiting Factors Affecting Phytoplankton Growth in Lake Okeechobee – Bruce Sharfstein – SFWMD
- 5:00 p.m. – 6:00 p.m. **Exhibitors Social – Exhibit Hall Turnbull Center (Refreshments Provided)**
- 9:00 p.m. – 12:00 p.m. **Hospitality Suite – Room (TBA) Doubletree Hotel**

Wednesday May 23

7:30 a.m. – 4:50 p.m. **Conference Registration** - Turnbull Center for Professional Development

7:30 a.m. – 8:20 a.m. **Breakfast** – Exhibit Hall Turnbull Center

8:20 a.m. – 8:30 a.m. **Announcements and Door Prize Drawings** (Must be present to win)

8:30 a.m. – 10:10 a.m. **Session 5 – Aquatic Plant Management**

Moderator: Don Hicks – Pinellas County

Status of the Aquatic Plant Maintenance Program In Florida Public Waters
Judy Ludlow – DEP

Nutrient Dynamics Associated with Aquatic Plant Management in Lake Istokpoga
Jennifer Brunty – Highlands County SWCD

Using Prescribed Fire for Aquatic Plant Management in Florida
Matthew V. Phillips – DEP

Post-Burn Assessment of Bald Cypress (*Taxodium distichum*) on Lake Miccosukee
Jess M. Van Dyke - DEP

Torpedograss (*Panicum repens*) Management in Lake Okeechobee
Chuck Hanlon - SFWMD

10:10 a.m. – 10:30 a.m. **Break** – Exhibit Hall Turnbull Center (Refreshments Provided)

10:30 a.m. – 12:10 p.m. **Session 6 – Macrophytes and Macroinvertebrates as Biological Indicators of Water Quality and Ecosystem Health**

Moderator: Ryan Maki - SFWMD

Bioassessment of Lakes Using a Systematic Visual Survey of Macrophytes
Russ Frydenborg – DEP

Trophic State Indicators and Plant Biomass in Florida Lakes
Roger Bachmann – University of Florida

High Resolution Gas Chromatography (HRGC) Method for the Analysis of Some Widely Used Chlorinated Pesticides and PCBs in Plant Tissues
Rao Kode - DEP

Aquatic Insects of Florida and Water Quality – Manuel L. Pesacador
Florida A & M University

Macroinvertebrate Community Structure and Response to Marsh Dry-out in a Subtropical Constructed Wetland – Michelle Lajti – SFWMD

12:10 p.m. – 1:10 p.m. **Lunch (Provided)** – Dining Room Turnbull Center

Poster Session 2 (Location to be Announced): Blue Green Algal Exposure,
Drinking Water and Primary Liver Cancer – John Burns – Cyanolab –
Presenting for Lora Fleming – University of Miami

1:10 p.m. – 2:50 p.m.

Session 7 – Phosphorus

Moderator: Kelli Hammer-Levy, Pinellas County

Influence of Dry Out and Re-flooding of Organic Soils on Phosphorus Retention
within Wetland Mesocosms – Christy A. Combs – SFWMD

Comparison of Sediment Accretion and Phosphorus Storage Between
Stormwater Treatment Area 1 West (STA – 1W) Cell 1 and the STA – 1W Test
Cells
Jana Newman – SFWMD

Phosphorus Binding in Nutrient Management and Nutrient Interception
Christopher B. Lind – General Chemical Corporation

Management Implications of Revised Hydrologic and Nutrient Budgets for the
Winter Park Chain-of-Lakes – Harvey H. Harper – Environmental Research and
Design, Inc.

Nutrient Management of Nitrate Rich (Phosphorus Limited) Lakes on the Lake
Wales Ridge – Keith V. Kolasa - SFWMD

2:50 p.m. – 3:10 p.m.

Break – Exhibit Hall Turnbull Center (Refreshments Provided)

3:10 p.m. – 4:50 p.m.

Session 8 – Sediments

Moderator: Sean P. McGlynn – Louisiana State University

Historic Sedimentation of Mercury, Nitrogen and Phosphorus in Lake Barco
William M. Landing – Florida State University

Recent Sediment History of Lake Jackson – J.F. Donoghue - Florida State
University

Lake Carlton Sediment Pesticide Study – Kate Himel – DEP

Development and Use of Sediment Assessment Techniques in Freshwater
Sediments of Florida – Thomas L. Seal – DEP

Use of Liquefied Activated Carbon for Bio-digestion of Organic Lake Bottom
Sediments – Larry D. Madrid – Madrid Engineering Group, Inc.

6:30 p.m. – 7:30 p.m.

Reception - Grand Ballroom Doubletree Hotel

7:30 p.m. – 9:30 p.m.

Banquet and Awards Ceremony - Grand Ballroom Doubletree Hotel

9:30 p.m. – 12:00 p.m.

Hospitality Suite - Room (TBA) Doubletree Hotel

Thursday May 24

- 7:30 a.m. – 12:10 p.m. **Conference Registration** - Turnbull Center for Professional Development
- 7:30 a.m. – 8:20 a.m. **Breakfast** – Exhibit Hall Turnbull Center
- 8:20 a.m. – 8:30 a.m. **Announcements and Door Prize Drawings** (Must be present to win)
- 8:30 a.m. – 10:10 a.m. **Session 9 – Lake Restoration**
- Moderator: Michael Hill – Florida Fish and Wildlife Commission
- The Application of Restoration Ecology to a Lake and Wetland Restoration Project
James C. Griffin – SWFWMD
- Management and Restoration Initiatives in the Sand Hill Lakes of Northwest Florida
Paul Thorpe – NFWFMD
- Selective Removal of Grass Carp from Lake Silver Using Rotenone
Kevin D. McCann – City of Orlando
- Restoring Lake Munson – Larry N. Schwartz - Camp, Dresser and McKee, Inc.
- Preliminary Design for the Restoration of Lake Panasoffkee and Enhancement of Lake Restoration Efforts by Access Canal Dredging – Mohamed Alawi
Parsons, Brinckerhoff, Quade & Douglas
- 10:10 a.m. – 10:30 a.m. **Break** – Exhibit Hall Turnbull Center (Refreshments Provided)
- 10:30 a.m. – 12:10 p.m. **Session 10 – Habitat and Critters**
- Moderator: Bruce Means - FSU
- Apalachicola River Low Water Study – Tom Frick – DEP
- Investigations of Mortality and Reproductive Failure of Alligators in Lake Griffin
James Perran Ross – Florida Museum of Natural History
- A Wildlife Hybridization Problem in Florida: Feral Mallards and the Florida Mottled Duck – Ronald R. Bielefeld – Florida Fish and Wildlife Commission
- Population Structure, Abundance, and Community Composition of Turtles at Lake Jackson: Implications for Management and Lake Food Webs
Matthew J. Aresco – Florida State University
- Effect of Dredging Lake Sediments on Populations of Aquatic Salamanders (*Amphiuma and Siren*) – Margaret S. Gunzburger – Florida State University
- 12:10 p.m. – 12:30 p.m. **Closing Remarks:** Sean McGlynn - Conference Chairperson
TBA - President Elect
- 12:30 p.m. – 2:00 p.m. **Lunch (On your own)**

2:30 p.m. – 10:00 p.m. **Field Trip and Dinner** – Departure from Doubletree Hotel
Lake Ella, Lake Jackson, Nicholson Farmhouse - *(Please Note: Separate
Registration Required - Cost is \$30.00)*

WORKSHOP PROGRAM

Session 1

**Monday May 21, 2001
8:30 a.m. – 10:00 a.m.**

Track 1 – Topics of Interest for Citizens, Volunteers and Professionals

OKEEHEEPKEE, AN INTRODUCTION TO THE DISAPPEARING WATERS, OR THE KARST LAKES OF LEON COUNTY

Seán E. McGlynn, Ph.D., President, McGlynn Laboratories, Inc., 568 Beverly Court, Tallahassee, Florida, 32301 and Adjunct Professor, Florida State University, Department of Biological Science, Phone: 850/222-4895, Fax: 850/222-4895, e-mail: mcglynnlabs@cs.com

This talk is designed to give a basic introduction to the unique and beautiful lakes of Leon County Florida and is intended to explain the basic concepts necessary to understanding the ecology of the Lakes of Leon County, Florida. The geology and biology as well as the hydrology and water chemistry of our unique shallow subtropical karst Lakes will be discussed and explained. There will also be a pictorial tour of our lakes in relation to development patterns and recreational usage.

An extended period of drought in North Florida has given us a unique opportunity to view the connection of our Lakes with the Aquifer. Many of our lakes, such as Talquin, Hall, McBride, and Carr remained full of water during the drought. These lakes probably do not have an active connection with the aquifer. Other area lakes such as Jackson, Iamonia and Miccosukee drained almost entirely into Sinkholes. These Lakes are directly connected to the aquifer. Florida is a gift of the sea, and its bedrock is composed of Limestone. Surface water can dissolve the limestone creating channels and subsurface flows. The flow of groundwater within the limestone is often called an underground river, but is more properly termed the Floridan Aquifer. This type of geologic area is called Karst. More than 3,300 karst features have been identified within Leon County, such as sinkholes, closed depressions, springs and large lake basins containing known sinkholes (Benoit et al., 1992). On the average, 2.5% of the land in Florida lies over some sort of cave, though this number is often as high as 16%. The average cave is an elliptical tube, 5 ft high by 10 ft wide (Wilson, 2000). The larger the cave, the less stable it becomes and as they grow in size they tend to collapse forming a depression or a sinkhole. The numerous caves that honeycomb the limestone beneath Leon County contain a large underground subsurface flow called the Floridan Aquifer. Collapses in the underlying limestone can allow surface waters to flow directly into (sinks) or groundwater may flow out of (springs).

Most of Leon County's Lakes were once tributaries of either the St. Marks or the Ochlockonee Rivers. They evolved from tributaries, to solution basins and finally into sinks and ceased flowing into surficial rivers and began to flow directly into the mighty underground river, the Floridan Aquifer. These caves may be called 'Sinkholes,' 'Swallowholes,' 'Go-Away Holes' or just 'Sinks', but they are really 'short circuits to the Aquifer'. While these Lakes no longer routinely flow into a river, the river can spill over into the Lake during times of high water. The analysis of naturally occurring Tritium in

waters of the Upper Floridan Aquifer below Leon County indicates that the water in the upper Floridan Aquifer has been underground less than 40 years (Katz et al., 1997). Additional evidence of recharge within the Floridan Aquifer is the presence of three distinct plumes of Perchloroethylene (PCE) in the Floridan Aquifer (Watts et al., 1991). PCE is a dry cleaning solvent used in Tallahassee since the late 1940's. The interchange of River, Lake and Ground Water is truly dynamic in North Florida and puts special emphasis on maintaining and protecting the Water Quality within our Lakes.

Upper Lake Lafayette was the first Leon County Lake to drain in August 1999. The rate of flow into the sink was measured at 96-cfs. Exploration of the caverns of the sink by divers has exposed a complex cavern system. Lake Miccosukee, a 6000-acre Lake has a control structure built around the sinkhole. In October the gates were opened and the lake drained into the Sink. An acceptance rate of 60 cfs was measured. Lake Jackson is a 3000-acre Outstanding Florida Waterbody and an Aquatic Preserve. The south-central portion of the Lake vanished into Porter's Hole Sink on September 16, 1999. Then on May 7, 2000, a second sinkhole, Lime Sink drained the Northern Half of the Lake. The acceptance rate of Porter Hole was measured at 12 cfs, Lime Sink was draining at a rate of less than 3 cfs. Lake Iamonia a 5757-acre Lake in northern Leon County has a sink on its northern shore. This lake drained too and the acceptance rate of the Sink was measured at 9 cfs, however the Ochlockonee River reflooded the basin in April 2001. The periodic draining and refilling of this Lake may be the natural force responsible for the health of our lakes. This dynamic cycle may be responsible for the trophy bass that anglers find within our Lakes. Periodic drawdowns inhibit aquatic plants and facilitate the oxidation of accumulated bottom sediments enhancing sandy clear water habitats that favor the proliferation of Large Mouthed Bass. There is also evidence that species competing with the Bass do not recover as rapidly.

The flow from the major Sinkhole Lakes in Leon County totals approximately 177 cfs. The flow from the springs south of the County represent part of the Floridan Aquifer emerging from beneath the ground is in excess of 3418 cfs. Thus Sinkhole Lake Water may represent as much as 5% of the flow of the Upper Floridan Aquifer from Leon County under optimal conditions. This may overestimate the contribution of karst recharge because many of the marine springs emerging within the Gulf have not been measured for flow, but does illustrate the significant contribution these lakes make to the groundwater.

Benoit, A. T., J. L. Johnson, L. Rains, E. F. Songer, and P. L. O'Rourke. 1992. Characterization of karst development in Leon County, Florida, for the delineation of Wellhead protection areas. Northwest Florida Water Management District Water resources Special Report 92-8.

Katz, Brian G., T. B. Coplen, T. D. Bullen, J. H. Davis. 1997. Use of Chemical and Isotopic Tracers to Characterize the Interactions between Ground Water and Surface Water in Mantled Karst. Ground Water, Vol. 35, No. 6.

Watts, G. B., G. E. Weigand, W. Riotte, and D. Watroba. 1991. Country Lane PCE contamination, Leon County. FDEP/BWC, GWI Report No. 91-04. Tallahassee, Florida.

BIOLOGICAL CONTROL OF AQUATIC WEEDS

Dr. Charles W. O'Brien, Professor, Director Center for Biological Control, Florida A&M University, Tallahassee, Florida 32307-4100, Phone: 850/599-3149, Fax: 850/561-2221, e-mail: charles.obrien@famuledu or biocontrol@nettally.com

Florida A&M University has established a Center for Biological Control in partnership with USDA-APHIS and USDA-ARS. Included among the research projects are studies on the biological control of *Hydrilla verticillata*, *Pistia stratiotes* (water lettuce), *Eichhornia crassipes* (water hyacinth), *Salvinia molesta* (Giant Salvinia), and *Melaleuca quinquenervia* (Australian Paperbark tree). Over the years we have identified or described potential biological control agents and vouchered samples of parent populations and their offspring. The benefits of biological control are evident from numerous successes in recent decades. The floating weed, water hyacinth, has been controlled successfully with two weevil biocontrol agents (*Neochetina eichhorniae* and *N. bruchi*) in Louisiana and Texas, and control of alligator weed with the leaf beetle *Agasicles*, continues throughout its range in the U.S.

FAMU has collected *Hydrellia pakistanae* leaf mining flies in South Florida and released and established this biological control agent of *Hydrilla* at Wakulla Springs. Follow-up studies are underway to determine the efficacy of this agent as a control in this invaluable State resource.

The use of natural enemies against pest species, plant or animal, is environmentally friendly, safe (when properly applied), relatively low cost, and generally produces permanent control. A prime requisite for successful biological control programs is patience, since immediate control is rarely attained. Nevertheless, success can and has been achieved and biological control is our best hope for the future, to meet our goals of control without environmental pollution or damage to non-targets in the delicately balanced aquatic environment.

INVOLVING K-12 TEACHERS AND STUDENTS IN MONITORING WATER QUALITY

Paul Ruscher, Ph.D. Florida State University, Associate Professor, Department of Meteorology Fellow, NOAA Cooperative Institute of Tropical Meteorology, 316 Love Building, Tallahassee, Florida 32306-4520
Phone: 850/644-2752 or Fax: 850/644-9642, e-mail: ruscher@met.fsu.edu

William Lusher, Florida State University, Outreach Programs, Department of Meteorology Program Manager, FLIES and EXPLORES! Programs, 303 Love Building, Tallahassee, Florida 32306-4520
Phone: 850/644-3465 or Fax: 850/644-9642, e-mail: lusher@met.fsu.edu

Kimberly Ruscher-Rogers, Florida State University, Outreach Programs, Department of Meteorology Program Assistant, FLIES and EXPLORES! Programs, 303 Love Building, Tallahassee, Florida 32306-4520

Phone: 850/644-3465 or Fax: 850/644-9642, e-mail: krusch@met.fsu.edu

Florida State University has partnered with GLOBE, an international science education program, to create FLIES, Florida Leadership Institute in Environmental Sciences. GLOBE is a program that equips K-12 students to take scientifically valid observations of their environment. When FLIES certifies teachers to participate in the GLOBE program they can perform hydrology observations with their students. These observations can be taken at any local body of water, such as a lake, a stream, or coastal waters. Protocols include:

- Identifying the location of the water body using GPS technology
- Water transparency
- Water temperature
- Dissolved oxygen
- Water pH
- Electrical conductivity
- Salinity
- Alkalinity
- Nitrate

GLOBE also has developed protocols for meteorological, land cover, and soil measurements, many of which are closely related to the hydrology measurements. The data collected by students and teachers are entered into the GLOBE program database. Researchers use these data worldwide to monitor the status of our environment. By collecting data for researchers, students learn scientific concepts that are in line with the Sunshine State Standards. Students also can perform research projects, such as comparing data collected by their school to others near their own. Involving students in collecting environmental data can foster a sense of environmental stewardship later in life. Graphs of student data will be shown, and the authors will disseminate information on involving K-12 schools in water monitoring.

Track 2 – STORMWATER BEST MANAGEMENT PRACTICES

Harvey Harper, Environmental Research & Design, Inc., 3419 Trentwood Boulevard, Suite 102, Orlando, Florida 32812-4863, Phone: 407/855-9465, Fax: 407/826-0419, e-mail: hharper@erd.org

The topics of discussion in this workshop will be: Stormwater Chemistry; Removal of Stormwater Pollutants; and the Selection of Appropriate BMPs. Considerable research has been undertaken to identify and quantify the sources of stormwater pollution. The eight major sources of pollution will be discussed: Street Pavement; Motor Vehicles; Atmospheric Fallout; Vegetation; Land Surface; Litter; Anti-Skid Compounds and Chemicals and Construction Sites. The major constituents of Stormwater Runoff are: Suspended Solids; Nutrients; Metals; Oxygen Demanding Substances; Oils, Greases and Hydrocarbons; and Pathogens. Taken from the various sources, this cocktail of pollutants

invariably makes its way from the site of human habitation to our beloved lakes. Various techniques have been developed to intercept and remove these deleterious compounds. Infiltration, Detention, Wet Detention, Filtration, Wetlands (Natural and Constructed), Alum Treatment and Liquid/Solid Separators will be evaluated and discussed.

Track 3 – STORET TRAINING: FLORIDA’S FOUNDATIONAL WATER QUALITY DATABASE

Patrick Detscher, Linda Ann Clemens, Ray Malloy, Gerold Morrison, Florida
Department of Environmental Protection, 2600 Blair Stone Road, Mail Station 3525,
Tallahassee, Florida 32399-2400, Phone: 850/921-9925, Fax: 850/922-6387

STORET is a STORage and RETrieval database, used for the storage of biological, chemical, and physical data for groundwater and surface water. STORET provides free, unlimited access to its data to all agencies and individuals. Scientists across the nation have been storing their water quality data in STORET for over 30 years. The national STORET database is supported and administered by the US Environmental Protection Agency (EPA). In Florida, the Florida Department of Environmental Protection (FDEP) STORET Program gathers and maintains water quality data statewide, providing the national water quality database with frequent updates.

During the 1990's, STORET was revised from a mainframe based; centralized database to the current desktop based web-enabled, de-centralized system. No user registration is required for data retrieval, and with the exception of preliminary data (so identified by its originator), all data in STORET are made freely available. STORET data may be browsed or downloaded using a standard web browser and are accessible from the EPA STORET Internet site.

In Florida, many organizations contribute information to STORET, including federal, state, local, and interstate agencies; universities; contractors; individual; and water laboratories. In addition, volunteer organizations such as the Choctawhatchee Basin Alliance and the Bream Fisherman’s Association have elected to use STORET to manage and store their data. STORET software is available to data collection agencies in Florida at no cost through the FDEP STORET Program.

Recent software developments have improved the utility of STORET. EPA has released a new and updated reporting module, which allows for easier retrieval and display of data within STORET. A STORET Interface Module is currently under development that will greatly improve data loading into STORET.

For more information about STORET in Florida
visit the Florida STORET website at:

<http://www8.myflorida.com/environment/learn/waterprograms/storet/index.html>
call Patrick Detscher, Florida STORET Coordinator at 850/921-9925

For more information about EPA and STORET

Visit the EPA STORET website at: <http://www.epa.gov/storet>
Call the EPA STORET hotline at 1-800/424-9067

Track 4 - AQUATIC PLANT IDENTIFICATION

Kathy Burks, Florida Department of Environmental Protection, Bureau of Invasive Plant Management, 3900 Commonwealth Boulevard, MS 710, Tallahassee, Florida 32399–2400, Phone: 850/487-2600, Fax: 850/488-2216, e-mail: Kathy.Burks@dep.state.fl.us

Learn more about the character and habitat of aquatic macrophytes found in Florida waters, both native and exotic. Kathy will discuss numerous species of submersed and emergent plants, their distinguishing features and their place in our "water world." Fresh samples will be available for firsthand, close-up review, along with helpful handout materials.

Kathy has been the botanist for the Bureau of Invasive Plant Management, Division of State Lands, in the Florida Department of Environmental Protection, for nine years. She worked previously as a consulting botanist at Tall Timbers Research Station, and did her graduate work at Florida State University. She is a co-author of the Department's new reference book, *Florida Wetland Plants: An Identification Manual*, and is co-editor of the new reference book supported by several public and private agencies, *Identification and Biology of Non-Native Plants in Florida's Natural Areas*.

WORKSHOP PROGRAM

Session 2

**Monday May 21, 2001
10:20 a.m. – 11:50 a.m.**

Track 1 – VOLUNTEER MONITORING PROGRAMS: CURRENT STATUS IN FLORIDA

Coordinator: Julie Terrell - Florida LAKEWATCH

There are many volunteer monitoring groups sampling different ecological parameters within the State of Florida. Several of these programs will be presenting the efforts of their work and discussing the current status of their program. There will also be a question and answer session at the completion of all presentations to address questions from the audience about any of the programs presented.

Monitoring groups participating in the workshop include:

Hillsborough County Stormwater Department
Resource Management Association (RMA)/ BEST in Panama City Beach
WAV in Seminole County
City of Orlando
Choctawhatchee Basin Alliance
Florida LAKEWATCH/Project COAST

Track 2 – SEDIMENT AND EROSION CONTROL

Dan Deweist, Florida Department of Environmental Protection, 2600 Blairstone Road, MS 3570, Tallahassee, Florida 32399-2400, Phone: 850/921-9866, Fax: 850/921-5217, e-mail: Dan.Deweist@dep.state.fl.us

Tom Ballentine and Wayne Toothman, Leon County, Department of Growth and Environmental Management, 3401 West Tharpe Street, Tallahassee, Florida 32303, Phone: 850/488-9300, Fax: 850/487-7956, e-mails: tomba@mail.co.leon.fl.us and waynet@mail.co.leon.fl.us

This one and one-half hour workshop will consist of two components:

The first part (presented by FDEP) will quickly identify erosion and sedimentation as a major water quality problem, and present the training program and the erosion control plan as the source of solutions. The erosion control plan and construction schedule will be presented from plan development through review, to pre-construction conference and implementation, i.e. cradle to grave approach.

The second part (presented by Leon County) will be an actual case study of the Thomasville Road widening project. Similarities and differences between the three contract phases will be shown. This will also be a cradle to grave study, paralleling and supporting the previous theoretical presentation with real life examples.

Track 3 – 10:20 a.m. – 11:00 a.m. STORET TRAINING (continued from Session 1)

See Session 1, Track 3 for abstract.

11:00 a.m. – 11:50 a.m.

