Program and Abstracts

Welcome to the Sixth Symposium on Biogeochemistry of Wetlands sponsored by the University of Florida, Institute of Food and Agricultural Sciences (UF/IFAS) - Center for Natural Resources, Soil and Water Science Department, and Wetland Biogeochemistry Laboratory. This interdisciplinary symposium is co-sponsored by the Louisiana State University, the St. Johns River Water Management District, and the U. S. Geological Survey-Biological Resources Division.

Biogeochemical cycles play an important role in determining the structure and function of wetlands. Attendance and participation in the last five symposia clearly established the importance and interest in biogeochemistry of wetlands. During the sixth symposium a total of 134 papers including 15 invited papers in the plenary session, and 120 volunteered papers (69 oral and 50 poster papers) will be presented over the two and one half days. Contributors to this symposium represent 15 countries (Belgium, Canada, China, England, Germany, Hungary, Ireland, Israel, Italy, Japan, Mexico, The Netherlands, New Zealand, Philippines, and the United States of America). A special plenary session is scheduled July 13, 1999, Tuesday, 8:30am-12:00 noon in honor of Dr. W. H. Patrick, Jr., Boyd Professor, Louisiana State University, for his outstanding research and educational contribution to wetland science spanning the past four decades.

Scientific sessions: The scientific sessions will be held at the Marina Marriott. Plenary sessions will be held on Monday, July 12 and Tuesday July 13, 1999 in Salons D and E. Three concurrent sessions will be held Monday and Tuesday afternoon in Salons D and E, and Section IV of the Atlantic Ballroom. Two concurrent sessions will be held Wednesday morning in Salons D and E. Poster papers will be on display throughout Monday and Tuesday in the Atlantic Ballroom. Authors of poster papers will be present at their posters from 7:00pm until 8:00pm on Monday evening. Slide, overhead and computer projectors will be available for the general and concurrent sessions.

Other activities: There will be a welcome reception for registered symposium participants on the Marriott's terrace Sunday evening (6:00pm-8:00pm). There will also be a dinner Tuesday night at the Marriott for symposium participants and registered dinner guests (7:00pm-9:00 pm).

Special thanks are extended to our sponsors and cooperators. I would like to thank all speakers and poster presenters and participants for supporting the symposium. The assistance of the UF/IFAS, Office of Conferences and Institutes staff who handled most of the symposium arrangements and registration is also gratefully acknowledged (especially Ms. Amanda Padgett). Thanks are also extended to the session moderators and the slide projector operators (graduate students of the Wetland Biogeochemistry Laboratory).

K. Ramesh Reddy
Wetland Biogeochemistry Laboratory
University of Florida - IFAS

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Program Agenda

Sunday, July 11, 1999

pm

1:00-8:00 **Registration** – *Salon C*

2:00-6:00 **Poster Display Set-up** – *Atlantic Ballroom, sections I-III*

6:00-8:00 **Welcome Reception** – *Outside on the Terrace*

Monday, July 12, 1999

am

7:30 **Registration** – *Salon C*

8:00 **Morning Refreshments**

Plenary Session I – Wetlands: Role in Landscape Processes

Salons D and E

Chair: **Randy Brown**, University of Florida, Gainesville, FL

am

8:20 **Introductory Remarks**—***K. R. Reddy***; University of Florida, Gainesville, FL

8:30 **Introduction and Welcome**— ***Mike Martin***; Vice President for Agriculture and Natural Resources, University of Florida, Gainesville, FL

8:40 **Wetland Biogeochemistry, Environmental Quality and Human Welfare: Some Challenges and Opportunities**—***Edward Maltby***; Royal Holloway Institute for Environmental Research, Surrey, England

9:10 **Solving Inland and Coastal Pollution with Restored and Created Wetlands in the Midwest**—***William J. Mitsch***; Ohio State University, Columbus, OH

9:40 **The Role of Biogeochemistry in Addressing Wetland Issues and Problems in Louisiana**—***R. P. Gambrell***, *R. DeLaune, I. Mendelssohn, S. Faulkner* and *W. H. Patrick*; Louisiana State University, Baton Rouge, LA

10:10 **Refreshment Break**

10:30 **Nitrate Retention and Denitrification in Riparian Wetlands**—***Oswald Van Cleemput***, *Stefan Van Damme* and *Pascal Boeckx*; University of Ghent, Ghent, Belgium

11:00 **Phosphorus Removal in Treatment Wetlands**—***Robert H. Kadlec***; Wetland Management Services, Chekea, MI

11:30 **Initial Steps in Developing Nutrient Criteria for Wetland Systems**—***Amanda Parker***; USEPA, Washington, DC

11:50 **Biogeochemical Issues in the Management and Restoration of Wetlands**—***Lawrence Keenan*** and *Edgar Lowe*; St. Johns River Water Management District, Palatka, FL

pm

12:10 **Adjourn and Lunch** *(on your own)*

Concurrent Session II – Microbial Processes/Activities

Salon E

Chair: ***Andy Ogram***, University of Florida, Gainesville, FL

pm

1:30 **Determination of Microbial Parameters in Flooded Peat Soils Using Fluorescent Compounds**—***Leonard J. Scinto***, *Meera K. Nair* and *Ronald D. Jones*; Southeast Environmental Research Center, Florida International University, Miami, FL

1:50 **The Control of Soil Aggregates on Sulfate Reduction in Freshwater Wetlands—*Yuch Ping Hsieh*** and *Jinan Feng*; Florida A & M University, Tallahassee, FL

2:10 **Effects of Crude Oils on Metabolic Activity of Soil Biota in Saline Soils—*Andy Nyman***; University of Southwestern Louisiana, Lafayette, LA; *T. E. McGinnis, II*; National Wetlands Research Center, Lafayette, LA

2:30 **Influence of Electron Donors on Microbial Respiration in Everglades Soils—*A. L. Wright*** and *K. R. Reddy*; University of Florida, Gainesville, FL

2:50 **Linking Soil Microbial Changes to Intensification of Agricultural Wetlands in the Tropics—*Wolfgang Reichardt***; International Rice Research Institute (IRRI), Los Banos, Philippines

3:10 **Refreshment Break**

3:30 **Comparison of Soil Organic Matter Concentrations and Microbial Activity of Restored and Natural Bottomland Hardwood Wetlands—*Rachael G. Hunter*** and *Stephen P. Faulkner*; Louisiana State University, Baton Rouge, LA

3:50 **Soil Processes Regulating the Fate of Chlorophenols in Wetlands—*Elisa M. D'Angelo***; University of Kentucky, Louisville, KY; and *K. R. Reddy*; University of Florida, Gainesville, FL

4:10 **Evaluation of Carbon Origins of CH4 Emitted from Rice Paddies**—***Makoto Kimura*** and *Akira Watanabe*; Nagoya University, Chikusa, Nagoya, Japan

4:30 **Methane Oxidation in Rice Rhizosphere; Experiments and Modelling—*Peter van Bodegom***, *Peter Leffelaar, Liesbeth Mollema, Sara Boeke* and *Fons Stams*; Wageningen Agricultural University, Wageningen, The Netherlands

4:50 **Unravelling and Understanding Peatland Gas Reservoir Dynamics—*Susan Waldron*, *Tom Preston, Tony Fallick*; Scottish Universities Research and Reactor Centre, Scotland; *Andy Baird* and *Clive Beckwith*; University of Sheffield, Sheffield, England, UK

5:10 **Discussion**

5:20 **Adjourn**

Concurrent Session III – Wetlands and Water Quality – I

Atlantic Ballroom, section IV

Chair: ***Ronnie Best***, Biological Resources Division, United States Geological Survey, Miami, FL

pm

1:30 **Influence of Wastewater Characteristics on Nitrogen Processing Gradients in Constructed Wetlands—*Chris C. Tanner*, *Max M. Gibbs, James P. S. Sukias* and *M. Long Nguyen*; National Institute of Water and Atmospheric Research, Hamilton, New Zealand

1:50 **The Effectiveness of Riparian Buffer Zones for Removing Nitrate from Groundwater of the Atlantic Coastal Plain—*Larry J. Puckett*; U.S. Geological Survey, Reston, VA

2:10 **Nitrogen and Phosphorus Processing in Riparian Wetlands Receiving Nutrient Inputs from a Sheep-grazed Catchment in New Zealand—*Long Nguyen*; National Institute of Water and Atmospheric Research, Hamilton, New Zealand; *Malcolm Downes*; National Institute of Water and Atmospheric Research, Christchurch, New Zealand; and *Jens Mehlhorn*; IMB, University of Karlsruhe, Karlsruhe, Germany

2:30 **Maximizing Wetland Benefits and Minimizing Impacts on Drinking Water Quality—*Marvin Jung*; Marvin Jung & Associates, Inc., Sacramento, CA

2:50 **Balancing Nitrate Removal and Wildlife Habitat in Constructed Wetlands—*Alex Horne*; University of California, Berkeley, CA

3:10 **Refreshment Break**

3:30 **Evidence for Plant Carbon and Nitrate Co-Limitation in Treatment Wetlands—*Maia S. Fleming*, *Noah P. Hume* and *Alex J. Horne*; University of California, Berkeley, CA

3:50 **Importance of Bottom Soil Redox Reactions in Aquaculture Systems—*Yoram Avnimelech*; Technion, Israel Institute of Technology, Israel

4:10 **Effects of FGD Liner Material on Ecological Functions of Mesocosm Treatment Wetlands—*Changwoo Ahn*, *William J. Mitsch* and *William E. Wolfe*; Ohio State University, Columbus, OH

4:30 **The Fate of Algal Phosphorus Input in a Large, Reed Dominated Wetland: A Modelling Approach**—***Vera Istvánovics***; Water Quality Research Group of the Hungarian Academy of Sciences, Budapest, Hungary

4:50 **Discussion**

5:00 **Adjourn**

Concurrent Session IV – Hydric Soils/Redox Reactions

Salon D

Chair: ***Stephen Faulkner***, Louisiana State University, Baton Rouge, LA

pm

1:30 **Groundwater and Solute Flow Characteristics in Altered Wetland Soils of the Hula Valley, Israel**—***M. Iggy Litaor***; Tel-Hai College, Israel; *Ami Nishri*; Kinneret Laboratory, Israel; *Oren Reichmann,* and *Moshe Shenker*; The Hebrew University of Jerusalem, Israel

1:50 **Trace Gas Exchanges in Hydromorphic Soils: Interactions at the Agricultural/Wetland Interface**—***Matt Clark*** and *Ed Maltby*; Royal Holloway College, University of London, Egham, Surrey, UK; and *Steve Jarvis*; Institute for Grassland and Environmental Research, Okehampton, Devon, UK

2:10 **Physicochemical Properties of Wetland Soils in Relation to Plant Growth**—***T. R. Yu***; Institute of Soil Science, Chinese Academy of Sciences, Nanjing, China

2:30 **Influence of Biogeochemical Processes on Hydric Soils, Wetland Delineation, and Functional Assessment**—***Stephen Faulkner***; Louisiana State University, Baton Rouge, LA

2:50 **Land Use Impacts on Glacially Shaped Potholes of Northeast Germany**—***Thomas Kalettka***, *Catrin Rudat* and *Jürgen Augustin*; Center for Agricultural Landscape and Land Use Research, Müncheberg, Germany

3:10 **Discussion**

3:15 **Adjourn**

Concurrent Session V – Trace Metals

Salon D

Chair: ***Len Scinto***, Florida International University, Miami, FL

pm

3:30 **Speciation and Cycling of Uranium in Redox-affected Evaporation Pond Sediments**—***Martine C. Duff***, *Douglas B. Hunter* and *Paul M. Bertsch*; University of Georgia's Savannah River Ecology Laboratory, Aiken, SC; and *Christopher Amrhein*; University of California, Riverside, CA

3:50 **Effects of Iron Enrichment on Sulfur, Iron and Phosphorus Distributions in Carbonate Wetland Sediments**—***Randy Chambers*** and *Regis Hoppenot*; Biology Department, Fairfield University, Fairfield, CT; and *James Fourqurean*; Florida International University, Miami, FL

4:10 **Atmospheric Fluxes of Toxic Metals and Environmental Changes in the Venice Lagoon as Recorded by Salt Marshes**—***Luca Giorgio Bellucci*** and *Mauro Frignani*; Istituto di Geologia Marina – CNR, Bologna, Italy; *James Kirk Cochran*; Marine Sciences Research Center – SUNY, Stony Brook, NY; and *Giovanni Cecconi*; Consorzio Venezia Nuova, Venezia, Italy

4:30 **Sustainable Retention of Metals in Natural Wetlands**—***Terri Stoddern*** and *Loveday Jenkin*; University of Exeter, Cornwall, GB; *Mark Andrews* and *Chris Underwood*; South West Water, Cornwall, GB

4:50 **Discussion**

5:00 **Adjourn**

Session VI – Poster Session

Atlantic Ballroom

pm

6:30-8:30 **Poster Reception** *(with light hors d'oeuvers)*

7:00-8:00 **Authors present at their posters** *(Posters will remain on display until 5:00pm, July 13, 1999)*

Poster No:

1 **Created, Drained (Protected), Historic, and Relict Hydric Soils: The Altered Soils**— ***Gregory Brannon***; USDA, Auburn, AL; and *Wade Hurt*; USDA, Gainesville, FL

2 **Using Hydric Soil Indicators in Disturbed Soils to Characterize Regulatory Wetlands—*Wade Hurt***; USDA, NRCS, Gainesville, FL; and *Victor Carlisle*; University of Florida, Gainesville, FL

3 **Graphic Representation of Field Indicators for Hydric Soils in the United States—*Mike Lilly***; USDA, Jackson, MS; and *Chris Noble*; USDA, Bozeman, MT

4 **Field Indicators of Hydric Soils: Boundary Indicators versus Interior Indicators—*Cameron Loerch***; USDA, Auburn, AL; *Wade Hurt*; USDA, Gainesville, FL; and *Victor Carlisle*; University of Florida, Gainesville, FL

5 **Using Soil Morphology and Soil Survey Data for Restoring and Creating Wetlands—*Jerry Ragus***; USDA, Atlanta, GA; and *Victor Carlisle*; University of Florida, Gainesville, FL

6 **Nitrogen and Phosphorus Retranslocation along a Salinity Gradient in Mangrove Forests Located at the Everglades Salinity Transition Zone—*Carlos Coronado-Molina,* *J. W. Day Jr., E. Reyes* and *B. Perez*; Louisiana State University, Baton Rouge, LA; and *S. Kelly*; South Florida Water Management District, West Palm Beach, FL

7 **A Proposed Mechanism for Rapid Gas Transport in Submersed Macrophytes—*William G. Crumpton*** and *Anne Kimber*; Iowa State University, Ames, IA

8 **Changes of the Element Content of Phragmites Australis from Different Habitats of Lake Ferto/Neusiedler See—*Mária Dinka***; Hungarian Danube Research Station of the Hung. Acad. of Sciences, Hungary

9 **Can Mangrove Root Communities Indicate Variations in Water Quality?—*Kisha Hoilett*** and *Mona K. Webber*; University of the West Indies, Kingston, Jamaica

10 **Growth, Nutrient Uptake Kinetic and Use Efficiency of Typha domingensis and Cladium jamaicense at Steady State Oxygen and Phosphorus Availability—*Bent Lorenzen*** and *Hans Brix*; University of Aarhus, Denmark

11 **Forms and Amounts of Soil Nitrogen and Phosphorus Across the Longleaf Pine-depresssional Wetland Landscape of Southwestern Georgia—*Christopher B. Craft*** and *Connie Chiang*; Jones Ecological Research Center, Newton, GA

12 **Coupling Phytoplanktonic Primary Production, Decomposition Processes and Nutrient Cycling in Two Natural Hypereutrophic Lagunas of Doñana National Park—***S. Alvarez, A. López-Archilla,* ***Carmen Coleto*** and *M.C. Guerrero*; Universidad Autonoma de Madrid, Madrid, Spain

13 **Litter Decomposition of Emergent Macrophytes in a Floodplain Marsh of the Lower Paraná River—*Carlos Bonetto*** and *Carlos Villar*; Instituto de Limnolgía Dr. Ringuelet. Florencio Varela, Buenos Aires. Argentina; *Laura de Cabo*; Museo de Ciencias Naturales B. Rivadavia, Buenos Aires, Argentina; and *Panchabi Vaithiyanathan*; Duke University Wetland Center, Loxahatchee, FL

14 **Relationships between Methane Production and Emission to Internal Methane Concentrations in Rice—*George Byrd***; St. Michael's College, Colchester, VT; *Frank Fisher* and *Ron Sass*; Rice University, Houston, TX

15 **Phosphine Production Potential of Various Wetland Soil, Wastewater and Sewage Sludge Sources—*Istvan Devai***, *Ronald D. DeLaune* and *William H. Patrick, Jr.*; Louisiana State University, Baton Rouge, LA; *Gyorgy Devai* and *Ildiko Czegeny*; Lajos Kossuth University, Debrecen, Hungary

16 **Aquatic Organisms and Microorganisms in Japanese Paddy Fields—*Makoto Kimura***, *Masatsugu Yamazaki, Akiko Okabe* and *Koki Toyota*; Nagoya University, Chikusa, Nagoya, Japan

17 **Rates and Controls of Microbial Respiration in Saltmarsh Sediments—***Joel E. Kostka*; Skidaway Institute of Oceanography, Savannah, GA; and *Alekendra Roychoudhury, **Carla Koretsky*** and *Philippe Van Cappellen*; Georgia Institute of Technology, Atlanta, GA

18 **Nitrogen Cycling in Sediments of the Lagoon of Venice, Italy—*Jonas M. Svensson***; Lund University, Sweden; *Giovanni M. Carrer* and *Martina Bocci*; Padova University, Italy

19 **A Nitrogen Budget in Soils along a Eutrophic Gradient in the Everglades Water Conservation Area 2A—*J. R. White*** and *K. R. Reddy*; University of Florida, Gainesville, FL

20 **Sorption and Desorption of Phosphorus in Soils and Limestones from South Everglades Wetlands and Adjacent Farmlands—*Meifang Zhou*** and *Y. C. Li*; University of Florida, Homestead, FL

21 **Nitrogen and Phosphorus Leached from Soil Disposal Mounds in Everglades National Park—*Jiangiang Q. Zhao*** and *Y. C. Li*; University of Florida, Homestead, FL; and *M. Norland*; Everglades National Park, Homestead, FL

22 **Organic Phosphorus Mineralization in a Freshwater Wetland as Affected by Substrate Quality and Phosphorus-hydrolyzing Enzymes—*T. Chua*** and *K. R. Reddy*; University of Florida, Gainesville, FL

23 **Effects of N P K Fertilization on Spatial Variability of Forest Soil pH, Al, Mn, Fe, and Zn—*Asfaw Bekele*** and *W. H. Hudnall*; LSU Agricultural Center, Baton Rouge, LA; and *A. E. Tiarks*; USDA-Forest Service, Pineville, LA

24 **An Environmental Assessment of the Use of Red Mud for Wetland Restoration: Release and Plant Availability of Trace and Toxic Metals—*Mehdi Aarabi*** and *Robert P. Gambrell*; Louisiana State University, Baton Rouge, LA

25 **Recent Developments in Arsenic Speciation Measurements for Routine Analysis of Environmental Matrices—*Robert Benz***; Banian, Deerfield Bch, FL; and *W. T. Corns* and *P. B. Stockwell*i; P S Analytical Ltd, Orpington, Kent, UK

26 **Mercury in Several Types of Aquatic Invertebrates in the Florida Everglades—*Yong Cai*** and *Ronald Jones*; Florida International University, Miami, FL; and *William F. Loftus*; USGS, Homestead, FL

27 **Fluorescence Spectroscopic Studies of DOM-Hg Complexation in Surface Waters of the Florida Everglades—*Xiaoqiao Lu*** and *Rudolf Jaffe*; Florida International University, Miami, FL

28 **Redox Potential and pH Effects on Arsenic in Municipal Sewage Sludge—** ***Aroon Jugsujinda****, R. D. DeLaune* and *W. H. Patrick, Jr.*; Louisiana State University, Baton Rouge, LA; and *A. A. Carbonell-Barrachina* and *F. Burlo*, Universidad Miguel Hernández, Alicante, Spain

29 **Spatial and Temporal Trends in Saltmarsh Sediment Geochemistry—** ***Carla M. Koretsky*** and *Philippe Van Cappellen*; Georgia Institute of Technology, Atlanta, GA

30 **Mercury Methylation Kinetics in Aquatic Macrophytes of Brazilian Wetlands—***Romilda Maria Alves de Lemos,* ***Jane Beatriz Narvaez Mauro****, Jean Remy Daveé Guimares* and *Elisa Diniz Reis Vieira*; Universidade Federal do Rio de Janeiro, Rio de Janeiro (RJ), Brasil; and *Irineu Bianchinii*; Universidade Federal de So Carlos, So Carlos (SP), Brasil

31 **Organic Micropollutants in a Core Sample of a Brazilian Mangrove—***Élcia Margareth Brito,* ***Elisa Diniz Reis Vieira****, Fernando Neves Pinto, Jane Beatriz Narvaez Mauro* and *Olaf Malmi*; Instituto de Biofísica Carlos Chagas Filho, UFRJ, Rio de Janeiro, RJ, Brazil

32 **Use of Solidifier in Removing Oil from Coastal Wetlands—*Ron D. DeLaune****, C. W. Lindau* and *A. Jugsujinda*; Louisiana State University, Baton Rouge, LA

33 **Remediation and Restoration of an Oil Contaminated Wetland—*Dean Goodin*** and *Wayne Hudnalli;* Louisiana State University Agricultural Center, Baton Rouge, LA; and C-K Associates, Inc., Baton Rouge, LA

34 **Operation and Management of Onsite Constructed Wetlands in Kentucky—*George F. Antonious***; Kentucky State University, Frankfort, KY; and *Richard C. Warner*; University of Kentucky, Lexington, KY

35 **Efficacy of Riparian Buffer Strips to Filter Nonpoint Source Pollutants from Animal Wastewater—*James A. Entry***; USDA Agricultural Research Service, Kimberly, ID; and *Robert K. Hubbard*; USDA Agricultural Research Service, Tifton, GA

36 **Characteristics of Submerged Aquatic Vegetation Communities Used to Remove Phosphorus from Agricultural Drainage Waters—*Kevin A. Grace****, Thomas A. DeBusk* and *Forrest E. Dierberg*; DB Environmental Laboratories, Inc., Rockledge, FL; and *Kathleen C. Pietro*; South Florida Water Management District, West Palm Beach, FL

37 **Continuous Assessment of Nutrient Removal and Physicochemical Conditions in Constructed Wetlands at a Distant Site—*Mel Johnson****, Kenneth Stone, Patrick Hunt* and *Terry Matheny*; USDA-ARS, Florence, SC; *Ariel Szogi*; Washington State University, Yakima, WA; and *Bhaskar Reddyi;* North Carolina A&T State University, Greensboro, NC

38 **Constructed Wetlands for Tertiary Treatment and Pollution Control in the Caribbean—*P. V. Devi Prasad*** and *C. Reid*; Univ. West Indies, Kingston, Jamaica

39 **Denitrification Potential of Soil in a Riparian Zone and a Swine Wastewater Spray Field as Measured by Denitrification Enzyme Analysis —***Patrick Hunt, **Terry Matheny*** and *Kenneth Stone*; USDA-ARS, Florence, SC

40 **Hydrologic and Nutrient Balances in Coastal Wetlands in the Pacific, SW Mexico—***Cristian Tovilla Hernández*; Facultad de Ciencias, UNAM, México; ***Guadalupe de la Lanza Espino***; Instituto de Biología, UNAM, México; and *Edith Orihuela Belmonte*; Escuela de Biología, UAS, México

41 **Functional Analysis of Surface-ground Water Interactions in Mediterranean Dunal Lagunas Using Water and Nutrient Budgets—*Carmen Coleto**, M. Florín* and *C. Montes*; Universidad Autónoma de Madrid, Madrid, Spain

42 **Characterization of Isolated Seasonal Wetlands in Subtropical Rangelands—*Patrick Bohlen*** and *Matthew Baber*; MacArthur Agro-ecology Research Center, Lake Placid, FL; and *Donald Graetz*; University of Florida, Gainesville, FL

43 **Chemical Characteristics of Water Environment of Saline Wetland in the West Songnen Plain of China—*Deng Wei Song Xinshan***; Chinese Academy of Sciences, Changchun, China

44 **The Ecological Assessment and Management of the Martha Brae River Estuary, Jamaica—***M. Hibbert, P. E. T. Edwards* and ***D. F. Webber***; University of the West Indies, Kingston, Jamaica

45 **Nitrogen Diffusion at a Coastal Wetland in North West Mexico, With and Without Agricultural Impact—***Lorena Campos Villegas* and ***Guadalupe de la Lanza Espino***; Instituto de Biología, UNAM, México

46 **The Influence of Water Density Difference in the Nutrient Dynamics for the Shallow Regions of a Tropical Reservoir: Tucuri Hydroelectric Reservoir, AM—*Osman Fernandes da Silva***; Universidade Estadual de Campinas (UNICAMP), Campinas, SP; and *Evlyn M. L. Novo*; Instituto Nacional de Pesquisas Espaciais (INPE), S_o José dos Campos, SP

47 **Contribution of Sediment Gases to Buoyancy of Organic Base Floating Wetlands—*Mark W. Clark*** and *K. R. Reddy*; University of Florida, Gainesville, FL

48 **The Effect of Improved Basin Management Practices on Sediment Phosphorus Chemistry in Lake Okeechobee—*M. M. Fisher*** and *K. R. Reddy*; University of Florida, Gainesville, FL

49 **Belowground Dynamics of a Mangrove Species—*Beatriz Giraldo***; Louisiana State University, Baton Rouge, LA; and *Karen L. McKee*; Louisiana State University, Baton Rouge, LA and USGS, National Wetlands Research Center, Lafayette, LA

50 **Temporal Evolution of Macronutrients in a Shallow Area of the Largest Amazon Reservoir—*Osman Fernandes da Silva***; Universidade Estadual de Campinas (UNICAMP), Campinas, SP

Tuesday, July 13, 1999

am

8:00 **Morning Refreshments**

Plenary Session VII – Origin and Applications of Wetland Biogeochemistry *(Special session in honor of Dr. W.H. Patrick, Jr.)*

Salons D and E

Chair: ***K. R. Reddy***, University of Florida, Gainesville, FL

am

8:30 **The Biogeochemistry of Dredged Material or Did I Really Learn Anything in College?—*Robert M. Engler***; U.S. Army Engineer Waterways Experiment Station

9:00 **Increasing Fertilizer Use Efficiency in Tropical Lowland Rice Production—*Roland J. Buresh***; ICRAF, Nairobi, Kenya; and *S. K. de Datta*; Virginia Tech University, Blacksburg, VA

9:25 **Effects of Redox Potential on Phosphorus Chemistry in Soils and Sediments—*Philip A. Moore, Jr.***; University of Arkansas, Fayettville, AR

9:50 **Fate and Transport of Explosives in the Environment—*James M. Brannon*, *Judith C. Pennington*, *Tommy E. Myers*** and ***Cynthia B. Price***; U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS; and *Kevin Thorn*; U.S. Geological Survey, Denver, CO

10:15 **Refreshment Break**

10:30 **The Prioritization of Wetland Restoration Sites in the Lower Yazoo River Basin—*Barbara A. Kleiss*, *Charles G. O'Hara*** and ***Angela A. Davis***; U.S. Geological Survey, Pearl, MS

10:55 **Fate and Distribution of Surfactants in Estuarine and Marine Environments—*Tom C. J. Feijtel***; Procter & Gamble, Strombeek-Bever, Belgium

11:15 **Soil Concerns for the Restoration of Coastal Salt Marshes—*John C. Callaway***; San Diego State University, San Diego, CA

11:40 **Oxidation-reduction Reactions in Flooded Crowley Silt Loam Soil: A Review of Five Decades of Research**—***K. R. Reddy***; University of Florida, Gainesville, FL

pm

12:05 **Discussion**

12:15 **Adjourn and Lunch** *(on your own)*

Concurrent Session VIII – Phosphorus Removal Technologies

Atlantic Ballroom, section IV

Chair: ***Susan Gray,*** South Florida Water Management Distict, West Palm Beach, FL

pm

1:30 **Critical Design Elements of the Everglades Stormwater Treatment Areas**—***Gary Goforth***; South Florida Water Management District, West Palm Beach, FL

1:50 **Differences in Nutrient Removal Performance within a South Florida Treatment Wetland**—***Michael J. Chimney***, *Martha K. Nungesser* and *Jana Newman*; South Florida Water Management District, West Palm Beach, FL

2:10 **Physical/Chemical Treatment Techniques to Reduce Phosphorus in Everglades Surface Waters**—*Earl E. Shannon* and ***Thomas C. Emenhiser***; Conestoga-Rovers and Associates, West Palm Beach, FL; and *Jose Lopez*; South Florida Florida Water Management District, West Palm Beach, FL

2:30 **Reducing Phosphorus Concentrations in Everglade Inflow Waters with Low Intensity Chemical Dosing**—***Philip A. M. Bachand***, *Panchabi Vaithiyanathan* and *Curtis J. Richardson*; Duke University Wetland Center, Durham, NC

2:50 **Refreshment Break**

3:05 **Testing a Managed Wetland Treatment System (MWTS) as an Advanced Treatment Technology for Phosphorus Removal in the Florida Everglades**—***William Dunn***; CH2M HILL, Gainesville, FL; *Paul Steinbrecher*; CH2M HILL, Deerfield Beach, FL; and *Greg Coffelt*; South Florida Water Management District, West Palm Beach, FL

3:25 **Phosphorus Removal from Everglades Agricultural Area Drainage Waters Using a Submerged Aquatic Vegetation/Limerock Treatment System**—***Scott D. Jackson***, *Forrest E. Dierberg* and *Thomas A. DeBusk*; DB Environmental Laboratories, Inc., Rockledge, FL; *Michael J. Chimney*; South Florida Water Management District, West Palm Beach, FL; and *Taufiqul Aziz*; Florida Department of Environmental Protection, Tallahassee, FL

3:45 **Periphyton-based Stormwater Treatment Research and Demonstration in the Florida Everglades**—***Robert Knight***; Gainesville, FL; *James Bays*; CH2M HILL, Tampa, FL; *Steve Gong*; CH2M HILL, Deerfield Beach, FL; and *Susan Gray*; South Florida Water Management District, West Palm Beach, FL

4:05 **Discussion**

4:20 **Adjourn**

Concurrent Session IX – Soil-Water-Plant Relationships

Salon D

Chair: ***M. S. Koch***, Florida Atlantic University, Boca Raton, FL

pm

1:30 **Sediment Subsidy: Effects on Soil-Plant Responses in a Rapidly Submerging Coastal Wetland**—***Irving A. Mendelssohn*** and *Nathan L. Kuhn*; Louisiana State University, Baton Rouge, LA

1:50 **Gas Exchange in the Genus Carex: From Cell to Canopy**—***Joachim Busch***; Heinrich-Heine-University, Düsseldorf, Germany

2:10 **Macrophyte Species Changes in the Everglades: Examination along a Eutrophication Gradient**—***Panchabi Vaithiyanathan*** and *C. J. Richardson*; Duke University, Durham, NC

2:30 **Sulfide Effects on Thalassia testudinum Carbon Balance and Adenylate Energy Charge**—***James M. Erskine*** and *Marguerite S. Koch*; Florida Atlantic University, Boca Raton, FL

2:50 **Refreshment Break**

3:05 **Oxidized Root Channels by Bulbul Rush Mediated a Micro-environment in Extreme Conditions of Lignite Mining Lakes**—***Abad Chabbi***; Brandenburg Technical University of Cottbus, Cottbus, Germany

3:25 **Seasonal Variation in Iron Deposition on Roots of the Annual Salt Marsh Plant *Salicornia* spp.**—***Frances J. Kenny*** and *Marinus L. Otte*; University College Dublin, Dublin, Ireland

3:45 **Discussion**

4:00 **Adjourn**

Concurrent Session X – Bigeochemical Indicators of the Ecological Status of the Everglades

Salon E

Chair: ***Curtis Richardson***, Duke University, Durham, NC

pm

1:30 **Introduction**

1:40 **An Assessment of Six years of Ecological Change in Everglades Communities to Phosphorus Dosing**—***Curtis J. Richardson*** and *Panchabi Vaithiyanathan*; Duke University Wetland Center, Durham, NC; *Jerry Qualls*; University of Nevada, Reno, NV; and *Jan Stevenson*; University of Louisville, Louisville, KY

2:10 **Spatio-temporal Patterns of Soil Phosphorus Enrichment in Everglades WCA2**—***W. F. DeBusk****, Y. Wang, M. M. Fisher* and *K. R. Reddy*; University of Florida, Gainesville, FL; and *S. Newman*; South Florida Water Management District

2:30 **Effects of Increased Phosphorus Loading on Water-column Oxygen Dynamics in the Northern Everglades**—***Paul McCormick*** and *James Laing*; South Florida Water Management District, West Palm Beach, FL

2:50 **Refreshment Break**

3:05 **Phosphatase Activity as an Early Warning Indicator of Wetland Eutrophication: Problems and Prospects**—***S. Newman***, *P. V. McCormick*, and *J. G. Backus*; South Florida Water Management District, West Palm Beach, FL

3:25 **The Distribution and Carbon Isotopic Composition of Dissolved Organic Matter in Florida Everglades**—***Yang Wang***; Florida State University & NHMFL, Tallahassee, FL; *Y. P. Hsieh*; Wetland Ecology Program, Florida A&M University, Tallahassee, FL; *W. M. Landing, V. Salters, W. Cooper* and *L. Proctor*; Florida State University, Tallahassee, FL

3:45 **Calcium Carbonate Precipitation in the Everglade Sloughs: Influence of Water Column Phosphorus Concentration**—***Panchabi Vaithiyanathan***, *T. Minto* and *C. J. Richardson*; Duke University, Durham, NC

4:05 **Effects of Four Years of Nitrogen and Phosphorus Additions on Everglades Plant Communities**—*Connie Chiang* and ***Christopher B. Craft***; Jones Ecological Research Center, Newton, GA; *David W. Rogers*; International Paper, Erie, PA; and *Curtis J. Richardson*; Duke University, Durham, NC

4:25 **Influence of Phosphorus Enrichment on N Transformations in Northern Everglades Soils**—***J. R. White*** and *K. R. Reddy*; University of Florida, Gainesville, FL

4:45 **Discussion**

4:55 **Adjourn**

5:00 **Poster Display Closed** *(poster presenters may begin removal of their displays)*

7:00-9:00 **Dinner** – *Salons D and E*

Wednesday, July 14, 1999

am

8:00 **Morning Refreshments**

Concurrent Session XI – Phosphorus Transformations

Salon E

Chair: ***W. F. DeBusk***, University of Florida, Gainesville, FL

am

8:30 **Characterization of Dissolved Organic Phosphorus Compounds in the Florida Everglades by Ultrahigh Resolution Fourier Transform Ion Cyclotron Resonance Mass Spectrometry**—***William T. Cooper*** and *Jennifer Llewelyn*; Florida State University, Tallahassee, FL; *Y. P. Hsieh*; Florida A&M University, Tallahassee, FL; *W. M. Landing* and *L. Proctor*; Florida State University, Tallahassee, FL; *Y. Wang* and *V. S. Salters*; Florida State University & National High Magnetic Field Laboratory, Tallahassee, FL

8:50 **Phosphorus Fractions and Incorporation in Sewage-impacted Wetland Sediments**—***Long Nguyen***; National Institute of Water and Atmospheric Research, Hamilton, New Zealand

9:10 **Bioavailability of Dissolved Organic Phosphorus in the Florida Everglades: Evaluation with Native Bacterial and Reference Enzymes**—***Lita M. Proctor***, *G. Schaefer* and *W. M. Landing*; Florida State University, Tallahassee, FL

9:30 **Hydrologic Influence on Stability of Organic Phosphorus in Detrital/Floc Material of a Constructed Wetland**—***H. K. Pant*** and *K. R. Reddy*; University of Florida, Gainesville, Florida

9:50 **Algal-induced Calcite and Phosphorus Coprecipitation in Created Freshwater Marshes**—***Michael A. Liptak*** and *William J. Mitsch*; Ohio State University, Columbus, OH

10:10 **Refreshment Break**

Concurrent Session XII – Nitrogen Transformations

Salon E

Chair: ***Elisa M. D'Angelo***, University of Kentucky, Lexington, KY

am

10:25 **Dynamics of Nitrate Loss in Emergent Wetlands**—***William G. Crumpton***; Iowa State University, Ames, IA

10:45 **N Dynamics of Grass and Forested Riparian Wetlands in Agricultural Landscapes of Western Oregon**—***Stephen M. Griffith***; USDA-Agricultural Research Service, Corvallis, OR; *J. H. Davis* and *S. L. King*; Oregon State University, Corvallis, OR; and *P. J. Wigington, Jr.*; U.S. Environmental Protection Agency, Corvallis, OR

11:05 **Factors Affecting the Nutrient Trapping Capacity in Riparian Wetlands**—***Malcolm Tredinnick Downes***; National Institute of Water and Atmospheric Research, Christchurch, New Zealand; and *Long Nguyen*; National Institute of Water and Atmospheric Research, Hamilton, New Zealand

11:25 **The Function of Cyanobacterial Mats in Wetlands of Belize Assessed through Field Sampling and a Nutrient Enrichment Experiment**—***Eliska Rejmánková*** and *Jaroslava Komárková*; University of California-Davis, Davis, CA and Czech Academy of Sciences, Ceské Budejovice

11:45 **Discussion**

pm

12:00 **Symposium Concluded**

Concurrent Session XIII – Wetlands and Water Quality – II

Salon D

Chair: ***Dave Rudnick***, South Florida Water Management District, West Palm Beach, FL

am

8:30 **Benthic Nutrient Fluxes in Florida Bay's Mangrove Ecotone**—***David T. Rudnick*** and *Stephen P. Kelly*; Everglades Systems Research Division, South Florida Water Management District, West Palm Beach, FL; *Stephen E. Davis*; Southeastern Environmental Research Center, Florida International University, Miami, FL; *Chelsea D. Donovan* and *Karl P. Picardi*; Center for Environmental Studies, Florida Atlantic University, Boca Raton, FL

8:50 **Root Proliferation by Mangroves in Decaying Roots and Old Root Channels: A Nutrient Conservation Mechanism?**—***Karen L. McKee***; U.S. Geological Survey, Lafayette, LA

9:10 **Bottom-up Linkages between Fringe Mangroves and Seagrasses in a Bahamas Tropical Lagoon**—***Marguerite S. Koch***; Florida Atlantic University, Boca Raton, FL; and *Chris Madden*; South Florida Water Management District, West Palm Beach, FL

9:30 **Impact of Logging on a Mangrove Wetland: Cost/Benefit by Soil Use Change Analysis**—*Cristian Tovilla Hernández*; Facultad de Ciencias, UNAM, Mexico; ***Guadalupe de la Lanza Espino***; Instituto de Biología, UNAM, Mexico; and *Edith Orihuela Belmonte*; Escuela de Biología, UAS, Mexico

9:50 **Quantifying the Effects of Enhanced Water Inflows on Wetlands throughout the Southern Everglades**—***Daniel L. Childers****, Jenny Davis, Stephen Davis, David M. Iwaniec, Frank M. Parker* and *Damon Rondeau*; Florida International University, Miami, FL; *Christopher Madden, David Rudnick* and *Fred Sklar*; South Florida Water Management District, West Palm Beach, FL; *Jaye Cable, John W. Day, Jr.* and *Enrique Reyes*; Louisiana State University, Baton Rouge, LA

10:10 **Refreshment Break**

10:25 **Biogeochemical Cycling in a "Hyperventilating" Shallow Estuarine Environment on Diel Time Scales**—***Nicole G. Beck*** and *Kenneth W. Bruland*; University of California-Santa Cruz, Santa Cruz, CA

10:45 **Impact of Marsh Impoundment Water Management on Indian River Lagoon Water Quality**—***Linda K. Blum***; University of Virginia, Charlottesville, VA; and *Douglas M. Scheidt*; Dynamac Corp., Kennedy Space Center, FL

11:05 **Effect of Sediment Grain Size on the C:N:P Ratios in a Coastal Wetland**—***Guadalupe de la Lanza Espino*** and *Salvador Hernández Pulido*; Instituto de Biologia, UNAM, México.

11:25 **Nutrient Dynamics in the Newly Created Shallow Lake Agmon (Hula), Israel**—***Moshe Gophen***; Kinneret Limnological Laboratory, Tiberias, Israel

11:45 **Discussion**

12:00 **Symposium Concluded**

Abstracts

Presenting authors appear in **bold**.
Abstracts are listed by session and order of presentation or by poster number as appropriate.

Plenary Session I – Wetlands: Role in Landscape Processes

Monday, July 12, 1999
8:20am-12:10pm

Wetland Biogeochemistry, Environmental Quality and Human Welfare: Some Challenges and Opportunities

Edward Maltby
Royal Holloway Institute for Environmental Research
Huntersdale, Callow Hill, Virginia Water, Surrey GU25 4LN, ENGLAND

A global perspective is presented of the significance of biogeochemical processes and resulting wetland functioning on environmental quality and human welfare. Examples are drawn from both the developing as well as the developed world to demonstrate the importance of regional, cultural and socio-economic context in determining the priorities for a science agenda in the effective management of wetland resources.

A number of key challenges are examined:
1. The need to better link science and policy
2. The need to translate wetland science for better public understanding
3. The need for more effective tools for wetland protection and management

The wetland scientific community historically has made very little use of international conventions and treaties to underpin the significance of research or as a guide to the priorities of civil society. Yet opportunities exist to underline the global as well as local importance of well-targeted science. These are examined in the context of the Ramsar Convention on wetlands of international importance and the Convention on biological diversity.