CHANGES IN THE FDEP QUALITY ASSURANCE PROGRAM FOR SAMPLE COLLECTION AND LABORATORY ANALYSIS

Michael Blizzard, Florida Department of Environmental Protection

Upcoming revisions to the FDEP Quality Assurance Rule, Chapter 62-160, Florida Administrative Code, will change the way samplers and laboratories are approved to do environmental business in Florida. All commercial, governmental and volunteer organizations handling environmental samples are affected by these changes. Major items include the elimination of the FDEP Comprehensive QA Plan (CompQAP) requirement and the institution of mandatory certification of all environmental laboratories by the Florida Department of Health (DOH) under the auspices of the National Environmental Laboratory Accreditation Program (NELAP).

This workshop will present an overview of these changes (which may be finalized by the time of the workshop) and their implementation within the FDEP Water programs. Specific details about complying with these new requirements will be presented in relation to lake monitoring projects. Laboratory quality assurance will be discussed with respect to the new NELAP Quality Systems document. Sampling quality assurance topics are incorporated in the revised FDEP Standard Operating Procedures for field-testing and sample collection (formerly DEP-QA-001/92) and will be presented in a review of this new draft manual.

Track 4 – BIOASSESSMENT TRAINING FOR THE LAKE CONDITION INDEX

Julie Riley, Lori Wolfe, Ashley O’Neal,
Florida Department of Environmental Protection

All components of the benthic invertebrate Lake Condition Index, including theoretical background, sampling, laboratory analysis, and interpretation of results will be presented. This biological community health tool is calibrated to Eco-regional reference conditions and to Lake Type (colored vs. clear, acid vs. alkaline). Advantages of using long-term biological indicators are presented as well the context by which the LCI fits into the Total Maximum Daily Load (TMDL) Impaired Waters process.

WORKSHOP PROGRAM

Session 3

**Monday May 21, 2001
12:50 p.m. – 2:20 p.m.**

Track 1 – VOLUNTEER MONITORING PROGRAMS: CURRENT STATUS IN FLORIDA (continued from Session 2)

Coordinator: Julie Terrell - Florida LAKEWATCH

See Session 2, Track 1 for abstract

Track 2 – National Pollutant Discharge Elimination System

Moderator: Phil Coram, Florida Department of Environmental Protection

PRIVATIZATION OF FLORIDA’S NPDES STORMWATER PROGRAM

Michael Bateman, P.E., Berryman & Henigar, 3200 Commonwealth Boulevard, Suite 101 Tallahassee, Florida 32303, Phone: 850/878-8963, Fax: 850/878-8964, e-mail: bateman@bhiinc.com - website: www.bhiinc.com

Delegation to Florida

Florida’s Department of Environmental Protection (DEP) assumed administration of the federal NPDES stormwater program on October 23, 2000, ending a delegation process that began over five years ago. Florida is the last state in EPA’s Region IV to accept delegation of the stormwater program. As part of a phased approach, Florida accepted delegation of domestic and industrial wastewater point sources in 1995. A five-year transition period was imposed on the delegation process by the Florida Legislature as allowed by the Clean Water Act.

Privatization of the Stormwater Program

Governor Jeb Bush’s privatization initiative is being tested at DEP by allowing “outsourcing” of several NPDES stormwater program functions. Administration of the program will be coordinated by the DEP’s Tallahassee office, under the Bureau of Submerged Lands and Environmental Resources. A core group of existing DEP staff will be responsible for directing and managing the program. However, processing of NOIs, MS4 permitting, and inspections services will be provided by a private contractor. The DEP will retain signatory responsibility of “agency action” documents and therefore will remain in responsible charge regarding all permitting and enforcement issues.

The selected contractor will provide a Notice Processing Center for accepting NOIs, NOTs, and DMRs associated with the general permitting program for construction and industrial activities. Available information state’s environmental resource permitting program indicates that between 3,000 and 4,000 permits are issued each year for construction sites over five acres. It is unknown how many industrial sites in Florida will require coverage under a NPDES stormwater permit. EPA’s PCS database indicates that over 2,500 facilities have received coverage under the federal MSGP or individual NPDES permits. However, information from the Florida Department of Labor’s database indicates there may be as many as 30,000 industries in Florida that fall within SIC codes covered by the NPDES stormwater rule.

Under the guidance of the DEP, a private contractor will be responsible for review of MS4 permit re-applications, modifications and annual reports. Duties will include evaluation of stormwater management plans, review of water quality monitoring data, and assembling other information needed for permit re-issuance. There are 28 Phase 1 MS4 permits in Florida involving 220 co-applicants.

At the direction of the DEP, the contractor will be responsible for compliance inspections. Activities will include review of records, observation of pollution prevention and best management practices, and interviews with maintenance personnel. For industrial and construction sites, the DEP will periodically assign a list of inspections to be conducted in the form of a task order. EPA expects annual compliance inspection rates of 30% for construction sites and 10% for industrial permittees. Each of the 28 municipal permits will be inspected annually.

Compliance reports will be prepared for each inspection and forwarded to the DEP. Staff at the DEP will evaluate non-compliance findings and decide what action will be taken in response to violations. All enforcement activities will be initiated by the DEP. The contractor may be required to provide testimony as a fact witness in subsequent legal proceedings.

Permit Fees

The 2000 Florida Legislature provided the DEP with \$1.9 million dollars of spending authority to implement the NPDES stormwater program. Florida law requires that all operating costs for administration of the NPDES program be recovered by collection of permit fees. The law also allows for collection of “annual” compliance and surveillance fees for larger facilities and MS4s.

Numerous workshops and meetings were held by the DEP with the regulated community in determining an equitable fee structure for MS4s. After dozens of draft versions, a reasonable fee formula was agreed upon. Each permittee is required to pay a standard flat fee, plus an additional amount based on population. The population-based portion of the fee is based solely on the 1990 census and is therefore “fixed in time.” This fee formula is equitable for municipalities of all sizes. The proposed fees are provided below:

<u>Program</u>	<u>Proposed Permit Fee</u>
MS4	\$8,000 + \$0.017 per capita (annual fee)
Industrial-GP	\$500 for 5 years NOI coverage
Construction-GP	One time \$150 NOI processing fee

Conclusion

After years of anticipation and preparation, the DEP is anxious to begin operating the NPDES stormwater program. The authorities provided by the Clean Water Act and federal regulations will provide the DEP with new tools for addressing water quality problems from stormwater run-off, one of the major sources of water quality impairment

in the State. Both the regulated community and the DEP are waiting to see how effective the “privatization” of this program will be. Successful implementation of this program may provide public agencies a new model for partnering with the private sector.

STRATEGIES FOR IMPLEMENTING NPDES PHASE II STORMWATER MANAGEMENT TECHNIQUES

Timothy Kelly, and Walter Reigner, BCI Engineers & Scientists, Inc., P. O. Box 5467 Lakeland, Florida 33807, Phone: (863) 667-2345, Fax: (863) 667-2662, e-mails: tkelly@bcieng.com and wreigner@bcieng.com

The federal Phase II regulations have been published and will impact small municipalities, most construction activities, and industry. This session will identify the specific elements of the regulations on storm water discharges. More importantly, strategies on implementing effective storm water management techniques to address the regulations and the upcoming Total Maximum Daily Loads (TMDLs) program will be discussed.

Track 3 – ENVIRONMENTAL STATISTICS

Harvey Harper, Environmental Research & Design, Inc., 3419 Trentwood Boulevard, Suite 102, Orlando, Florida 32812-4863, Phone: 407/855-9465, Fax: 407/826-0419, e-mail: hharper@erd.org

In this comprehensive workshop the applicability and proper use of statistical techniques for handling environmental data will be discussed. Do you need to test your hypothesis? Do you want irrefutable valid conclusions for your tests? Environmental data should not be handled like other data. Specialized statistical techniques need to be utilized. The proper use of Summary Statistics like Trophic State Analysis (TSI) that compress data will be evaluated. You will learn how to test a hypothesis, analyze variance and learn when and how to perform valid linear regressions. Box and Whisker Plots, Normal and Gaussian Distributions, and logarithmic distributions will be applied to environmental contexts. Skewness and Probability Plots, the applicability of trend analysis and the necessity of long-term data sets will be put into an environmental perspective. If you would like to better understand the statistical techniques for handling Environmental Data, you need to attend this workshop.

Track 4 – Characterization of Algae Blooms

Moderator: Carlos Fernandez, Hillsborough County Public Works

FIELD VERSUS LABORATORY MEASUREMENT OF CHLOROPHYLL AND THE RESULTING DIFFICULTIES OF INTERPRETING CHLOROPHYLL RESULTS IN RELATION TO HARMFUL ALGAL BLOOMS

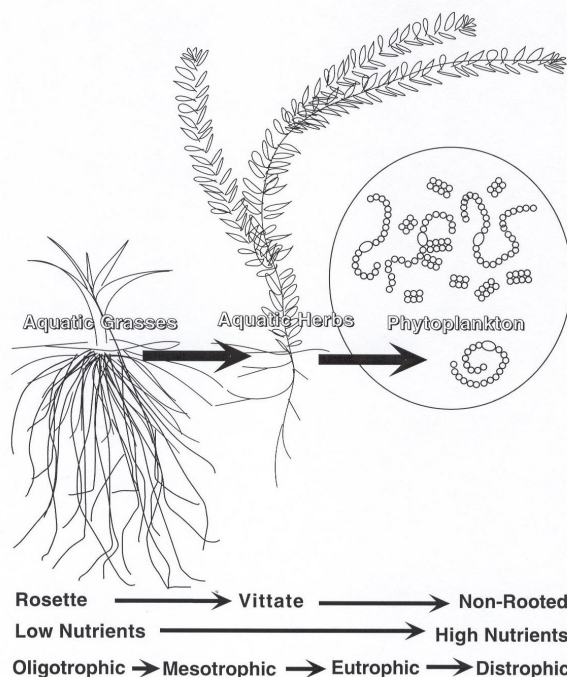
Seán E. McGlynn, Ph.D., President, McGlynn Laboratories, Inc., 568 Beverly Court, Tallahassee, Florida 32301 and Adjunct Professor, Florida State University, Department of Biological Science, Phone: 850/222-4895, Fax: 850/222-4895, e-mail:

mcglynnlabs@cs.com

There is a predictable pattern of succession in Florida lakes from aquatic grasses, to aquatic herbs and eventually to plankton dominated systems. As blue green algae or cyanobacteria dominates our Lakes, we are identifying health risks as these toxin-producing algae proliferate. We need accurate and quick measurement of chlorophyll, the best method to measure the density of phytoplankton. Field Chlorophyll sensors provide a solution to this dilemma confronting the aquatic resource manager.

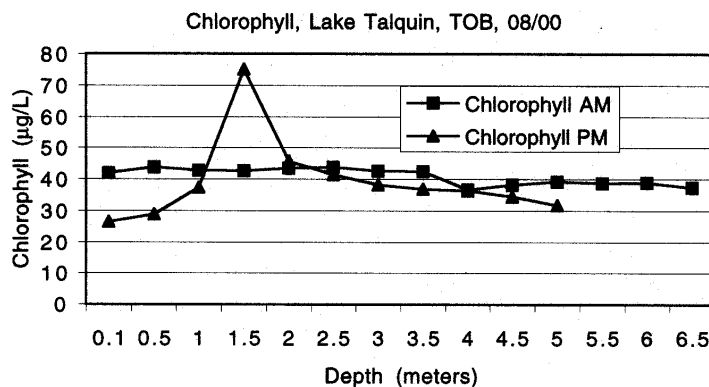
As our Lakes increase in trophic status the macrophyte communities change from aquatic grasses, adapted to exist in nutrient deserts, with high root to shoot biomass specializing in extracting nutrients from the sediments, to aquatic herbs whose filamentous branches are specialized for extracting available nutrients from the water column. Eventually, as the trophic state increases the lake will lose its macrophyte population and become plankton dominated.

Aquatic Plant Succession



As phosphorus concentrations within the lake continues to rise, and ceases to be the limiting nutrient, primitive cyanobacteria begin to dominate the algal population. These cyanobacteria can fix atmospheric nitrogen. They can produce toxins. They possess a competitive advantage in hypereutrophic lakes. Phytotoxins are designed to decrease grazing and inhibit competition from other plants. Many are harmful to humans, hence the term HAB, or HARMFUL ALGAL BLOOM.

Algal blooms, composed of potentially harmful species of cyanobacteria such as *Microcystis aeruginosa* and *Anabaena spiroides*, and *Anabaena limnetica*, are naturally occurring in Florida waters. These algae can periodically produce toxins. Introduced species such as *Cylindrospermopsis* always produce toxins. These bluegreen algae often pose a human health risk. The simplest method of screening for algal blooms is with a field chlorophyll sensor. This instrument will give instantaneous chlorophyll readings and can alert the user to the presence of algal blooms, and instantaneously quantify the concentrations of chlorophyll within the Lake. The aquatic resource manager can then contract for expensive algal toxicity measurements based on hard evidence that there is a substantial bloom.



Furthermore, Field Chlorophyll sensors reveal that Algal blooms are able to migrate within the water column in order to optimize light regimes. Gas vesicles can change the relative buoyancy of these algal cells. Traditional sampling techniques often miss maximum levels of chlorophyll, since sampling is

traditionally a half-meter from the surface and a half-meter above the sediment at the bottom of the water column. Profiling, where continuous readings of chlorophyll a are taken with an insitu fluorometer reveal that maximum levels of chlorophyll will often occur at mid water depths. The traditional surface and bottom-sampling regime can miss the algal bloom as shown in the figure above and to the left where the maximum algal bloom density is at 1.5m. Also, the traditional laboratory assay for chlorophyll requires filtration, overnight extraction in an organic solvent followed by multiwavelength spectroscopy and complicated calculations. In short, it takes several days. By the time the laboratory results are available to the aquatic resource manager the bloom may be gone. In-situ chlorophyll reading is instantaneous, capable of identifying potential health risks in a timely manner.

The reason that algal blooms migrate within the water column is due to a process called photoinhibition. High intensities of light will damage the chlorophyll molecule and eventually cause chlorosis or bleaching of the plant followed by death. Algal blooms can migrate within the water column to optimize their aquatic light regime. They often dive or sink to avoid the hot noon sun, but will rise to the surface under low light conditions. This very process is the major drawback of the field chlorophyll sensor. With very intense light algae will be photoinhibited and will not fluoresce. This will lead to false readings. Thus, the diligent lake manager should avoid using the Field Fluorometers in the heat of the day corresponding to solar noon. Go sit in the shade. Take your readings in the morning or afternoon.

QUALITY CONTROL AND QUALITY ASSURANCE FOR ALGAL IDENTIFICATIONS

Elizabeth B. Miller, Steve Wolfe, Florida Department of Environmental Protection, Biology Section, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400, 850/921-9826, Fax 850/922-5368, e-mail: elizabeth.miller@dep.state.fl.us

The Florida Department of Environmental Protection Biology Laboratory routinely performs QA/QC for the analyses we conduct. In developing some of these QA/QC procedures, it became clear that some of the common measures for assessing accuracy and precision are not meaningful for algal identifications unless carefully implemented due to the inherent patchiness or variability in the sample itself and issues of changing taxonomy. However, given the increasing emphasis on algal communities in our lakes and streams and the imminent development of an algal index with which to judge the relative health or impairment of a water body, it is very important that our identifications be accurate and consistent. We will present the measures we have developed to track our algal identification QA/QC and our current QC values.

ADVANTAGES AND LIMITATIONS OF MEASURING CHLOROPHYLL IN ENVIRONMENTAL WATER USING *IN VIVO* FLUORESCENCE

John W. McDonald, Ron L. Chandler, YSI Environmental, Yellow Springs, OH

The amount of phytoplankton present in environmental water can be an important indicator of the overall water quality at a particular site and is generally found to correlate to the chlorophyll content of water. Using commercial instrumentation from various manufacturers, it is possible to estimate the chlorophyll (and thus the phytoplankton) content of water by measuring the fluorescence of the chlorophyll molecules which are resident in the living microorganisms without disrupting the cells. This technique is generally known as *in vivo* fluorescence and has been in use for many years, but is now seeing increased usage because of greater emphasis on the measurement of chlorophyll as it relates algal blooms and to estimates of nutrient loading. In addition, the *in vivo* fluorescence technology has recently become available for use with multiparameter sondes, which prove water quality data from a variety of other sensors such as temperature, dissolved oxygen, conductivity, pH, and turbidity.

The primary advantages of *in vivo* fluorometry over standard laboratory methods to measure chlorophyll are (a) ease of use and (b) the ability to carry out long term continuous monitoring studies. These factors will be demonstrated with a discussion of actual field data acquired in horizontal and vertical profiling and in monitoring applications.

The limitations of the fluorescence method are significant in terms of affecting the correlation between the *in vivo* readings and laboratory chlorophyll determinations where

the cells are disrupted and molecular chlorophyll is extracted. These limitations will be discussed and demonstrated with literature references and field data.

WORKSHOP PROGRAM

Session 4

**Monday May 21, 2001
2:50 p.m. – 4:30 p.m.**

Track 1 – AQUASCAPING FOR IMPROVED WATER QUALITY AND HABITAT: THE RIGHT PLANT FOR THE RIGHT PLACE AND THE RIGHT FUNCTION

Kevin Songer, Northwest Florida Regional Manager of Environmental, Management Systems, Tumushui@msn.com

Geoff Brown, Natural Resources Management Agent for University of Florida Extension/Leon and Wakulla Counties, Phone: 850/926-3931, e-mail: geoffb@mail.ifas.ufl.edu

Aquascaping is the act of installing aquatic plants in or around water bodies, wetland areas or areas that experience frequent or occasional inundation like retention or detention ponds. There is a multitude of reasons for aquascaping. Aesthetic and wildlife values are greatly enhanced in an area that has been well aquascaped and managed. Aquascaping also affects the clarity, temperature and appearance of algae in a pond used for fishing or for retention or detention. Aquascaping an area of 20-25 feet around a pond with an assortment of aquatic and wetland plants provides a buffer to reduce non-point source pollution from entering the water body. (The Florida Yards and Neighborhoods Program of the University of Florida Extension Service requires that homeowners must provide a buffer area if they live on or around a body of water in order to be certified with having an ‘Environmentally-friendly’ yards.)

Not all aquatic plants are equally beneficial choices in aquascaping and in spite of its benefits, there are management issues involved. The importance of making good choices in the selection of plants to address the objectives for each planting situation must be stressed. This workshop will review site selection, planting techniques, and a survey of aquatic and wetland plants useful for meeting a variety of situations or objectives including: upland plantings; areas of fluctuating water levels; grasses useful for buffers; uptake of nutrients, wildlife benefits; biomass contributing to eutrophic conditions; plants considered as invasive exotic. The workshop will include a slide presentation, live samples of plants, and some hands-on activities.

Track 2 – HANDS-ON OPPORTUNITY TO LEARN MORE ABOUT THE GLOBE PROGRAM FOR TEACHING SCIENTIFIC SKILLS TO K-12 STUDENTS

Paul Ruscher, Ph.D. Florida State University, Associate Professor, Department of Meteorology Fellow, NOAA Cooperative Institute of Tropical Meteorology, 316 Love Building, Tallahassee, Florida 32306-4520, Phone: 850/644-2752, Fax: 850/644-9642, E-mail: ruscher@met.fsu.edu

This will be a hands-on workshop based on the talk presented in session 1, track 1 about Involving K-12 Students and Teachers in Monitoring Water Quality. Please see pages 12 & 13 for the abstract.

WORKSHOP PROGRAM

Citizen Session

**Monday May 21, 2001
7:00 p.m. – 8:30 p.m.**

Conserving Our Area Lakes through This Decade and Beyond

Moderator: Curtis Watkins, City of Tallahassee

LOCAL LAKE MANAGEMENT ISSUES, ACTIONS AND NEEDS

Curtis Watkins, City of Tallahassee

Lakes provide many benefits to northwest Florida's residents and visitors. Aesthetics provide perhaps the most widely recognized benefit. Findings from a public survey conducted in the late 1980s revealed that almost all of the respondents consider our community's lakes as a "valuable community asset." Our lakes provide many recreational benefits that include fishing, skiing and sailing. Our lakes and associated wetlands provide Eco-structure by sustaining a variety of flora and fauna. Local area lakes provide economic benefits to our community. A study conducted on one local lake revealed lake-related purchases supported 100 jobs and generated \$10 million dollars. Local lakes also benefit residents by enhancing property values. Several lake issues have been on the minds of residents and visitors. One issue has been improvement in the quality of degraded local lakes. Another issue has been the concern for maintaining lake water quality due to development associated with increasing population. Finally, a more recent issue has been declining lake levels due to lower rainfall and the need to refill lakes that have been partially drained by the formation of sinkholes. Several actions have been taken by state and local government to address these issues. This presentation will review lake management actions that have been taken by government to conserve our local area lakes. The presentation will also discuss lake management needs that are necessary during this decade to maintain, and in some cases improve, the quality of our local lakes. The presentation will also discuss the important role we all have as residents in protecting and conserving our local lakes.

A STATISTICAL ANALYSIS OF WATER QUALITY DATA FOR THE LAKES OF LEON COUNTY, FL., TRENDS

Craig J. Diamond, Supervisor of Environmental Planning, Tallahassee-Leon County Planning Department, 300 South Adams, City Hall, Tallahassee, Florida 32301, Phone: 850/891-8621, Fax: 850/891-8734, e-mail: diamond@mail.ci.tlh.fl.us.

Seán E. McGlynn, Ph.D., President, McGlynn Laboratories, Inc., 568 Beverly Court, Tallahassee, Florida 32301 and Adjunct Professor, Florida State University, Department of Biological Science, Phone: 850/222-4895, Fax: 850/222-4895, e-mail: mcglynnlabs@cs.com

A 10-year database has been assembled from several sources (The Leon County Lakes Ecology Program, the City of Tallahassee Aquifer Protection Program and Florida LakeWatch). Much of the data is monthly, and includes water quality parameters such as nutrients, metals and organics. Water bodies sampled range from the largest Lakes in

Leon County like Lake Talquin (8850 acres), Lake Miccosukee (6312 acres), Lake Iamonia (5700 acres), Lake Jackson (4325 acres) and Lake Lafayette (1825 acres) to ponds less than an acre in surface area. All of these basins have undergone varying degrees of development as Leon County and the City of Tallahassee have become one of the fastest growing regions in the State of Florida. This paper presents a statistical analysis of the data focusing on Water Quality trends. How well are we protecting our lakes? We hope to answer that question for you in this fascinating discussion.

LAKE HALL, THE CLEANEST LAKE IN LEON COUNTY

Thomas Deck, Senior Chemist, McGlynn Laboratories, Inc., 568 Beverly Court, Tallahassee, Florida, 32301, Phone: 850/570-1476, Fax: 850/222-4895 and e-mail: tad1318@garnet.acns.fsu.edu.

Seán E. McGlynn, Ph.D., President, McGlynn Laboratories, Inc., 568 Beverly Court, Tallahassee, Florida 32301 and Adjunct Professor, Florida State University, Department of Biological Science. Phone: 850/222-4895, Fax: 850/222-4895, e-mail: mcglynnlabs@cs.com

Lake Hall has undergone varying degrees of development as Leon County and the City of Tallahassee have become one of the fastest growing regions in the State of Florida. Most of the lakeshore is within a State Park, Maclay Gardens and is considered an Outstanding Florida Waterbody. The rest of Lake Hall is developed as high priced mansions of the wealthy. An Eight-lane highway (Thomasville Road) skirts the eastern shore. Despite all these developments recent retrofits have actually improved water quality in Lake Hall. The lake boasts some of the most healthy macrophyte communities in North Florida. *Hydrilla verticillata* has not yet been introduced into the Lake and the Lakebed is covered with healthy beds of *Vallisneria americana* and *Sagittaria stagnorum*, a rare site in Florida. Water quality remains good in this clear water, macrophyte dominated North Florida Lake.