The case for such engagement is based not only on the need for society to better harness the results of good wetland science but also to improve the level of public support for research funding and its application to political priorities such as poverty alleviation, sustainable development, climate change, water quality and biodiversity maintenance.

Solving Inland and Coastal Pollution with Restored and Created Wetlands in the Midwest

William J. Mitsch
Olentangy River Wetland Research Park
The Ohio State University
Columbus, OH 43210

Surface water wetlands provide an ideal system for the ecological solution to high nutrients, whether from wastewater or from nonpoint source pollution. We now have about 22 wetland-years of experience at 3 wetlands sites in the continental cold-winter climate of Midwestern USA where nutrient (NO3-N and P) have been investigated over a wide range of hydrologic conditions and nutrient loadings. The sites are the Des Plaines River Wetland Demonstration Project in northeastern Illinois, the Olentangy River Wetland Research Park experimental wetlands in Columbus, Ohio, and the Licking County wastewater wetland in Licking County, Ohio. The Des Plaines River wetlands were used to investigate the effects of hydrology on ecosystem function to simulate nonpoint source pollution. The Olentangy River experimental wetlands, constructed in 1994, also received polluted riverwater and were part of an experiment to investigate the concept of self-design of ecological systems. One of the first wetlands constructed in Ohio for wastewater treatment, the Licking County wastewater wetland was designed to retain the nutrients nitrogen and phosphorus and provide a wildlife habitat in climate conditions of Ohio (45°N, mid-continent). Results from these wetland studies illustrate many common patterns that are assisting us in determining proper ecological engineering design and extent of wetlands needed to deal with large landscape-scale questions such as excessive nitrogen in the Mississippi River basin and the hypoxia in the Gulf of Mexico. Recommendations from our report for solving the hypoxia involve extensive restoration of wetlands and riparian zones (24 million acres) in the Midwestern USA, one of the most ambitious targets of watershed restoration in the nation.

The Role of Biogeochemistry in Addressing Wetland Issues and Problems in Louisiana

R. P. Gambrell*, R. DeLaune, I. Mendelssohn, S. Faulkner* and *W. H. Patrick*
Wetland Biogeochemistry Institute
Center for Coastal, Energy, and Environmental Resources
Louisiana State University
Baton Rouge, LA 70803

The Wetland Biogeochemistry Institute at Louisiana State University conducts research on biogeochemical processes associated with sediment-water and soil-plant systems, addressing wetland issues and problems important to the state of Louisiana. The state has large expanses of wetlands in close association with major agricultural and industrial activities and population centers. Also in close association with the state's wetlands are oil and gas exploration, production, and processing industries and major water transportation routes supporting the oil and chemical industries. Wetland loss of around 20 square miles per year due to subsidence and other processes compounds stress to wetlands in the state.

Research topics and programs at the institute include wetland delineation, processes stressing marshes and marsh plants, greenhouse gas production and amelioration by flooded rice production and natural wetlands, the environmental chemistry of trace and toxic metals, pesticides, industrial organics, and petroleum hydrocarbons, and wetland restoration and enhancement research.

This presentation will present a summary of selected research activities by the institute to illustrate some of the problems and impacts associated with wetlands in the state and efforts to address some of these issues.

Nitrate Retention and Denitrification in Riparian Wetlands

Oswald Van Cleemput, *Stefan Van Damme* and *Pascal Boeckx*
Faculty of Agricultural and Applied Biological Sciences
University of Ghent
Coupure 653, B-9000 Ghent, Belgium

Riparian wetlands are vegetated buffer zones lying between terrestrial upland soils and inland streams or lakes. They contain two interfaces. The first interface is important for nitrate retention from drainage water from agricultural watersheds, while the second one is involved in nitrate removal from river water.

Riparian wetlands can play a significant role in retaining diffuse nitrate pollution. Nitrate retention is usually situated in the first few meters of the riparian zone where groundwater rich in nitrate reaches a substrate supporting nitrate removal. Nitrate retention is usually higher than 90%.

Denitrification has been identified as a primary mechanism of nitrate removal in riparian zones since many years. The intensity of nitrate reduction as measured by redox potential has been shown to be an important factor affecting denitrification. It also has an influence on the denitrification products.

Results will be described on the nitrate removal in a tidal wetland of the 'Zeeschelde, Belgium'. The estuary of this river covers a full salinity gradient. It was found that 25% of the nitrate entering the river does not reach the North Sea due to denitrification. The nitrate removal occurred less intensively in the brackish part than in the freshwater part. Nitrous oxide was found as an important denitrification gas.

Phosphorus Removal in Treatment Wetlands

Robert H. Kadlec
Wetland Management Services
Chekea, MI

Treatment wetlands may be built and used for sustainable phosphorus (P) removal. Depending on hydraulic loading and P loading, the result may range from removal to background P concentrations, to no measurable removal. Long-term sustainable removal is to the creation of new, refractory soils and sediments. The storage contains refractory organic P, as well as iron and calcium forms.

Data from a variety of wetlands typically show an exponentially decreasing concentration profile from inlet to outlet. This observation invites the utilization of a first order removal equation, which states that accretion is proportional to surface water concentration. This rule hides the necessary role of the biogeochemical cycle in creation of the stored residuals. More sophisticated models can include the phosphorus cycle through wetland biota, but at the expense of more model parameters.

Wetland background P concentrations are achieved in systems that are large enough to remove all P added in the inflow. Atmospheric deposition, groundwater discharge, and episodic releases from sediments can contribute to non-zero background P concentrations, and therefore place a limit on the lowest achievable P concentration. Second level descriptive models incorporate such a limiting P value.

Wetland hydrology controls several important processes. Release of stored P may occur during dry periods, due to the oxidation of accreted residuals, which in turn create soluble P fractions. Evapotranspiration pulls water and dissolved P into the rhizosphere. Episodic high flow events can lower diffusion resistances, and provide a subsidy to the various forms of algae. The imperfect flow patterns in marshes may route some incoming P directly to the outlet, thus creating the appearance of a high wetland background.

Storages in soils and biota provide no long-term benefit for storage, but may function as temporary sinks that cause load equalization over time. An increase in water column P causes increased sorption and luxury uptake by biota, which leads to greatly enhanced uptake rates in times of excess P. In times of low P availability, these reserves may be drawn down to support growth and metabolism. These saturable storages may also cause higher or lower apparent uptake during the startup of a new system.

New knowledge from the growing number of P control wetlands is improving our ability to model and design effective P treatment systems.

Initial Steps in Developing Nutrient Criteria for Wetland Systems

Amanda Parker
USEPA
Office of Science and Technology
Health and Ecological Criteria Division
Washington, DC

As directed by the President's Clean Water Action Plan (1998), the US Environmental Protection Agency (EPA) began a National program to provide guidance to States and Tribes in developing nutrient criteria. This program is tasked with publishing waterbody-specific guidance for lakes and reservoirs, rivers and streams, estuaries and coastal waters, and wetlands; and with developing default criteria for the fourteen delineated nutrient ecoregions of the US (Omernik 1998). Guidance manuals for lakes and reservoirs, and rivers and streams will be published in summer 1999. Expert workgroups have been formed to draft the coastal and estuaries, and the wetlands guidance manuals.

Developing nutrient criteria for wetland systems is a particularly difficult due to the complexity of wetlands and diversity of wetland types. Effects of nutrient enrichment and nutrient assimilative capacity of natural wetlands is not well defined. Nutrient criteria development for wetland systems will involve defining cause-effect relationships of nutrient enrichment in wetlands. Our initial effort involves developing a matrix of wetland types and potential parameters for use in identifying nutrient enrichment. We are actively seeking case studies of nutrient effects in wetlands to provide guidance with a broad geographic scope. We invite input on developing nutrient criteria for wetland systems.

Biogeochemical Issues in the Management and Restoration of Wetlands

Lawrence Keenan and *Edgar Lowe*
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32178

The St. Johns River Water Management District owns more than 190,000 ha of public land. Most of these lands are wetlands or will be restored to wetland from other land-uses. Successful management and restoration of these wetlands rest, to a large extent, upon our knowledge of biogeochemical processes. At present, our knowledge of the interactions between the biota and major forcing functions such as hydrology, nutrient loading, and fire is inadequate to predict the outcome of many management actions. Issues centered around the availability and effects of phosphorus are presently one of our foremost concerns. Cultural eutrophication of wetlands has created the potential for conflicts among management objectives. These conflicts heighten the need for more precisely defining biogeochemical interactions. For example, fire is a necessary component of wetland management yet the introduction of fire can increase P availability and, potentially, elicit unwanted changes in plant community composition and structure. Similarly, periods of drydown are essential to maintenance of wetland biological communities but exposure of histosols to the atmosphere can cause mineralization of organic P and, thereby, increase P availability causing undesirable effects. Another area critical for management decisions is elucidation of the effects of P gradients on the biota. These problems will be discussed with reference to properties owned by the District.

Concurrent Session II – Microbial Processes /Activities

Monday, July 12, 1999
1:30pm-5:20pm

Determination of Microbial Parameters in Flooded Peat Soils Using Fluorescent Compounds

Leonard J. Scinto*, Meera K. Nair* and *Ronald D. Jones*
Southeast Environmental Research Center
Florida International University
Miami, FL USA

Effective evaluation of the impacts increased phosphorus supply has on the oligotrophic Everglades includes determination of shifts in microbial processes. To aid in these assessments we conducted research to develop a rapid, simple assay procedures for comparing microbial enzyme activities and bacterial densities in soils, flocculent detrital materials (floc), and water. Enzymes studied were alkaline phosphatase (P), (-1,4-glucosidase (C), (-N-acetylglucosaminidase (N), and sulfatase (S). Enzyme activity was assayed as liberation of highly fluorescent moiety from non-fluorescent 4-methylumbelliferyl substrates (MUF-P, C, N, and S). Soil/floc dilution, incubation and analysis pH, and incubation time were varied to determine the most efficient assay parameters. We found that optimum incubation conditions were pH = 6.0 and 24 h for MUF-C, N, S, and at pH = 8.7 and 2 h for MUF-P with 103 dilutions of soil and floc. Increasing pH >10 by addition of NaOH immediately prior to analysis increased fluorescence intensity. Bacterial density was determined by assay using the double-stranded DNA-specific fluorochrome PicoGreen(r) on similarly diluted soil and floc samples. All fluorescent analyses were conducted on a 96-well plate reader. We believe application of these techniques will increase understanding of nutrient induced change in the Everglades.

The Control of Soil Aggregates on Sulfate Reduction in Freshwater Wetlands

Yuch Ping Hsieh and Jinan Feng
Florida A & M University
Tallahassee, FL 32307

Previous study has established that while sulfate reduction is an active process in a black gum (Nyssa biflona) swamp and a titi (Cliftonia monophylla) swamp, only the former could be further stimulated by increased loading of sulfate, organic substrate and lime. We suspected that light texture and lack of soil aggregates in the titi swamp might have limited the sulfate reduction capability. We initiated this study to investigate the effect of soil aggregation on sulfate reduction in the titi and the black gum swamps of North Florida. The swamp soils were wet sieved to obtain three aggregate fractions (large: >2 mm, medium: 1-2 mm, and small: <1 mm). The three fractions were incubated with addition of sulfate and organic substrate. Hydrogen sulfide evolution and sulfate reduction rate determinations indicated that sulfate reduction was stimulated in all three fractions of the black gum swamp soil and in just the small fraction of the titi swamp soil. The results indicated that texture and lack of soil aggregation limit sulfate reduction in the titi swamp soil.

Effects of Crude Oils on Metabolic Activity of Soil Biota in Saline Soils

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Hydrocarbons increase abundance of hydrocarbon-degrading microorganisms and decrease microbial diversity. Such disturbances could disrupt soil organic matter mineralization and resultant nutrient remineralization rates. We therefore compared the soil-microbial-community's gross metabolic rate for 6 months among microcosms containing marsh soils that differed in soil organic matter (Spartina alterniflora Loisel. or Juncus roemerianus Scheele dominated marshes), crude oil (Alaskan crude, Louisiana crude, or no oil), and additives (cleaner, dispersant, nutrients, no additive). As in a previous experiment using fresh marsh soils, crude oils stimulated activity in saline soils. In addition to toxins, crude oils apparently contain components that stimulate activity of surviving microbes. Accelerated activity disappeared by the end of the fresh marsh study. However, accelerated activity persisted throughout the saline study in S. alterniflora soils receiving the dispersant or no additive, and in all J. roemerianus soils. Accelerated activity disappeared by the end of the saline study in oiled S. alterniflora soils treated with nutrients or the cleaner. Post priori, we hypothesize that the time for soil-microbial-metabolic-activity to recover from disturbance by crude oil is governed primarily by the innate metabolic rate of the soil microbial community, which varies with dominant vegetation, and secondarily by chemical additives.

Influence of Electron Donors on Microbial Respiration in Everglades Soils

A. L. Wright and *K. R. Reddy*
Wetland Biogeochemsitry Laboratory
Soil and Water Science Department
University of Florida-IFAS
Gainesville, FL 32611

A method to assess catabolic diversity of soil microorganisms by quantifying short term (~1 d) utilization of electron donors was investigated. This method involves addition of electron donors to soil and measurement of CO_2 evolution. Response to added substrates by soil microorganisms in the short term likely indicates previous exposure of microorganisms to particular substrates. Differential utilization of substrates indicates presence of different microbial consortia in soil.

The objective of the study was to identify types of electron donors utilized during soil microbial respiration under various soil P conditions. The influence of several electron donors on microbial respiration was investigated at 3 stations along a eutrophic gradient in Water Conservation Area-2a of the Florida Everglades. Phosphorus loading in WCA-2a has caused a distinct soil P and vegetation gradient south of surface water inflow point. Types of electron donors used in the experiment included several carboxylic acids, amino acids, polysaccharides, and alcohols. Soil was incubated with and without added substrates and CO_2 evolution was quantified over time. Basal and substrate induced respiration rates were highest at the P impacted area near the inflow and decreased at unimpacted areas in both surface detritus and the 0-10 cm soil depth. Total respiration was generally higher in surface detritus than in underlying 0-10 cm soil. All substrates were utilized as electron donors, although at varying degrees. Substrates having highest utilization rates were oxalic acid, ketoglutaric acid, acetic acid, and alanine. Most substrates exhibited differential utilization along the P gradient, suggesting different microbial communities may exist along P gradient. Highest substrate utilization rates were observed at the P impacted area. Substrates showing greatest difference in utilization rates along P gradient were glutamine, lysine, and galactose. The majority of added substrates was used in soil microbial respiration, although differences in rates were observed between soil depths and along P gradient. The greater utilization of substrates in P impacted areas suggests that P may limit microbial respiration in unimpacted areas.

Linking Soil Microbial Changes to Intensification of Agricultural Wetlands in the Tropics

Wolfgang Reichardt
International Rice Research Institute (IRRI)
Los Banos, Philippines

Sustainability of traditional tropical rice cropping systems such as the Ifugao rice terraces in the Philippines is strikingly high. Unlike arable non-flooded soils, irrigated rice soils tend to conserve and even increase their organic carbon and nitrogen contents. Microbial parameters in practically input-free rice terrace soil have been compared with those of more intensely cropped, irrigated lowland soils on the Philippine island of Luzon. Measures of microbial diversity based on either signature lipid profiles or respiratory carbon source utilization assays show only minor differences. On the other hand, principal component analyses for different field sites and treatments suggest drastic shifts in the profiles of microbial biocatalysts driving biogeochemical functions. Intensified cropping systems are characterized by increased prokaryotes : eukaryotes ratios, often elevated levels of indicators of metabolic stress incurred by nutrient limitation among the soil microflora, enhanced levels of soluble phenolic compounds, as well as suppressed activities of respiratory electron transport system (ETS) activity. Profiles of microbial carbon and nitrogen respiration in soil indicate most rapid responses of copiotrophic segments in the soil microbial community to measures of agricultural intensification. The extreme sustainability of tropical agricultural wetlands grown to rice can be linked to their richness in diverse microbial energy carriers and "energy channels".

Comparison of Soil Organic Matter Concentrations and Microbial Activity of Restored and Natural Bottomland Hardwood Wetlands

Rachael G. Hunter and *Stephen P. Faulkner*
Louisiana State University
Baton Rouge, Louisiana

Wetland restoration involves replanting appropriate vegetation and restoring the hydrologic regime. After restoration, many characteristics of the wetlands, such as vegetation type and soil organic matter concentrations, may be different from the original wetland. To determine how restoration affected specific soil characteristics, three types of bottomland hardwood (BLH) wetlands were studied: natural wetlands, restored wetlands with hydrology restored (RWH), and restored wetlands without hydrology restored (RWOH). Heterotrophic microbial activity, soluble organic carbon, and readily mineralizable carbon concentrations were measured seasonally for one year in soils of six study wetlands. There was no difference in soluble organic carbon concentrations measured among wetland types (P=0.6250), however concentrations measured in winter were higher than the other three seasons (P=0.0001, (=0.05). Microbial activity was highest in the natural wetlands and lowest in the RWOH wetlands (P=0.0001) and significantly different among seasons (P=0.0001). Readily mineralizable carbon concentrations were also highest in natural wetlands and lowest in RWOH wetlands (P=0.0001) and higher in winter than any other season (P=0.0001). Denitrification potentials were also higher in natural wetlands than in RWOH wetlands. These results indicate that restoration of wetland hydrology is necessay to successfully restore biogeochemical functions in BLH wetlands.

Soil Processes Regulating the Fate of Chlorophenols in Wetlands

E. M. D'Angelo
University of Kentucky
Louisville, KY

K. R. Reddy
University of Florida
Gainesville, FL

Transformations of agricultural and industrial pollutants in wetlands depend on the presence and activity of appropriate microbial groups inhabiting the soil, as influenced by interactions with their physical and chemical environment. This research was conducted to ascertain the dominant regulators of microbial activities in a spectrum of wetland soils, and in turn, how these activities governed biodegradation and sorption of chlorinated phenols (CPs).

Biodegradation of pentachlorophenol (PCP) was observed in most (80%) wetland soils, however rates were governed by environmental conditions. Maximum PCP degradation was restricted to the range 0.3 to 10 µM, due to sorption-controlled bioavailability and toxicity constraints. Degradation was promoted under aerobic and methanogenic conditions, and inhibited under denitrifying and sulfate reducing conditions. Aerobic PCP degradation produced pentachloroanisole, and methanogenic degradation yielded lower chlorinated phenols by reductive dechlorination, however >63% of these were lost in 30 d from half of the soils. Reductive dechlorination was highly correlated to electron donor availability and microbial biomass (94%), and enhanced with amendments of protein-based electron donors, suggesting the role of fermentative and hydrolytic bacteria.

Sorption of CPs were described by linear isotherms. Sorption was highest in low pH and high organic matter soils, and these factors explained 80% of the variation in results in ten wetland soils. Sorption was up to a 30 times lower under methanogenic compared to aerobic conditions, largely due to microbial activity affects on pH, ionic strength, and colloidal concentration. Results predicted that CP mobility, bioavailability, and toxicity will be higher under methanogenic conditions compared to aerobic conditions.

The Wetland Toxic Organic Fate Model, which coupled transport, transformation, and partitioning processes, may be used to assess the influence of management strategies on pollutant fate in the flooded soil column.

Evaluation of Carbon Origins of CH4 Emitted from Rice Paddies

Makoto Kimura and *Akira Watanabe*
Nagoya University
Chikusa, Nagoya, Japan

Possible carbon sources for CH4 emitted from rice paddies are applied organic materials such as rice straw (RS), soil organic matter (SOM), and organic carbon supplied from rice plants (RP). To estimate the contribution of each carbon source to CH4 emission, a pot experiment was conducted using 13C-enriched soil sample and 13C-enriched RS as tracers. The percentage contribution of RP carbon was estimated by subtraction.

When RS was applied at a rate of 6 tons ha-1, the percentage contributions of RS, SOM, and RP carbon to CH4 emission throughout the period of rice growth were 42, 18-21, and 37-40%, respectively. The values for SOM and RP carbon for the treatment without RS were 15-20 and 80-85%, respectively. Seasonal variations in the percentage contribution of SOM to CH4 emission was small in the range between 13 and 30% for the pots with RS, and between 15 and 24% for the pots without RS. In the RS-applied treatment, RS and SOM accounted for almost 100% of the CH4 carbon early in the period of rice growth, while 65-70% of the CH4 emission in the milky stage was derived from RP carbon.

Methane Oxidation in Rice Rhizosphere; Experiments and Modelling

Peter van Bodegom
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Methane is a principal greenhouse gas and rice paddies are an important source of methane emission. A major uncertainty in methane emissions is methane oxidation in the rice rhizosphere. Spatial and temporal dynamics of potential methane oxidation was quantified and showed a large variability. Many processes influence the efficiency of methane oxidation and might cause the variability found. Therefore, the consumers of oxygen released into the rhizosphere were quantified. The most important oxygen consumers, heterotrophic and methanotrophic bacteria, were isolated and characterised. The kinetic parameters of these organisms were also determined and coupled to a kinetic computer model to explain methane oxidation. According to the model, methane oxidizers were outcompeted at almost all conditions. For a further understanding of the role of methane oxidation, the model was extended to include transport in the rhizosphere as well. Sensitivity analysis of this rhizosphere model shows that the uncertainties in root exudation and root oxygen release have major influences on the estimation of methane oxidation. Quantification and dynamics of these processes will thus have to be understood to allow methane oxidation prediction.