PLENARY PROGRAM

Session 1 – Florida Springs

Tuesday May 22, 2001

8:50 a.m. – 10:10 a.m.

Moderator: Honorable Bob Rackleff – Leon County Commission

FLORIDA SPRINGS PAST, PRESENT AND FUTURE

James A. Stevenson, Florida Department of Environmental Protection, Division of State Lands, 3900 Commonwealth Boulevard, MS140, Tallahassee, Florida 32399-3000, Phone: 850/487-1750, e-mail: james.stevenson@dep.state.fl.us

According to legend, Florida was discovered by Ponce de Leon during his search for a spring. Since then 600 springs have been discovered and enjoyed by residents and tourists. Health spas were built at a number of springs in the early 1900's because of their perceived medicinal qualities and churches commonly conducted baptisms in local springs. Florida's 33 first magnitude springs exceed in number and quantity of water discharged those of any country.

Today increasing levels of contamination and loss of discharge are seriously degrading the natural, recreational and economic values of many of the springs. The Department of Environmental Protection formed the Florida Springs Task Force to develop protection strategies for Florida's Springs. The task force report presents twelve strategies with over one hundred recommendations. Governor Bush proposed a \$2.5 million appropriation in his budget for the 2001 Legislative session to fund four of the strategies. Implementation of several of the strategies is underway.

IMPACTS FROM GROUNDWATER DEMANDS UPON SPRING FLOW TO THE WEKIVA RIVER

Brian E. McGurk, P.G., Ground Water Programs Division, St Johns River Water Management District, P. O. Box 1429, Palatka, Florida 32178 USA, Phone: 386/329-4245,
Fax: 386/329-4820, e-mail: brian_mcgurk@district.sjrwmd.state.fl.us

The Wekiva River is a tributary to the St. Johns River in east-central Florida near Orlando. It is fed by several Floridan aquifer springs with a combined flow averaging 64% of the downstream flow on the river's main stem. The Wekiva River's classification as an Outstanding Florida Waterway is due to this unique baseflow characteristic as well as to the wetlands through which the river flows.

The demand for potable water in east-central Florida is supplied almost exclusively by ground water from the Floridan aquifer. Total Floridan withdrawals in the counties surrounding the Wekiva River basin increased from 150 to 250 million gallons per day between 1970 and 1995. Projected 2020 pumpage is approximately 600 million gallons per day.

The concern exists that projected pumping will decrease Floridan aquifer potentiometric levels, consequently lowering spring discharges to the Wekiva River. The St Johns River Water Management District has adopted minimum flows for 8 of the springs in the Wekiva River system. Reduction of average spring discharge rates below the established minimum flows may result in significant harm to wetlands.

A regional-scale numerical ground water flow model was used to estimate the cumulative impact of Floridan withdrawals upon spring discharge rates and baseflow. Model predictions indicated that 2020 withdrawals may cause a significant decrease in spring flow. Predictive sensitivity analyses indicate that declines in total Wekiva River basin spring flow could vary between approximately 9% and 20% relative to 1995 (Table 1). Predicted declines in discharge at individual spring locations also vary with distance from the areas of greatest predicted drop in the potentiometric surface. These areas are located to the south and east of the Wekiva River basin, within Orange and Seminole counties.

Reverse particle tracking was used to analyze model output. Using the MODPATH post-processor, particles were located at the grid cell representing each second-magnitude spring within the Wekiva basin. These particles were tracked upgradient to their source in order to identify the size and extent of the springs' steady-state recharge area. Most particles were recharged at model cells near the springs, indicating that most recharge occurs in nearby upland areas. However, many cells were recharged at cells far upgradient, indicating that the steady-state recharge areas extend outside of the Wekiva River surface water basin. The sizes of each spring's recharge areas were successively smaller for the 1995 and 2020 simulations compared to those estimated for predevelopment conditions due to capture of water by production wells.

The cumulative effect of projected Floridan aquifer pumping upon the potentiometric surface extends throughout much of the east-central Florida region and crosses municipal, county, and water management district boundaries. The predicted potentiometric surface decline has a direct effect upon spring flow rates. Although there is uncertainty in the magnitude of the predicted spring flow declines, currently projected average 2020 withdrawal rates may cause average 2020 flow rates at several second-magnitude springs that supply the Wekiva River to be below the adopted minimum average flow rates. Those springs closest to projected increases in pumping would be impacted the most. Steady-state spring recharge areas extend beyond the Wekiva River surface water basin for all simulations. The predicted 2020 steady-state recharge areas are, however, smaller in size than those estimated for 1995.

Table 1. Average Flow Rates and Predicted Changes at Springs in the Wekiva River Basins (cubic ft/sec):

Spring Name	1995 Measured	1995 Simulated	Predicted % Decline (Minimum)	Predicted % Decline (maximum)	2020 Predicted (Maximum)	2020 Predicted (Minimum)	Adopted Minimum Flow
Wekiva	73.0	76.4	6.8	14.4	68.1	62.5	62.0
Rock	61.4	58.9	9.8	19.5	55.4	49.4	53.0
Seminole	38.9	40.4	9.0	16.1	35.4	32.6	34.0
Palm and Sanlando	28.2	27.6	16.3	41.9	23.6	16.4	22.0
Messant	16.4	16.7	5.4	10.2	15.5	14.7	12.0
Starbuck	14.9	14.7	14.0	35.0	12.8	9.7	13.0
Island	6.4	7.6	6.5	15.8	6.0	5.4	nd
Miami	6.2	6.5	8.5	19.0	5.7	5.0	4.0
Witherington	2.2	2.3	9.6	20.5	2.0	1.7	nd
Camp-La-No-Che	1.0	1.0	8.2	14.6	0.9	0.9	nd
Sulfur	0.8	1.0	9.2	18.8	0.7	0.6	nd
Droty	0.7	0.8	4.2	7.7	0.7	0.6	nd
Basin-Wide Totals:	250.1	253.9	9.3	19.7	226.7	199.6	

nd: minimum flow not adopted

NITRATE-NITROGEN IN THE SUWANNEE RIVER

H. David Hornsby, Suwannee River Water Management District, 9225 County Road 49, Live Oak, Florida 32060, Phone: 386/362-1001, Fax: 386/362-1056, e-mail: hornsby_d@srwmd.state.fl.us

The Suwannee River is the second largest river in the State of Florida with a mean annual discharge of 10,470 cubic feet per second or 6.7 billion gallons per day. The Suwannee River Basin covers 9,950 square miles. Forty three percent of the Basin is in Florida and fifty-seven percent of the Basin is in Georgia. The predominantly developed land use in the Florida portion of the Basin is agriculture, including forestry, pasture, row crops, and intensive animal husbandry.

The Suwannee River Water Management District (SRWMD) maintains a surface water quality-monitoring network comprised of 67 stations. This network has been operational since 1989, and is funded in part by the Surface Water Improvement and Management (SWIM) Trust fund. Using data from this network, a statistically significant (95 percent confidence level) increasing trend in nitrate-nitrogen concentration has been identified. There is an inverse relationship between nitrate-nitrogen concentrations and flow at Branford, Florida. The nitrate-nitrogen is transported into the river via ground water in Florida. The SRWMD's groundwater monitoring network, as well as other studies, show elevated concentrations of nitrate-nitrogen in the upper Floridan aquifer system. At low flow conditions, the base flow of the Suwannee River is made up of ground water from the upper Floridan aquifer system.

The total load of nitrate-nitrogen for the Suwannee River Basin for water year 2000 was estimated 2,676 tons. Of the total load, the Santa Fe River Basin accounts for an estimated 786 tons or 30 percent and the Middle Suwannee River Basin accounts for an estimated 942 tons, or 36 percent. The Santa Fe River Basin is 1,390 square miles, or 14 percent of the Suwannee River Basin area; while the Middle Suwannee River Basin is 862 square miles, or 8.7 percent of the Suwannee River Basin Area.

EXAMINATION AND PREDICTION OF NITRATE LOADING AND RESPONSE IN THE SURFACE WATER/GROUND WATER SYSTEM IN THE LOWER ST. MARKS/WAKULLA RIVERS WATERSHED

Angela R. Chelette, Bureau of Ground Water Management, Northwest Florida Water Management District, 81 Water Management Drive, Havana, Florida 32333, e-mail: angela.chelette@nwfwm.d.state.fl.us

Florida's springs can help us understand the present status and predict future trends in ground water quality in their vicinity. Given the intimate relationship between ground and surface waters, it is obvious that changes in the quality of either one of these resources will be reflected in the other. Indeed, such impacts have likely already occurred. Recent water quality data for Wakulla Springs, found in the Woodville karst plain, show nitrate (dissolved) concentrations on the order of one milligram per liter (mg/L). Based on a discharge of 350 cfs, this amounts to nearly 340 tons of nitrate per year expelled from Wakulla Springs. If other discharge features effected by the karst plain, such as Spring Creek and the St. Marks River, have similar outputs, the total nitrate load will be on the order of 1,400 tons per year (3.7 tons/day or 0.64 tons per year per square mile of zone of contribution).

The District and the U.S. Geological Survey are presently involved in a project which has a goal of constructing a sensitivity-analysis tool that will enable users to hypothetically vary nitrate inputs and observe the predicted responses. In order to do this, a better understanding of the hydrodynamics of the flow system in the lower St. Marks/Wakulla River watershed, more complete knowledge of the sources and sinks of nitrate, and an increased understanding of the dominant hydrochemical processes that control the movement and fate of nitrate in surface and ground waters is required. Once these parameters are known and quantified, a sensitivity-analysis tool in the form of a graphical interactive computer program will be constructed to enable users to hypothetically vary nitrate inputs and observe the predicted responses. Thus, as population grows, increases in anthropogenic nitrate can be estimated. These increases represent an impact to the water quality as well as an indicator of associated pollutants. As part of this project, several springs (Wakulla Spring, Spring Creek, and River Sink Spring) as well as several sinks (Ames Sink, Lost Creek, and Fischer Creek) are being monitored.

Key words: springs, sinks, karst, ground water, pollution

PLENARY PROGRAM

Session 2 – Karst Influences on Lakes

**Tuesday May 22, 2001
10:30 a.m. – 12:10 p.m.**

Moderator: Tyler Macmillan – Northwest Florida Water Management District

CHARACTERIZING INTERACTIONS BETWEEN GROUND WATER AND SURFACE WATER IN MANTLED KARST USING CHEMICAL AND ISOTOPIC TRACERS

Brian G. Katz, U.S. Geological Survey, 227 North Bronough Street, Tallahassee, Florida 32301, Phone: 850-942-9500 ext. 3018, e-mail: bkatz@usgs.gov

J. Hal Davis, (USGS, Tallahassee, FL)

Tyler B. Coplen, (USGS, Reston, VA)

Thomas D. Bullen, (USGS, Menlo Park, CA)

In the mantled karst terrain of northern Florida, the water quality of the Upper Floridan aquifer is influenced by the degree of connectivity between the aquifer and the surface. Chemical and isotopic analyses (^{18}O , ^2H , ^{13}C , ^3H , $^{87}\text{Sr}/^{86}\text{Sr}$) of ground water and surface water along with geochemical modeling were used to identify the dominant hydrochemical processes that control the composition of ground water as it evolves downgradient in two systems.

In one system, surface water enters the Upper Floridan aquifer through a sinkhole located in the Northern Highlands physiographic unit. In the other system, surface water enters the aquifer through a sinkhole lake (Lake Bradford) in the Woodville Karst Plain.

Differences in the composition of water isotopes (^{18}O and ^2H) in rainfall, ground water, and surface water were used to develop mixing models of surface water and ground water. Based on differences in ^{18}O and ^2H , the proportion of Lake Bradford water that mixed with meteoric water ranged from 7 to 86% in water from wells located in close proximity to the lake. In deeper parts of the Upper Floridan aquifer, water enriched in ^{18}O and ^2H from five of 12 sampled municipal wells indicated that recharge from a sinkhole (1 to 24%) and surface water with an evaporated isotopic signature (2 to 32%) was mixing with ground water.

The Upper Floridan aquifer is highly susceptible to contamination from activities at the land surface in the Tallahassee area. The presence of post late-1950's concentrations of ^3H in ground water from depths greater than 100 m below land surface indicates that water throughout much of the aquifer has been recharged during the last 40 years.

LONG-TERM RESPONSE OF SINKHOLE LAKES TO STORMWATER RUNOFF: BLUE-GREEN ALGAE BLOOMS AND DETERIORATION OF SECONDARY PRODUCTION IN LAKE JACKSON

R. J. Livingston, Professor and Director, Center for Aquatic Research and Resource Management, Florida State University, Tallahassee, Florida 32306-1100, Phone: 850/644-1466, Fax: 850/644-9829, e-mail: livingst@bio.fsu.edu

A 12-year study was carried out to determine the effects of urban runoff on north Florida sinkhole lakes. The FSU Lakes Program was based on a series of continuous field collections of data and field/laboratory experiments. Data were taken from 1988-1997 in Lake Jackson and from 1991-1997 in Lakes Lafayette, Hall, Munson, McBride, and Ella and No-Name Pond. Such information included monthly changes of primary habitat factors (water depth, Secchi depth, temperature, specific conductance, pH, dissolved oxygen, oxygen anomalies, nutrients [ammonia, nitrite, nitrate, orthophosphate, total phosphorus, total nitrogen], and chlorophyll *a*). Long-term changes of sediment nutrients, heavy metals, and PAHs were analyzed. Detailed studies of the biological organization of Lake Jackson were carried out concerning phytoplankton, submerged aquatic vegetation, zooplankton, infaunal macroinvertebrates, fishes, and trophic organization.

Lake Jackson is an Aquatic Preserve and Outstanding Florida Water, and has, in the past, been noted throughout the country for its bass fishing. The lake is a closed system with inputs from three major drainages: Megginnis Creek (draining portions of the southern basin that are highly urbanized), Ford's Creek (draining portions of the southern basin that have been recently urbanized), and Ox Bottom Creek (draining the northeastern basin where urban development has also begun).

Long-term changes of water chemistry of Lake Jackson indicated significant increases of conductivity in areas receiving storm water runoff. These trends were accompanied by a gradual loss of light penetration in the lake. Ammonia concentrations were also significantly higher during the last three years of sampling (compared to the first year) at various Lake Jackson stations whereas orthophosphorus concentrations were significantly lower. These changes were associated with development of blue-green algae blooms throughout the lake. General increases of TIN/TIP ratios over the sampling period reflected these nutrient trends. Chlorophyll *a* concentrations were significantly higher at various Lake Jackson stations during the last 3 years of sampling.

Continual urban runoff into Lake Jackson has led to increased frequency of blue-green algae blooms from 1988 to 1999. Sediment nutrient releases added to the bloom frequency. Dominant blue-green species (*Microcystis aeruginosa*, *Anabaena flos-Aquae*, *A. planktonica*) had spatial/temporal successions of dominance relationships. Significant associations were noted between bloom species and nitrogen concentrations (i.e., ammonia). During 1998, Lake Jackson reached a definitive state with habitat deterioration in the form of flocculent sediments, replacement of rooted vegetation by the

blue-green alga *Lyngbya*, and lake-wide blooms of blue-green algae. These blooms were associated with precipitous declines of phytoplankton species richness, and altered SAV distributions.

Hydrilla, an invasive exotic species, is known to proliferate in nutrient-enriched areas. This species became dominant in various areas of the lake affected by urban storm water whereas overall species richness of the benthic macrophytes decreased over the sampling period. Complex long-term trends of water and sediment quality, Hydrilla proliferation, and deterioration of submerged aquatic vegetation were noted with indications of direct and indirect competitive interactions between the benthic macrophytes and the blue-green algal blooms.

Sediment studies indicated that sites receiving urban storm water had higher silt, clay, and organic components than unpolluted reference sites. Total numbers of individuals of infaunal macroinvertebrates collected over a 12-month period at an unpolluted reference site was approximately 3.5 times that of areas affected by urban runoff. Infaunal species richness was also higher at the reference site with fifteen more taxa taken in unpolluted waters. Fish stomach analyses indicated deterioration of associated food webs with consumption of less profitable prey types and sizes and greater incidence of empty fish stomachs in areas affected by urban runoff and blue-green algae blooms. From 1988 through 1997, there was a progressive decline in the size of largemouth bass in Lake Jackson. Periodic herbicidal applications for Hydrilla control appeared to exacerbate the adverse effects of the blue-green algal blooms on fish feeding in Lake Jackson. There appeared to be a direct connection between the increased incidence and proliferation of blue-green algae and adverse impacts on the trophic response of fishes in Lake Jackson.

During the drought of 1999-2000, considerable portions of Lake Jackson disappeared into the sinkholes of the lake. After the lake dried out, about \$8 million was spent to remove contaminated sediments of the lake. However, preliminary water quality analyses after Lake Jackson started to fill during July 2000, indicated that Megginnis Arm was filled with polluted water and major blooms of blue-green algae. Current water quality indices used for determination of the effects of nutrient loading are inadequate due to sediment nutrient changes and the effects of blue-green algae blooms on water quality. The key to the analysis of lakes affected by urban runoff and anthropogenous nutrient loading is an understanding of long-term changes of water/sediment quality and the response of aquatic plants (i.e., benthic macrophytes and blue-green algae) which undergo complex, long-term changes due to biological interactions such as competition that result in the elimination of natural aquatic plant biota. These changes then lead to adverse responses by benthic invertebrates and altered trophic processes of associated fish assemblages that result in major reductions of useful secondary production in lakes affected by urban runoff.

Nutrient loading due to urban and agricultural runoff is destroying lakes throughout Florida. There is little in the way of regulation that is impeding the progressive deterioration of statewide freshwater resources.

THE DISAPPEARENCE OF LAKE JACKSON, A KARST BASIN LAKE

Thomas M. Scott, Florida Geological Survey, 903 West Tennessee Street, Tallahassee, Florida 32304-7700, e-mail: thomas.scott@dep.state.fl.us

Lake Jackson, a 4000 acre karst basin lake north of Tallahassee, Leon County, Florida, partially drained into Porter Hole sinkhole during September 1999. In early 2000, the remainder of the lake disappeared into the Floridan aquifer system through Lime Sink, one mile west of Porter Hole. The loss of Lake Jackson through these sinkholes provided an excellent opportunity to investigate the lake basin, study the subsurface sediments through exploring Porter Hole and drilling cores and to educate the public concerning karst geology, groundwater-surface water interaction, hydrogeology of the Floridan aquifer system and geomorphology.

Porter Hole Sink became visible during the evening hours of September 16, 1999 during a “fishing frenzy” as local residents caught large-mouth bass by hand. Spectators gathered around the sink despite the often more than a foot deep organic-rich mud. A few people became mired up to their waists in the mud.

Water flow into the sink decreased slowly for several weeks. October 7, 1999, the remaining limited flow was dammed off and scientists entered the hole for the first time. This trip into the sink and numerous subsequent trips allowed for the investigation of the cavities and documentation of changes in the cavities over a year and one-half. Cavities explored and mapped extend to the northwest, east and southeast from the sinkhole throat. The maximum estimated depth explored was 45 feet below the lake bottom with the deepest point being found in the eastern cavity.

Geologists, examining the sediments exposed in the sink, determined that the bottom of the accessible portions of Porter Hole Sink were developed in the limestone of the Lower Miocene (approximately 23-22 million years old) St. Marks Formation. The St. Marks Formation forms the uppermost portion of the Floridan aquifer system in this area. The St. Marks Formation was overlain by the dolostones and siliciclastics (sands and clays) of the Lower Miocene

(20-18 million years old) Torreya Formation, Hawthorn Group which confine the Floridan aquifer system. Holocene (less than 10,000 years old) lake bottom sediments were suprajacent to the Miocene sediments. Five cores were drilled on the lake bottom to investigate the subsurface formations. A 119 feet deep core drilled approximately 100 feet southwest of Porter Hole encountered the Lower Oligocene (36-30 million years old) Suwannee Limestone at 67.5 feet below the lake bottom (blb). The top of the St. Marks Formation was at 36.5 feet blb and the Torreya Formation was at 8.5 feet blb. Other cores revealed a highly variable subsurface picture.

The draining of the southern portion of Lake Jackson through Porter Hole Sink and, to a lesser degree, the lowering of the northern part of the lake in Lime Sink, created a media sensation. Information was communicated to the public through discussions on site,

lectures to civic groups and homeowners' associations, TV news reports, talk shows, and display posters at boat landings (former). PBS and NPR documentaries by Georgia Davis and Buz Conover, respectively, educated the public about sinkholes in general and the "happening at Lake Jackson." A unique approach to educating the public came through the running of the Lake Jackson Bare Bottom 5K Run/Walk. At the event, the Florida Geological Survey and the Northwest Florida Water Management District set up displays, handed out educational materials and fielded questions. More than 325 runners/walkers participated in the event. Overall winners received trophies made of rocks from Porter Hole Sink. The most important factor in educating the public is utilizing terminology that nonscientists understand. A Florida Geological Survey Special Publication on the 1999 – 2000 draining of Lake Jackson is being prepared.

Key Words: Karst, education, sinkholes, hydrogeology

**MODELING THE HYDRODYNAMICS OF KARSTIC
CLOSED LAKE SYSTEMS,
LAKE JACKSON, TALLAHASSEE, FLORIDA**

Will Evans, Professional Geologist, Florida Geological Survey, FDEP, 903 West Tennessee Street, Tallahassee, Florida 32304-7700, Phone: 850/488-9381, Suncom: 278-9380, Fax: 850/488-8086, e-mail: evans.william@dep.state.fl.us

Fluctuations in lake levels are known to involve seepage beneath lakes. Lake level decline due to seepage is governed by the effective-head gradient acting across the lake bottom, the hydraulic conductivity of the lake bottom, and the hypsometry of the lake basin. The conductivity and hypsometry are constant for geologically short periods of time, and the head gradient is determined by the lake level. Thus, as a lake level declines, the hydraulic gradient decreases, and the rate at which the level of a lake declines is a function of its level. After accounting for the effects of potential evapotranspiration (PET) and delayed recharge, fluctuations in lake level should resemble a series of exponential decay curves whose parameters reflect basin hypsometry and lake-bottom conductivity.

Hydraulic conductivity estimates of lake sediment cores were used to estimate seepage through the lake bottom by utilizing a weighted average approach. As lake levels and lake area fluctuated, the equivalent areal hydraulic conductivity (K_A) varied. A second order polynomial was derived to describe the variation in K_A . From the K_A estimates, seepage flow ($L^3 t^{-1}$), and seepage ($L t^{-1}$) through the lake bottom were modeled. Seepage flow, as a primary function of declining lake level, behaved exponentially. Seepage, as a function of seepage flow and lake hypsometry declined linearly with declining lake level. Lake PET was estimated from the modeled seepage and is approximately double that of the pan evapotranspiration data, which suggests that, the modeled PET is more representative of lake transpiration.

TWO RIVERS, THE KARST LAKES OF LEON COUNTY, AND THE FLORIDAN AQUIFER, WATER QUALITY DYNAMICS IN TIMES OF DROUGHT

Seán E. McGlynn, Ph.D., President, McGlynn Laboratories, Inc., 568 Beverly Court, Tallahassee, Florida, 32301 and Adjunct Professor, Florida State University, Department of Biological Science, Phone: 850/222-4895, Fax: 850/222-4895 and e-mail: mcglynnlabs@cs.com

A prolonged drought in North Florida has focused attention on the unique dynamics and interrelations between our lakes, rivers and the Floridan Aquifer. Surface and Ground Water interactions are common. Some of the Largest Lakes in Leon County, Miccosukee (6312 acres), Iamonia (5700 acres), Jackson (4325 acres) and Lafayette (1825 acres) were once tributaries of either the Ochlockonee or St. Marks Rivers that flow south into the Gulf of Mexico.