Unravelling and Understanding Peatland Gas Reservoir Dynamics

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The stable isotope ratios of methane and carbon dioxide from EllergowerMoss, a raised peat bog in SW Scotland were characterized in two profilesof gas samples, collected in situ under pools at 1 m intervals from thesurface to a depth of 5 m: ?13C(CH4) = -76±3ä(n = 22), ?13C(CO2) = 3.8±5.3ä (n = 22), and ?D(CH4) = -294±39ä (n = 21). The profiles revealed two isotopically distinct methanereservoirs within Ellergower Moss, a dynamic zone between 0-2 m and astatic zone from 3-5 m. The zonation appears to be independent ofmethanogenic pathway and of changes in ?13C or ?D of bulk substrate,but there is a positive correlation between an increase in ?D(CH4) and reported increasing partial pressure of methane with depth(r = 0.943 and n = 18, >99.9% significant). Deeppeat methane reservoirs have been little considered, although may be asource of 'catastrophic' gas flux if breached, thus the mechanisms that lead to such accumulationare unknown. We are currently trying to address whether the observedprofiles result from gas transport and storage within the peat body and/oron-going methanogenesis.

Concurrent Session III – Wetlands and Water Quality – I

Monday, July 12, 1999
1:30pm-5:00pm

Influence of Wastewater Characteristics on Nitrogen Processing Gradients in Constructed Wetlands

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Hydraulically, horizontal-flow constructed wetlands are generally designed to approach plug-flow conditions. This creates strong downstream gradients of organic matter and nutrient loading, and associated biogeochemical conditions. We compare the influence of four different organic wastewaters with different C:N ratios on nitrogen processing gradients along replicate gravel-bed wetland mesocosm cascades. Each cascade comprised a series of five gravel-filled tanks (20 L) planted with soft-stem bulrush (*Schoenoplectus tabernaemontani*). Wastewaters were dosed four times per day into the initial tank of each cascade, to give an overall theoretical hydraulic residence time of 5 days. Changes in oxygen demand (COD) and forms of nitrogen in the wastewaters, and the passage of pulses of ^{15}N stable isotope and Br tracers were followed along the cascades, and used to describe N processing gradients. Implications for modelling of nitrogen removal performance in constructed wetlands will be discussed.

The Effectiveness of Riparian Buffer Zones for Removing Nitrate from Groundwater of the Atlantic Coastal Plain

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There is growing interest in the ability of riparian buffers to remove nitrate from groundwater before it discharges to streams. Streams in the Atlantic Coastal Plain are considered vulnerable because of widespread use of fertilizer and animal manure, high recharge rates, and well-drained soils. The National Water Quality Assessment Program conducted studies in Georgia, South Carolina, North Carolina, and Maryland to evaluate the effectiveness of riparian buffers in removing nitrate from groundwater. In Georgia, clay layers prevented nitrate from leaching to groundwater, routing it instead through drains and ditches to the stream. In South Carolina denitrification took place near the water table but nitrate in deeper groundwater passed under the forest and discharged into the stream. In North Carolina stream chemistry indicated a mixture of groundwater from the surficial aquifer and older, deeper groundwater from a semi-confined aquifer. In Maryland nitrate passed under the riparian forest and discharged into the stream at one location but at another site it was denitrified. These results suggest that the presence of riparian buffers alone cannot guarantee nitrate removal from groundwater. Other factors such as hydrogeology, geomorphology, and depositional environment are also important in determining whether denitrification will occur.

Nitrogen and Phosphorus Processing in Riparian Wetlands Receiving Nutrient Inputs from a Sheep-grazed Catchment in New Zealand

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The ability of a riparian wetland to strip nitrogen (N) and phosphorus (P) from surface runoff and ground water was investigated over a 6-month period when most of the annual water flows from a sheep-grazed pasture catchment to the wetland occurred. Water flows to and out of the wetland were monitored daily and periodically analysed for ammonium (NH4+), nitrate (NO3-), total Kjeldahl N (TKN), dissolved reactive phosphate (DRP), total P (TP), and natural oxygen-18 (18O). Rainwater was also sampled weekly for O18 analyses. Differences in 18O between various waters indicated that groundwater was the source of base flow events and was a major contributor (66-72%) to water export during the high flow events (>75m3/day). Over a 6-month period, the wetland removed 27% P (mainly as DRP) and 54% N (mainly as NO3-). However, it was a source of NH4+ and particulate N (outputs exceeded inputs by 44-50%). Both NO3- and TN outputs showed a linear increase (r^2 = 0.965-0.971; $P < 0.01$) with an increase in water flow within the wetland, suggesting an inadequate soil-water contact time for nitrate denitrification and particulate N retention at high flow rates (>75 m3/day).

Maximizing Wetland Benefits and Minimizing Impacts on Drinking Water Quality

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California is evaluating a proposal to restore nearly 100,000 acres of the Sacramento-San Joaquin Delta to wetland habitat. This restoration will replace existing farmland. While there may be ecological benefits, there are concerns about the potential impacts from wetlands on future drinking water quality and treatment costs. During chlorination at municipal water treatment plants, organic matter and bromide (from seawater) form trihalomethanes and other disinfection byproducts (DBP). These DPBs, some which are carcinogenic, are regulated by the USEPA. Studies have already shown that agricultural drainage from peat soil islands in the Delta is a large source of organic carbon. Wetlands could be a greater carbon source than farm drainage. New studies including computer modeling of organic carbon transport in the Delta from proposed wetlands will be used to provide guidance in the location of these restored wetlands. The results of mesocosm factorial designed experiments will be used to develop design, construction, and operational schemes that minimize organic carbon concentrations in waters from flooded peat soil environments. Will these wetland designs also meet the ecological goals and needs of the Delta?

Balancing Nitrate Removal and Wildlife Habitat in Constructed Wetlands

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Constructed wetlands designed for the treatment of wastewater are not usually designed with wildlife benefits as a major consideration. Some scientists and engineers think that such duel purpose wetlands risk problems due to food web contamination and potential toxicity. While such concerns are valid, it is possible to use many treatment wetlands for wildlife and be assured that problems will not arise. Two constructed wetlands in Southern California (200 and 30 ha) were recently completed with nitrate removal as the main or co-equal purpose. Bird habitat was an important consideration, especially in the 30 ha site where emergent macrophyte vegetation was kept to about 10%, rather than the 50 + % typical of treatment wetlands in order favor small shore birds ("peepers"). The ramification of these designs include addition of carbon and plant diversity enhancement.

Evidence for Plant Carbon and Nitrate Co-Limitation in Treatment Wetlands

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Treatment wetlands offer a simple and economical means for reduction of high nitrate levels in treated wastewater and agricultural runoff. Wetland plant litter provides a large surface area for microbial attachment, low oxygen diffusion, and a rich supply of organic matter to fuel microbial denitrification. Despite this, there is a wide range of average reported nitrate removal efficiencies (30-95%), which are not adequately explained by bulk water quality parameters (pH, Temp., DOC). After correction for temperature, long-term supply of carbon remains an important factor in achieving reliably high denitrification rates.

Carbon availability for denitrifying bacteria is better described by plant carbon quality measures (e.g., C:N, lignin) than productivity or water column DOC alone. Our laboratory results show decreasing removal efficiencies with decreasing ratios of available plant carbon to applied nitrate (Cavail:Nappl). This co-limitation confounds first order rate comparisons, as a system receiving low nitrate loading (high Cavail:Nappl) may result in a relatively high effective denitrification rate. In contrast, a system receiving high nitrate loading (low Cavail:Nappl) may result in a lower denitrification rate. We propose future inter-system rate comparisons should consider Cavail:Nappl using a combination of plant species composition and productivity estimates.

Importance of Bottom Soil Redox Reactions in Aquaculture Systems

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Aquaculture systems, fishponds, shrimp ponds and other are "wetlands" with a very high load of organic matter. Typical daily feed addition is in the order of 5-30 g/m2, thus, bottom soil is rapidly getting to be anoxic. Oxygen penetration depth in stagnant bottom soils is limited to 1 mm and less and redox values higher than 200 mv limited to a the topmost 1-3 cm.The exposure of fish or shrimps to low redox environment is deleterious. Fish do not graze in reduced sediments and growth slow down or stop when reducing conditions prevail.

A number of toxic chemicals are produced and accumulate under reducing conditions. Ammonium accumulates, to a large extent due to the low energy efficiency of anoxic metabolism. Sulfide is a known toxic material. However, besides the conventional redox species, it was found that high concentrations (102 mg/kg soil) of organic acids accumulate in reduced sediments. Many of these acids are known to be toxic toward fish.Control means include continual resuspension of the sedimented organic residues, removal of the organic sludge and poising the redox using nitrate.

Effects of FGD Liner Material on Ecological Functions of Mesocosm Treatment Wetlands

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Two year's of experiments have been conducted on the effectiveness of FGD (Flue-Gas-Desulfurization) by-product as a liner in constructed wetlands. The ecological impact of the FGD material and the possible benefits should be known before it is reused as a liner in constructed wetlands.

A set of 20 flow-through mesocosms (1m2 x 0.6m polyethylene tubs) was positioned at the Olentangy River Wetland Research Park. FGD by-products were used as liners in half of the mesocosms; the other half with no FGD liner in the tubs served as controls. A water delivery system was constructed to simulate natural flows of contaminated surface runoff into natural or constructed wetlands. Surface outflow and leachate samples were obtained from the mesocosms. Three Schoenoplectus tabernaemontani rhizomes were introduced into each of 20 mesocosms. Number of stems, number of stems bearing flowers and stem lengths were investigated during the first growing season experiment and the biomass and tissue elemental composition through harvesting in the second year of the study. The results in the mesocosms showed the material's effectiveness in removing phosphorus from the water. The toxic effect of the material on the plant biomass production was negligible but noticeable during the first year in the morphological growth of plants.

The Fate of Algal Phosphorus Input in a Large, Reed Dominated Wetland: A Modelling Approach

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The Kis-Balaton Reservoir has been established in order to reduce nutrient loads to Lake Balaton. The yearly average chlorophyll concentration is 100-150 mg m-3 at the outflow of the Upper Reservoir (1985). The Ingói Copse (16 km2) was inundated in 1992 by diverting the outflow water of the Upper Reservoir through the area. Reed covers 70% of the copse. This wetland retained 40-50% of its TP load. However, TP retention was coupled with a summer export of 1-10 tons of SRP.

Three hypotheses were formulated to explain net SRP release. (i) Release was a transitory phenomenon caused by flushing of some loosely bound P fraction from the soils. (ii) SRP release was a consequence of bacterial decomposition of reed litter, that is the phenomenon is an inherent feature of the reed stands. (iii) The source of SRP was the decomposition of algae imported from the Upper Reservoir. In the present study, I examine this third hypothesis by the means of a dynamic P cycle model.

Concurrent Session IV – Hydric Soils/ Redox Reactions

Monday, July 12, 1999
1:30pm-3:15pm

Groundwater and Solute Flow Characteristics in Altered Wetland Soils of the Hula Valley, Israel

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Ami Nishri
Kinneret Laboratory, Israel

Oren Reichmann, and *Moshe Shenker*
The Hebrew University of Jerusalem, Israel

The quantity and flow characteristics of groundwater in the altered wetlands of the Hula Valley directly affect the water quality of Lake Kinneret because 63% of the annual recharge and 50% of the nutrients load to the Lake flows through the Hula Basin. Lake Kinneret is a fresh water lake that provides about 25% of the total water demands for the State of Israel and more than 50% of its drinking water. Notwithstanding, the current understanding of groundwater and solute fate and transport in the Valley is quite limited. We launched a pilot study using pattern recognition analysis to ascertain the groundwater flow attributes within the soils of the altered wetland ecosystem. We have identified five distinct groups: 1) highly oxidized Histosols, 2) moderately oxidized Histosols, 3) calcareous and basaltic alluvial soils, 4) limnic-marly soils, and 5) deep artesian flow. Electrical conductivity (EC) and the molar ratios of Ca/Cl and Na/Cl were the most significant parameters in the analysis. The spatial distribution of the EC and other biogeochemical parameters indicated that groundwater flow within these soils extends well beyond the presumed no flow boundary conditions imposed by the major drainage canals as suggested by the hydraulic head distribution.

Trace Gas Exchanges in Hydromorphic Soils: Interactions at the Agricultural/Wetland Interface

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Hydromorphic soils can be important sources of greenhouse gases such as N2O and CH4, provided that both substrates and energy supplies are present. Where intensive agricultural land is adjacent to wetland areas, there may be significant transfer of both mobile carbon and excess NO3 into the wetlands.

The interface between these systems, largely ignored in favour of river margins, may provide an important "buffering" capacity which, whilst removing some excess materials (NO3-) may result in leakage of environmentally important gases (N2O, CH4), and may modify the chemical status of the drainage water. It is hypothesised that there will be hydrogeomorphically distinct units (HGMU's) at this interface.

Weekly emissions were determined using a closed chamber technique. Other monitored variables include redox potential, soil NO3-, NH4+, TOC and water table depth. Gas production at depth in situ was determined using a novel silicone diffusion chamber technique.

Results show relationships between gas fluxes and the hydrological status of the soil. Methanogenesis appears to contribute a more significant proportion of greenhouse gas to the atmosphere than denitrification in interfacial soils. It is clear that the interfacial zones may respond differently than agricultural and wetland soil types.

Physicochemical Properties of Wetland Soils in Relation to Plant Growth

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It is generally considered that Eh and pH are two important parameters of submerged soils in relation to the growth of plants. Actually, it was found that not Eh or pH per se, but some chemical factors related to them that directly affect plant roots. Reducing substances, including organic and inorganic forms, were characterized in the author's laboratory as strongly reducing and weakly reducing, according to their half-wave potentials measured voltammetrically. Ferrous iron was found to be present in forms of precipitated, exchangeable, complexed with the solid part of soil organic matter, and water-soluble which was further distinguished into chelated and ionic. Sulfides can be distinguished as precipitated, S2- ions and H2S. The latter two were determined with electrochemical sensors, so that the chemical equilibrium of the system was not disturbed appreciably. H2S was of most concern to us, because it is the only species of various sulfides that is directly toxic to plant. In the paper, physicochemical equilibria of these substances as related to Eh and pH are discussed, and critical toxic levels with respect to plant growth, taking paddy rice as the example, are given.

Influence of Biogeochemical Processes on Hydric Soils, Wetland Delineation, and Functional Assessment

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Biogeochemical processes in wetlands are dominated by oxidation-reduction (redox) reactions. These reactions yield distinctive assemblages of soil characteristics and biotic components that are an integral part of wetland ecosystems. These characteristic components are, in turn, used to identify hydric soils, delineate wetlands, and assess wetland functions. Specifically, reactions involving iron, manganese, and carbon are particularly diagnostic and provide visual evidence of soil redox processes. Transformations of nutrients and contaminants are important biogeochemical functions in wetlands. However, the relationships between wetland structure and specific functions are poorly understood with little supporting data. In addition, the use of quantitative field data to identify hydric soils and evaluate wetland functions is complicated by the spatial and temporal variability of redox reactions. These issues challenge us to improve our understanding of structure:function relationships. I will discuss the impact of these biogeochemical processes on wetlands and their application to identifying hydric soils and assessing wetland functions. While there are methodological limitations, quantitative evaluation of soil redox processes and their linkages to structure and function provides an important tool for evaluating wetland ecosystems.

Land Use Impacts on Glacially Shaped Potholes of Northeast Germany

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Potholes with high water dynamics are typical small wetlands in young pleistocene landscapes of Northeast Germany. The intensive land use impaired them due to erosion, eutrophication, drainage, structure impoverishment and removal.

The objective is to characterize the functioning of pothole types as a basis for the development of protection and restoration strategies. In our study, the impacts of agricultural land use on water, sediments, macrophytes and gas emissions were investigated at selected potholes.

1) Specific accumulations of nutrients and heavy metals were detected with respect to matter loading disposition, transect site and plant species.
2) Water quality was mostly polytrophic, with highest values for SRP and NH4+ at reducing conditions. The dynamics of quality parameters were depended on trophic level and water dynamics.
3) Eutrophication was correlated with high amount of TP and instable binding P at surface submers sediments, but not with C/N ratio.
4) Only 25 % of 275 macrophyte species were frequent. That was especially applicable for hydrophytes.
5) Nitrous oxide and methane emissions at riparian zones were determined by water regime and enhanced at polytrophic potholes.

Concurrent Session V – Trace Metals

Monday, July 12, 1999
3:30pm-5:00pm

Speciation and Cycling of Uranium in Redox-affected Evaporation Pond Sediments

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Elevated levels of the radioactive element uranium (U) exist in the agricultural drainage water of the San Joaquin Valley (CA, USA). Due to problems associated irrigated agriculture in a semi-enclosed basin, approximately 2500 hectares (7200 acres) of shallow evaporation ponds were created for the disposal of these highly saline waters. The ponds sustain wildlife and are potential sources of U toxicity via food chain transfer. The incoming drainage waters contain elevated levels of U that was leached from the soil during irrigation. Periodically, the ponds are filled with drainage waters and allowed to evaporate to dryness. These cycles influence the redox status of the pond waters and sediments. Algae in the ponds sorb U(VI) and become incorporated in the sediment often as layers of organic material (OM) when the ponds dry. The OM serves as an energy source, which can promote the reduction of U, SO42- and other elements. In this presentation, we will discuss results from field and laboratory studies on the chemical speciation of U and the physicochemical processes that influence U cycling in the evaporation ponds.

Effects of Iron Enrichment on Sulfur, Iron and Phosphorus Distributions in Carbonate Wetland Sediments

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James Fourqurean
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Florida Bay is a shallow, seagrass-dominated wetland system formed atop iron-poor carbonate sediments. We compared the depth distribution of sulfur, iron and phosphorus compounds in sediment cores collected from control sites and experimental sites amended with a surface application of reactive iron aggregates. After two months, deposition of iron monosulfides (FeS) and pyrite (FeS2) in the upper 2.5 cm of sediments was significantly greater in iron-enriched plots (63.3 (13.1 (mol S/gdw) relative to controls (25.6 (6.0 (mol S/gdw). Elevated concentrations of extractable iron, however, were detectable to 20 cm, suggesting that sediment mixing had occurred and that rates of sulfide formation were higher in surface sediments. Our hypothesis that decreases in sediment sulfide toxicity would be apparent in measurements of plant vigor has not been supported to date. Sediment phosphorus concentrations were higher in surface sediments and elevated in iron-enriched plots (51.9 (26.5 (mol P/gdw) relative to controls (7.7 (0.8 (mol P/gdw), concomitant with elevated concentrations of dithionite-extractable iron oxides (41.7 (14.3 (mol Fe/gdw in experimental plots versus not detected in controls). Nuisance algal blooms in Florida Bay are stimulated by water column phosphorus, so phosphorus sorption to iron-enriched sediments could enhance bay water quality.

Atmospheric Fluxes of Toxic Metals and Environmental Changes in the Venice Lagoon as Recorded by Salt Marshes

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In many coastal areas, salt marshes have been shown to be good recorders of the fluxes of atmospherically transported contaminants. Cochran et al. (1988) used a salt marsh core (M1), collected in the northern Venice Lagoon and representative of an area windward with respect of both the town of Venice and the industrial area of Porto Marghera, to reconstruct the chronology of contaminant inputs. In order to evaluate the fluxes leeward of these sources and expand our knowledge of the accretion mechanisms of salt marshes of the Venice Lagoon, a second site (M2) was sampled in the central lagoon and studied with the same methodology.

The depositional history of core M2 is different from that recorded in the northern area, and the average mass accumulation rate, based on the 137Cs peaks is nearly double (0.27-0.32 vs 0.14-0.15 g cm-2 y-1). Evidences exist that the accretional history of the two marshes is heavily dependent on the periodic flooding of the lagoon due to exceptionally high tides (acqua alta phenomenon).

The new site (M2) recorded metal fluxes that are generally one order of magnitude higher with respect to M1. Metal concentrations and fluxes peak in the second half of the 1970s, then decrease significantly. Ag and Cd, which behave differently, show a recent increases. The highest fluxes were calculated for Zn: 40-115 (g cm-2 y-1.

Cochran J.K., M. Frignani, M. Salamanca, L.G. Bellucci, S. Guerzoni, 1998. Lead-210 as a tracer of atmospheric input of heavy metals in the northern Venice Lagoon. Mar. Chem., 62, 15-29.

Day J.W, D. Are, A. Rismondo, F. Scarton, G. Cecconi, 1995. Relative sea level rise and Venice Lagoon wetlands. Proc. 2nd Int. Conf. "MEDCOST 95" (October 24-27, 1995; Terragona, Spain), 793-807.

Sustainable Retention of Metals in Natural Wetlands

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Natural wetland areas contribute significantly to the retention of metals from metal-rich water. Previous studies at CSM have shown that long-term amelioration of minewater with little metal export can occur in established natural freshwater wetlands. Engineered wetlands are species-poor and only designed to retain metals over a short life-span but natural metal-rich wetlands tend to develop distinct vegetational communities and some have the capacity to retain metals for over 100 years.

Natural wetlands can, however, remobilise and export mobile metals such as iron and manganese, thus leading to problems for water companies who abstract drinking water or discharge from reservoirs. Remobilisation appears to be linked to climatic cycles of drying and rewetting of the wetland.

We have studied the movement of metals through a range of wetland mesocosm types. Continuous sub-surface flow mesocosms with similar vegetation communities grown on a range of sediments were studied during steady state and flushing. The amount and localisation of metals retained indicate that under saturated conditions low levels of metals are exported, particularly from sediments with low organic material. The release of metals post drying and re-wetting is linked to release of fine organic material. A final mass-balance of metals is presented.

Session VI
– Poster Session

Monday, July 12, 1999
6:30pm-8:30pm

POSTER – 1

Created, Drained (Protected), Historic, and Relict Hydric Soils: The Altered Soils

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Gainesville, FL

According to the National Technical Committee for Hydric Soils (NTCHS), hydric soils are soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. These soils are currently supporting or capable of supporting wetland ecosystems. Conversely, nonhydric soils currently are not supporting nor are they capable of supporting wetland ecosystems without soil-hydrology modifications. Altering soil hydrology by human activities or geologic processes may change the status of a nonhydric soil to hydric, or that of a hydric soil to nonhydric. Created Hydric Soils are soils that once were nonhydric but are currently hydric due to human activities. Drained (Protected) Hydric Soils are hydric soils that have reduced wetness due to altered hydrology by human activities. Historic Hydric Soils were once hydric but are now nonhydric due to alterations by human activities. Relict Hydric Soils are nonhydric soils altered by geologic activities. Human or geologic additions or removals may change the hydric/nonhydric soil status; however, to be considered hydric a soil must a) have a hydric soil indicator, or b) meet Hydric Soil Criteria 3 or 4, or c) meet the NTCHS technical standard requirements for hydric soils.

POSTER – 2

Using Hydric Soil Indicators in Disturbed Soils to Characterize Regulatory Wetlands

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Victor Carlisle
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Gainesville, FL

Hydric soil determinations and delineating hydric soils in areas that have been filled, dredged, land leveled, or otherwise disturbed can be difficult and an extremely challenging assignment. In some instances of disturbance the vegetation has been destroyed or removed; therefore, soils are the only on-site indicator of predisturbance hydrology and the only feasible means of identifying wetlands. Where upturned soil disturbance is recent, sufficient clods of various soil horizons may remain that will aid experienced soil scientists in verifying the original soil morphology. Predisturbance soil surveys should be consulted where available. Undisturbed areas in the vicinity may be investigated to provide information of predisturbance soil morphology. Small areas of unaltered soil may be found at the base of remaining trees; however, most frequently, the disturbance is more extreme. Fill materials spread on disturbed sites usually compound the difficulties of making hydric soil determinations. Guidelines have been established to determine the hydric status of disturbed soils after varying amounts of fill materials have been added. These guidelines, where properly applied, identify and delineate the hydric soil component of regulatory wetlands.

POSTER – 3

Graphic Representation of Field Indicators for Hydric Soils in the United States

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Field indicators for hydric soils in the United States were published in July 1996 by the National Technical Committee for Hydric Soils in cooperation with USDA, NRCS. As published, thirty-six indicators were approved for use in hydric soil identification and delineation. Each indicator was defined and notes were added to assist in the recognition of soil morphological properties used for hydric soil identification and delineation. Nevertheless, considerable confusion in understanding the established hydric soil indicators continues to exist. Much of this confusion can be eliminated through the application of visual graphic representations. Soil morphological ranges of each indicator are more easily explained by graphic illustrations than by definitions and user notes. Graphic illustration of all approved field indicators for hydric soils in the United States will be presented.

POSTER – 4

Field Indicators of Hydric Soils: Boundary Indicators versus Interior Indicators

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The National Technical Committee for Hydric Soils (NTCSH) has approved hydric soil field indicators for use in identifying and delineating wetlands without regard to their location within the hydrological gradient of wetlands. We differentiate those indicators that occur in the wettest of wetlands (interior indicators) from those at the delineation edge of wetlands (boundary indicators). Indicators identified as primarily interior indicators usually occur in the wettest of wetlands and are normally saturated or inundated for much of most years and those identified as primarily boundary indicators, although where maximally expressed they may also occur within the wettest parts of a wetland, where minimally expressed occur at the much drier delineation boundary. Soil morphologies on the nonhydric side of wetland delineations are usually significantly different from the morphologies within the wetland.

POSTER – 5

Using Soil Morphology and Soil Survey Data for Restoring and Creating Wetlands

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Wetland construction, wether restoration or creation efforts, often fail when the hydrology of the proposed construction site is not identified correctly. Precise morphological interpretations of soils of a proposed construction site should result is a successfully constructed wetland. Probable depth to saturation and duration of inundation may be identified by understanding and utilizing soil survey data. Familiarity with redoximorphic processes and recognizing their morphological expressions in soils facilitates on-site determination of depth to saturation and/or duration of inundation. Presence of one or more National Technical Committee for Hydric Soil's (NTCHS's) approved hydric soil indicators identifies soils with near surface saturation and/or inundation. These soils have wetland morphology and support or have the capability of supporting wetlands. Wetlands can also be constructed on most locations where hydric soils are not present. Typically, excavation for constructed wetlands is to a depth to or below the seasonal high saturation. Morphological interpretations identify saturation at lower depths in nonhydric soils. Soil morphological, physical, chemical, and mineralogical properties must be correctly interpreted and a predictable source of water is needed if wetlands are to be constructed above the depth to seasonal high soil saturation. Soil morphology must be correctly interpreted and available soil survey should be throughly explored prior to attempting and wetland construction or restoration.

POSTER – 6

Nitrogen and Phosphorus Retranslocation along a Salinity Gradient in Mangrove Forests Located at the Everglades Salinity Transition Zone

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Green and senescent leaves were collected in mangrove forests located along a salinity gradient in Taylor Slough at the Everglades National Park, Florida. Data were compared between two dwarf red mangrove forests and a taller mangrove forest located in the Ridge zone. The objective was to assess the relative importance of nutrient retranslocation and nutrient conservation of Rhizophora mangle along a salinity and nutrient gradient among the three mangrove zones.

Nitrogen and phosphorus tissue concentrations were higher in green leaves of mangrove trees located in the Ridge zone compared to that of the ones located in the dwarf zone. There were differences in the amount of nutrient reabsorbed and differences between N and P retranslocated. Mean nitrogen retranslocation was 29 and 37 % in the dwarf forests and 49 % in the Ridge forest. Phosphorus retranslocation was higher (85 %) than that of nitrogen; however, phosphorus retranslocation was similar among the three mangrove forests.

The high phosphorus retranslocation reflects the low availability of phosphorus in carbonate environments and suggests that phosphorus is used very efficiently since the plant recirculates more phosphorus. The low nitrogen retranslocation suggests that this nutrient is not limiting factor.

POSTER – 7

A Proposed Mechanism for Rapid Gas Transport in Submersed Macrophytes

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Gas transport through lacunae of submersed macrophytes is thought to occur primarily by diffusion and secondarily by mass flow when pressure gradients develop. Since the lacunae of submersed macrophytes are essentially closed systems that pressurize quickly, mass flow is unlikely to sustain transport for long. However, in some cases, diffusion alone is insufficient to explain apparent rates of oxygen transport and root oxygen consumption. We propose an alternative model in which diffusion through lacunar diaphragms is augmented by turbulent mixing of gases in lacunar spaces, as might be expected when plants flex due to water movements. We used published data on lacunar anatomy to model rates of transport through 50 cm sections of five different species of submersed macrophytes assuming either diffusion alone or diffusion augmented by turbulent mixing. Lacunar mixing increased rates of transport by an order of magnitude and for each species was sufficient to meet published rates of oxygen demand without invoking mass flow. The proposed transport mechanism provides for rapid gas transport that does not require pressure gradients and allows for simultaneous bidirectional flow of oxygen and carbon dioxide.

POSTER – 8

Changes of the Element Content of Phragmites Australis from Different Habitats of Lake Ferto/Neusiedler See

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Shoot density, dry mass, element concentration and content of reed was studied at a die-back, a vigorous and a vigorous site with high water cover (100-130cm water depth) at Lake Ferto/Neusiedler See (an alkaline lake on the Hungarian-Austrian border) from April to October, 1996. Samples were collected in every month.

The investigated elements were: C, N, S, P, Mg, K, Na, Ca, Fe, Mn, Zn.
The data series clearly indicate that the concentrations of the elements (exception of the C and Na) are always higher in the leaves than in the culms (including leaf-sheats). Continuous N, P, K and Zn concentration decrease till the end of the vegetation period followed the spring maxima in the aboveground organs (leaves and culm with leaf sheats). In the leaves the Ca and Na concentrations increased during the vegetation period and their concentrations did not change remarkably in the culm. The Mg and S concentration show a summer (in July-August) maxima in the leaves.

In the spacial comparision of the data of the dry mass, P, K, Ca and Mg concentration and content of the aboveground organs were significantly lower at the die-back than at the vigorous sites.
This work was supported by the EC-EUREED project (Contract number IC-CT96-0020/ CT960020 A2).

POSTER – 9

Can Mangrove Root Communities Indicate Variations in Water Quality?

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Mangrove communities exist throughout the world's tropical and sub-tropical coasts. These environments are characterised by organisms that can survive salinity fluctuations and other features of the intertidal zone. Within the mangrove habitat, a micro habitat exists on the root of the red mangrove, Rhizophora mangle. In this study the micro habitat was investigated along a eutrophication gradient. The main objective was to describe the variation in mangrove root epibiota in areas with different water quality types. An attempt was made to explain the variation of the epibiota on the basis of water quality (indicated by D.O., salinity, temperature, pH, Redox, phytoplankton biomass and light). To this end, four pairs of stations were sampled in four different mangrove areas believed to be experiencing different physiographic conditions and different levels of eutrophication. The sessile flora and fauna were identified and biomass determined (A.F.D.W). Significant spatial variation between the communities was demonstrated. Algal and faunal diversity was greatest at the more pristine stations and lowest in eutrophic areas. In the case of the fauna differences could be attributed to water quality changes as well as inhibitory mechanisms of primary colonizers. With respect to the algae, Ulva sp. was dominant in high nutrient areas, while Caulerpa vertticillata was important in pristine area.

POSTER – 10

Growth, Nutrient Uptake Kinetic and Use Efficiency of Typha domingensis and Cladium jamaicense at Steady State Oxygen and Phosphorus Availability.

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In comparison to species from fertile habitats, species from infertile environments often demonstrate low responsiveness in growth, nutrient use efficiency and nutrient uptake capacity to increased nutrient availability. Typha domingensis and Cladium jamaicense are both able to withstand periodical flooding and grow in natural low nutrient habitats like the Florida Everglades, a rainfall driven phosphorus limited ecosystem with seasonal wet and dry periods. However, the species responded very differently to increased phosphorus availability.

Cladium demonstrated inherent characters to low phosphorus availability, which included slow relative growth rate (0.02 - 0.04 d-1), low capacity for phosphorus uptake (0.5 mg P g-1 root dw d-1), and low responsiveness in biomass partitioning and growth to increased phosphate levels. In contrast, Typha adjusted growth, biomass partitioning and nutrient use efficiency to increased phosphorus availability. The growth rate of Typha (0.05 - 0.09 d-1) was more than twice as high as the growth rate of Cladium at the actual phosphate levels (10 - 500 µg l-1). However, while the phosphate accumulation rate was 16 fold higher in Typha at high phosphate level, the two species had similar phosphate accumulation rate at low phosphate level.

POSTER – 11

Forms and Amounts of Soil Nitrogen and Phosphorus Across the Longleaf Pine-depresssional Wetland Landscape of Southwestern Georgia

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Forms and amounts of soil nitrogen and phosphorus were measured in three longleaf pine - wiregrass and freshwater depressional wetland areas in southwest Georgia to assess the role of N versus P limitation in the Coastal Plain. Most of the N and P existed as recalcitrant / organic forms, with two-thirds to three quarters of total N and P concentrated in the surface soil (0-5 cm). There was a gradient of increasing plant available NO3- (0.04 - 3.7 (g/cm3) and organic N (890 - 2000 (g/cm3), and decreasing C:N (43:1 - 17:1) from the longleaf forest down to the wetland. Easily exchangeable Po (0.88 - 2.6 (g/cm3) and humic acid bound P (23 - 56 (g/cm3) also increased from uplands to wetlands, whereas total Fe and Al-bound P decreased along the gradient (14 - 7 (g/cm3). Nitrogen:phosphorus ratios ranged from 52:1 - 82:1 from the uplands to the wetlands, suggesting that the wetlands may be P limited. Based on our C:N and N:P ratios, we hypothesize that N limits Coastal Plain longleaf pine forest productivity, while N and P may co-limit depressional wetland productivity.

POSTER – 12

Coupling Phytoplanktonic Primary Production, Decomposition Processes and Nutrient Cycling in Two Natural Hypereutrophic Lagunas of Doñana National Park

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Santa Olalla and Dulce are two shallow natural eutrophic lakes ('lagunas') located in Doñana National Park (south of Spain). Their characteristic features are high values of algal biomass (chlorophyll-a can reach values of 700 mg/m3 for Santa Olalla and 350 mg/m3 for Dulce) and pH (7-11 for Sta Olalla and 7-10 for Dulce). In both systems the primary production community is dominated mainly by phytoplankton. Due to their homogeneity and relatively well defined primary production inputs, the coupling between primary production and processing of organic matter and nutrients is studied. For this pourpose, measurements of primary production (C14), algal biomass, and nutrient concentration were carried from February 1998 to February 1999. Microbial activity (using a set of four extracellular enzyme activities: phenol-oxidase, (-glucosidase, aminopeptidase and alkaline phosphatase), sedimentation rates and organic matter content in sediment were also measured. Despite the fact the lagunas are contiguos, they present differences in their functional patterns. In both lagunas the coupling between primary production and breakdown processes is quite efficient. However, in Santa Olalla, with higher rates for the different processes studied, the coupling between primary production, decomposition and nutrient cycling is much tighter than in Dulce laguna, specially for N cycle. A decrease in breakdown rates is also observed during summer season due to an apparent limitation of N and P.

POSTER – 13

Litter Decomposition of Emergent Macrophytes in a Floodplain Marsh of the Lower Paraná River

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The role of litter decomposition of the dominant emergent macrophytes on organic matter accumulation and nutrient cycling was studied by means of in situ litterbag experiments in a floodplain marsh of the Lower Paraná River. The effect of waterborne nutrients on decomposition rates was studied through a laboratory litterbag experiment. Litter decomposition was rather slow, remaining 50% of the initial mass after two years incubation. Similar decomposition rates were observed in laboratory and field experiments. Water fertilization did not significantly affect decomposition rates. Since litter production is faster than decomposition a net organic matter accumulation takes place in the upper layers of the marsh soil. N and P litter concentration increased along the studied period. Floodplain marshes represent effective long term sinks of nutrients through litter accumulation.

POSTER – 14

Relationships between Methane Production and Emission to Internal Methane Concentrations in Rice

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We measured internal methane concentrations in field-grown rice plants as a correlative to both methane production and emissions. Using a gas-tight syringe, 100 microliter samples were withdrawn from the plant below the water level and diluted to provide enough volume for analysis by gas chromatography. Internal methane concentrations increased throughout the season and, for each sampling date, were usually significantly higher in the cultivars Mars and Cypress (high emitters) when compared to Lemont and Della (low emitters). The field site influenced internal methane concentrations; wherein greater internal methane concentrations corresponded with greater methane. Methane emission rates were positively correlated with plant internal methane concentrations for each cultivar, with an improvement in the relationship during the pre-heading season. With increases in methane production determined by soil incubations or by emissions following field-induced anoxia, internal methane concentrations increased accordingly. Internal methane concentrations also clearly increased as plant biomass increased, but the relationship depended on field location and rice cultivar, both of which also influenced emissions. Sampling internal methane concentrations of wetland species although labor intensive is quite flexible, using little field equipment, and may provide an effective alternative to large scale flux measurements in areas not easily accessible.

POSTER – 15

Phosphine Production Potential of Various Wetland Soil, Wastewater and Sewage Sludge Sources

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In contrast to the gaseous flux of major biogenic elements the formation and emission of reduced gaseous phosphorus compounds in wetland ecosystems have been in question for several decades. The interest and research in reduced volatile phosphorus compounds expanded rapidly following Devai's report (1988) on formation of phosphine in sewage sludge. Recent studies have also detected phosphine and diphosphine in feces and bacterium cultures, in harbor sediments, in fluvial and marine hydrospheres, in the lower terrestrial and offshore troposphere. Evidence for phosphine production and emission from Louisiana and Florida marsh soils has also been reported.

Laboratory incubation procedure followed by gas chromatographic detection was used to measure phosphine production potential in wetland soil, wastewater and sewage sludge sources. Phosphine production potential was determined by measuring rate of phosphine formation in samples incubated under laboratory conditions over a seven-day period when both electron donors and the targeted electron acceptor were not limiting factors. Results showed that except effluent wastewater samples all other samples studied produced phosphine. The minimum phosphine production potential value (0.39 pg/ml wastewater/day) was measured in influent wastewater samples while the maximum (268 pg/g wet sludge/day) was measured in sediment samples collected from an open-air sewage treatment plant.

POSTER – 16

Aquatic Organisms and Microorganisms in Japanese Paddy Fields

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The kind and abundance of aquatic organisms (the size over 30 (m) and phospholipid fatty acid (PLFA) composition of microbiota in the floodwater were compared among long-term (more than 70 years) fertilizer trial plots during the period of rice cultivation: a plot without fertilizers, a plot with chemical fertilizers only, and plots with chemical fertilizers and rice straw compost. Aquatic organisms were classified mainly on the order level. Thirty-nine kinds of aquatic organisms were found in all plots. Although difference in fertilizer type did not influence the composition of aquatic organisms, it changed significantly the abundance of respective aquatic organisms.

Major PLFAs were 16:0, 16:1(7c, and 18:1(7 in every plot, and their relative abundance showed the seasonal variation. From the finding that the trans/cis ratio of 16:1(7, which is considered to reflect the stressed environment, recorded less than 0.1, the floodwater was regarded to be low-stressed environment. The ratio of (iso15:0 + anti-iso15:0)/16:0 was very low relative to reported values from upland soils, indicating the dominance of Gram-negative bacteria that lack iso15:0 and anti-iso15:0.

POSTER – 17

Rates and Controls of Microbial Respiration in Saltmarsh Sediments

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To elucidate the controls of microbial respiration in saltmarsh sediment, this multidisciplinary study incorporated microbial rate measurements and sediment geochemistry along with an extensive sampling scheme designed to constrain temporal and spatial variability in a saltmarsh at Sapelo Island, Georgia. Rates of microbial respiration, dominated by sulfate reduction, were measured using a radiotracer technique and carbon dioxide production in sediment incubations during 5 sampling periods spaced throughout the growth season. Reactants and products of respiration were monitored using standard geochemical methods. The levee of the marsh, with enhanced chemical fluxes and the tall form of the dominant marsh grass, Spartina alterniflora, consistently exhibited the highest rates of sulfate reduction and carbon oxidation (> 4000 nmol/cm3/d). Respiration rates varied seasonally with temperature and hydrologic environment exhibiting an equal effect on rates. Fe(III) respiration successfully competed with sulfate reduction comprising > 20% of the C oxidized in saltmarsh sediment. Acetate was the most abundant microbial fermentation product (concentrations up to > 1 mM) in marsh porewaters, and its distribution correlated with respiration activity. Chemical exchange, caused by tidal inundation and bioturbation, appeared to control the rates/ pathways of microbial respiration in a feedback loop with plant physiology.

POSTER – 18

Nitrogen Cycling in Sediments of the Lagoon of Venice, Italy

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Undisturbed sediment cores were collected in late April in the Lagoon of Venice, Italy. The core were transfered to the laboratory and incubated for denitrification activity using the method of "nitrogen isotope pairing". The sampled sediments were collected in a freshwater stream (A), an intertidal area (B), in an area characterised by Ulva sp (C) and in an area vegetated by Zostera sp. (D). The D sediment was collected close to the lagoon outlet (mouth) and highly affected by tidal actions.

The highest denitrification rate was found in area with the highest concentration of water nitrate, i.e. at station A and station B, 292±75 and 204±52 µmol m^{-2} h^{-1}, respectively. Sediment denitrification in the areas closer the lagoon outlet was significantly lower, 16±2 µmol m^{-2} h^{-1} at station C and 11±2 at station D. Oxygen- and nitrate consumption, release of ammonium and denitrification in the sediment at station B was correlated to the biomass of benthic infauna. The D sediment was found to release large amounts of organic nitrogen to the water column, 302 µmol m^{-2} h^{-1}. This release was attributed to leakage from dead or alive macrophyte biomass above the sediment surface or from root-rhizomes below the sediment surface.