The underlying limestone of Leon County, Florida's Capitol County, is a maze of fractures and faults that facilitate the formation of solution basins and subsurface flows. Over the millennia the water flowing within these tributaries of the Ochlockonee

tributaries ceased flowing to the Rivers but developed channelized flow within conduits that now flow directly into the Floridan Aquifer.

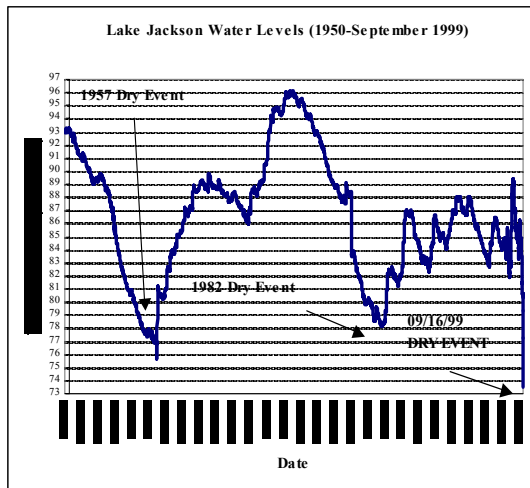


Fig. 1: Hydrocycle of Lake Jackson

River formed Karst connections to the aquifer. As these basins aged these



Fig. 2: Iamonia Sink, 10-15 cfs.

Caverns in the depths of these lakes, called Sinks, provide a direct path, a short circuit, to the Aquifer. The surface water, including the biota inhabiting these lakes, periodically disappears into these cavernous sinks. This paper presents water quality data in these lakes a function of their unique hydrocycle. The current drought allowed the

measurement of the acceptance rates of various sinks, some for the first time ever. Unique Lake Management opportunities were presented by these natural drawdowns. Restorations techniques such as sediment removal, proscribed burns and natural oxidation of sediment were employed to enhance these aquatic habitats.



Fig. 3: Lafayette Sink, 30-40 cfs.

In many instances human efforts proved to confound the natural benefits of the drawdowns. In the late 19th century, human



Fig. 4: Porter Hole Sink, Lake Jackson (10-12 cfs)

efforts were centered on draining the Lakes for agricultural purposes. During the early 20th Century, lake management shifted to impounding the lakes to maximize the recreational potential of the water body. After 50 years of impoundment most of these Lakes became nutrient enriched beds of topped out macrophytes. Lake management perspectives regarding this unique Karst region have again shifted in favor of the natural hydrocycle, which keeps the various aquatic communities in balance.



Fig. 5: Miccosukee Sink (40-50cfs).

POSTER SESSION 1

A REMOTE SENSING AND GIS STUDY OF LONG TERM WATER MASS BALANCE OF LAKE JACKSON, LEON COUNTY, FLORIDA

Stephen A. Kish, Department of Geosciences, Florida State University, Tallahassee, Florida 32306-4100, e-mail: kish@gly.fsu.edu

James H. Balsillie, Florida Geological Survey, 903 West Tennessee Street, Tallahassee, Florida 32304-7700, e-mail: Jim.Balsille@dep.state.fl.us

Katherine Milla, Division of Agricultural Sciences, Florida A&M University, Tallahassee, Florida 32307, e-mail: Katherine.milla@famu.edu.

Lake Jackson is a large (1600 ha), shallow lake (<4m) located 10 km northwest of Tallahassee, Florida. The lake has no surface outlets but is drained by sinks, including Porter Hole in the eastern portion of the lake, and Lime Sink in the western portion of the lake. Direct precipitation (128 cm/yr.) is the dominant source of water inflow for the lake, plus some runoff from the lake's watershed during major storms. Evaporation (~116 cm/yr) and lake bottom leakage are the only mechanisms that regulate lake level. There appears to be a very tight budget between inflow and outflow mechanisms; this produces major changes in lake level over short periods of time. These changes include periodic loss of the lake during drought and major flooding by the lake during periods of high rainfall.

Hydrometeorologic controls of lake level are being evaluated using remote sensing and GIS techniques to quantify parameters such as lake hypsometry, volume versus lake level, distribution of karst-related features, and variation in the permeability of lake bed sediments and underlying clastic and carbonate units. A new hypsometric map of the lake has been produced using air photos of the lake taken at different elevation stages, combined with ground-based leveling and GPS surveying. Preliminary evaluation of variations in lake level, rainfall, and evaporation suggest that sinkhole-related drainage is a very important factor in regulating the lake's surface elevation. Monitoring of the lake for management purposes, requires measurement of water levels within underlying aquifers, local rainfall, evapotranspiration and stormwater inflow.

PLENARY PROGRAM

Session 3 – Policy and Science Updates for a Variety of Critical Environmental Issues

Tuesday May 22, 2001

1:10 p.m. – 2:50 p.m.

Moderator: Sandy D'Alemberte – Florida State University

THE RELATIONSHIP BETWEEN THE FLOW REGIME ON THE APALACHICOLA RIVER AND MANAGEMENT OF RESERVOIRS IN THE WATERSHED

Steve Leitman, Northwest Florida Water Management District, 5812 Old Federal Road, Quincy, Florida 32351, Phone: 850/627-3527, Fax: 850/875-4568, e-mail: leitman@tds.net

For the past decade Florida has been involved in negotiations with Alabama, Georgia and the federal government to develop a Water Allocation Formula for the Apalachicola-Chattahoochee-Flint watershed. These negotiations are part of the process of establishing the first Interstate River Basin Commission in the U.S. since the early 1970s. At the heart of Florida's negotiating position has been the protection of the flow regime in the river and into the estuary. As consumptive demands in the basin increase, the only means of protecting the flow regime is through conservation and other demand management measures and reservoir management. The capacity of the reservoir system to offset consumptive losses in the basin is limited because of the volume of storage available for flow augmentation is small relative to flow in the Apalachicola River.

Using a fixed set of forecasted consumptive demands for the year 2050, the effect of alternative reservoir management approaches on the flow regime are evaluated using a computer simulation model of the Basin. Comparing the resulting flows and reservoir elevations with the historical flow regime shows that management of the reservoir system is critical to determining whether in the future the lower portion of the flow regime will resemble historical flows or be substantially less than historical flows. The potential ecological effects of these actions are cause for alarm, but are uncertain since the conditions that could be experienced have never occurred in the basin for a sustained period of time.

INTERSTATE ISSUES REGARDING WATER QUALITY IN THE OCHLOCKONEE RIVER

Kevin R. Pope, Environmental Compliance Director, Leon County Growth and Environmental Management, 3401 West Tharpe Street, Tallahassee, Florida 32301, Phone: 850/488-9300, Fax: 850/487-7956, e-mail: kevinp@mail.co.leon.fl.us

Seán E. McGlynn, Ph.D., President, McGlynn Laboratories, Inc., 568 Beverly Court, Tallahassee, Florida, 32301 and Adjunct Professor, Florida State University, Department of Biological Science, Phone: 850/222-4895, Fax: 850/222-4895, e-mail: mcglynnlabs@cs.com

The Ochlockonee River flows 162 miles, from Southwestern Georgia into the Gulf of Mexico at Panama, Florida. Three of the Largest Lakes in North Florida, Talquin (8850 acres), Iamonia (5700 acres) and Jackson (4325 acres), all lie within the drainage basin of the Ochlockonee River. Lake Talquin, the largest Lake in the area is an impoundment of the Ochlockonee River, and as such is fed directly by the Ochlockonee River. The Ochlockonee River periodically flows into Lake Iamonia, through a series of sloughs, which connect the two bodies of water.

The Ochlockonee River impacts more than half the surface waters of Leon County, Florida. The degraded nature of the Ochlockonee water coming from Georgia has been well documented. Three studies by the Florida Department of Environmental Protection (FDEP) found very poor water quality in the Ochlockonee River. Water quality data from the Florida Fish and Wildlife Commission and Florida LAKEWATCH also document the nutrient problems associated with the Ochlockonee River. Data received from the Georgia Department of Environmental Regulation, taken by the United States Geological Survey further corroborate the problems associated with water quality on the Ochlockonee River in Georgia. Additional sampling was requested by the Leon County Board of Commissioners to document the impacts on area Lakes associated with the Ochlockonee River.

Water quality within the Ochlockonee River has further deteriorated since these reports were issued. The water of the Ochlockonee River, during a period of base flow caused by the drought, seemed to be almost entirely composed of STP discharges originating within the State of Georgia. Nitrates were commonly over 3 mg/L. Total Coliform and Enterococci bacterial assays routinely exceed Florida Surface Water Quality Standards for Class III Recreational Waters. This nutrient laden water has negative environmental impacts on Lakes Iamonia and Talquin, elevating the trophic status of these waterbodies, causing eutrophication excessive macrophyte growth and nuisance algal blooms.

A clean Ochlockonee River would revitalize Lakes Talquin and Iamonia and would itself be a boon to the people of Florida and Georgia who could once again utilize this magnificent River to the fullest. Both Lake Talquin and the Ochlockonee River are classified as Outstanding Florida Waters (OFW). The Ochlockonee River should be clear and clean. Fishing and Recreation would benefit. We should try to encourage the people of Georgia to adopt more effective water quality standards, similar to those here in Florida. Leon County has already organized one meeting with environmental officials from Georgia. Results of this meeting were an exchange of data between the two parties, a first step in the dialog necessary to clean this vital Florida River.

MERCURY IN FLORIDA'S ENVIRONMENT

Thomas D. Atkeson, Ph.D., Mercury Coordinator, Florida Department of Environmental Protection, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400

In 1989 monitoring by DEP, FWC and DOH found mercury in largemouth bass from the Everglades to average in excess of 2 ppm. Because of its potential neurotoxicity to humans, these findings led to issuance of Health Advisories to fishermen urging cessation of consumption of bass from the Everglades and limited consumption of several other species. Subsequent surveys have shown average mercury levels to exceed 0.5 mg/kg in the majority of freshwater lakes and streams in the Atlantic and Gulf Coastal Plain Provinces and down through the peninsular region and the issuance of advisories to limit consumption of bass from the affected waters.

Beginning in 1994, DEP, USEPA Region 4 and ORD, South Florida Water Management District, FWC, the Florida utility industry and others began collaborating on series of monitoring, modeling and research studies to determine the causes of the problem of mercury in the Everglades. Operating as the South Florida Mercury Science Program, our collaborators have demonstrated that the rate of mercury accumulation in the Everglades in 1990 is approximately 5-fold greater than in 1900, indicating that the problem is not simply a natural phenomenon. Comparisons of surface water inputs of mercury with atmospheric deposition measurements made by the Florida Atmospheric Mercury Study reveal that air sources of mercury are >95% of annual load to the Everglades. Consequently, a major area of focus for the SFMSP has emerged to elucidate the importance of air sources of mercury.

Also beginning in the early 1990's there have been significant reductions in the use of mercury in commercial products and industrial processes, vigorous pollution prevention activities, and source controls. The result of these has been significant declines in mercury emitted to the atmosphere, for example, in southern Florida emissions from medical and municipal incinerators have declined by over 95%.

Recent analysis of long term trend monitoring of mercury in Everglades biota suggests that beneficial trends are apparent. The nature of these trends and their potential relationship to emissions trends will be discussed.

THE EVERGLADES FOREVER ACT – AN ENVIRONMENTAL SUCCESS STORY

Frank Nearhoof, Florida Department of Environmental Protection, 2600 Blair Stone Road, MS 3560, Tallahassee, Florida 32399-2400, Phone: 850/921-9489, e-mail: frank.nearhoof@dep.state.fl.us.

In 1994 the Florida Legislature ended years of legal bickering with the passage of the Everglades Forever Act (EFA; Section 373.4592, F.S.). The EFA authorizes a comprehensive program providing funding, regulatory, research and monitoring, land acquisition, and construction activities to initiate the process of restoring and protecting the Florida Everglades.

Implementation of the EFA programs has produced some remarkable success stories thus far.

Excessive levels of phosphorus in inflows to the Everglades have been responsible for a number of adverse changes to the ecology of the Everglades. Therefore, reducing phosphorus levels is the primary goal of the EFA. The EFA requires the Florida Department of Environmental Protection (FDEP) to initiate rulemaking to establish a numeric phosphorus criterion for the Everglades while the South Florida Water Management District (SFWMD) simultaneously implements phosphorus load reduction programs. The required phosphorus reductions are being achieved by the SFWMD through two programs: (1) source reduction through implementation of agricultural Best Management Practices (BMPs); and (2) subsequent treatment for further reduction through construction of large wetland treatment facilities, termed Stormwater Treatment Areas (STAs) by the EFA.

Extensive research has been implemented in accordance with the EFA and the FDEP has conducted extensive evaluations and compiled the results into a detailed technical support document for rulemaking. The Department's evaluations indicate that a criterion derived from these evaluations is not statistically differentiable from the 10 ppb default criterion established by the EFA. The Department is preparing to proceed with rulemaking in advance of the EFA deadline of December 31, 2001.

The SFWMD has required Everglades Agricultural Area (EAA) farmers to implement BMPs for managing water, nutrients and sediments. The basin-wide EAA BMP program, which has been fully implemented since 1995, requires EAA farmers to achieve a 25% P load reduction from the EAA to the Everglades Protection Area compared with historic loads. The EAA load reductions have exceeded program requirements, having averaged 54% for the five years since full implementation of the BMPs. Phosphorus concentrations are also down, having averaged 108 parts per billion (ppb) for the five years since full implementation of the BMPs relative to the pre-BMP average of 173 ppb.

The EFA also requires the SFWMD to design and construct six STAs, totaling approximately 44,000 acres, for the purpose of further reducing phosphorus loads and concentrations from the EAA to the Everglades. The design goal of the STAs is to achieve an average outflow of 50 ppb. To date, the SFWMD has completed the construction of four STAs, totaling over 12,000 acres. Construction has proceeded both on schedule and on budget.

The operational STAs have consistently achieved phosphorus concentrations substantially lower than the 50 ppb design goal. The 3,800 acre Everglades Nutrient Removal Project, the original pilot project for the STAs which began operation in 1994, has been consistently achieving outflow concentrations of less than 25 ppb. STA-6, which began operation in 1997, has also been consistently achieving outflow concentrations of less than 25 ppb. STAs 2 and 5 have recently passed their startup operations and are also expected to achieve similar levels of performance.

The SFWMD is also conducting extensive research to optimize STA performance and to evaluate promising advanced treatment technologies that can be used in conjunction with the STAs to achieve further phosphorus reductions. The advanced treatment technologies include wetland treatment-based systems and chemical treatment-based systems. A modeling tool, the Dynamic Model for Stormwater Treatment Areas (DMSTA), is also under development by a consultant to the Federal Government working in coordination with State experts. The DMSTA will be used to translate research results into engineering design improvements for the STAs.

As EFA implementation continues toward its 2006 conclusion, an excellent framework has been established upon which the U.S. Army Corps of Engineers' 7.6 billion dollar Comprehensive Everglades Restoration Program can be built.

POLICY ISSUES ASSOCIATED WITH THE RESTORATION OF LAKE OKEECHOBEE

Jerry Brooks, Florida Department of Environmental Protection, 2600 Blair Stone Road, MS 3500, Tallahassee, Florida 32399-2400, Phone: 850/487-1855, e-mail: jerry.brooks@dep.state.fl.us.

Over the past decades, Lake Okeechobee, Florida's largest lake, has experienced a steady decline in water quality resulting from the delivery of nutrient-rich stormwater runoff from activities in the watershed coupled with the release of phosphorus from the lake's underlying mud, where past phosphorus loads have accumulated. Restoration efforts will be directed by the phosphorus reduction identified in the Lake Okeechobee phosphorus total maximum daily load and the management activities identified in the Lake Okeechobee Protection Act, section 373.4595, Florida Statutes. This legislation mandates restoring and protecting Lake Okeechobee using a phased watershed-based approach to reduce phosphorus loadings to the lake and downstream receiving waters.

Using a watershed approach allows flexibility in implementing management strategies, as new information becomes available. The responsible agencies have formed an interagency committee to assist with the implementation of the legislation. The restoration of Lake Okeechobee will require unprecedented cooperation between the public and private sector. Within the watershed, there is growing consensus among the stakeholders for immediate implementation of effective control measures. This kind of agreement and cooperation is essential if Lake Okeechobee is to be restored.

The costs to restore Lake Okeechobee will be funded through a combination of public and private resources. Restoration will require expensive local (best management practices) and regional treatment systems (part of the Comprehensive Everglades Restoration Plan), which will be funded through cost sharing. Achieving this balance will require close interaction with landowners in the watershed.

PLENARY PROGRAM

Session 4 – Lake Okeechobee

Tuesday May 22, 2001

3:10 p.m. – 4:50 p.m.

Moderator: Chuck Hanlon – South Florida Water Management District

POTENTIAL FOR SAV RECOVERY IN LAKE OKEECHOBEE AFTER YEARS OF HIGH LAKE STAGE AND HURRICANE IRENE

Matthew C. Harwell, South Florida Water Management District, 3301 Gun Club Road, P.O. Box 24680, West Palm Beach, Florida 33416-4680, Phone: 561/681-2500 x 4567, Fax: 561/681-6310, e-mail: mharwell@sfwmd.gov

In Lake Okeechobee, above average water depths from 1994 to early 2000 created poor light conditions on the bottom, raising questions about the recovery potential of submerged aquatic vegetation (SAV). Additionally, the SAV seed bank was potentially removed by a passing hurricane that generated water currents as great as 1 m s^{-1} . After a managed recession in Spring 2000, the potential for SAV recovery was examined in two ways.

First, an incubation study was conducted to determine if a viable seed bank had survived the hurricane, and to examine potential SAV seed germination under conditions typical of bottom irradiance values at high and low-lake stage ($\sim 100 \mu\text{E m}^{-2} \text{ s}^{-1}$ vs. $\sim 500 \mu\text{E m}^{-2} \text{ s}^{-1}$, respectively). Second, a field transplant study was conducted to examine the survival potential of Vallisneria americana, the dominant native macrophyte in the lake, in regions of the lake that had not supported SAV in the recent past.

Germination of V. americana seeds, and the emergence of Chara spp. suggest that Hurricane Irene did not eliminate the seed bank. Few differences in germination response to the two irradiance levels by V. americana indicate that lake stage may not be as important for seed germination as for seedling establishment. In general, V. americana transplants fared better in the peat sediments characteristic of their current habitat than in the sand sediments characteristic of areas where SAV has been lost in the recent past. If low water levels persist for several years, SAV abundance and distribution is predicted to increase in this lake.

**THE EFFECTS OF SHADING ON MORPHOMETRIC AND MERISTIC
CHARACTERISTICS OF WILD CELERY, *VALLISNERIA AMERICANA*,
TRANSPLANTS FROM LAKE OKEECHOBEE, FLORIDA**

H. J. Grimshaw, e-mail: jgrimsha@sfwmd.gov

K. Havens, e-mail: khavens@sfwmd.gov,

B. Sharfstein, e-mail: bsharfs@sfwmd.gov

A. Steinman, e-mail: astein@sfwmd.gov

D. Anson, e-mail: danson@sfwmd.gov

T. East, e-mail: teast@sfwmd.gov

R. P. Maki, e-mail: rmaki@sfwmd.gov

M. C. Harwell, e-mail: mharwell@sfwmd.gov

A. Rodusky, e-mail: arodusk@sfwmd.gov

K-R. Jin, e-mail: kjin@sfwmd.gov

South Florida Water Management District, 1480-9 Skees Road, West Palm Beach, Florida
33411, Phone: 561/681-2500, Fax: 561/681-2539

The effects of shading, on morphometric and meristic characteristics of *Vallisneria americana* from Lake Okeechobee, were investigated using a large, plastic-lined 7,700 L outdoor tank filled with lake water. Plants were grown in peat sediments, collected from the same area as the plant material, under ambient conditions of temperature (27.0- 30.6 °C) and photoperiod (13L:11D). Experimental PAR treatments, achieved by differentially screening plants with varying numbers of layers of neutral density screen, ranged from 8 to 155 $\mu\text{mole photons m}^{-2} \text{s}^{-1}$, which were from 1.1 to 21.6 percent of average incident irradiance.

Response variables examined included total, above-, and below-ground ash-free dry mass (AFDM); epiphyte AFDM; leaf area; number of leaves; mean and maximum leaf widths; and longest, average, and cumulative leaf lengths. More than sixty percent of these variables showed statistically significant treatment effects. With the exception of cumulative leaf length, all significant response variables decreased linearly with decreasing PAR.

INTEGRATING GIS AND GPS TO CREATE A HIGH RESOLUTION MAP OF SUBMERGED AQUATIC VEGETATION, LAKE OKEECHOBEE, FLORIDA.

Mark Brady, e-mail: mbrady@sfwmd.gov

Karl Havens, e-mail: khavens@sfwmd.gov

Dan Anson, e-mail: danson@sfwmd.gov

Therese East, e-mail: teast@sfwmd.gov

Chuck Hanlon, e-mail: chanlon@sfwmd.gov

Mathew Harwell, e-mail: mharwel@sfwmd.gov

Ryan Maki, e-mail: rmaki@sfwmd.gov

Andrew Rodusky, e-mail: arodusk@sfwmd.gov

Bruce Sharfstein, e-mail: bsharfs@sfwmd.gov

South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, Florida 33461, Phone: 561/686-8800, Fax: 561/682-6442

The spatial extent of submerged aquatic vegetation (SAV) in Lake Okeechobee has been drastically reduced over the past decade. A managed recession intended to lower lake stage from about 15 feet NGVD to 13 feet NGVD was implemented in April of 2000 to stimulate the recovery of SAV by increasing light availability. Due to below average rainfall during the wet season, continued water supply deliveries to local users, and high rates of evapotranspiration, lake stage has continued to drop well past the 13 foot target.

The goal of this project was to map the response of SAV to the lower lake stage conditions, as well as to establish a mapping methodology that would allow for standardized repeatable comparisons of SAV coverage over time in support of restoration and modeling efforts. Arc/Info GIS was used to create a grid of sampling cells covering the entire lake at 500m intervals. The coordinates for the center point of each sampling grid were loaded into Trimble® PRO-XR GPS units and associated data loggers. A data dictionary was developed using Trimble Pathfinder Office software, making data acquisition menu driven. Field crews navigated to the center of each sampling grid and logged SAV presence and density by species, water depth, secchi depth, and sediment type. The data loggers were downloaded weekly, and the resulting tabular data linked to georeferenced Arc/Info coverages. More than 1600 stations were visited in this manner. Maps were produced using ArcView 3.0. These maps were used to effectively communicate the response of SAV to the managed recession and to show that by October 2000, SAV covered approximately 43,000 acres of the bottom of Lake Okeechobee.