POSTER – 19

A Nitrogen Budget in Soils along a Eutrophic Gradient in the Everglades Water Conservation Area 2A

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The northern Everglades ecosystem has been affected by phosphorus (P) loading over the past 40 y, resulting in increased soil total P concentrations. Coincident with P loading, changes in ecosystem structure, in particular, composition of the vegetative community has shifted from *Cladium sp*. to *Typha sp*. We investigated the effects of elevated soil total P on the biogeochemical cycling of N, an important element regulating plant growth. A series of laboratory and field experiments were conducted to estimate potential N transformation rates and storages in the peat soil within three distinct zones along a gradient; impacted, transitional, and unimpacted. The soil profile was subdivided into three compartments; detritus, 0-10 cm, and 10-30 cm depths. An N budget was constructed from the experimental data to determine relative turnover rates and the rate limiting process for N cycling in soil. Results demonstrated the size and activity of the microbial pool within the impacted zone was significantly higher than the unimpacted zone and consequently, microbial mediated cycling of N was also higher. Nitrification was the rate limiting process for N removal in all zones and was highest within the impacted region. Although rates were expressed as potentials, this simplistic model has applications for management. The bioavailability of N can be moderated, dependent upon surface water management of flooding or diversion. Increasing soil exposure to the atmosphere, thereby increasing rates of nitrification can increase N removal from the system. Conversely, continually flooded conditions will encourage low nitrification rates and greater availability of NH_4^+, which could stimulate plant growth. This mechanism might help explain how *Typha*, once established into areas once historically dominated by *Cladium*, spreads quickly outcompeting the sawgrass for available space and light.

POSTER – 20

Sorption and Desorption of Phosphorus in Soils and Limestones from South Everglades Wetlands and Adjacent Farmlands

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Phosphorus enrichment in surface and ground water in Everglade area is a major environment concern. Phosphorus adsorption/desorption that control P mobility in soils and rocks are relevant to the assessment of risks associated with P application in farmlands. Twenty-four each of soils and bed rocks have been collected from south Everglades National Park and adjacent farmlands in C111 basin. Wide range initial concentrations of P solutions (0.1 to 1250 (g P/ml) have being used to determinate the P sorption capacity of soils and rocks. Phosphorus adsorption isotherms for these soils and rocks are well fitted to both Fruendlich and Langmuir isotherms at low P concentrations (R2= 0.953-0.9999). However, when P concentration reaches near10-4M, P begins to precipitate. Native wetland soils have the higher Langmuir adsorption maximum (Smax = 3489 (g g-1) and Fruendlich K (Kf = 124.8) than agricultural soils (e.g., Smax = 1017-2283(g g-1 and Kf = 45.6-97.4). Bed rocks have the lowest Fruendlich K value (Kf = 12.7).

POSTER – 21

Nitrogen and Phosphorus Leached from Soil Disposal Mounds in Everglades National Park

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The Hole-In-The-Dount (HID) is one of the most important restoration sites in the unique Florida Everglades. Restoration of wetlands in the HID requires excavation of the exotic plants and topsoil. Currently, the excavated substrates are being stockpiled in wetland areas. Nutrient leaching, particularly N and P, from the soil disposal mounds, and its subsequent transport to surrounding wetlands are among environmental concerns since the topsoil had been intensively farmed for more than 30 years. The purpose of this study was to determine the potential leaching rates and mobility of N and P in soil disposal mounds. Results showed that potential leaching rates ranged from 0.9-19.5% for NO3-N, 11.9-67.5% for NH4-N, 7.0-41.3% for inorganic N, and 0.01-0.035% for total P during the simulated rainfall leaching study (equivalent to 550-cm precipitation). Regression analysis showed that concentrations of N and P in leachates were exponentially related to the change in soil pore volume. Ortho-P and total P showed similar mobility and leaching patterns.

POSTER – 22

Organic Phosphorus Mineralization in a Freshwater Wetland as Affected by Substrate Quality and Phosphorus-hydrolyzing Enzymes

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The effects of organic P (P_o) substrate type, and activities of P-hydrolyzing enzymes on the rate of P_o mineralization in a freshwater wetland were determined. Four labile organic P substrates - glucose-6-phosphate, glycerophosphate, phytic acid and adenosine triphosphate (ATP) were incubated with impacted (station E2; 3.3 km from inflow) and unimpacted (station U3; 10 km from inflow) soils of water conservation area 2A (WCA-2A) of the Florida Everglades. The P_o substrates were incubated for 4 h, and 1, 2, 4, 7, and 15 d under aerobic and anaerobic incubations. About 60-80% of added ATP and 50-60% of added glucose-6-phosphate or glycerophosphate were hydrolyzed after the 4-h incubation. For phytic acid, only 3% of added P_o were hydrolyzed in the unimpacted soil while 19% was hydrolyzed in the impacted soil after a 4-d incubation. Therefore, the rate of P_o mineralization in WCA-2A can be regulated by the nature of P_o substrates present.

Alkaline phosphatase (Apase) and phosphodiesterase (Pdase) activities were also determined in soils collected from various sampling stations of WCA-2A. Alkaline phosphatase was five times higher than Pdase activities. Potentially-mineralizable P (PMP) and enzyme-mineralizable P were determined in 0-10 cm soil and detritus from three stations representing impacted, mixed, and unimpacted areas of WCA-2A. Enzyme-mineralizable P was higher in the detritus compared to the 0-10 cm soil. In the detritus, enzyme mineralizable P was highest in the impacted area. Phosphodiesterase activity was not significantly correlated to PMP and enzyme-mineralizable P in both detritus and soil. In the 0-10 cm soil, APA was not significantly correlated while negative correlations ($p \leq 0.01$) were obtained for both PMP and enzyme-mineralizable P in the detritus. While the nature of P_o controls the rate of P_o mineralization in a freshwater wetland, P-hydrolyzing enzymes particularly phosphodiesterase are less important. In WCA-2A, there is an abundance of labile P_o substrates that are immediately available after mineralization which diminishes the need for P-hydrolyzing enzymes.

POSTER – 23

Effects of N P K Fertilization on Spatial Variability of Forest Soil pH, Al, Mn, Fe, and Zn

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Studies evaluating the effect of fertilization on the spatial variability of nutrients within forest soils have been limited. The information is needed to design sound forest management practices that takes advantage of nutrient interaction in the soil to improve productivity. Data were obtained from a field experiment designed to study the response of loblolly pine (Pinus taeda L.) to applied N, P and K using the continuous function design on a plot area of 10m X 10m, replicated three times. One year after fertilization, soil samples were collected at two depths, 0-15 cm and 15-30 cm at a 1 m grid interval from all three replications. The soil samples were analyzed for pH and resin extractable Al, Mn, Fe and Zn. Soil Fe, Mn, and Zn for the 0-15 cm depth showed similar coefficient of variation (CV) of 20 to 23 %. Greater CV values (26 to 31 %) were obtained for these nutrients for the 15-30 cm depth. Aluminum showed the greatest variation (CV = 64 %) at the 0-15 cm. Experimental variograms showed that these nutrients and pH exhibit differential spatial structure at the two depths. Soil pH, Fe, Mn and Al showed directional spatial dependence for each depth. This information is useful for planning future fertilizer prescription at the same site.

POSTER – 24

An Environmental Assessment of the Use of Red Mud for Wetland Restoration: Release and Plant Availability of Trace and Toxic Metals

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Greenhouse and field studies were conducted to examine the potential use of compost-amended red mud (by-product of Bauxite extraction) as a substrate to support fresh and salt marsh plant growth for potential use in enhancing or restoring wetlands. Red mud was amended with compost (50:50%, v:v) application rates to examine the mobility and plant availability of metals associated with red mud. The fresh water plant species used were maidencane, smartweed, and lizard's tail. Spartina alterniflora was grown in the salt marsh simulation. A field study indicated that the soluble concentration of some metals (Cd, Pb, Cr, and Ni) in surface runoff and interstitial water were either below the detection limits as measured by ICP in both brackish and fresh water samples, or they were below the fresh/marine acute and chronic criteria (EPA, 1991). The concentrations of Cu and Zn in surface runoff water and interstitial water exceeded fresh and marine acute and chronic criteria. The concentrations of Cu, Zn, Mn, and Ni in all plant tissue were comparable to concentrations found in plant tissues grown in natural swamp soil (reference). The concentrations of Cd and Pb in plant tissue were below the detectable range, whereas Cr was much higher in plants grown in red mud than reference plants.

POSTER – 25

Recent Developments in Arsenic Speciation Measurements for Routine Analysis of Environmental Matrices

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The toxicity and biochemical behavior of arsenic species relies on their chemical forms.

Toxic inorganic arsenic species (arsenate and arsenite) are biomethylated by bacteria, fungi, algae, invertebrates and man to yield monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA) which are considered less toxic than the inorganic forms. In this presentation a system utilizing strong anion exchange (SAX) ion chromatography coupled to hydride generation atomic fluorescence spectrometry will be described.

Non reducible forms of arsenic, such as arsenobetaine and arsenochlorine, are determined using online UV photodegradation. Absolute limits of detection are found to be below 10 picograms of arsenic for each species. A range of applications for environmental matrices will be presented.

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POSTER – 26

Mercury in Several Types of Aquatic Invertebrates in the Florida Everglades

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Cycling of mercury in aquatic environments is a complex process because of the number of chemical species and biological organisms involved and various geochemical pathways. It is generally recognized that mercury is bioaccumulated and biomagnified at all levels of the aquatic food chain. Although mercury in fish has been found to be predominated by methylmercury, dramatically various methylmercury/total mercury ratios have been reported for different types of aquatic organisms. The purpose of this research is to provide preliminary information on the methylmercury/total mercury ratio in several types of aquatic invertebrates collected from the Florida Everglades.

POSTER – 27

Fluorescence Spectroscopic Studies of DOM-Hg Complexation in Surface Waters of the Florida Everglades

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Interaction between Hg2+ and dissolved organic mater (DOM) of surface water samples collected from the Florida Everglades was studied by emission and synchronous fluorescence measurements. Both emission and synchronous spectra showed that the dissolved organic matter can complex Hg2+ since fluorescence was quenched upon addition of Hg2+ to the DOM samples. The synchronous spectra showed some structural information, which potentially could be used for the study of the metal binding sites in the DOM samples. The behavior of DOM-Hg complexes was influenced by the pH and by the presence of Cl- ion. The complexing capability and stability of complexes seemed to be dependent on the DOM concentration and source of the DOM. The role of CaCO3 precipitation during primary productivity of phytoplankton in the transport of mercury from surface waters to the sediments by coprecipitation of DOM-Hg was also investigated.

POSTER – 28

Redox Potential and pH Effects on Arsenic in Municipal Sewage Sludge

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A laboratory experiment examined As speciation and solubility in sewage sludge suspensions as affected by pH and redox potential (Eh). Under oxidizing conditions, As solubility was low with the major portion of soluble As present as organic species; dimethylarsinic acid (DMAA) was always the dominant organic species. Under moderately reducing conditions (0-100 mV), arsenite was the major inorganic As species in solution and As solubility significantly increased due to dissolution of iron oxyhydroxides. Upon reduction to -250 mV, As solubility was controlled by the formation of insoluble sulfides, and as a result soluble As contents dramatically decreased as compared to levels measured at 0 mV. Speciation was drastically influenced by pH. Soluble As was maximum at a neutral pH value, and decreased under both more acidic and alkaline concentrations. At pH 5.0, inorganic species were the dominant forms in solution, however, at pH 6.5, organic species were the major soluble forms. Alkaline conditions (pH 8.0) resulted in similar concentrations of soluble inorganic and organic As species. Arsenic biomethylation was measured at pH 6.5 and 8.0, but was drastically restricted at pH 5.0.

POSTER – 29

Spatial and Temporal Trends in Saltmarsh Sediment Geochemistry

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Saltmarsh sediment geochemistry is controlled by complex interactions between primary production, microbial activity, climate, tidal flushing and bioturbation. These interactions lead to distinct spatial and temporal geochemical trends, which are illustrated here by comparing seasonal porewater data from two sites at Sapelo Island, GA. One site is located in a heavily bioturbated, unvegetated creek bank, the other in a ponded marsh vegetated by medium-height Spartina alterniflora. Alkalinity, pH, Fe(II)/Fe(III), manganese, phosphate, ammonium, sulfate and sulfide were measured on porewater samples collected with diffusion equilibrators. The porewater data delineate an oxic zone overlying a suboxic zone at the creek bank site, whereas a more compressed vertical sequence of oxic, suboxic, sulfidic and methanogenic zones is found in the ponded marsh sediments. The redox zonation of sediment porewaters is traditionally explained by invoking a vertical succession of microbial populations that oxidize organic matter using terminal electron acceptors in order of decreasing free energy yields. However, microbial and solid sediment data collected at the same sites indicate a more complex microbial structure, with overlapping zones of aerobic respiration, sulfate reduction and dissimilatory iron reduction. The lack of vertical separation of microbial respiration pathways implies the coexistence of distinct geochemical microenvironments within the upper 5-10 cm of the sediments. Differences between porewater zonation at the two sites appear to be due primarily to the depth and intensity of irrigation by macrofauna.

POSTER – 30

Mercury Methylation Kinetics in Aquatic Macrophytes of Brazilian Wetlands

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Methylmercury, a strong neurotoxin, is mainly formed by the microbiological methylation of inorganic mercury in macrophyte substrates. This work describes the kinetics of mercury methylation in different aquatic macrophytes (Eichhornia azurea, Salvinia sp, Scirpus cubensis, Eleocharis sellowiana and Eichhornia crassipes) from three Brazilian wetlands. Samples were incubated with 203HgCl2 during 5 days for E. crassipes and 12 to 16 days for the other plants. Me203Hg was extracted in toluene after acid leaching and measured by beta counting. Methylmercury percentages obtained were fit to a first order kinetic model in order to calculate the methylation (k1) and demethylation (k2) coefficients. Methylation was about three times higher in Salvinia sp. (25 %) and in E. crassipes (26 %) than in E. azurea and S. cubensis. E. azurea and S. cubensis presented the highest k1 values (2.50 and 1.50, respectively) while E. sellowiana presented the lowest values (< 0.11). Highest demethylation coefficients (k2) were observed for S. cubensis (0.14) and Salvinia sp. (0.12). The kinetics differences between macrophytes could be associated with the root architecture and with the nature of the material composition adhered to the roots that change according to the diverse environmental processes acting in the wetlands dynamics.

POSTER – 31

Organic Micropollutants in a Core Sample of a Brazilian Mangrove

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The mangrove ecosystem has the ability to filter some micropollutants from rivers upstream or from the tide. Most of these micropollutants are retained in the sediment, which becomes an excellent pollution's indicator. In Rio de Janeiro, at the Guanabara Bay, the mangrove of Jequiá is an example of this ecosystem, since there are some industrial factories and oil refinery plant located around the Bay shore and its basin rivers.

A core sample from Jequiá was analyzed to verify the local historic pollution. The micropollutants studied were: organochlorine compounds (PCBs, DDT and metabolites and other pesticides) and policyclic aromatic hydrocarbons. The analytical method used was a Soxhlet extraction of the sediment, an Al2O3 clean-up and silica fractioning, with further analyses in ECD-GC (OCs) and HPLC (PAHs).

The concentrations were usually low. Mean values (ng/g d.w. 10% O.M.) were: ?PCB 22.88, max. = 46.52 at 18 cm depth; ?DDT 4.05, max. = 7.66 at 3 cm depth. The low pesticides concentration was expected due to the low agricultural activity in this region. Mean ?PAH was 2764, max. = 4366 at 18 cm depth. The PAHs values were relatively high, indicating the influence of industrial effluents.

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POSTER – 32

Use of Solidifier in Removing Oil from Coastal Wetlands

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The use of solidifier in oil spill has been minimal due to lack of practical application methods and testing under various coastal and environmental conditions. Solidifiers are dry granular, hydrophobic polymers that react with oil and forming a cohesive mass that float on water. Unlike sorbents the oil is retained in the solid mass allowing for easy removal. A field test was conducted in coastal Louisiana in which replicated enclosures were oiled with South Louisiana Crude. Granular solidifier was spread over oil in open water enclosures. Results demonstrated that solidifier may be an option for removing oil from Louisiana's wetlands should a spill occur.

POSTER – 33

Remediation and Restoration of an Oil Contaminated Wetland

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In August 1997, an oil and brine spill severely impacted a wetland adjacent to a blown-out oil well in Cravens, LA. In order to remove the oil from the wetland, the oil was ignited and allowed to burn. In order to estimate the amount of residual salt after the burn and the type of clean-up necessary for the wetland soil, 23 sample points were randomly chosen within the wetland. Each of these points were sampled at depths of 0-10, 10-20, and 20-30 cm and analyzed for electrical conductivity (EC) and pH. Electrical conductivity was measured to determine the amount of residual salts due to brine contamination. Results of the analysis show that brine concentration decreased with increasing soil depth. The highest concentrations of brine were found in the 0-10 cm layer and the lowest concentrations in the 20-30 cm layer. Brine was concentrated on the western edge of the wetland and adjacent to Little Sixmile Creek, which lies south of the wetland. Recommendations to remove the residual oil and brine include applications of ammoniated bagasse, gypsum, topsoil additions, and/or a combination of these.

POSTER – 34

Operation and Management of Onsite Constructed Wetlands in Kentucky

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Many residents of Kentucky live in rural areas not served by sanitary sewers. A promising solution to the wastewater problem in rural areas is an onsite subsurface flow (SSF) constructed wetland (CW) system for proper wastewater disposal.

This research summarizes results of an extensive CW survey of data collected from 67 county health departments and results of monitoring five systems selected from Marshall, Letcher, and Fayette counties, Kentucky. Counties were grouped into those with <5 CW systems, 5 to10, 10 to 50, 50 to 100, and >200. The most common plants used in SSF systems were cattails (Typha latifolia, 24.9%), reed canary grass (Phalaris arundinaceae, 12.6%), blue water iris (Iris versicolor, 12.2%), and soft stem bulrush (Scirpus validus, 11.7%).

Effluent BOD5 and TSS concentrations have averaged 12.3 and 19.8 mg/L respectively, and consistently have been below the state's discharge requirements. Ammonia nitrogen removal was low (51%) and little nitrate concentration was detected. Nitrate levels dropped from 7.3 in influent to 1.8 mg/L in effluent wastewater (75% removal). Removal of soluble phosphorus averaged 46%. Fecal coliform reduction averaged 94.7% but still exceeds the reference level. Dissolved oxygen increased from 0.53 in influent wastewater to 1.35 mg/L in the effluent discharge.

POSTER – 35

Efficacy of Riparian Buffer Strips to Filter Nonpoint Source Pollutants from Animal Wastewater

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We investigated the survival total and fecal coliform bacteria in surface runoff, soil water and shallow groundwater after application of swine waste to 30 m riparian filterstrips growing 20 m grass/10 m forest, 10 m grass/20 m forest and 10 m grass/20 m madiencane during each season of the year. Populations of total and fecal coliform bacteria in surface runoff did not decline as water moved downslope regardless of vegetation type or season of the year. Surface runoff did move to 30 meters in all treatments in the winter and in the 20 meters grass, 10 meters forest treatment in winter and spring. Total and fecal coliform bacteria in shallow groundwater at 20 and 30 meters from the input source was slightly higher in the 20 m grass/10 m forest filterstrip than the 10 m grass/20 m madincane filterstrip and 10 m grass/20 m forest filterstrip in winter, spring and autumn. Total and fecal coliform bacteria in soil water and shallow groundwater declined by approximately one order of magnitude every 7 days regardless of vegetative treatment or season of the year. Total and coliform bacteria in 1.5 and 2.0 wells correlated with groundwater temperature and soil moisture in a curvinilear relationshi p (r2 = ranged from 0.76 to 0.89).

POSTER – 36

Characteristics of Submerged Aquatic Vegetation Communities Used to Remove Phosphorus from Agricultural Drainage Waters

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Submerged aquatic vegetation (SAV) occurs over a range of nutrient regimes, including the oligotrophic Everglades. As part of a larger study on the use of SAV-dominated wetlands for removing phosphorus (P) from agricultural drainage waters (ADW), we evaluated the standing crop and elemental composition of Najas guadalupensis, Chara sp., and Ceratophyllum demersum in waters containing total P concentrations ranging from 180 to 10 ?g/L. Triplicate SAV mesocosms (3.7 m2, 65 -80 cm deep) seeded with a mixture of the above species were established on peat and limerock substrates. The mesocosms received ADW at P loadings ranging from 1.2 to 8.4 g P/m2?yr.

Najas guadalupensis was the sole species to increase in biomass under all treatments. Low P concentrations favored Chara, while C. demersum persisted only in high P-loaded mesocosms. The standing crop of N. guadalupensis and other macrophytes declined with decreasing P loadings, as did tissue concentrations of P. Similar relationships between water column P concentrations and SAV species composition and zonation were observed in portions of the Everglades Nutrient Removal Project treatment wetland, where N. guadalupensis was also most prevalent. Growing well along the 10-200 ?g/L P gradient, N. guadalupensis appears to play an important role in effective SAV-based wetland treatment of ADW to low P levels.

POSTER – 37

Continuous Assessment of Nutrient Removal and Physicochemical Conditions in Constructed Wetlands at a Distant Site

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Measurement of constructed wetland performance and conditions can be difficult at a distant site. Our Center is located in Florence, SC, and we wished to investigate constructed wetlands located at the North Carolina A&T University swine facility in Greensboro, NC. The wetlands consist of six marsh-pond-marsh systems. The marsh areas have a mixture of cattail and bullrush plant communities. The monitoring requirements were 24-hour monitoring capability, a multitude of measurement channels, logging capability, and remote data retrieval for four of the six wetland systems. Water quality parameters were measured at the center of each marsh and pond area. These parameters include pH, ORP, and temperature of the water and ORP of the soil at two depths. Inflow, outflow, and water level of each wetland system were measured. In addition, rainfall and air temperature was measured. Weekly composite water samples for nutrient analysis were collected at the inlet and outlet of each wetland system using automated samplers and a unique switching device. System components included a datalogger, modem, switch-closure module, multiplexers, pH sensors, ORP sensors, temperature sensors, platinum electrodes, pressure transducers, solar panel, a rain gauge, and automated samplers.

POSTER – 38

Constructed Wetlands for Tertiary Treatment and Pollution Control in the Caribbean

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An integrated wastewater treatment system was constructed for a new township of about 70000 people comprising of facultative ponds, maturation ponds and constructed wetlands. The system was designed to handle about 4 million gallons of wastewater per day. The township is close to the coastline and a narrow strip of natural wetland is present between the township and the coastline, which is a recreational beach. A 12ha artificial wetland was constructed next to the ponds to facilitate the treatment so that the natural wetland and the coastline receive minimal amounts of nutrients. The constructed wetlands comprised of Typha and rice. Water and Plant samples were analyzed over a Three-year period. The results show there is reduction in suspended solids, nutrient levels, BOD5 and coliforms. Ammonia-nitrogen, nitrate nitrogen, phosphate phosphorus in the effluent from Typha beds was less than a mg L-1. In the effluent from Rice fields, ammonia-nitrogen was 1.9mg L-1.The effluent BOD5 ranged from low of 20 to 70mgL-1. The results indicate that reduction in BOD5 peaks in the late evening hours. The natural wetland was engineered to optimize the flow of water and the influx of salt water to create a proper mix and gradient of brackish water. The natural wetland recovered significantly with the recovery of natural vegetation and the return of bird flora. This system is the first of its kind in the English speaking Caribbean and has proved to be highly efficient in nutrient removal and pollution control, especially for the coastal areas.

POSTER – 39

Denitrification Potential of Soil in a Riparian Zone and a Swine Wastewater Spray Field as Measured by Denitrification Enzyme Analysis

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Nonpoint source pollution of streams from excess nitrogen is a general agricultural problem, and its control is particularly difficult in areas of intense animal waste applications. Streams contamination in such areas can be reduced by use of riparian zones. The objective of this investigation was to assess the relative denitrification potential (DP) of soils at various depths and positions in transects from the edge of a swine wastewater spray field through a Coastal Plain riparian zone. Soil samples were taken from three depths at four locations along two transects during four seasons of the year over a three-year period. Four treatments were used - the control, nitrate addition, carbon addition, or carbon and nitrate additions. The DP was lowest near the field edge, but it varied within the riparian zone. It was highly correlated to the total kjeldahl nitrogen of the soil. It decreased with depth for all treatments. It was highest in the summer. Carbon was not a limiting factor for DP in any of the locations or depths, but nitrate was a common limiting factor in the riparian zone.

POSTER – 40

Hydrologic and Nutrient Balances in Coastal Wetlands in the Pacific, SW Mexico

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Water, salinity and nutrient balances (N02, N03, NH4, P04) were measured. The volume of fresh water that penetrated into the wetland was different in the two years, with a 0.87 m3/s average. It was high in September (1.62 m3/s) and low in April (0.37 m3/s) with 31.4 x 106 m3/yr. Marine water was more constant with an average per year of 1.72 m3/s, and 28.5 x 106/yr. This situation favoured to oligohalíne condition.

Nitrates were the most abundant with a high input of 7.5 µmol in June (16.8 µmol) and a low input of 1.6 µmol in December. The exportation was twice the importation with an average of 14.5 µmol . The ammonium and nitrites were second in place in exportation. The orthophosphates were different, with a high of 2.7 µmol in August and a low of 0.09 µmol in February. The wetland received 33.7 tons of nutrients during the rainy season and 14.5 tons during the dry season. The lower amount caused by a diminishing river flow. The export of nutrients from the wetland was greater than the import, with 86.5 ton/yr vs 48.0 ton/yr, respectively.

POSTER – 41

Functional Analysis of Surface-ground Water Interactions in Mediterranean Dunal Lagunas Using Water and Nutrient Budgets

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Interactions between surface and ground water, and overall water and solute budgets were analyzed in a system of two groundwater fed shallow lakes ('lagunas'). These are located in the dune formation of the Doñana National Park (SW Spain), and they present natural hypereutrophic conditions. Shallow and deep ground water levels, surface water level, meteorological parameters, major ions and nutrients are being monitored monthly during a period of two years, that started in February 1998. For shallow ground water measurements, a network of piezometers was installed following hydrogeomorphological criteria. Preliminary results suggest that the greatest source of biogeochemical variability is the input of ground water with two different origins (i.e., short flows from the dune front and long flows from the sand aquifer). These water sources determine overall ecological asymmetries between the shores of lagunas, in apparent contradiction with previous studies. These found an overall biogeochemical evolution of water in its flow through the lagunas system, using a few piezometers located in the main axis of the system. This contradiction is analyzed by discussing the importance of using an ecosystem approach in the design of biogeochemical studies.

POSTER – 42

Characterization of Isolated Seasonal Wetlands in Subtropical Rangelands

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Nutrient dynamics of freshwater wetlands in subtropical rangelands are poorly understood. We examined soils and vegetation of isolated, seasonal wetlands in embedded in subtropical rangelands to determine the influence of land-use and grazing on wetland characteristics. We sampled soils in the dry season from interior and edge habitats of 8 wetlands in improved pastures and 4 in semi-native pastures. We analyzed soils for NO3- and NH4+, P fractions, organic matter and water content. Pontederia cordata dominated vegetation in the interior habitats of all wetlands. Vegetation of edge habitats was dominated by Juncus spp, Digitaria ciliaris and Hydrochloa caroliniensis in improved pasture and by Panicum hemitomon, Eleocharis vivipara and Andropogon spp in semi-native pastures. Wetland soils were drier in semi-improved than in semi-native pasture, reflecting the drainage status of the two land-use types. Concentrations of both nitrate and total inorganic N were greater in ungrazed than in grazed wetlands. Nitrate levels were greater in improved than semi-native pastures in the organic horizon but the opposite was true in the mineral soil. Soil nitrate levels were greater in the interior then edge habitats. Both land-use and grazing intensity appear to have important influences on nutrient and organic matter dynamics in these wetlands.

POSTER – 43

Chemical Characteristics of Water Environment of Saline Wetland in the West Songnen Plain of China

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In the west of Songnen Palin, the saline alkali degree is high in saline water-body and wetland. pH value is more than 8.0, and the chemical type of water is HCO3- -Na+. Basing on the synthetic analysis of natural environment of this region, this paper explained the sources and movement of water in saline wetland and its chemical characteristics of water environment. Through analysis on the basic variables of saline alkali such as CO32-,HCO32-, Cl-,Ca2+,Mg2+,SO42-,Na+ etc. and the composed variables such as (Cl-+SO42-)/ HCO32- and Na+/(Ca2++Mg2+), the relationships between different variables were found, i.e. there are obvious relationships among CO32-,HCO32-,Cl-,SO42-, Na+,(Cl-+SO42-)/HCO32- and Na+/(Ca2++Mg2+), and pH of its water body can be expressed by linear function of [CO32-],[SO42-] and [Na+], and the discriminatory function and critical region map were got basing on the pH value, by which the significant study method on chemical characteristics of saline-alkali wetland water environment was attempted and obtained.

Key Words: Saline Wetland; Chemical Characteristics of Water; Correlation Analysis; Discriminatory Analysis

POSTER – 44

The Ecological Assessment and Management of the Martha Brae River Estuary, Jamaica

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The Martha Brae River Estuary (MBRE) one of the few remaining areas of mangrove wetlands on the north coast of Jamaica is the site of rafting tourist attraction and the bioluminescent Oyster Bay. The area experiences severe human impact and has thus been examined to provide baseline evaluation of the ecological status to facilitate the development of management plans. Sixteen water quality stations were sampled monthly from September 1996 to August 1997. Vegetation assessments and faunistic surveys were conducted contemporaneously. Nitrate and phosphate levels were high in river samples (32µg/L N and 0.98µg/L P) and significantly lower in nearshore waters (1.1µg/L N and 0.45µg/L P). The toxic, bioluminescent dinoflagellate Pyrodinium bahamense previously thought to be lost, has returned but in much lower numbers. Phytoplankton and zooplankton abundances were high in the constructed mangrove drainage, lower in the bay and near shore waters, the reverse was true for diversity. Four terrestrial zones were identified based on different land usage patterns which host a wide variety of avian species (some endemic) as well as numerous insects. While some tracts of mangroves remained untouched other areas experienced squatting, charcoal and agricultural production and inland fisheries with invasive species such as Achrostichum aureum dominating one zone. A management plan is suggested to provide social and economic development in denuded zones while protecting the unique features of one zone .

POSTER – 45

Nitrogen Diffusion at a Coastal Wetland in North West Mexico, With and Without Agricultural Impact

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The accelerated advance of agriculture near the coastal wetlands of North West Mexico has brought a nutrient enrichment, especially in the sediments, which later diffuses them into the water column. This situation is studied through the NH4, N02, and N03 in low light conditions and high, turbidity, using transparent and opaque experimental chambers placed in-situ. In sediment-water diffusion, turbid conditions favoured more that of NH4, and N03. In the absence of impact, ammonium reached up to 6.3 µmol/m2/h in illuminated conditions versus 17.6 µmol/m2/h in high turbidity. In waters adjacent to drainage it was 32.9 µmol/m2/h in illurninated waters and maximum diflusion occurred in turbid waters with 63.10 µmol/m2/h as a consequence of the high organic charge supplied by the drainage. Nitrite showed a marked difference between impact (0.4 µmol/m2/h) and non-impact (1.5 µmol/m2/h) independently of illumination conditions. Nitrate in illuminated waters did not vary substantially with impact (1.12 µmol/m2/h and 1.07 µmol/m2/h with and without impact respectively) in turbid waters the difference became marked (4.7 µmol/m2/h without and 0.38 µmol/m2/h with impact). It stands out from the above that in impacted areas of reduced conditions, ammonification is preferential while in non-impacted conditions nitrification is preferential.

POSTER – 46

The Influence of Water Density Difference in the Nutrient Dynamics for the Shallow Regions of a Tropical Reservoir: Tucuri Hydroelectric Reservoir, AM

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High temperatures in aquatic systems frequently control their internal processes. This occurs due to differences in water density as small variations in temperature cause large differences in water density preventing the advective transport, mix and exchange of energy and matter in the water. During six years, data from seven limnological variables (temperature, dissolved oxygen, total nitrogen, nitrate, total phosphorus, phosphate, BOD and COD) were collected in the Tucurui reservoir (Para, Brazil) for a vertical profile at seven depths of a shallow area of the reservoir. This area contains epiphytic algae and large aquatic macrophyte stands. The results of the analysis revealed differences ((=1%) in the density of water through the vertical profile as well as seasonal stability in the concentration of nutrients. The only exception was total nitrogen and nitrate (limiting nutrients) which varied in time and space. The results also showed the existence of thermocline, oxycline and permanent anoxic conditions on the hypolimnion. In addition, small variations in the water temperature revealed an important forcing function for the biogeochemical processes.

POSTER – 47

Contribution of Sediment Gases to Buoyancy of Organic Base Floating Wetlands

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Formation of floating organic substrates occur in many wetland ecosystems and are most common in systems with thick organic bottom sediments. Separation and floatation of substrate from the bottom results in newly exposed habitat for vegetative colonization and a unique hydropattern due to autochthonous factors which control buoyancy. These conditions result in species composition often in stark contrast to vegetative assemblages in adjacent non-floating habitat. In 1996 and 1997, a survey of floating and emergent wetland communities was conducted in Orange Lake, northcenteral Florida. In this survey, buoyancy components of floating and non-floating wetlands were analyzed to determine what environmental factors may be influencing formation of floating substrates. Results indicate organic base floating wetlands are principally buoyed by gases trapped within the sediment matrix and secondarily by below-ground biomass. It was also determined that several communities of non-floating emergent wetlands had net positive buoyancy values, indicating these communities should have been floating, yet they were not. In these communities it was determined that sufficient anchoring by roots to underlying mineral sediments was sufficient to offset the positive buoyancy measured in the organic profile. The significance of these findings indicate that thickness, type of organic sediment, production of sediment gases and delamination from more negatively buoyant mineral sediments are factors regulating formation of organic base floating substrates.

POSTER – 48

The Effect of Improved Basin Management Practices on Sediment Phosphorus Chemistry in Lake Okeechobee

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Best Farm Management Practices (BMP's) were developed and implemented in the Lake Okeechobee drainage basin in the late 1980's in order to reduce nutrient runoff from dairies and agricultural land. The intent of the BMP's was primarily to reduce phosphorus (P) loading to Lake Okeechobee, a lake believed to be undergoing accelerated eutrophication. The effect of the BMP's has been the reduction of P loading to Lake Okeechobee by approximately 25%, to an annual loading of 380 metric tons per year.

Lake Okeechobee sediments were sampled in 1988 in order to determine the total storage and forms of nitrogen (N) and P. This data provided a convenient reference point which could potentially be used as a barometer of the effects of future lake restoration efforts. Lake Okeechobee sediments were again sampled in 1998 and characterized for many of the same physico-chemical properties measured in 1988. The primary motivation for the re-sampling was to determine if: 1.) the lake sediment physico-chemical properties are sensitive to changes in land use practices, and if so, 2.) would the changes in land use be reflected in a change in sediment nutrient pools.

Total P, calcium/magnesium-bound P, and total porewater dissolved P in the surficial sediment (0 -10 cm) showed no significant differences between the two sampling events, averaging approximately 680 mg kg^{-1}, 475 mg kg^{-1}, and 0.5 mg L^{-1}, respectively. There were significant differences ($P<0.05$) in porewater dissolved reactive P (DRP) levels between 1998 and 1988. Lake-wide average porewater DRP increased from 0.25 mg L^{-1} in 1988 to approximately 0.5 mg L^{-1} in 1998. The lake can be divided into four distinct sediment zones, mud, sand, peat, and a western littoral fringe. When these zones were analyzed separately, the centrally located mud zone is the only zone to show a significant change in the ten year interval. On average, the porewater dissolved reactive P in the surficial sampling stations falling within this zone increased from 0.4 mg L^{-1} in 1988, to approximately 0.8 mg L^{-1} in 1998. These observed changes suggest that the sediment buffering capacity to maintain low porewater P levels decreased during the ten year period. It is also possible that soils in the drainage basin respond slowly to relatively recent changes in land use practices and thus may require more time to show up as changes in lake sediment P chemistry.

POSTER – 49

Belowground Dynamics of a Mangrove Species

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The major objective of this project was to investigate the effect of abiotic factors (hydrology and nutrients) on mangrove root dynamics in relation to aboveground dynamics. A randomized greenhouse experiment of 2x3 factorial treatments arrangement (2 phosphorus levels x 3 flooding levels) with five replicates of each treatment combination and with a set of controls for a total of 36 experimental units (rhizotrons) was designed. Then, propagules of *Avicennia germinans* L were planted into small pots with commercial soil, once they were rooted, they were transplanted into the rhizotrons. Root demography, and rates of root production and turnover were measured. It has been observed that extended hydroperiod decreases belowground production, particularly fine root production. Therefore, fine root production and turnover increase with bioavailable phosphorus. Also, the mangrove roots architecture has been described.

POSTER – 50

Temporal Evolution of Macronutrients in a Shallow Area of the Largest Amazon Reservoir

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In 1984 the largest amazon reservoir was filled up innundating approximately 2,500 km of rain forest. Part of this area (40% of the reservoir) originated a littoral zone. Due to the non-clearance of the forest before the reservoir was filled up, there was a period of 4 months of complete anoxy. At this time, large quantities of nutrients were released and disruped a rapid eutrophication process with the increase of ammonia, nitrate, phosphate and total phosphorus about 255, 8, 182 and 50 times respectively on the bed of the shallow area. After that, a fast occupation of these areas by macrophytes occured, originating some new problems like the proliferation of mosquitoes, the seasonal drop of dissolved oxygen and the leaching of nutrients during senescent periods. For seven years after this, the concentration of nutrients as well as the area of macrophyte have been diminishing mainly due to a strong thermocline which has isolated epilimnion from the permanent anoxic hypolimnion.

Plenary Session VII – Origin and Applications of Wetland Biogeochemistry

Tuesday, July 13, 1999, 8:30am-12:15pm

The Biogeochemistry of Dredged Material or Did I Really Learn Anything in College?

Robert M. Engler
U.S. Army Engineer Waterways Experiment

Abstract: The U.S. Army Corps of Engineers has statutory authority to regulate the disposal of dredged material in waters of the United States under the Clean Water Act and in the oceans under the Marine Protection, Research and Sanctuaries Act. In carrying out this authority, the Corps has conducted over $100 million of research on dredging and the disposal of dredged material.

As required by domestic law and the International London Dumping Convention, the suitability of dredged material for open-water disposal is determined by an ecological effects-based approach rather than consideration of the concentrations of chemical contaminants in the sediments. The rationale for this is that dredged material is a complex mixture of many substances whose bioavailability and potential interactions cannot be predicted merely on the basis of the concentrations of the chemicals of concern.

The effects-based approach uses physical, chemical, and biological assessments and consists of contaminant mobility/bioavailability, modeling, acute toxicity bioassays which address the benthic and water column environments, and contaminant uptake bioassays, which provide information on the potential for bioaccumulation. Risk assessment procedures are available for the more difficult projects. The procedures followed by the Corps in accordance with U.S. Environmental Protection Agency regulations have significant potential for the evaluation of sediments in general. However, it must be recognized that the disposal of dredged material is usually an instanteous event (hopper dredges, dump scows) or very short term (hydraulic pipeline). Thus, acute, rather than chronic, effects are of primary concern. Chronic/sublethal tests will be available in the near future when these impacts of concern.

Increasing Fertilizer Use Efficiency in Tropical Lowland Rice Production

Roland J. Buresh
ICRAF, Nairobi, Kenya

S. K. de Datta
Virginia Tech University

Rice is a main staple food crop throughout Asia, and rice globally provides 23% of the total human calorie consumption. The production of sufficient rice to meet human demand relies heavily upon the application of fertilizers, particularly N. Following the release of the first modern rice varieties, the Tennessee Valley Authority (TVA) initiated a project in 1968 on "Tailoring of fertilizers for rice". The project drew upon the awareness of fertilizer use, together with modern varieties and irrigation, as the key ingredients for the "Green Revolution" with rice in Asia. This 4-year project recognized losses of applied N as a constraint to efficient fertilization of lowland rice, identified the potential of coated N fertilizers for increasing the effectiveness of applied N, found most commonly known zinc sources to be satisfactory for lowland rice, and found marked varietal differences in the response of rice to added zinc.

Efficient fertilization of rice took on added urgency with the "oil crisis" and consequential increases in urea fertilizer prices in 1974-75. The recommendations of the "Tailoring of fertilizers for rice" project to evaluate additional sources of N, determine the mechanisms and extent of N loses, and increase effectiveness of conventional N sources became the foundation for N fertilizer research on tropical lowland rice through the late 1970s and 1980s. As a member of the Advisory Committee for this project, W.H. Patrick, Jr. was instrumental in establishing this foundation on which fertilizer research in Asia by the International Rice Research Institute (IRRI) and International Fertilizer Development Center (IFDC) was based. His research on N loss mechanisms and ways to minimize these losses forced scientists to reevaluate fertilizer management strategies for maximum use efficiency. The 1986 book entitled "Nitrogen economy of flooded rice soils", which he co-edited, further heightened awareness of N fertilizer constraints within lowland rice production.

This heightened awareness of N fertilizer constraints paved the way for subsequent research in Asia on integrated nutrient management in rice-based cropping systems, the N-supplying capacity of intensively cropped lowland rice fields, and greenhouse gas emissions from rice fields. The subsequent knowledge base led to fine-tuning of fertilization practices for increased rice yield and profit to farmers through better synchronization of N supply with N demand by rice.

The continued importance of rice production to human calorie and protein consumption necessitates sustainable increases in rice yields in the tropics. The efficient use of fertilizers will remain a key ingredient for achieving such yields. The vision, research, guidance, and encouragement of W.H. Patrick, Jr. has laid a solid foundation for tropical farmers to achieve profitable production of sufficient rice through efficient use of fertilizers.