THE INFLUENCE OF A LAKE DRAWDOWN ON *CHARA* ABUNDANCE IN LAKE OKEECHOBEE

A. D. Steinman, e-mail: (astein@sfwmd.gov)

K. E. Havens, e-mail: (khavens@sfwmd.gov)

A. J. Rodusky, e-mail: (arodusk@sfwmd.gov)

B. Sharfstein, e-mail: (bsharfs@sfwmd.gov)

R. T. James, e-mail: (tjames@sfwmd.gov)

M. C. Harwell, e-mail: (mharwell@sfwmd.gov)

South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, Florida
33416-4680

The biomass of *Chara* (a benthic macroalga) was assessed at 42 sites in Lake Okeechobee during 1999-2000, as part of a long-term submersed aquatic vegetation (SAV) survey. In late April 2000, a 0.6 meter drawdown of Lake Okeechobee was conducted to establish improved environmental conditions for SAV re-growth. We compared *Chara* biomass both prior to and after the drawdown and evaluated the influence of various environmental variables (total and Secchi depths, surface and bottom irradiance, water column chlorophyll *a*, and total suspended solids) on growth. Since *Chara* was found to be positively associated with peat sediments, the comparisons were restricted to the 14 peat bottom sites.

Following the drawdown, water column irradiance and mean Secchi depth:total depth ratio were significantly increased, while water column chlorophyll *a* and total suspended solids were significantly decreased. *Chara* biomass among all sites was significantly greater during the post-drawdown period and had a strong association with the measured variables. These results suggest that growth of *Chara* is strongly influenced by the light regime in the water column, and are consistent with results from previous studies in Lake Okeechobee and in other lakes. We hypothesize that a positive feedback loop occurred, in which the shallower water column allowed greater light penetration to the sediments, resulting in increased *Chara* abundance. Increased *Chara* biomass then helped to stabilize the sediments, leading to further increases in water column transparency, which further improved conditions for *Chara* growth.

**NUTRIENT ENRICHMENT AND LIGHT GRADIENT BIOASSAYS AS A
TECHNIQUE FOR ASSESSING SPATIAL AND TEMPORAL DISTRIBUTION OF
LIMITING FACTORS AFFECTING PHYTOPLANKTON GROWTH IN
LAKE OKEECHOBEE, FLORIDA**

Bruce Sharfstein, e-mail: mbsharfs@sfwmd.gov

Therese East, e-mail: mailto:mteast@sfwmd.gov

South Florida Water Management District, 1480-9 Skees Road, West Palm Beach, Florida
33411, Phone: 561/681-2500, Fax: 561/681-2539

Lake Okeechobee has undergone cultural eutrophication during the past 50 years. Currently, the lake has high TN and TP levels and the light climate is strongly impacted by high turbidity as a result of wind driven resuspension of pelagic zone mud sediments. Previous bioassay results have indicated that in the early 1990s phytoplankton in the Lake were limited by nitrogen or light. Phosphorus limitation of phytoplankton growth was never encountered, in contrast with findings of frequent phosphorus limitation in the 1960s.

This paper reports the results of the first 3 years (10/97 to 11/00) of an ongoing bimonthly nitrogen/phosphorus/light limitation bioassay based assessment program at four stations representative of the major ecological zones in Lake Okeechobee. Compared to the early 1990s, the Lake was on average 0.5 m deeper and had an average 125.3% higher TP concentration during this time. Bioassay results indicated a continuing absence of P limitation, and an increase in light limitation relative to N limitation or NP co-limitation compared to the previous period. In the present period, predominant limitation status appears to be strongly influenced by station location and season. Strong relationships between limitation status and wind speed, chlorophyll content, tributary flow rates, or secchi depth:total depth ratios were also found to exist for a number of the stations.

Lake Okeechobee is now on the threshold of major environmental changes that will be driven by the Comprehensive Everglades Restoration Plan (CERP) and the Lake Okeechobee Protection Act. Restoration activities are geared to reduce both internal and external P loads to the lake with the ultimate goal of restoring P limitation of phytoplankton growth. As such, these bioassays might be a good early indicator of system functional recovery.

PLENARY PROGRAM

Session 5 – Aquatic Plant Management

**Wednesday May 23, 2001
8:30 a.m. - 10:10 a.m.**

Moderator: Don Hicks – Pinellas County

STATUS OF THE AQUATIC PLANT MAINTENANCE PROGRAM IN FLORIDA PUBLIC WATERS

Jeff Schardt and Judy Ludlow, Florida Department of Environmental Protection, 3900 Commonwealth Boulevard, MS 705, Tallahassee, Florida 32399, Phone: 850/488-5631, Fax: 850/488-4922, e-mail: judy.ludlow@dep.state.fl.us

Florida's aquatic plant management program mission is to reduce negative impacts of invasive non-indigenous plants. Non-native plants pollute 89% of Florida's 459 public lakes and rivers. Continuous maintenance of invasive non-native plants is needed to sustain navigation, flood control, and recreation while preserving native plant habitat on sovereign state lands.

Water hyacinth and water lettuce, which once covered more than 125,000 acres of public waters, covered approximately 1,530 acres during 2000 and are under maintenance control in 96% of the 235 public waters that they infest. Hydrilla populations impacted nearly 140,000 acres by the early 1990s and have been recorded in as many as 60% of Florida's public waters since 1991. Nearly 60,000 acres of hydrilla were reported in public waters in 2000, and is under maintenance control in 92% of the 182 public waters in which it was reported in 2000. The Florida Exotic Pest Plant Council lists 11 of the 21 non-native plants found in Florida public waters as Category I pest plants. Like hydrilla in the mid 1990s, some of these plants are on the verge of overwhelming lake and river marshes across the state.

Funding for identified aquatic plant control needs in Florida's public waters will be adequate beginning FY 01-02 through the *Florida Forever Act*.

This presentation will highlight the challenges and status of invasive plant management in Florida's public waters including hydrilla herbicide tolerance, and coordination of plans for increased funds in FY 2001-2002.

NUTRIENT DYNAMICS ASSOCIATED WITH AQUATIC PLANT MANAGEMENT IN LAKE ISTOKPOGA, HIGHLANDS COUNTY FLORIDA

Jennifer Brunty , e-mail: jbrunty@hotmail.com

Clell Ford, e-mail: highlands_lakes@hotmail.com

Highlands Soil and Water Conservation District, 4505 George Boulevard, Sebring, Florida
33875, Phone: 863/402-6545, Fax: 863/385-7028

Lake Istokpoga is an 11,000 ha lake with an average depth of approximately 2 meters located in the Lake Okeechobee drainage basin. Annual lake level fluctuations were reduced from 2 meters to 0.5 meters in 1962 with the installation of the S68 water control structure, resulting in an 800 ha accumulation of tussock along the north shore and around two natural islands. Hydrilla has also infested approximately 75% of the lake area.

Nutrients enter the northeast section of the lake through Arbuckle and Josephine Creeks and exit primarily through the structure at the southeast end of the lake. Previous nutrient studies suggest that the tussock and hydrilla remove approximately 11.5 metric tons per year, resulting in improved water quality in outflow water compared to inflow water. Previous studies also suggest that water quality declines following large hydrilla treatments.

Tussock removal, through lake drawdown, and hydrilla spraying will occur during spring 2001 and are expected to have some impact on lake nutrient dynamics and nutrient removal capacity. Total N, Total P, Chlorophyll, Total Suspended Solids and Color changes were monitored throughout the lake and in outfall water during the drawdown process. Nutrient changes throughout the lake are being monitored through the tussock removal and hydrilla spraying to determine changes in water quality and nutrient removal capacity of the lake.

USING PRESCRIBED FIRE FOR AQUATIC PLANT MANAGEMENT IN FLORIDA

Matthew V. Phillips, Department of Environmental Protection, Bureau of Invasive Plant Management, 2001 Homeland Garfield Road, Bartow, Florida 33830, Phone: 863/534-7074, Fax: 863/534-7181

Prescribed fire is used religiously in upland plant communities to restore or maintain various habitats by mimicking the natural effect of fire in the ecosystem. In the wetland environment though, it is rarely used as a management tool. It is ironic that, historically, fire has not only shaped upland plant communities but, under extreme environmental conditions, has influenced wetland communities as well. In wetlands, fire can set back successional processes by consuming organic soils and vegetation. In fact, fire, in addition to frost, rain, and changing hydrological conditions, is one of the major environmental events that effect the wetland environment.

Alone or integrated with other management methods, prescribed fire is an effective and efficient tool and has been used in the last several years by the Department of Environmental Protection's Invasive Plant Management Program. Several projects where prescribed fire was used to help achieve particular management goals in wetland environments were conducted in 1999 and 2000. Using prescribed fire in this environment requires the burn manager to be aware of a few additional factors than might be considered in an upland burn. The days following significant rain and soil moisture characteristics may be much more critical for the successful wetland burn than other factors and must be considered before executing a burn plan.

The results from using fire on the dried lake bottoms of Lakes Jackson, Iamonia, and Miccosukee in Leon County, Florida during the recent drought will be presented. The process, techniques and approach used to conduct prescribed fires on the dried lake bottom of Lakes Jackson, Iamonia, and Miccosukee provided a good model to achieve specific management goals for these and other systems. The initial results from post burn monitoring show a good response of desirable herbaceous vegetation and an immediate reduction in the target vegetation following prescribed fire. Continued monitoring will look at the long- term response of wetland vegetation to fire management.

**POST-BURN ASSESSMENT OF BALD CYPRESS
(*TAXODIUM DISTICHUM* VAR. *DISTICHUM*)
ON LAKE MICCOSUKEE, JEFFERSON COUNTY, FLORIDA**

Jess M. Van Dyke, Department of Environmental Protection, 3900 Commonwealth Boulevard, M.S. 710, Tallahassee, Florida 32399, Phone: 850/487-2600, Fax: 850/488-2216, e-mail: Jess.VanDyke@dep.state.fl.us

Matthew V. Phillips, Department of Environmental Protection, 2001 Homeland-Garfield Road, Bartow, Florida 33830, Phone: 863/534-7074, Fax: 863/534-7181, e-mail: Matt.V.Phillips@dep.state.fl.us

Donald D. Eggeman, Fish and Wildlife Conservation Commission, 620 Meridian Street, Tallahassee, Florida 32399, Phone: 850/488-4068, Fax: 850/413-0381, e-mail: EGGEMAD@gfc.state.fl.us

Lake Miccosukee is an impounded, 2525 ha lake/marsh. Though heavily vegetated prior to impoundment, floating islands and a broad band of shrubs occupied 20% of this system after water level stabilization in 1957. In 1989, an interagency committee developed a management plan that recommended periodic "drawdowns" and testing of "controlled burning techniques to provide optimal marsh habitat." In a joint effort of the Fish and Wildlife Conservation Commission and the Department of Environmental Protection, the impoundment structures were opened on March 1999. By October 1999, the water level had dropped 2.9 m. In February and March 2000, 500 ha of lake bottom and 600 ha of wetland and upland habitats were burned to improve lake bottom drying and removed the large biomass of dead vegetation. In January 2001, 1200 ha of the system were burned. Because of manpower and funding limitations, the fires were contained by lines in the uplands and allowed to burn through the fringe of bald cypress (*Taxodium distichum* var. *distichum*).

In order to evaluate the impact of fire on the beneficial, non-target cypress, field methodology was developed. Trees were categorized according to the percent of the circumference of the buttress that was charred (Rank 5 = 0-20%, Rank 4 = 20-40%, Rank 3 = 40-60%, Rank 2 = 60-80%, Rank 1 = 80-100%, Rank 0 = fallen), where "charred" means burned through the bark and cambium. In February 2001, a total of 1300 trees were evaluated in thirteen, band transects. For long-term evaluation, an additional 300 trees were assessed for basal charring, then tagged and geo-referenced.

As reported in southern pine, there was an inverse relationship between tree diameter and the percent circumference charred. Larger trees were less likely to be girdled by fire, while seedlings and saplings were killed outright. Fire frequency also had a significant impact. A second, annual burn resulted in twice the percent charring and four times the tree fall as a single prescribed burn. Finally, firing technique was important. An intense, prolonged fire caused 40% of the trees in one plot to have greater than 60% basal charring. An additional 15% of the trees in that plot were toppled by fire. However, two plots burned via multiple stripping resembled the unburned, control plot with little charring and had no fallen trees. Future monitoring of tagged trees will reveal whether or not a simple, field observation (% basal charring) made shortly after a fire can accurately predict long-term mortality in bald cypress.

TORPEDOGRASS (*Panicum repens*) MANAGEMENT IN LAKE OKEECHOBEE - THE BATTLE HAS BEGUN

Chuck Hanlon, South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, Florida 33416, Phone: 561/682-6748, e-mail: chanlon@sfwmd.gov.

During the past 25 years, much of the littoral landscape in Lake Okeechobee's 40,000 ha marsh has been impacted by the spread of torpedograss (*Panicum repens*) an exotic perennial. Torpedograss has displaced more than 7,000 ha of native plants in the lake's marsh and it continues to invade new areas. Because plant density can exceed 1,000 stems m² and the dissolved oxygen concentration below thick mats of plant thatch is commonly less than 1 ppm, areas impacted by torpedograss generally provide poor habitat for wildlife.

Research was conducted between 1995 and 1999 to develop treatment methods that can be used to control torpedograss in Lake Okeechobee. Treatment efficacy varied considerably within and between treatments suggesting that environmental conditions may have an effect on treatment efficacy. Greater than 90% torpedograss control was achieved in some unburned areas following one or two herbicide treatments while almost no control was observed at nearby replicate treatment sites. Burning dense stands of torpedograss prior to treating re-growth with a single herbicide treatment resulted in more than 3 years of control (> 90%) and a rapid reestablishment of native plants throughout the burned areas.

For the first time in Florida, large-scale torpedograss treatments have begun. Treatments in Lake Okeechobee's marsh are based on best available technology and include combining prescribed fires with a herbicide treatment. Since June 2000, nearly 7,000 ha of torpedograss have been burned and nearly 800 ha of burned and unburned torpedograss have been treated with herbicide. Additional treatments are planned for 2001. Monitoring to evaluate long-term treatment efficacy and quantify additional torpedograss expansion in untreated areas is continuing.

PLENARY PROGRAM

**Session 6 – Macrophytes and Macroinvertebrates as
Biological Indicators of Water Quality and Ecosystem Health**

**Wednesday May 23, 2001
10:30 a.m. – 12:10 p.m.**

Moderator: Ryan Maki – South Florida Water Management District

BIOASSESSMENT OF LAKES USING A SYSTEMATIC VISUAL SURVEY

Russel Frydenborg, Florida Department of Environmental Protection, Environmental Assessment Section, 2600 Blair Stone Road, M.S. 6511, Tallahassee, Florida 32399-2400, Phone: 850/921-9821, e-mail: russel.frydenborg@dep.state.fl.us

Julie Riley, Florida Department of Environmental Protection, Biology Section, 2600 Blair Stone Road, M.S. 6515, Tallahassee, Florida 32399-2400, Phone: 850/921-9828, Fax: 850/922-5368, e-mail: julie.riley@dep.state.fl.us

For several years now we have been looking to improve our bioassessments of lakes. The lakes of Florida are very diverse, so it has required analyzing many different biological and chemical components to get a clear picture of a lake's water quality. It has been determined for Florida lakes that water color is the most important factor to the macroinvertebrate community response. For lakes with a color value greater than 40 PCU, the macroinvertebrate response is not distinguishable. Therefore we turned to the algal community and the vascular plants to broaden the scope of the bioassessment. This presentation addresses the vascular plant part of these evaluations or a Systematic Visual Survey, which basically consists of an inventory of the macrophytes found submerged and in the littoral zone of a lake.

TROPHIC STATE INDICATORS AND PLANT BIOMASS IN FLORIDA LAKES

Bachmann, R. W., C. A. Horsburgh, M. V. Hoyer, and D. E. Canfield, Jr., Department of Fisheries and Aquatic Sciences, University of Florida, 7922 Northwest 71st Street, Gainesville, Florida 32653, Phone: 352/392-9617, Fax 352 846-1088, e-mail: mdbach@aol.com

Over the past three decades there have been many studies on the relationships between the nutrients phosphorus and nitrogen and phytoplankton standing crops. In contrast there is very little information on the role of these nutrients in determining the standing crops of macrophytes and the periphyton that colonize the surfaces of submersed plants. To answer these questions, we have sampled the biomass of macrophytes and water chemistry in over 300 Florida lakes and have looked at periphyton densities in 60 other lakes.

While we found significant reductions in the biomass of both macrophytes and phytoplankton when water color was over about 150 Co-Pt Units, for the other lakes there was no correlation between the standing crops of macrophytes and the concentrations of total phosphorus or total nitrogen except at very high values. We also found that periphyton densities showed slightly negative correlations with the concentrations of these nutrients. In most of our lakes the macrophyte biomass far exceeded that of the phytoplankton. There was also no relationship between the number of species of aquatic macrophytes in Florida lakes and the trophic state indicators total phosphorus, total nitrogen, chlorophyll, and Secchi disk depth. There was a positive relationship between the number of macrophyte species and lake area.

Since neither the numbers of species of macrophytes nor the various measures of macrophyte abundance showed any consistent relationship with several trophic state indicators in our lake sample, it seems unlikely that these plants will be useful as biological indicators of water quality and ecosystem health in Florida lakes.

HIGH RESOLUTION GAS CHROMATOGRAPHY (HRGC) METHOD FOR ANALYSIS OF SOME WIDELY USED CHLORINATED PESTICIDES AND PCBS IN PLANT TISSUES

Nageswara Rao Kode, Adrian Niculescu, Madhava Reddy Sathavaram and Mohammad Ghaffari,
Department of Chemistry, Florida Department of Environmental Protection, 2600 Blair Stone Road,
Tallahassee, Florida 32399-2400, Phone: 850/921-9766

An electron capture detector assisted High Resolution Gas Chromatographic (HRGC) method for the analysis of 20 Chlorinated Pesticides [1] and 16 Polychlorinated Biphenyl Congeners (PCBs) [2] from plant tissues has been developed. This method can be used to investigate any plant that grows in Florida lakes for the targeted [1] and [2]. The method detection limits are in the range of 2.4 to 5.0 µg/Kg.

Summary of the method: 25 g of the plant tissue was placed in a Waring blender and spiked with the target [1] and [2]. 100 mL of acetone was added and blended for one minute at high speed and processed through a series of steps to get the crude extract. The crude extract was chromatographed on a short column of florisil using methylene chloride as the eluent where all the chlorophylls were removed at this stage. The methylene chloride eluate was concentrated and subjected to Gel Permeation Chromatography (GPC) [3] to remove carotenoids and related large molecules. The resulting purified GPC fraction was concentrated and solvent exchanged to iso-octane and analyzed on a HP 5890 Gas Chromatograph equipped with dual columns (DB-5 and DB-1701) and dual ECD detectors [4].

RETENTION TIMES AND DETECTION LIMITS

Chlo. Pesticides [1]	(minute)	(minute)	GPC	GPC
Aldrin	26.66	26.78	0.48	2.4
Alpha-BHC	18.48	15.96	0.48	2.4
Beta-BHC	30.85	16.66	-	-
Delta-BHC	34.90	18.56	0.48	2.4
Gamma-BHC	22.08	17.86	0.48	2.4
Cis-Chlordane	45.33	40.21	0.96	2.4
Cis-Nonachlor	58.31	50.32	-	-
DDD-o,p	51.24	44.89	1.2	4.8
DDD-p,p'	57.48	49.79	0.96	4.8
DDE-o,p	41.43	38.47	0.72	4.8
DDE-p,p'	46.62	43.63	1.7	4.8
DDT-o,p	53.05	50.32	-	-
DDT-p,p'	59.44	54.92	1.4	4.8
Dieldrin	47.86	42.54	0.96	4.8
Endosulfan I	42.23	38.33	0.72	4.8
Endosulfan II	57.24	47.13	0.72	4.8
Endosulfan Sulfate	65.98	53.11	2.2	3.2
Endrin	50.74	45.81	0.96	4.8
Heptachlor	24.16	23.88	0.48	4.8
Hexachlorobenzen	15.60	16.53	-	-

RETENTION TIMES AND DETECTION LIMITS
(Continued)

Chlo. Pesticides [1]	(minute)	(minute)	GPC	GPC
Mirex	64.47	66.69	1.2	4.8
Methoxychlor	60.27	65.28	1.9	9.6
Trans-Chlordane	44.15	37.67	0.72	2.4
Trans-Nonachlor	45.73	41.05	0.96	2.4
Toxaphene	10-71	21-75	-	-
PCBs [2]				
PCB 8	15.97	15.85	0.48	2.4
PCB 18	18.75	18.40	0.72	2.4
PCB 28	22.92	22.15	0.96	2.4
PCB 52	26.95	25.65	-	-
PCB 44	30.75	28.30	1.2	2.4
PCB 66	37.95	34.94	0.48	2.4
PCB 101	41.02	39.02	0.48	2.4
PCB 118	51.41	48.74	0.72	2.4
PCB 153	53.47	51.94	0.72	2.4
PCB 105	55.88	52.40	0.48	2.4
PCB 138	57.88	55.59	0.48	2.4
PCB 187	58.80	57.76	0.48	2.4
PCB 128	62.04	59.00	1.2	2.4
PCB 180	65.55	63.86	0.48	2.4
PCB 170	69.38	67.14	0.48	2.4
PCB 195	73.55	71.93	0.48	2.4
PCB 206	80.44	78.94	0.72	2.4

[3] GPC conditions: Shimadzu LC 10AD with fraction collector FRC 10A, Phenomenex Envirosep 350 X 21.2 mm column equipped with 60 X 21.1 mm guard column, U.V detector at 254 nm were used. Solvent 100 % Methylene chloride at 4mL per minute. Calibration of the GPC column was done with the GPC calibration mix containing a) Corn oil RT 12.11 & 13.18, b) Bis(2-Ethylhexyl)phthalate RT 15.88, c) Methoxychlor RT 24.90, d) Perylene RT 17.94 e) Sulfur RT 29.94. The collection window was from 16.1 to 28.80.

[4]: HP 5890 GC OPERATING PARAMETERS FOR GC/ECD ANALYSIS

GC PARAMETER	SETTING	GC PARAMETER	SETTING
Temperature 1	80 degree C	Injector Temperature	250 degree C
Time 1	1 minute	Detector Temperature	325 degree C
Ramp 1	30 degree C per minute	Carrier Gas	Helium
Temperature 2	200 degree C	Constant Flow Pressure	A 20 psi/B 26 psi
Time 2	30 minutes	Total Flow Rate	36 mL per minute
Ramp 2	2 degree C per minute	Septum Purge Flow Rate	4 mL per minute
Temperature 3	270 degree C	Make up Gas	Nitrogen
Time 3	16 minutes	Make up Gas Flow Rate	55 mL per minute
Ramp 3	0 degree C per minute	Injection Mode	Splitless for 1 minute
Temperature 4		Injection Volume	0.5 uL/ 1.0 uL
Constant Flow: ON		R T Window	0.1/0.2 minute

(NOTE: The operating parameters for both columns are the same)

AQUATIC INSECTS OF FLORIDA AND WATER QUALITY

Manuel L. Pescador, Andrew K. Rasmussen and Barton A. Richard, Entomology/Center for Water Quality, Florida A&M University, Tallahassee, Florida 32307, Phone: 850/561-2214, Fax: 850/561-2221, email: manuel.pescador@famu.edu

Aquatic insects are a diverse and major biotic component of freshwater ecosystems, and their vital role in the food web, in nutrient cycling, and as biological indicators of water quality has been well documented. This presentation will discuss the major thrust of our aquatic research projects at Florida A&M University which include: 1) a comprehensive inventory of the aquatic insect fauna of Florida and analysis of their spatial distribution, and 2) documentation of certain responses in aquatic insects to environmental stress. For 10 or more years, we have been conducting comprehensive inventories of aquatic insects in the state with special emphasis on three major groups, the mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) commonly referred to collectively with the acronym “EPT” fauna. Published results of our studies are vital resources for the state’s water quality biomonitoring, watershed management and conservation programs.

We have found that Florida has a relatively high species diversity of EPT fauna which are as follows: mayflies - 81 species representing 42 genera in 15 families; for stoneflies, 42 species, 19 genera, 9 families; and caddisflies - 176 species, 44 genera, 20 families. Approximately seventy to ninety percent of these insect groups occur in the panhandle region. Prevalence of watersheds connected to the northern East Gulf Coastal Plain, Piedmont, and Blue Ridge physiographic provinces, the relative proximity and likely dispersal of species associated with the Mississippi River Basin, and the panhandle’s array of ravine forests, rivers, unspoiled steepheads creeks, and seepage bogs providing diverse habitats help explain the high species diversity in the region.

MACROINVERTEBRATE COMMUNITY STRUCTURE AND RESPONSE TO MARSH DRY-OUT IN A SUBTROPICAL CONSTRUCTED WETLAND

Michelle Lajti, Tammy Lynch, and Jana Newman, Ph.D., South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, Florida 33406

The Everglades is an oligotrophic ecosystem that is being negatively impacted by hydrologic changes and nutrient-rich runoff generated from urban and agricultural sources. The Everglades Forever Act requires the South Florida Water Management District to construct a series of treatment wetlands (ca. 17,000 ha) called Stormwater Treatment Areas (STAs) and optimize nutrient removal in runoff. STA optimization experiments are conducted in shallow, fully lined wetlands (test cells), about 0.2 ha in size. The test cells are located within Cells 1 and 3 of STA1-W.

One of the experiments conducted in the test cells as part of the Marsh Dry-Out Study (MDOS) was designed to assess the effects of a dry period on the phosphorus retention capabilities of a constructed wetland. Macroinvertebrate communities are sensitive indicators of aquatic ecosystem disturbance and were sampled to evaluate environmental conditions and to aid in establishing baseline data for future monitoring. Hester-Dendy samplers were used to compare macroinvertebrate communities located in the inflow and outflow regions of the MDOS experimental test cell and a control test cell.

Preliminary results suggest effects consistent with macroinvertebrate response to disturbance, indicating greater densities in the dry-down test cell when compared to the control test cell. Densities in the dry-down test cell inflow and outflow were 4158 organisms/m² and 2367 organisms/m², respectively, while densities in the control test cell inflow and outflow were 1208 organisms/m² and 208 organisms/m², respectively. Macroinvertebrate diversity (Shannon-Weiner Index) were greatest in the control test cell where densities were lowest. Crustaceans such as *Hyaella azteca*, *Argulus* spp., and *Daphnia* spp. dominated the fauna regardless of hydrologic conditions and fluctuation in taxonomic composition. However, decreased diversity and increased numbers of chironomids in the dry-down test cell suggest that the dry period had a negative effect on macroinvertebrate community structure.

POSTER SESSION 2

BLUE GREEN ALGAL EXPOSURE, DRINKING WATER AND PRIMARY LIVER CANCER

L. E. Fleming, and K. Shea, NIEHS Marine and Biomedical Sciences Center, University of Miami, Miami, Florida

C. Rivero, GEOCore GIS Facility, University of Miami

J. Burns, and C. Williams, Department of Environmental Sciences, St. Johns River Water Management District, Palatka, Florida

A. Rowan, and S. Wiersma, Florida Dept of Health, Tallahassee, Florida

The blue green algae (cyanobacteria) represent a diverse group of organisms that produce potent natural toxins. Although there has been little epidemiologic research on toxin effects in humans, a study by Yu et al (1995) found an increased association between primary liver cancer in humans and the use of surface drinking water sources. Surface drinking water supplies are particularly vulnerable to the growth of these organisms; in general, current US drinking water treatment practices do not monitor or treat for the blue green algal toxins.

This pilot study was an ecological study using a Geographic Information System (GIS) evaluation of the risk of hepatocellular carcinoma (HCC) and proximity to a surface water treatment plant at the time of cancer diagnosis. The study linked all primary liver cancers diagnosed in Florida from 1981-1998 with environmental databases on sampling, drinking water sources and treatment plants. A significantly increased risk for HCC with residence at diagnosis within the distribution area of a surface water treatment plant was found compared to persons living in unserved contiguous areas. However, this increased risk was not seen in comparison to persons living in randomly selected ground water treatment areas or compared to the Florida cumulative incidence rate for the study period, using various comparison and GIS methodologies. There are significant issues of latency, high population mobility, and the lack of individual exposure information. Nevertheless, the issue of human health effects associated with the consumption of surface waters possibly contaminated by blue green algal toxins merits further investigation.

Funded in part by the Florida Harmful Algal Bloom Taskforce, the Florida Marine Research Institute, and the Florida Cancer Data System.

Corresponding Author: Lora E Fleming MD Ph.D., Associate Professor, University of Miami School of Medicine, Department of Epidemiology & Public Health, P. O. Box 016069 (R-669) Miami, Florida 33101, Phone: 305/243-5912, Fax: 305/243-3384, email: lfleming@med.miami.edu

PLENARY PROGRAM

Session 7 – Phosphorus

Tuesday May 23, 2001

1:10 p.m. – 2:50 p.m.

Moderator: Kelli Hammer-Levy, Pinellas County

INFLUENCE OF DRY OUT AND RE-FLOODING OF ORGANIC SOILS ON PHOSPHORUS RETENTION WITHIN WETLAND MESOCOSMS

Christy A. Combs, Jana Majer-Newman, Ph.D. and M. Zaki Moustafa, Ecological Technologies Department, South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, Florida 33406, 561/682-2128 and 561/682-2820, Fax: 561/682-0100, e-mail: ccombs@sfwmd.com and jmnewman@sfwmd.com

The Everglades Forever Act mandated construction of wetland treatment systems, referred to as Stormwater Treatment Areas (STAs). The STAs have been designed to reduce the total phosphorus (P) concentration of stormwater runoff before it enters the Florida Everglades. Soils in many of these STAs are highly organic and when exposed to the atmosphere, such as during periods of dry out, may release phosphorus into the water column upon re-flooding and potentially reduce overall nutrient removal efficiency of the wetlands.

To determine the effect of dry out on phosphorus retention, the South Florida Water Management District conducted experiments within 24 mesocosms located in STA-1W. Twelve mesocosms are located at the inflow of STA-1W (North Site) and receive water with high P concentrations (average = 0.104 mg L^{-1}), while the remaining mesocosms are located at the outflow of STA-1W (South Site) and receive water with low P concentrations (average = 0.026 mg L^{-1}). Mesocosms at both locals are divided into two vegetation types (emergent and submerged) and two flooding regimes (continuously and intermittently flooded). At high phosphorus concentrations, both submerged and emergent treatments reduced influent P concentrations by approximately 75.5%. Phosphorus reduction was lower at the South Site when compared to the North, with P reduction of 45 and 31% for submerged and emergent treatments, respectively. Outflow concentrations at both sites were comparable, therefore decreased reduction was a factor of reduced influent concentration and not increased outflow concentration. Preliminary results indicate that re-flooding dry organic soils with a high inflow P concentration (North Site) produced an average 3 – 6.4 fold increase of outflow total phosphorus during the dry season and an average 2.5 – 3.4 fold increase during the wet season when compared to continuously flooded treatments (**Table 1**). These increases were approximately twice the amount of flux seen at the South Site (Dry Season YR 2000 – 2 fold increase; Wet Season YR 2000 – no significant average increase). Additionally, the North Site exhibited a longer period (approximately four to six time longer) of P release into the water column than the tanks at the South Site (**Figure 1**).

Vegetation type (emergent vs. submerged) did not appear to affect the level of phosphorus released into the water column, except during the YR 1999 dry season at the North Site when the submergent treatments released more P into the water column than the emergent treatments. This anomaly could have been due to several factors including a late startup of dry out submergent tanks, increased decomposition of submergent vegetation, or an increase in soil oxidation.

Treatment	Average Effluent Total Phosphorus (\pm SE) (mg L ⁻¹)							
	Interm Phase		Year 1999		Year 2000			
			Dry Season	Wet Season	Dry Season		Wet Season	
	North	South			North	South	North	South
Continuously Flooded Submergent	0.023 (0.001)	0.012 (0.001)	0.018 (0.001)	0.026 (0.002)	0.033 (0.002)	0.016 (0.001)	0.029 (0.001)	0.012 (0.001)
Intermittently Flooded Submergent	0.021 (0.001)	0.013 (0.001)	0.115 (0.016)	0.065 (0.010)	0.100 (0.018)	0.029 (0.004)	0.079 (0.015)	0.016 (0.001)
Continuously Flooded Emergent	0.023 (0.001)	0.016 (0.001)	0.018 (0.001)	0.048 (0.009)	0.032 (0.004)	0.018 (0.001)	0.024 (0.002)	0.021 (0.004)
Intermittently Flooded Emergent	0.029 (0.001)	0.015 (0.001)	0.070 (0.007)	0.048 (0.009)	0.116 (0.016)	0.033 (0.005)	0.081 (0.014)	0.021 (0.002)

Table 1. Average effluent total phosphorus concentrations of the north and south site mesocosms during the interm and dry out phases. The interm phase represents those time periods when tanks were flooded and not in the dry out phase. The dry out period was determined when intermittently flooded P concentrations returned within 0.004 mg L⁻¹ of control P.

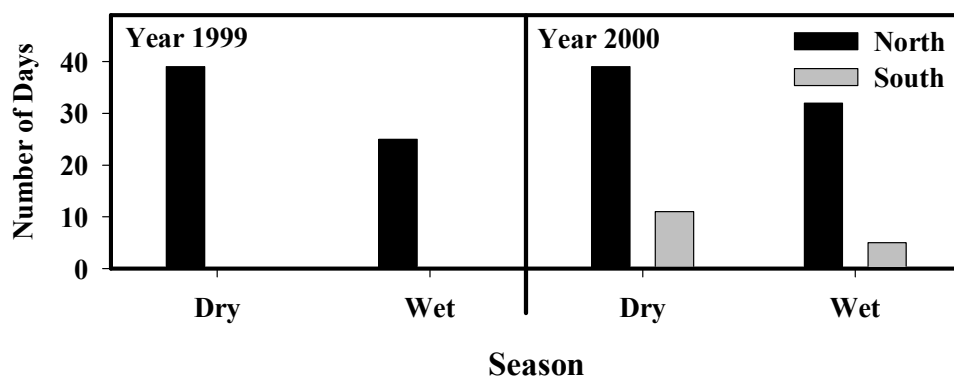


Figure 1. The number of days taken for the dry out treatment effluent P to return to control P concentrations during the wet and dry seasons in mesocosms located at the North and South Site.

COMPARISON OF SEDIMENT ACCRETION AND PHOSPHORUS STORAGE BETWEEN STORMWATER TREATMENT AREA 1 WEST (STA-1W) CELLS AND THE STA-1W TEST CELLS

Tammy Lynch, Jana Newman, Ph.D., and Michael Chimney, Ph.D., South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, Florida 33406, Phone: 561/682-2820, Fax: 561/682-0100, e-mail: jmnewman@sfwmd.gov

The Everglades ecosystem is known to be extremely sensitive to phosphorus (P) loading (Light and Dineen, 1997). The Everglades Forever Act (EFA) requires the South Florida Water Management District (District) to construct a series of large treatment wetlands (ca. 42,000 acres) called Stormwater Treatment Areas (STAs) to reduce nutrient levels in runoff to levels that will have no negative impact on the Everglades flora and fauna (Chimney and Moustafa, 1999). The EFA also requires the District to conduct research to develop an operational strategy that maximizes performance of the STAs. One part of this program involves conducting research in the STA-1W test cells, to examine how hydrologic conditions may influence STA performance; i.e., what water management scenarios will promote maximum TP removal efficiency. The test cells are shallow, fully lined wetlands, about 0.5 acres in size located in cells 1 and 3 of STA-1W (Chimney et al., 2000).

Feldspar horizon markers, sediment cores and sediment TP analyses were conducted in STA-1W Cells 1 through 4 (3,800 acres in total size), which has been operating since 1994 and in the test cells, which have been operating since 1999, at different hydraulic loading rates (HLRs) (0.78 to 15.5 cm/dy). These systems had inflow phosphorus loading rates of 0.24 to 3.93 g P/m²/yr and outflow phosphorus loading rates of 0.10 to 2.34 g P/m²/yr. Analysis of 1999 sediment data indicated that the range of accretion rates varied correspondingly (0.32 to 1.77 g P/m²/yr). This provides an interesting comparison between systems of such different sizes (**Table 1**). The data shows that the STA-1W cells have a lower sediment deposition rate (7.6 mm/yr) compared to the test cells (14.5 mm/yr). This difference is attributed to the length of time that each system has been operating; the STA-1W cells have been operating for 5 years whereas the test cells have been operating for only one year, therefore the sediments have compacted more in the STA-1W cells over time. The data also shows that the STA-1W sediment has a higher phosphorus content (884 mg P/kg) compared to the test cells (330 mg P/kg) while sediment bulk densities remain comparable suggesting differences in sediment accretion and/or mineralization of the two systems over time.

Table 1. Preliminary data for phosphorus inflow and outflow loading, sediment deposition, bulk density, phosphorus sediment concentration and sediment accretion rates for STA-1W and the Test Cells.

	TP Inflow Load (g P/m ² /yr)	TP Outflow Load (g P/m ² /yr)	Sediment Deposition (mm/yr)	Sediment Bulk Density (g/cm ³)	Sediment TP Concentration (mg P/kg)	Phosphorus Accretion (g P/m ² /yr)
STA-1W Cell 1	0.52	0.29	10.5* (9.0 – 13.4)	0.06 (0.03 – 0.11)	936 (307 – 1620)	0.57
STA-1W Cell 2	2.59	1.42	22.4** (6.1 – 37.0)	0.08	716	1.28

Table 1. Continued

	TP Inflow Load (g P/m ² /yr)	TP Outflow Load (g P/m ² /yr)	Sediment Deposition (mm/yr)	Sediment Bulk Density (g/cm ³)	Sediment TP Concentration (mg P/kg)	Phosphorus Accretion (g P/m ² /yr)
STA-1W Cell 3	1.14	0.34	19.7	0.07 (0.04 – 0.13)	1212 (964 – 1850)	1.77
STA-1W Cell 4	3.93	1.48	4.7 (1.4 – 11.9)	0.17 (0.04 – 0.69)	628 (344 – 924)	0.50
STA-1W (except Cell 5)	0.83	0.24	7.6 (1.4 – 13.4)	0.12 (0.03 – 0.76)	884 (307 – 1850)	0.81
Low HLR Test Cell	0.24	0.10	22.6 (15.0 – 32.1)	0.11 (0.07 – 0.18)	260 (168 – 325)	0.67
Control HLR Test Cell	0.86	0.41	5.7 (1.1 – 9.6)	0.33 (0.18 – 0.58)	172 (148 – 210)	0.32
High HLR Test Cell	3.30	2.24	15.1 (1.3 – 33.5)	0.07 (0.04 – 0.10)	558 (397 – 718)	0.60

* **Mean** (range of values).

**Values based on 1995 and 1996 feldspar data.

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PHOSPHORUS BINDING IN NUTRIENT MANAGEMENT AND NUTRIENT INTERCEPTION

Christopher B. Lind, Director of Environmental Products General Chemical Corporation, 90 East Halsey Road, Parsippany, New Jersey 07054, Phone: 973/515-1861, Fax: 973/515-4461, e-mail: CBL5602@aol.com or clind@genchemcorp.com

Regulations for the production of Comprehensive Nutrient Management Plans (CNMP) for Animal Feeding Operations and Confined Animal Feeding Operations will be in force and their goal is to reduce the runoff of nutrients and other pollutants from livestock waste generating facilities. CNMP's address all aspects of nutrient management from the feed additives to the ultimate disposal of the manure including land application methods. Bioavailable or soluble phosphorus - that which is readily and rapidly utilized by algae and bacteria - can be bound into insoluble forms that are not a nutrient to algae.

The purpose of the presentation is to provide an introduction/overview on the various technologies to bind/intercept nutrients to reduce the impact of runoff of receiving waters. Type of animal and the quantities of each waste produced will provide data on the phosphorus content of livestock waste. Alternative manure disposal and nutrient management technologies such as pelletizing, incineration, and feed additives will be discussed relative to the predominant chemistries utile for phosphorus binding. Phosphorus binding by iron calcium and aluminum salts will be discussed in light of solubility of phosphorus compounds produced and efficiencies of the binding material. Phosphorus reclamation from manure and waste streams as struvite or calcium phosphate, technology employed in Europe and Japan will also be overviewed.

The significant results and conclusions are to inform of some of the means to prevent or mitigate the introduction of nutrients into the water for which they are responsible. So informed the "Comprehensive" part of the CNMP might better protect water quality.

MANAGEMENT IMPLICATIONS OF REVISED HYDROLOGIC AND NUTRIENT BUDGETS FOR THE WINTER PARK CHAIN-OF-LAKES

Harvey H. Harper, Ph.D., P.E., Environmental Research & Design, Inc., 3419 Trentwood Boulevard, Suite 102, Orlando, Florida 32812, Phone: 407/855-9465, Fax: 407/826-0419

The Winter Park Chain-of-Lakes consists of four interconnected waterbodies, located in the cities of Winter Park and Maitland, which includes Lake Virginia, Lake Mizell, Lake Osceola, and Lake Maitland. These four lakes are the terminal lakes of an interconnected system of 21 lakes with a total drainage area of approximately 17 square miles. During the period from 1989-1992, the U.S. Geological Survey (USGS) performed a study of the Winter Park Chain-of-Lakes which presented preliminary hydrologic and nutrient budgets for each of the four lakes. During 1999-2000, this preliminary budget was updated by ERD to include updated stormwater characterization data, impacts of groundwater seepage on the hydrologic and nutrient budgets of the four lakes, and estimates of internal recycling of phosphorus. The significance of groundwater seepage inputs was evaluated by installation of monitoring of 31 groundwater seepage meters in the four lakes. The significance of internal phosphorus recycling was estimated by direct measurement of phosphorus release from large diameter lake sediment core samples incubated under aerobic and anoxic conditions.

With the exception of Lake Mizell, the most significant hydrologic input into the Chain-of-Lakes consists of inflow from creeks and streams, combined with interconnected lake flow. The most significant hydrologic input to Lake Mizell appears to be direct precipitation. The most significant phosphorus inputs into the Chain-of-Lakes appears to originate from stormwater runoff followed by interconnected lake flow and internal recycling. Inputs of phosphorus from groundwater seepage and direct precipitation appear to be relatively minimal in each of the four lakes.

The results of the nutrient budgets for the Chain-of-Lakes suggests that significant improvements in water quality can be achieved by treatment of phosphorus inputs originating from stormwater runoff and/or internal recycling. Phosphorus reduction efforts should be emphasized in upstream waterbodies, since the resulting improvements in water quality characteristics will migrate downstream to the remaining lakes. Reduction of phosphorus inputs from internal recycling should also be emphasized since this management technique is relatively inexpensive in terms of cost per kg of phosphorus removed.

NUTRIENT MANAGEMENT OF NITRATE RICH LAKES ON THE LAKE WALES RIDGE, FLORIDA

Keith V. Kolasa, Resource Management Department, Southwest Florida Water Management District, Brooksville, Florida 34604, Phone: 352/796-7211 ext. 4236, Fax: 352/797-5806, e-mail: keith.kolasa@swfwmd.state.fl.us

Ken Romie, Resource Data Department, Southwest Florida Water Management District, Brooksville, Florida 34604, Phone: 352/796-7211 ext. 4316, Fax: 352/754-6885 e-mail: ken.romie@swfwmd.state.fl.us

Laura A. Sacks, U.S. Geological Survey, Tampa, Florida 33634, Phone: 813/884-9336, ext. 138, Fax: 813/889-9811, e-mail: lsacks@usgs.gov

Nitrate-nitrogen concentrations in Florida lakes rarely exceed 0.25 mg/L (Romie, 2000; Hand, 1991); however, of the 96 lakes monitored on the Lake Wales Ridge, 21 exhibited median nitrate-nitrogen concentrations greater than 0.5 mg/L. These lakes are relatively small (less than 100 acres) and are primarily surrounded by soils noted as vulnerable to leaching of nitrates and pesticides (Choquette and Sepulveda, 2000). Nine lakes had median concentrations greater than 3 mg/L. Despite these high concentrations, eight of the nine lakes are characterized as oligotrophic lakes with low algal productivity and high transparency. For example, a maximum Secchi transparency of 18 m was recorded on one lake with a median nitrate-nitrogen concentration of 8.4 mg/L. These nine lakes have similar morphology. They are characterized as deep sinkhole lakes with depths ranging from 50 to 70 feet.

Significant and fairly strong Spearman rank correlations were observed between median nitrate concentrations of the 96 lakes and median conductivity ($S=0.609$, $p<0.001$), as well as with several major ions such as median potassium ($S=0.691$, $p<0.001$), median sulfate ($S=0.623$, $p<0.001$), and median magnesium ($S=0.693$, $p<0.001$). These ions have been identified as geochemical markers of citrus agriculture (Stauffer, 1991). Although the lakes with high nitrate concentrations (>3 mg/L) displayed low algal productivity, chlorophyll *a* concentrations and water clarity varied greatly ($0.4 \mu\text{g/L}$ - $46 \mu\text{g/L}$) in lakes with moderately high nitrate (0.5 mg/L - 2 mg/L). Overall, significant correlations were not observed between median nitrate of the 96 lakes and median Secchi, median chlorophyll *a*, or the median Florida Trophic State Index.

A positive correlation was found between the amount of ground-water inflow to 27 Ridge lakes (estimated from an isotope mass balance approach) and lake nitrate concentrations, suggesting that high nitrate lakes receive high amounts of nitrate loading from the ground water (Figure 1). For lakes with the highest nitrate-nitrogen concentrations (greater than 3 mg/L), ground-water inflow accounted for more than 75% of water-budget gains.

Phosphorus is clearly the limiting nutrient on these lakes with total phosphorus concentrations typically less than 0.01 mg/L. As residential development expands around these lakes, consideration needs to be given to the effect that increased phosphorus loading will have on lake trophic state. Preservation of water quality may depend upon the implementation of

management strategies that will limit or control phosphorus loading. For nitrate rich lakes in urban areas, retrofit of direct stormwater inflows should be evaluated. Long term water quality preservation and enhancement of these lakes will require the reduction of nitrate inputs through the implementation of agricultural and residential nitrogen reduction BMPs. Priority should probably be given to supporting fertilizer application BMPs such as implementing fertigation practices and residential education programs. Increased buffer zones for septic systems should also be considered, especially for areas where high density development is planned.

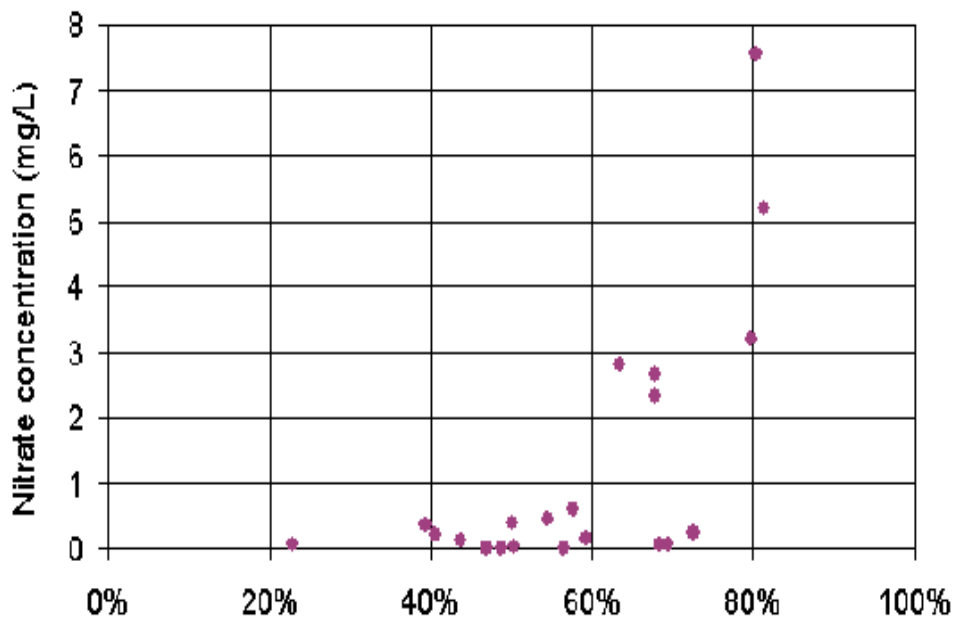


Figure 1. Nitrate concentration plotted against ground-water inflow to 27 lakes in the Lake Wales Ridge, Polk and Highlands Counties, Florida.

PLENARY PROGRAM

Session 8 – Sediments

Wednesday May 23, 2001

3:10 p.m. – 4:50 p.m.

Moderator: Sean P. McGlynn – Louisiana State University

HISTORIC SEDIMENTATION OF MERCURY, NITROGEN, AND PHOSPHORUS IN LAKE BARCO, FLORIDA

Scott Sigler, and Stephanie Smith-Moore, William M. Landing Ph.D., Department of Oceanography, Florida State University, Tallahassee, Florida 32306-4320, Phone: 850/644-6037, Fax: 850/644-2581, e-mail: wlanding@mail.fsu.edu; <http://ocean.fsu.edu>

Jaye E. Cable, Ph.D., Coastal Ecology Institute, 208 Old Coastal Studies Building, Department of Oceanography and Coastal Sciences, Louisiana State University, Baton Rouge, Louisiana 70803, Phone: 504/334-2390, Fax: 504/388-6326, e-mail: jcable@unix1.sncc.lsu.edu

The Florida Aquatic Ecosystem Mercury cycling and Modeling Project (FAEMCMP) was initiated to study and model Hg cycling in an acidic seepage lake in Florida in an effort to “re-calibrate” the Tetra Tech Mercury Cycling Model for sub-tropical environments. A seepage lake was chosen to minimize the departures from the Wisconsin seepage lake studies for which the model was developed. Lake Barco, located in the northern Central Lakes District near Keystone Heights, is an acidic seepage lake, typical of many such lakes in Florida. It was chosen because of its pristine and protected environment, the long history of hydrologic and biogeochemical investigations at the lake, and because it was one of the sites for the Florida Atmospheric Mercury Deposition Study (FAMS). We have a 5-year record (1992-1997) of rainfall Hg deposition, aerosol Hg concentrations and gaseous Hg concentrations from Lake Barco. One of the most important Hg removal mechanisms from lakes is burial in the sediments, and this portion of the FAEMCMP project was designed to quantify that particular process.

Cores were carefully collected by SCUBA divers to avoid disturbing the sediment/water interface along a transect across the center of the lake to establish the historic trends in the sediment accumulation rates of Hg(II), nitrogen, and phosphorus. Cores up to 60 cm in length were collected using sharpened polycarbonate push cores (3.8 cm internal diameter). Cores were extruded and sectioned immediately on the lakeshore, stored on ice, then frozen in the lab until processed. The cores analyzed for ^{210}Pb , ^{137}Cs , ^7Be , organic C and N, total Hg, and total P. Dry weight was determined by drying at 60°C for 36 hours. Organic matter content was determined by Loss on Ignition (dry ashing) at 550°C for 2 hours. Total C and N were determined using a Carlo-Erba NA1500 CNS analyzer. Total phosphorus was determined by colorimetric analysis following persulfate oxidation in an autoclave. Total Hg was determined by CVAFS following microwave wet digestion ($\text{HCl}/\text{HNO}_3/\text{HF}$). Methyl mercury was determined at Frontier Geosciences on thawed samples using aqueous phase ethylation, purging onto Carbotrap, isothermal GC separation and CVAFS detection. Radionuclides were measured by direct gamma radiation counting using a low background well-type intrinsic germanium detector.

In the organic-rich sediment in the center of the lake, bioturbation in the upper 1.5 cm is visible from the ^7Be profile, while the ^{137}Cs profile exhibits remobilization and downward diffusion in the ammonium-rich porewaters. Excess ^{210}Pb drops below detection limits from 7-8 cm, indicating an age of 100 ± 1 years at 6.5 cm depth. Using the constant rate of supply model, the shape of the ^{210}Pb profile requires an exponentially increasing sediment mass accumulation rate from 60 $\text{g}/\text{m}^2/\text{yr}$. in 1895 to a modern rate of 330 $\text{g}/\text{m}^2/\text{yr}$.

In the pelagic sediments, the lowest total Hg concentrations (75-80 ppb) were found between 50 and 35 cm (150-750 AD). Total Hg increased to 100 ± 10 ppb from 30 to 6.5 cm (950-1895 AD), then increased linearly to 190 ppb at the top of the core. These total Hg concentrations yield Hg sedimentation rates ranging from pre-1900 values of $3 \mu\text{g-Hg/m}^2/\text{yr}$, increasing linearly to modern values of $30 \pm 5 \mu\text{g-Hg/m}^2/\text{yr}$. This is 2x the modern wet deposition flux of total rainfall Hg, and suggests that aerosol Hg and RGM dry deposition are also important. The absolute carbon and nitrogen content of the sediment decreased towards the surface due to dilution by inorganic material. The C/N ratio in the sediments was relatively constant (22 gC/gN) from 30-50 cm depth then decreased smoothly to much lower ratios (18 gC/gN) in the upper 10 cm (representing the last 200 years). This is most likely due to increased atmospheric N loading, from $800 \text{ mg-N/m}^2/\text{yr}$ prior to 1900 increasing to $3,000 \text{ mg-N/m}^2/\text{yr}$ in modern times. The Hg/C ratio is used because Hg is often associated with the organic fraction of the sediments. This normalization shows that the Hg/C ratio increased slightly between 10-30 cm depth then doubled over the last 200 years. Total phosphorus increased from pristine concentrations of 150-200 ppm in the deep sections of the core to over 400 ppm in the upper sections. This indicates an increase in phosphorus loading from $11 \text{ mg-P/m}^2/\text{yr}$ prior to 1900 to $130 \text{ mg-P/m}^2/\text{yr}$ in modern times.

A mass-balance for total Hg and MeHg in Lake Barco was modeled using the Tetra-Tech Regional Mercury Cycling Model (R-MCM) (Reed Harris and Curt Pollman). A simplified model of the pathways of mercury cycling in a seepage lake includes wet and dry deposition plus leaf litter transport and ephemeral flow from the lake watershed during rain events. The average wet deposition of Hg to the lake surface was obtained from the FAMS program. The dry deposition of aerosol and reactive gaseous Hg was assumed to be approx. 50% of the wet deposition, based on other lake studies. Groundwater inflow was calculated using the hydrologic budget for the lake and our measured groundwater Hg concentrations (0.5 ng/L). Biological methylation is calculated within the R-MCM model. Output terms included measured sediment burial (scaled to the entire lake surface area). Groundwater loss (recharge) was based on our measured in-lake Hg concentrations and the hydrologic budget for the lake. Dissolved gaseous Hg (DGM) can be greatly supersaturated in Lake Barco surface waters during sunny days (Gill and Amyot, personal comm.) however the long-term average loss must be small in order for the total Hg budget to be close to balanced. The terms in the Hg budget with the greatest uncertainty are the dry deposition term, the sediment burial term, and the DGM evasion term. We need better methods of measuring or estimating dry deposition in order to constrain this value. The sediment burial term is uncertain since the sediments do not accumulate uniformly across the lake bottom. A more detailed study would include numerous dated cores and Hg profiles from across the lens of organic sediment in order to quantify the total burial of Hg. DGM evasion can be modeled using the traditional boundary-layer thin-film diffusion model, but are limited by a poor understanding of the effective exchange coefficients as a function of wind speed for this lake.

The history of mercury sedimentation in Lake Barco is consistent with the patterns seen around the world, with significant increases in Hg loading over the past 130 years. While global Hg budgets suggest only a factor of 3-4 increase in atmospheric loading, the Lake Barco Hg sedimentation rate increased by a factor of 14. In the absence of nearby point sources of Hg, we speculate that regional sources such as urban emissions in the Jacksonville area might be responsible for the large increase in Hg deposition. As we develop more accurate techniques for quantifying dry deposition of aerosol and reactive gaseous Hg, and for quantifying DGM evasion, our ability to accurately constrain and model the Hg budget for any water body will improve.

RECENT SEDIMENT HISTORY OF LAKE JACKSON, A KARST-CONTROLLED LAKE IN NORTHWEST FLORIDA

J. F. Donoghue, M. O. O'Sullivan, S. A. Kish, and S. W. Wise, Department of Geological Sciences, Florida State University, Tallahassee, Florida 32306, Phone: 850/644-2703, Fax: 850/644-4214, e-mail: jdonoghue@mailers.fsu.edu

J. Balsillie, Florida Geological Survey, Florida Department of Environmental Protection, 903 West Tennessee Street, Tallahassee, Florida 32304-7700

P. Krottje, T. Macmillan, and R. Bartel, Northwest Florida Water Management District, 81 Water Management Drive, Havana, Florida 32333

Lake Jackson is the westernmost of several large lakes of the Tallahassee Hills physiographic region of north Florida. The lakes represent a late stage in fluvial development, after enlargement of preexisting stream valleys by karst processes. The 109 sq. km watershed includes the 1600-hectare lake, with a maximum depth of 9.1 m. The karstic lake has drained at least 5 times during the 20th century, exposing most of the lake bottom. In September, 1999, a major draining event exposed most of the lake floor, enabling the collection of undisturbed bottom sediment cores.

Sediment cores (~50 cm. length) were collected at three locations on the lake bed. Core sub-samples were analyzed for bulk properties and lead-210 geochronology. Nearby core samples were also analyzed for trace elements. Lake Jackson sediment bulk densities were found to be quite low in the uppermost, organic-rich layers, increasing to densities typical of muck or loam soils at depth. Organic content was high in the upper parts of the lake sediment cores, averaging about 50%, decreasing with depth to 10% or less. Fine-grained mineral sediment ranged 10-20% in the uppermost sediments, increasing downcore to approximately 45%. Concentrations of trace metals in lake sediments immediately below the organic-rich layer appear to reflect pre-urbanized levels. Lead-210 analysis revealed that sedimentation rates at the sampling sites have increased substantially in recent decades, with present rates approximately 5-6 times pre-urbanization levels.

Input of organic material to the sediments has increased over the past century, while bulk density and the proportion of fine-grained mineral sediment have decreased. The core profiles indicate that accelerating urbanization of the formerly rural watershed, increased runoff, and the resultant increased inputs of sediments and nutrients have all played a role in significantly altering the quantity and character of the lake sediments.

LAKE CARLTON SEDIMENT PESTICIDE STUDY

Kate Himel, Biological Scientist III, Florida Department of Environmental Protection, Southwest District, 3804 Coconut Palm Drive, Tampa, Florida 33619, Phone: 813/744-6100 x442, FAX: 813/740-3906, e-mail: Katherine.Himel@dep.state.fl.us

In early 1998, many areas of Hillsborough County were aerially sprayed with Malathion to treat a citrus medfly infestation. In February 1998, following the medfly eradication effort, Lake Carlton, a 35-acre undeveloped lake surrounded by cypress wetlands in southern Hillsborough County, was one of several area lakes monitored by FDEP to characterize the effects of spraying on the water and sediment quality and benthic macroinvertebrate community.

Analyses included tests for semi-volatile organic pollutants and organochlorine, organonitrogen and organophosphorus pesticides in the water column and sediments obtained from the lake centers. The analytical results showed that Lake Carlton had a detectable level of DDT-p, p' (79 µg/Kg) in the lake sediment. The expected DDT degradation compounds of DDD-p, p' and DDE-p, p' were not detected.

The results obtained from the February 1998 samples prompted additional sediment monitoring in Lake Carlton to be conducted in May 1999. No DDT was detected in the sediment samples obtained and analyzed in the second set of samples, although relatively low levels of DDD (11 – 15 µg/Kg) and DDE (1.9 – 19 µg/Kg) were detected in the sediments in the northeast portion of the lake. Historical land use may explain the introduction of the pesticide to the lake basin; currently, there are very few residences on the lake and no known sources of DDT within its watershed. Depth, sediment particle-size distribution and prevailing wind direction may help explain the distribution of the pesticides in the lake sediments.

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

Thomas L. Seal, Gail M. Sloane and Thomas P. Biernacki, Florida Department of Environmental Protection, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400

Sediments in aquatic systems provide important habitat for benthic organisms, but also integrate contaminants within watersheds. Sediment quality issues and concerns are becoming more important to natural resource managers, especially in restoration and dredging projects. Regulating the water column alone can not fully assess or protect aquatic ecosystems, as water quality monitoring programs are not usually designed to assess cumulative impact of contaminants on aquatic ecosystems. Recognizing the need to answer sediment contamination questions, the Florida Department of Environmental Protection (FDEP) developed tools for assessment of estuarine and marine sediment, and now is developing similar tools for freshwater sediments.

To assess anthropogenic metal contamination in estuarine and marine sediments, FDEP developed a statistical tool based on natural distributions of trace metal concentrations to the major element aluminum. Preliminary evaluation of a freshwater sediment database (over 100 stations) indicates this geochemical relationship also exists in Florida's freshwater sediments. While chemical data provide information on possible contamination, they do not predict adverse effects on biota, or indicate the potential for biological effects. Therefore, to assess sediment quality with respect to biological effects, FDEP published a set of Sediment Quality Assessment Guidelines (SQAGs). These were derived adopting a weight-of-evidence approach developed by the NOAA National Status and Trends Program. The SQAGs identify minimal, possible, and probable biological effects predicted to coincide with ranges of sediment contaminant concentrations. SQAGs currently exist for 34 sediment contaminants, ranging from trace metals to organic contaminants. Development of freshwater SQAGs is underway, and will be complete by 2002.

USE OF LIQUEFIED ACTIVATED CARBON FOR BIO-DIGESTION OF ORGANIC LAKE BOTTOM SEDIMENTS

Larry D. Madrid, P.E., Principal, Madrid Engineering Group Inc., P. O. Box 2506, Bartow, Florida 33831, Phone: 863/533-9007, Fax: 863/533-8997, e-mail address: lmadrid@madridengineering.com

Liquefied Activated Carbon (LAC) was invented in 1991 by a Canadian firm and has been used successfully in Canada and the U.S. by the agricultural industry to assist microbial digestion of bio-solids from pig and dairy farms. LAC reduces the volume of organic solids by stimulating naturally occurring bacteria that can break down the organics. A technology transfer experiment was conducted in an urban lake to determine the effectiveness of LAC in removing organic sediments from lakes.

Approximately 700 liters of LAC was applied to a 6.7 acre eutrophic, shallow central Florida lake that had extensive deposits of highly organic sediment. The sediment was characterized by a 1-foot thick layer of loose, flocculent “fluid mud” overlying peaty muck. The lake was monitored for water quality and sediment characteristics over a period of 6 months. Test results indicate significant improvement of water clarity (Secchi disk readings), eradication of the flocculent sediments, deepening of the lake by over 1 foot, and reduction in the organic content of the near-surface sediments. Based on these results, LAC may become a new and innovative approach to lake restoration.

PLENARY PROGRAM

Session 9 – Lake Restoration

**Thursday May 24, 2001
8:30 a.m. – 10:10 a.m.**

Moderator: Michael Hill – Florida Fish and Wildlife Commission

LAKE AND WETLAND RESTORATION: THE APPLICATION OF RESTORATION ECOLOGY TO A WETLAND AND LAKE RESTORATION PROJECT

James C. Griffin, Southwest Florida Water Management District, 2379 Broad Street, Brooksville, Florida 34604-6899, Phone: 1-800/423-1476, Fax: 352/797-5806, e-mail: jim.griffin@swfwmd.state.fl.us

The twenty first century is in for two nasty ecological surprises. The first is what happens when unreasonable densities of human beings begin to acquire extraordinary technological abilities to modify environments, the second is when humanity turns to ecologists to solve the resulting problems. (adapted from statement by Howard Levene)¹

Restoration projects are both expensive and difficult to successfully complete. Hence, the decision to restore must be based on a good understanding of the problems to be solved by the proposed restoration, and the measurements of success that should be applied to the project. All too often restoration projects are planned and executed without the development of parallel scientific investigation goals that can provide the necessary understanding of the ecological mechanisms necessary for a successful project. Restoration ecology combines restoration activities and scientific investigation to establish a better understanding of restoration processes, develop a greater knowledge of the interactions of ecological systems and subsystems and codify this knowledge.

The paper's focus is the application of restoration ecology principles to a wetland and a lake restoration project. The subject projects have the overall goals of restoring wetland habitats and improving water quality. Additionally, the projects were proposed based on the recommendations of in-depth wetland and watershed studies. Finally, the projects presented opportunities to improve the general understanding of wetland restoration. The paper discusses the advantages of a pre-planned ecological investigation conducted in concert with a restoration project.

The McIntosh Park Wetland and Water Quality Enhancement Project² is located in the Black Water Creek watershed in Hillsborough County. The project has two primary goals. The first is to rehydrate and restore a historic wetland and the second is to provide water quality treatment for the 6301 acre Eastside Canal watershed. To accomplish these goals, a 100-acre historic wetland, part of a larger land parcel acquired through an environmental lands acquisition program, was selected for a wetland restoration.

One of the primary questions asked during this phase was: "what is the quantitative pollutant reduction capacity of the project?" Fortunately, studies conducted by the Southwest Florida Water Management District^{3 4} and other agencies⁵ are available to provide estimates of pollutant load reductions expected for wetland-treatment systems. However, several areas of study remain which are necessary to improve our understanding of wetland processes and allow a better answer to the posed question in the future.

The McIntosh Park project, like many planned restoration projects offers some unique opportunities to answer many of the remaining questions related to wetland treatment of

stormwater. As shown in Figure 1, the project provides convenient points for the measurement of the base and storm flow (diversion weir and control). By adding stormwater sample sites at these structures and within the wetland, the gross pollutant load reduction can be determined for various rain events and for various changes to the wetland structure. Additionally, pre-project water quality and loading values have been established by studies completed in 1999⁶. Hence, the project is ideal for evaluating wetland design parameters such as zonation, wetland dimensions and vegetation community structure as they relate to the stormwater treatment functions and survivability of the wetland.

Lake Seminole is a hypoeutrophic, 684 acre urban lake located in Pinellas County Florida. The lake was the subject of a feasibility study completed in 1992⁷ and a watershed management plan completed in 1999⁸. The primary goals of the restoration project are to control nutrient loading to the lake and reduce the lake's internal nutrient load. A primary tool that will be employed in the lake restoration project is the use of alum to reduce the pollutant load entering the lake through stormwater.

The use of alum raises two important questions. What is the comparative effectiveness of alum systems vis-à-vis a stormwater pond system? What are the short and long term effects of alum systems on flora and fauna? Again, there is a need to design studies in conjunction with the restoration project. The most immediate need is to begin collecting pre-project biological and water quality data. These data would then be used in conjunction with post construction data to answer the questions posed above. This project also has unique aspects that will allow the implementation of restoration ecological research as part of the project scope.

MANAGEMENT AND RESTORATION INITIATIVES IN THE SAND HILL LAKES OF NORTHWEST FLORIDA

Paul Thorpe, Northwest Florida Water Management District, 81 Water Management Drive, Havana, Florida 32333, Phone: 850/539-5999, Fax: 850/539-4380, e-mail: Paul.Thorpe@nwfwm.d.state.fl.us

In the sand hills of Bay, Washington, and Holmes counties, numerous karst lakes and sinks have formed from the dissolution of the underlying limestone and subsidence of the ground surface. Some of these are steep-walled, round sinks, while others can be characterized as broad, flat pans. The majority lack appreciable surface inflows or discharge streams, and many are dry during drought conditions.

These lakes are among the most oligotrophic in Florida. Many support distinctive littoral communities, frequently dominated by the state endangered endemic smoothbark St. John's-wort (*Hypericum lissophloeus*). Other rare plants supported by this habitat include the threatened Kral's yelloweyed grass (*Xyris longisepala*), threadleaf sundew (*Drosera filiformis*), and quillwort yelloweyed grass (*Xyris isoetifolia*). The benthic habitat can be either barren or, in some cases, support submerged aquatic vegetation such as bladderwort (*Utricularia* spp.). The upland watershed area in the Sand Hill Lakes consists of xeric sand hills covered primarily by sand pine plantations occupying former longleaf pine-wiregrass habitat.

The Sand Hill Lakes region encompasses the primary recharge area for that portion of the Floridan Aquifer that discharges into Econfinia Creek. Econfinia Creek and its receiving waterbody, Deer Point Lake, are Florida Class I waters that provide the primary source of drinking water for Panama City and Bay County. Surficial Aquifer water throughout the Sand Hill Lakes tends to leak through the Intermediate and into the Floridan Aquifer. This is indicated by Karst topography, closed surface water basins, and a general scarcity of perennial or intermittent streams.

To protect and restore water and habitat resources in the Sand Hill Lakes and to protect the waters of Econfinia Creek and Deer Point Lake, the NFWMD has acquired approximately 36,000 acres of land in the Econfinia Recharge Area. Land management and restoration activities include a major effort to reestablish the native longleaf-wiregrass forest ecosystem throughout the area and to protect wetland and aquatic communities in and around the lakes and Econfinia Creek.

Although the area is largely undeveloped, the landscape and lakes have been impacted by a variety of historical activities. Large-scale forestry has been the primary land use, and inappropriately placed dirt roads in particular have caused substantial erosion and habitat degradation. Off-road driving and associated erosion have also directly impacted littoral vegetation and lake bottoms.

To help address the lake impacts, the NFWFMD recently received a U.S. EPA 319(h) program grant. With the grant funding, the District contracted with the Orange Hill Soil and Water Conservation District to design and implement restoration plans for impacted sites. Erosion controls and vegetation restoration have been completed at two sites, and design activities are proceeding for four others. The District is also excluding vehicles from sensitive areas, and several inappropriate roads have been closed. Monitoring includes analysis of water quality and monitoring of littoral vegetation at restoration and reference sites.

Completion of this project, together with improved land and recreation management, is expected to result in long-term improvement and protection of water and habitat quality in the Sand Hill Lakes. Severe erosion and recreational impact problems will be alleviated, future problems will be avoided, and sensitive species will receive improved protection. This, in-turn, will help preserve and improve the quality of the lakes as recreational and educational resources for the citizens of Washington and Bay counties.

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SELECTIVE REMOVAL OF GRASS CARP FROM LAKE SILVER USING ROTENONE

Kevin D. McCann, City of Orlando Stormwater Utility Bureau, 400 South Orange Avenue,
Orlando, Florida 32801, Phone: 407/246-2234, Fax: 407/246-2512, e-mail:
kmccann@ci.orlando.fl.us

John A. Osborne, Ph.D., Department of Biology, University of Central Florida, P. O. Box 25000
Orlando, Florida 32816, Phone: 407/823-2980, Fax: 407/823-5769, e-mail:
josborne@pegasus.cc.ucf.edu

Lake Silver is a 64 acres lake located in Orlando Florida, which was stocked with 776 triploid grass carp between 1986 and 1989. Aquatic plant data indicated a shift from a diverse submerged plant community to predominantly filamentous and planktonic algae. A rotenone treatment was determined to be the only effective option for removing the grass carp so that a diverse plant community could be reestablished.

Thirty-five gallons of 5% rotenone was applied to Lake Silver on December 2, 2000 to achieve a whole lake dosage of 0.10 mg/l. This application resulted in the removal of 105 grass carp, which appears to be the remaining population. Threadfin and gizzard shad were the only native fish that had a low tolerance to this concentration of rotenone. Approximately 200 largemouth bass, which is believed to be a relatively small percent of the population, were collected following the treatment. No significant numbers of any other fish were affected.

Results from the Lake Silver project indicated that grass carp can be removed from lakes using rotenone with minimal impacts to native game fish if certain precautions are taken. The dosage of rotenone was determined with a bioassay using juvenile grass carp and centrarchids. The water and centrarchids were collected from Lake Silver to determine site-specific rotenone toxicity. The precautions used for the Lake Silver treatment included doing the application under un-stratified conditions with water temperatures less than 25 Celsius and choosing a time period when most game fish are not in shallow water spawning. Application techniques are also critical to avoid mortality to non-targeted species resulting from localized areas with elevated rotenone concentrations.

LAKE MUNSON RESTORATION PROJECT

Larry N. Schwartz, Ph.D., P.W.S., Principal, Environmental Scientist, Camp Dresser & McKee Inc., 2301 Maitland Center Parkway, Suite 300, Maitland, Florida 32751

Theresa Heiker, P.E., Chief, Stormwater Engineering, Leon County Public Works, 2280 Miccosukee Road, Tallahassee, Florida 32308

Once a viable wildlife habitat and recreational site, Lake Munson, in Leon County, Florida is now choked with aquatic vegetation, and sediments and trash had blocked the only streamflow to the lake with formation of a delta. Munson Slough and Lake Henrietta, just upstream of Lake Munson, were channelized and this accelerated delta formation and eliminated the natural treatment of stormwater in the Lake Munson Basin. System wide improvements are now underway to improve water quality, alleviate flooding, and restore the system to a more natural state. Upon completion of the ecosystem restoration activities, the natural system will provide the necessary stormwater treatment to protect Lake Munson.

The work described here consists of three main components; excavation of the Lake Munson delta (27 acres), improvements to Munson Slough, and restoration of Lake Henrietta and the adjacent wetland communities. Subsequent work efforts will include improvements in Lake Munson. Restoration of Lake Henrietta is critical to prevent the recurrence of the delta, provide natural stormwater treatment, additional flood storage, and recreational and educational opportunities for the public.

Stormwater and groundwater modeling was performed to provide the most suitable design for this system. Stormwater modeling included a hydrologic/hydraulic analysis of the drainage basin and determination of hydrologic and nutrient budgets, addressing precipitation, stormwater and baseflow conditions and groundwater seepage components. The model was also used to set structure elevations to restore floodplain wetland hydroperiods. The final design balances project goals and permitting, construction and maintenance requirements. This project addresses lake restoration, wetland restoration, stormwater management and sediment control, and recreational and educational uses.

PRELIMINARY DESIGN FOR THE RESTORATION OF Lake PANASOFFKEE (1) AND
ENHANCEMENT OF LAKE RESTORATION EFFORTS BY ACCESS CANAL DREDGING
(2)

Mohamed Alawi, Corresponding author: e-mail: Alawi@pbworld.com (1) and (2)

Janice Abaray, Parsons Brinckerhoff Quade & Douglas, Inc., 1000 Legion Place, Suite 1700,
Orlando, Florida 32801 (1)

Sharon Beverly, Parsons Brinckerhoff Quade & Douglas, Inc., 1000 Legion Place, Suite 1700,
Orlando, Florida 32801 (2)

Ronald Hart, Lake County Water Authority, 107 North Lake Avenue, Tavares, Florida 32278-
3119 (2)

(1)

The Southwest Florida Water Management District (SWFWMD) with the efforts of PB Water, a division of Parsons Brinckerhoff Quade & Douglas, Inc. (PBQD), has performed a preliminary design for the dredging of Lake Panasoffkee in Sumter County, Florida. Over the years, sediment build-up has promoted woody/shrubby vegetation to encroach on the east-southeast shoreline of the lake. As a result, almost 800 acres (or 22 percent of the lake area) of desirable habitat for fisheries has been lost since the 1940s. These factors negatively affected the lake's fishery, promoted increased shoreline vegetation and tussock formation, and limited the recreation and navigational uses of the lake. Concerned with its health, the Lake Panasoffkee Restoration Council (LPRC) prepared and presented to the Legislature a report on November 25, 1998, presenting a restoration plan for the lake. The restoration plan included six (6) steps, involving a substantial element of sediment removal.

The main objective of the preliminary design phase is to restore the historical fish bedding areas located along the northeast and western shorelines of the lake by dredging and removing the soft sediment from the 34-foot NGVD contour toward the shoreline to expose the hard bottom (e.g., shell deposits, sand, etc.). The preliminary design includes: 1) estimation of sediment types, horizontal and vertical distributions, and corresponding volumes and characteristics; 2) identification and site assessment of potential sediment disposal sites around the lake, and 3) preliminary sizing analysis of potential disposal areas.

Both field and GIS-based baseline vegetation and bathymetric surveys of the entire lake were performed to provide input to this study. In addition, a field coring and sampling program was conducted to collect sediment samples from the areas to be dredged. The samples were sent to laboratories to determine the sediment types and physical and chemical characteristics.

The average *in-situ* solids content was estimated at 28.5 percent for all sediment samples, collected to a maximum depth of five feet. However, the average solids content of the fine fraction of sediment (-10 U.S. Sieve) was measured at only 24.1 percent. Assuming a maximum dredging depth of three feet (i.e., to a minimum elevation of 34 feet NGVD), an average in-situ

solids content of 23 percent was estimated for the fine fraction of sediment and used to size potential sediment disposal area(s).

Three large privately-owned areas were identified around the lake and assessed as potential sediment disposal sites and a preliminary sizing analysis of potential disposal area(s) was conducted.

(2)

Since the decade of the 1970's, a marked increase in the eutrophication of Florida lakes has been observed. The measures taken in the 1940's and 1950's to ameliorate flooding altered the natural fluctuations of many lakes. This, combined with an increase in nutrients caused by agricultural run-off, has resulted in lower fish populations, increased turbidity and increased color in Lake Griffin, a member of the Harris Chain of Lakes.

Lake County Water Authority (LCWA) of Florida, in conjunction with the St. Johns River Water Management District (SJRWMD) and the Florida Department of Environmental Protection (FDEP), has embarked on a unique program to return Lake Griffin to a more natural fluctuation state, thereby allowing the flushing action of natural flows to lessen the nutrient level of the lake. The comprehensive program includes maintenance dredging of up to 36 access canals which provide navigation into the lake by local residents. The spoil from the canals will be used to help restore the Emeraldal Marsh Conservation Area, once a heavily utilized muck farm.

Over the last twenty years, the land at Emeraldal Marsh has subsided, sometimes allowing water to be trapped in the former agricultural areas. What were once hundreds of acres of saw grass marsh are now a compromised area full of highly turbid water, muck and organic silts. The land has also seen high levels of contamination from chlorinated pesticides. Recent efforts by SJRWMD have decreased levels of nutrients and pesticides on the Emeraldal property, but the long-range goal is to restore more natural vegetation to the area. It is hoped that marsh may once again thrive at Emeraldal.

Since the disposal area is a lowland, this project is the first of its kind. With the combined efforts of the government agencies listed and engineering by PB Water, a division of Parsons Brinckerhoff Quade & Douglas, Inc., the multiple goals of improved navigation for the citizens, restoration of Emeraldal Marsh and improved water quality in Lake Griffin can be attained. Early laboratory and field testing indicated that the settleability of solids had an inverse relationship to the organic content of the sediment. Further tests are planned which would give indications of settleability in actual field conditions, taking into account wind and other environmental factors. Initial solutions to settling problems included using filter cloth at the disposal site or employing a cyclone separator to divide the dredged material into coarse and fine fractions.

Phosphorus loading from the dredged material was a concern for the conservation area. Testing using alum as a coagulant indicated that a dose of 5 mg/L as Aluminum resulted in a reduction of more than half of the phosphorus in the supernatant of the sample. A dose of 10 mg/L as Aluminum resulted in a 67% - 90% reduction. Greater than 90% reductions were possible with an alum dose of 50 mg/L as Aluminum.

The agencies hope to use Lake Griffin as an example of how maintenance dredging and disposal of collected sediments can be beneficial for many different reasons. In this case, the residents benefit from improved navigation, as well as a return of a natural marsh area. Long-term benefits include restoration of Lake Griffin's flow patterns and improvements in water quality.

Keywords: *dredging, restoration, sediment, settling tests, lowland disposal area, lake fluctuations, eutrophication, Harris Chain of Lakes*

PLENARY PROGRAM

Session 10 – Habitat and Wildlife

Thursday May 24, 2001

10:30 a.m. – 12:10 p.m.

Moderator: Bruce Means – Florida State University

APALACHICOLA RIVER LOW-WATER STUDY

Tom Frick, Florida Department of Environmental Protection, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400. Phone: 850/413-0247, Fax: 850/922-4614, e-mail: thomas.frick@dep.state.fl.us

Hydrologic modifications from damming and consumptive uses along the Apalachicola-Chattahoochee-Flint River systems have reduced the amount of water delivered into Florida. This reduction in water, especially during periods of low flow, has Florida residents and regulators concerned about potential effects on aquatic life in the Apalachicola River, its associated slough systems, and in Apalachicola Bay. The Florida Department of Environmental Protection designed a study to investigate the effects of low water levels on habitat availability and biological health in selected sloughs of the river. Habitat assessment, habitat mapping, and Stream Condition Index sampling was performed at twenty-four sites in four slough systems. The goal of the project is to correlate water levels in the Apalachicola River to water quality, habitat, and biological condition in the sloughs. The first sampling was completed in July of 2000 to determine a baseline condition at the lowest water levels in the river. Further sampling, at different water levels, will be conducted this year.

INVESTIGATIONS OF MORTALITY AND REPRODUCTIVE FAILURE OF ALLIGATORS IN LAKE GRIFFIN, CENTRAL FLORIDA

James Perran Ross, Florida Museum of Natural History, Gainesville, Florida 32611, Phone: 352/846-2566, Fax: 352/392-9367, e-mail: prosscsg@flmnh.ufl.edu

Franklin Percival, United States Geological Survey, Biological Resources Division (USGS-BRD) Coop Unit, Department of Wildlife Ecology and Conservation, Newins Zigler Hall, University of Florida, Gainesville, Florida 32601, Phone: 352/392-1861, e-mail: PercivalF@wec.ufl.edu

Dwayne Carbonneau and Allan Woodward, Florida Fish and Wildlife Conservation Commission, 4005 South Main Street, Gainesville, Florida 32601, Phone: 352/955-2230, Fax: 352/376-5359, e-mail: carbond@fwc.state.fl.us and woodwaa@fwc.state.fl.us

Trenton Schoeb, Department of Comparative Medicine, University of Alabama at Birmingham, 402 Volker Hall, 1670 University Boulevard, Birmingham, Alabama 35294-0019, Phone: 205/934-2288, Fax: 205/975-4418, e-mail: trs@uab.edu

Unexplained alligator mortality has been observed on Lake Griffin, Florida, since 1997. To date, more than 280 dead alligators have been recorded. The mortality appears to affect adult alligators in good condition and occurs on a bimodal annual pattern with peaks in early spring and fall. In the same period the hatch success of alligator eggs from Lake Griffin has been unusually low, apparently as a result of early embryonic mortality. These observations are thought to be associated with the highly perturbed and eutrophic nature of Lake Griffin and possibly indicative of a serious ecosystem disruption.

Necropsy and pathology examination during 1999-2000 of alligators from Lake Griffin has revealed that alligators demonstrating abnormal behavior in the wild (and presumed to be those that subsequently die) have severe neurological impairment of unexplained origin including slow nerve conduction velocity, and focal lesions in the mid brain. Analysis of alligator tissues for heavy metals, organochlorine pesticides, botulism and certain cyanotoxins has not revealed any obvious cause of neuropathology, reproductive failure or death.

Additional possible causes of neural pathology under investigation include thiamine deficiency, and exposure to organophosphates, methyl bromide and Diazanone. Current studies include additional pathology investigation, tissue analysis and a dietary study.

A WILDLIFE HYBRIDIZATION PROBLEM IN FLORIDA: FERAL MALLARDS AND THE FLORIDA MOTTLED DUCK

Ronald R. Bielefeld, Florida Fish and Wildlife Commission

The Florida mottled duck (*Anas fulvigula fulvigula*) is unique to peninsular Florida, and its future is threatened by genetic introgression from introduced mallards (*Anas platyrhynchos*). Research on mottled ducks indicates that a minimum of 5% of the population is composed of mallard x mottled duck hybrids. We continue to address this problem by implementing a comprehensive conservation plan for the Florida mottled duck. The plan calls for studies to gain new information, and several of these studies are under way. We also are working with other agencies to provide more legal flexibility in dealing with feral mallards. Most importantly, we are implementing a campaign to educate the public about the threat feral mallards pose to the integrity of Florida's mottled duck population. Because of the large scope of this problem, we believe that the key to a solution lies with the citizens of Florida. Florida citizens must be educated about this problem and take it upon themselves to educate others. If this effort fails, the outcome could ultimately be the loss of Florida's mottled duck.

POPULATION STRUCTURE, ABUNDANCE, AND COMMUNITY COMPOSITION OF TURTLES AT LAKE JACKSON: IMPLICATIONS FOR MANAGEMENT AND LAKE FOOD WEBS

Matthew J. Aresco, Florida State University, Department of Biological Science, Tallahassee, Florida 32306-1100, Phone: 850/644-6585, e-mail: aresco@bio.fsu.edu

Turtles are abundant in freshwater systems in the southeastern United States but complete data on their density, population structure, and biomass in large lakes are scarce. In lakes of northern Florida, the turtle community may consist of six or more species that occupy several trophic positions ranging from selective herbivores to generalist omnivores to specialized carnivores. Precise data on population structure and abundance of turtles is often limited by sampling difficulties and trapping biases. The objectives of this study were to: 1) determine the composition of the turtle community in a large sinkhole lake, 2) determine the population structure, absolute abundance, and biomass of each turtle species, 3) describe the migration patterns in response to the drying of a sinkhole lake, and 4) design a fence to prevent road mortality during the migration.

This study was conducted at Lake Jackson in Leon County, Florida. Lake Jackson is typical of lakes in this region with thick aquatic vegetation, relatively shallow, flat-bottomed basin, and an underlying karst topography. Water level is controlled naturally by variation in rainfall and by two primary sinkholes. Following several successive years of low rainfall, Lake Jackson drained in 1999-2000 and was almost completely dry by August 2000. From February - December 2000, I monitored the migration of turtles from a 143 ha area of northwestern Lake Jackson to a 7 ha portion of Lake Jackson (Little Lake Jackson) to the west of US Highway 27. Turtles were intercepted using an 885 m drift fence that was constructed along the US Highway 27N. As all species and sizes migrated from the drying lake, the sampling design greatly reduced biases normally associated with aquatic trapping and yielded more accurate estimates of absolute and relative abundance. I recorded species, sex, carapace length, and mass of each turtle captured. I collected data on 4856 turtles from 7 species that were found at the drift fence or in drying pools. The two most abundant species were the omnivorous yellow-bellied slider, *Trachemys scripta*, (N = 2097; 14.7/ha) and the herbivorous Florida cooter, *Pseudemys floridana*, (N = 2028; 14.2/ha). Common musk turtles, *Sternotherus odoratus*, represented 12% of the turtle community (N = 576; 4/ha). In contrast, Florida softshells, *Apalone ferox*, (N = 87; 1.6/ha) and common snapping turtles, *Chelydra serpentina*, (N = 8; 0.06/ha) were in low abundance and represented only 1.8% and 0.002% of the turtle community, respectively. Low densities of these turtles indicate that specific harvest regulations may be necessary. Density and biomass of all turtles were estimated at 34 turtles/ha and 29 kg/ha.

Sex ratios of the three most abundant species were significantly male-biased. Male:female ratios of sliders were 7:3, cooters were 4:1, and musk turtles were 3:1. The size distribution of sliders and cooters was dominated by adult males; whereas subadult and adult females were less abundant. Boat propeller scars were present on 3.9% of 2736 turtles (5.4% of cooters and 2.4% of sliders) and mortality via collisions may be significant for large cooters and slider turtles. The overall distribution of both species was typical of a stable stage distribution for long-lived

reptiles; smaller number of juveniles compared to mature adults. The population structure of Florida softshells showed a 1:1 sex ratio and evidence of recruitment, however few large adult females exist in the population. Reproductive females are the most important stage in the population and should be the focus of management and conservation attention.

During the 28-week drought migration, turtles moved nonrandomly to Little Lake Jackson to the west. Aerial photos of hundreds of turtle tracks confirm the nonrandom direction of movements. Many turtles of all size classes migrated > 1 km. There were three major pulses of emigration that corresponded to drying of three major areas of water at northwest Lake Jackson. I observed species- and size-specific patterns of migration. Florida cooters emigrated earlier than other species and large females migrated earliest. In contrast, sliders remained longer, moved from pool to pool, and scavenged on dead fish in shallow, drying pools. Softshells emigrated primarily during a 3-week period in June after Lime Sink drained. Musk and mud turtles migrated throughout the study primarily during and after rain. During the terrestrial migration, predation by raccoons was significantly greater ($P < 0.01$) on cooters (72 of 1912; 3.8%) than on slider turtles (36 of 1838 2.0%). The mass migration documented at Lake Jackson indicates that turtles are adapted to the dynamic hydroperiod of sinkhole lakes and are capable of locating and migrating to new water. However, highways constructed across wetlands can be significant sources of mortality and barriers to natural dispersal and migration events. This study demonstrates that a drift fence design used in combination with existing drainage culverts can facilitate migration and greatly reduce road mortality.

This study indicates that omnivorous and herbivorous turtles dominate the lake community in terms of both absolute abundance and biomass. Omnivorous and herbivorous turtles are likely to have strong effects on plant and animal community composition and structure in littoral zone lake communities. Grazing by herbivorous turtles is predicted to have strong direct effects on the abundance and diversity of vascular and nonvascular plants and indirect effects on species that use these plants for food and cover. Omnivorous turtles are predicted to have strong direct and indirect effects on both plant communities and populations of snails, arthropods (e.g., crayfish, insect larvae), and small fish (e.g., shiners, killifish). The additive effects of omnivorous and herbivorous turtles are likely to influence the population dynamics of other species that occur at higher trophic levels in lake food webs (e.g., predatory fish, salamanders, frogs, alligators). Therefore, turtles are likely to have strong effects on lake food webs, plant and animal community composition, and nutrient cycling. Furthermore, density of herbivorous and omnivorous turtles is associated with specific habitat characteristics and resource availability. Thus, turtles such as herbivorous cooters may be key indicators of habitat quality and diversity of aquatic plants and animals in Florida lakes. Lakes should be managed on an ecosystem level and the ecological requirements of turtles should be incorporated into the management and restoration plans Florida lakes.

EFFECT OF DREDGING LAKE SEDIMENTS ON POPULATIONS OF AQUATIC SALAMANDERS (*AMPHIUMA* AND *SIREN*)

Margaret S. Gunzburger and Matthew J. Aresco, Department of Biological Science, Florida State University, Tallahassee, Florida 32306-1100, Phone: 850/644-6585, Fax: 850/644-3826, e-mail: (gunz@bio.fsu.edu) and (aresco@bio.fsu.edu)

During the recent drought in North Florida, many lakes and ponds were dredged in order to remove organic sediment (“muck”). These operations are undertaken with objective of “restoring” or “cleaning up” the lakes affected. Standard procedure at all lakes and ponds we observed in Leon County was to remove all organic sediment in the area being dredged until a sandy layer of soil was exposed. However, we argue that some organic sediment at the bottom of lakes and ponds is natural and necessary to support aquatic ecosystems.

Large aquatic salamanders in the genera *Amphiuma* and *Siren* are only found in the coastal plain of the southeastern United States. These species are among the largest salamanders in the world, often growing to lengths of over 60 cm and weighing more than 500 g. Sirens and amphiumas are specialized to live in lentic aquatic habitats with thick vegetation and organic sediment. Both species form chambers in the sediment at the bottom of drying lakes and ponds in which to aestivate during droughts. In order to estimate the density and biomass of salamanders killed by dredging operations, we regularly visited several dredging sites and collected salamanders uncovered by dredging machinery. We sampled three large lake areas in Leon County: 2 areas of Lake Jackson (Meginnis Arm and at US highway 27) and Lake Iamonia; and two smaller suburban wetlands in Tallahassee: Harriman Pond and McCord Pond.

Large aquatic salamanders were abundant at all sites we visited. Population densities of the two species varied across sites. We removed 11 amphiumas and 49 sirens from the Lake Jackson (US 27) dredging site, 30 amphiumas and 66 sirens from Meginnis Arm, and 63 amphiumas and 8 sirens from Lake Iamonia. The smaller suburban ponds also supported large populations of these salamanders, we found 62 amphiumas and 43 sirens at McCord Pond, while Harriman Pond contained no amphiumas and 189 sirens. Total biomass of salamanders we found at Lake Iamonia was 15 kg, at Lake Jackson (US 27) was 21 kg, and at Meginnis Arm was 20 kg. The majority of salamanders we found were large adults, although smaller individuals were more likely to be missed with our sampling method. The majority of salamanders were uncovered from their aestivation chambers in areas of dried sediment that was often overgrown with vegetation, but some active salamanders were dredged from thick liquid organic material.

The removal of large numbers of salamanders as well as the organic sediment they rely on for burrowing probably has negative effects on the populations of these species. In large lakes such as Lake Iamonia where only a small portion of the lake bottom is dredged, long term effects on the entire lake population may be minimal. However, at large scale dredging operations where sediment from the entire lake bottom is removed, such as at Lake Jackson and at the smaller ponds, negative effects may persist for some time. Amphiumas and sirens are poor overland dispersers and probably only recolonize wetlands through flooding events. However, the habitat degradation from dredging often results in an aquatic habitat entirely devoid of vegetation and

organic sediment, and thus is inappropriate for sirens and amphiumas. We argue that dredging not only removes a substantial number of large aquatic salamanders, but it renders the habitat unsuitable for their subsequent recolonization.

Because these species occur in very high densities they probably play an important role in lake ecosystems. Very little is known of the basic natural history of these salamanders. Amphiumas are carnivorous, feeding mostly on crawfish, aquatic insects, frogs, and small fish. Sirens are more omnivorous and may consume aquatic vegetation, algae, detritus, carrion, snails, as well as aquatic insects and crawfish. Both species probably serve as prey for large species of fish when small. Larger amphiumas and sirens are prey for alligators, snakes, and wading birds. Life history information such as clutch size, growth rate, size at maturity, and lifetime fecundity of these species is very limited so their ability to recover from population disturbances is almost impossible to predict.

In order to determine the effect of dredging on long-term population dynamics, a thorough evaluation of salamander density at each site before and after dredging is necessary. However, based on the fact that all salamanders in areas that are dredged are removed, we conclude that dredging probably has a negative effect on populations of these species. Future plans to dredge organic sediment at the bottom of lakes and ponds should consider the impact of these activities on populations of sirens and amphiumas. We suggest that dredging negatively affects populations of large aquatic salamanders and any other aquatic species dependent on organic sediment. The possible benefits of dredging must be carefully weighed against the negative effects of this habitat degradation.

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