Effects of Redox Potential on Phosphorus Chemistry in Soils and Sediments

Philip A. Moore, Jr.
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Fayettville, AR

This is a review paper on research on the effects of the oxidation/reduction status on phosphorus (P) chemistry in soils and sediments. Phosphorus mobility and bioavailability is greatly affected by the redox status of soils and sediments, since many of the phosphate minerals contain ferric iron or manganic manganese. Iron phosphate minerals include vivianite ($Fe_3(PO_4)_2 \cdot 8H_2O$), strengite ($FePO_4 \cdot 2H_2O$) and amorphous ferric phosphate ($FePO_4$), whereas manganese phosphate minerals include reddingite ($Mn_3(PO_4)_2 \cdot 3H_2O$), hureaulite ($Mn_5H_2(PO_4)_4 \cdot 4H_2O$) and trivalent manganese phosphate ($MnPO_4 \cdot 1.5H_2O$). Ferric and manganic oxides and hydroxides are also important with respect to phosphorus bioavailability, because they have a high phosphate sorption capacity. The solubility of all of these mineral phases is highly dependent on redox potential (Eh) and pH. Under reducing conditions, such as that found in flooded rice fields or in lake sediments, ferric (Fe^{3+}) iron and manganic (Mn^{4+}) manganese can be reduced to the more soluble ferrous (Fe^{2+}) and manganous (Mn^{3+}) forms, releasing phosphorus in the process. This release of phosphorus in paddy rice fields is beneficial because it reduces the need for flooded rice to receive phosphorus fertilizer inputs, however, it can be detrimental in lake systems, if eutrophication is a problem.

Fate and Transport of Explosives in the Environment

James M. Brannon, *Judith C. Pennington, Tommy E. Myers* and *Cynthia B. Price*
U.S. Army Engineer Waterways Experiment Station
Vicksburg, MS

Kevin Thorn
U.S. Geological Survey
Denver, CO

Pre- and post-World War II military production of munitions containing high explosives such as TNT, RDX and HMX has resulted in significant contamination of soil and ground water on these sites. Development of remediation and risk management strategies for explosives contamination requires an understanding of environmental fate and transport processes such as adsortion and desorption, transformation and immobilization. Transformation and soil sorption are two important environmental processes affecting the fate and transport of TNT. Redox potential strongly affects the rate of transformation and the products formed. For RDX and other explosives, different processes such as mineralization to CO2 may also be important while sorption is less important. Sorption can be affected significantly by cation substitutents on clay minerals. Competitive sorption can affect the mobility of both parent compounds and transformation products. Covalent bonding between amino transformation products and soil organic carbon functional groups may be a significant immobilization process for TNT. This chapter summarizes the current understanding of fate and transport processes for explosives in soil and ground water. Emphasis is placed on recent research conducted by the authors in the areas of transformation, sorption, immobilization and development of quantitative process descriptors.

The Prioritization of Wetland Restoration Sites in the Lower Yazoo River Basin

Barbara A. Kleiss, *Charles G. O'Hara* and *Angela A. Davis*
U.S. Geological Survey, Pearl, MS

The extent of bottomland hardwood wetlands in the Lower Mississippi River Valley has been greatly diminished by conversion to agriculture. Less than 25 percent of the pre-settlement acreage of this wetland type remains today. The U.S. Geological Survey, in cooperation with the U.S. Environmental Protection Agency, has developed a Geographic Information Systems assessment model that prioritizes areas with high potential for successful wetland restoration in the lower Yazoo River Basin in Mississippi. The assessment model predicts the restorability of an area as well as the relative probability that an area will perform wetland functions. Variables considered in the model include indexed values of geomorphology, hydric soils, farmed wetlands, the 0.5, 2, and 100-year flood levels, topographic depressions, and inclusion within stream buffer areas. Other variables were related to the proximity of an area to existing forested land, primary and secondary roads, wildlife management areas, other public lands, and permanent water bodies. Additional priority was assigned to areas that were part of large blocks and maintained a significant amount of "interior" as defined by the ratio of patch size to core area. Several management scenarios were evaluated with the assessment model, and this information was output in a format that could be analyzed by economists at Virginia Tech University to assess the economic costs and benefits of forested wetland restoration.

Fate and Distribution of Surfactants in Estuarine and Marine Environments

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The production, distribution, use and disposal of chemicals leads almost invariably to their presence in the environment on a localized basis and in some cases to their more widespread occurrence. Detergents are manufactured in large quantities, used by many people and they are usually disposed into the environment after their use in the household. It is therefore likely that these chemicals may reach coastal environments and expose marine aquatic life. Hence it is important to determine the potential exposure and risk that detergent chemicals may pose on these marine environments.

Risk assessment methods have been developed to address a wide range of health and environmental risk situations, for e.g.; air, water and soil pollution. The assessment of whether a substance presents a risk to organisms present in the environment of interest is based on a comparison of the predicted environmental concentration (PEC) with the predicted no effect concentration (PNEC) to organisms in ecosystems.

This assessment can be performed for different compartments (e.g. air, water and soil) and on different spatial scales (local, regional). Within the environmental exposure assessment, it is essential to define the primary target compartment of the exposure assessment i.e. what is being exposed and for how long (point-source versus diffuse and intermittent versus continuous)? The exposure estimate may describe the exposure of the aquatic compartment close to the source of emission (e.g. wastewater effluent) and assess maximum exposure (i.e. "local" realistic worst-case estimates). Alternatively, the exposure assessment may be developed taking into consideration the fate, transport and distribution of the chemical into different media (air, water, soil and biota) away from the source of the emission (i.e. "regional" background estimates).

Reliable data on release and emission of a substance are needed for the calculation of realistic exposure estimates for the different receiving environmental compartments. In addition, while physico-chemical parameters are inherent properties of the substance, the nature and properties of the environment may vary widely depending on the location. Even small ecosystems like a tributary are very complex and are difficult to characterize - both physically as well as biologically. In order to decrease the complexity inherent to "real" spatial/temporal environments, the use of "generic" or "evaluative" steady state environments with standard properties have been suggested and developed for chemical assessments.

The predicted exposure integrated in both time and space for such generic scenarios will form the basis for an initial integration with the effect data of the chemical. If appropriate, the exposure will be further refined by using more representative data and/or model formulations for the environmental compartment of concern. Realism can further be introduced by taking into account environmental specifications of the receiving environment such as spatial and temporal variability in river flows and/or chemical emissions, landscape characteristics, and by verifying each underlying assumption used in the fate and distribution models.

This presentation will review the 1/ the release and emission of surfactants during the whole life cycle of a substance (production, formulation, use and disposal) into different environmental compartments (air, water and soil) and 2/ assess the potential exposure of several compartments. This will be illustrated with a case-study through the use of mathematical exposure modelling.

Soil Concerns for the Restoration of Coastal Salt Marshes

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San Diego State University
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Over the last decade it has become clear that soil dynamics frequently are overlooked in restoring coastal salt marshes. Recurring problems include poor soil texture, low organic matter content, and low soil nitrogen. An 11-year dataset from a restored marsh in San Diego Bay showed that organic matter and nitrogen were slow to accumulate, with most nitrogen in organic form. At the Tidal Linkage (a recently restored 2-acre marsh in Tijuana Estuary), accumulation of belowground biomass was slow but significantly greater in plots with greater plant species richness. Soil amendments (kelp and clay) also significantly increased biomass accumulation. Planned research at a 20-acre experimental marsh will evaluate the importance of tidal creeks, soil amendments, planting combinations, and topographic heterogeneity on plant and soil development. These projects highlight the value of incorporating large-scale scientific experiments into restoration projects.

In southern California, storm sedimentation is an additional concern at restored salt marshes. Up to 30 cm of sediment was deposited in the south arm of Tijuana Estuary during winter storms in 1994-1995, burying vegetation and changing marsh elevation. This magnitude of sedimentation will have enormous impacts on restored marshes, and watershed-based planning should be considered for future restoration efforts.

Oxidation-reduction Reactions in Flooded Crowley Silt Loam Soil: A Review of Five Decades of Research

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Wetland biogeochemistry is an interdisciplinary science that includes the study of physical, chemical, and biological processes, as related to the functions and values of wetland ecosystems. The fundamental framework for much of the wetland biogeochemistry research was provided by the basic research conducted on flooded rice soils. Dr. William H. Patrick, was one of the few scientists in the world initiated research to study physical, chemical, and biological processes of flooded rice soils, as related to plant nutrition. About five decades ago, Dr. Patrick initiated his research on Crowley silt loam, a soil predominantly used for rice culture in Louisiana and Arkansas, to study the concentration and movement of oxygen as related absorption of ammonium and nitrate by rice. During the next four decades, number of studies were conducted by Dr. Patrick and his students and associates, to determine the influence of soil oxidation-reduction potential on the fate of various nutrients, metals, and toxic organics in flooded soils, using flooded Crowley silt loam as a 'model' soil. The concepts and techniques developed using this 'model' soil were used to study the fate of nutrients, metals, and organics in wetland, as related to ecosystem functions. In this paper I will review key findings of the research conducted on flooded Crowley silt loam soil and discuss the relevance of this research to our current understanding of wetland biogoechemistry.

Concurrent Session VIII – Phosphorus Removal Technologies

Tuesday, July 13, 1999
1:30pm-4:20pm

Critical Design Elements of the Everglades Stormwater Treatment Areas

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The South Florida Water Management District (District), in partnership with other state and federal agencies and stakeholders, is undertaking one of the largest ecosystem restoration program in the world for the Everglades. The cornerstone of the District's phosphorus control program for the Everglades is the implementation of six large constructed wetlands, referred to as Stormwater Treatment Areas, or STAs. The design of the STAs began in 1988 with a 4,000-acre prototype treatment area, and continues today on the last remaining areas, totaling over 47,000 acres.

Throughout the design process, engineers and scientists collaborated to capture the best available ecologic information and develop the most appropriate design criteria. In addition, even traditional engineering concepts required careful examination in order to apply to them to the design of these large-scale constructed wetlands. Some of the more critical design issues included

1. characterization of stormwater inflows and phosphorus loads from upstream areas which were concurrently implementing best management practices,
2. nutrient removal performance characteristics of wetlands,
3. hydraulic analyses associated with densely-vegetated systems,
4. design of levees specific to the local muck and limerock soils, and
5. incorporation of downstream hydroperiod restoration criteria.

Through a multi-disciplined approach combining in-house staff with engineering consultants, construction contractors, external review groups and independent peer-review, the District was able to effectively manage the uncertainties associated with expanding the state-of-knowledge for designing large constructed wetlands.

Differences in Nutrient Removal Performance within a South Florida Treatment Wetland

Michael J. Chimney, *Martha K. Nungesser* and *Jana Newman*
South Florida Water Management District
West Palm Beach, FL

The South Florida Water Management District's Everglades restoration program includes constructing and operating large treatment wetlands, i.e., Stormwater Treatment Areas (STAs), to achieve water quality goals. The Everglades Nutrient Removal Project (ENRP) was built by the District as a prototype treatment system to demonstrate the efficacy of using subtropical wetlands for water quality improvement. The ENRP began operating in August 1994.

Water in the ENRP flows first into a small buffer cell and then down two parallel flow-paths, each of which is divided into two separate treatment cells by internal levees. The plant community in the buffer cell and three of the four treatment cells is a mixture of emergent, floating, and submerged macrophytes (mixed macrophyte community). The remaining treatment cell (Cell 4) supports a submerged macrophyte (SAV)/periphyton community.

Treatment efficiency varied substantially among the 5 ENRP cells. For example, the buffer cell had an overall P settling coefficient > 60 m yr-1 and P retention > 7 g P m-2 yr-1, rates that were 2 to 10 times those observed in other cells. Cell 4 generally outperformed Cells 1, 2, and 3. Nutrient removal performance was related to differences in plant community type, hydraulic and P loading rates, and transformation of P species along the flow-path.

Physical/Chemical Treatment Techniques to Reduce Phosphorus in Everglades Surface Waters

Earl E. Shannon and ***Thomas C. Emenhiser***
Conestoga-Rovers and Associates
West Palm Beach, FL

Jose Lopez
South Florida Florida Water Management District
West Palm Beach, FL

Under a research contract to the South Florida Water Management District, Conestoga-Rovers and Associates is conducting pilot study investigations at the Everglades Nutrient Removal (ENR) Site to assess the ability of chemical treatment coupled with filtration techniques to remove total phosphorus in EAA stormwaters.

A Pilot facility has been constructed at the ENR which includes 9 cylindrical filtration columns containing various filtration and absorption medias, and 2 treatment trailers containing chemical mixing, flocculation and clarification process equipment. A microfiltration pilot facility has also been included at the testing site.

The research is assessing the optimal combination of coagulation chemical (e.g., ferric sulfate, alum, etc.) and filter media (sand, shale, etc.) that will prove to be the most practicable at removing stormwater total phosphorus content to 10 micrograms per liter or less while producing an effluent that will have a benign environmental impact on the downstream wetlands and surface water bodies of the South Florida Everglades Ecosystem. Research is also being conducted to assess the feasibility of land application of solids residuals produced during the treatment process.

The results of the ongoing research will be presented in both graphical and tabular summaries showing the most effective coagulant type and dosages along with types of filter medias that are achieving the target phosphorus concentration in the most cost effective and environmentally sound manner.

Reducing Phosphorus Concentrations in Everglade Inflow Waters with Low Intensity Chemical Dosing

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Durham, NC

Low Intensity Chemical Dosing (LICD) is used in lakes and wastewater treatment systems to reduce water column phoshorus (P) and dissolved organic carbon (DOC) concentrations. LICD is currently being investigated as a method to sufficiently reduce P concentrations in Everglade inflows. However, within-marsh application of this technology, very low target P concentrations (10-25 ppb range), and high DOC waters make this an unusual application for LICD.

Three replicated sites with eight mesocosms each were constructed in the Everglades Nutrient Removal Project to evaluate in situ LICD. Continuous flow experiments with FeCl and alum dosing (50-200 µM L-1) treatments were initiated at one site. Dosing resulted in P speciation changes in mesocosm inflows. Resulting total P, filtered total P and ortho-P concentrations in the water column were lower in the dosed mesocosms than in the control. High filtered metal concentrations indicated the need for improved rapid mixing. Continued particulate P suspension suggested the need for better floc building.

Jar test results show metal-polymer blends more effectively mixed and formed floc, and achieved total P concentrations below 10 ppb. Field experiment modifications are currently underway to test polymer blends, improve rapid mixing (for coagulant dispersion) and add slow mixing (for floc building).

Testing a Managed Wetland Treatment System (MWTS) as an Advanced Treatment Technology for Phosphorus Removal in the Florida Everglades

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South Florida Water Management District
West Palm Beach, FL

The goal of a Managed Wetland Treatment System (MWTS) is to reduce water column total phosphorus (TP) concentrations by chemical precipitation and adsorption. Treated water is delivered to receiving wetlands to complete P polishing and accomplish ionic stabilization. The MWTS testing addresses three research objectives:

1. Achieve TP concentration of 10 parts per billion (ppb) by chemical treatment.
2. Determine overflow rates and solids retention times for chemically treated stormwater runoff with selected P concentrations and loads. Quantify solids overflow into and deposition rate within the wetland.
3. Evaluate whether effluent from an MWTS differs qualitatively from effluent from constructed wetlands with no chemical treatment.

Phase 1 testing uses a nested block, paired watershed design. The nested design contains two blocks and two treatments. Two blocks of three test cells differ in influent P concentrations. Chemical treatments will be applied to four of the six cells, and two will remain untreated. Treatment cells will be monitored for six months prior to chemical treatment, followed by twelve months with treatments applied.

The treatment effects being tested are:

* TP loading - high (100 to 200 ppb) and low (50 to 100 ppb),
* Chemical type - ferric chloride, alum, and a control.

Phosphorus Removal from Everglades Agricultural Area Drainage Waters Using a Submerged Aquatic Vegetation/Limerock Treatment System

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Rockledge, FL

Michael J. Chimney
South Florida Water Management District
West Palm Beach, FL

Taufiqul Aziz
Florida Department of Environmental Protection
Tallahassee, FL

A demonstration of phosphorus (P) removal by a Submerged Aquatic Vegetation/Limerock (SAV/LR) treatment system was performed from June 1998 to February 1999 using Everglades Agricultural Area (EAA) drainage water. The treatment system consisted of SAV mesocosms (1.7 - 3.7 m2, 40 - 120 cm deep) followed by crushed LR reactors and used source water from the Everglades Nutrient Removal Project (average total P [TP] concentration of 100 (g L-1). Experimental treatments included (a) hydraulic loading rate, (b) water depth, and (c) an assessment of a sequential depth SAV/LR treatment system.

Hydraulic loading rates of 53, 23 and 11 cm day-1 (hydraulic retention times of 1.5, 3.5 and 7.3 days) produced average effluent TP concentrations of 39, 23, and 18 (g L-1 from the SAV mesocosms and 32, 15, and 12 (g L-1 from the subsequent LR reactors. Shallow (0.4m) SAV systems performed better than deeper (0.8 and 1.2 m) systems.

A sequential treatment system consisting of a deep (0.8 m) SAV mesocosm, a shallow (0.4m) SAV mesocosm, and a LR reactor reduced mean TP levels from 130 to 9 (g L-1 and had a mass removal rate of 4.8 g P m-2 yr-1 (92% load reduction). These results demonstrate that SAV/LR treatment systems have promise for reducing EAA drainage [TP] to extremely low levels.

Periphyton-based Stormwater Treatment Research and Demonstration in the Florida Everglades

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James Bays
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Steve Gong
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Susan Gray
South Florida Water Management District
West Palm Beach, FL

Periphyton-dominated plant communities are typically associated with the lowest P concentrations in the Florida Everglades. The creation of periphyton-based stormwater treatment areas (PSTA) has been proposed as a means of supplementing existing and planned stormwater treatment wetlands to achieve an average goal of 10 ppb P, the default P standard required by the Everglades Forever Act. Limited data exist to evaluate PSTA technical and economic feasibility for comparison to other alternative treatment technologies currently under study by the District, and others.

This presentation describes research and demonstration studies being conducted for the District on the conceptual PSTA technology. The plan of study addresses Everglades periphyton growth and P removal capacity in three types of constructed mesocosms:
* Twenty-four replicated fiberglass portable mesocosms (6 m L x 1 m W x 1 m H)
* Three 0.2-ha test cells
* Eight 0.4-ha field mesocosms to be constructed at the future location of Stormwater Treatment Area 3/4.

Principal experimental variables selected to evaluate possible design parameters include:
* Substrate (peat, shell/limerock)
* Water Depth (30 cm, 60 cm, or varied)
* Presence of emergent macrophytes
* Hydraulic loading rate.

Water and phosphorus balances will be developed for all mesocosms and used to calibrate a performance forecast model for engineering and economic evaluation of long-term phosphorus removal capacity.

Concurrent Session IX – Soil-Water-Plant Relationships

Tuesday, July 13, 1999
1:30pm-4:00pm

Sediment Subsidy: Effects on Soil-Plant Responses in a Rapidly Submerging Coastal Wetland

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Excessive wetland submergence due to a sediment aggradation deficit is a major cause of wetland deterioration in the Mississippi River Delta Complex. We assessed the structural and functional responses of a deteriorating salt marsh to different intensities of sediment addition as a means of mitigating the sediment aggradation deficit. Sediment was hydraulically dredged from the Gulf of Mexico and discharged into a Spartina alterniflora-dominated salt marsh, resulting in an initial gradient in sediment addition from trace amounts to as much as 60 cm above natural marsh elevation over a 20 ha area. The addition of sediment created significantly different marsh elevations. The greatest sediment accumulations initially caused aboveground mortality of the vegetation. However, by Fall 1993, almost two years after dredging, both plant cover and aboveground biomass responded positively to sediment addition. Sediment addition increased the soil bulk density as a result of the mineral matter added to the marsh surface. The higher mineral matter increased soil fertility and marsh elevation and thereby reduced nutrient, flooding and interstitial sulfide stresses. Thus, sediment addition generated a more favorable plant growth environment by increasing elevation and reducing potentially toxic sulfides as well as increasing soil fertility.

Gas Exchange in the Genus Carex: From Cell to Canopy

Joachim Busch
Department of Geobotany
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Düsseldorf, Germany

Sedges of the genus Carex are often the dominant species in wetlands of the subboreal to humid northern hemisphere. Therefore the gas exchange of this species plays an important part within the large exchange processes between vegetation and atmosphere.

In a comprehensive study the leaf gas exchange of different sedge species and its response to microclimate and soil water status are worked out. The species differ mostly in their response to soil waterlogging and the dependence of leaf conductance (g) on changes in the leaf to air vapour pressure deficit (VPD). The first is due to the capability of the species to oxidize their rhizosphere. The later parallel with different abaxial leaf epidermal structures. Models to calculate leaf conductance and net-assimilation rates are developed. Microclimate and biomass data from a large sedge canopy separated for two different layers are used together with the models for an upscaling of net-assimilation and transpiration rates from leaf to canopy level. The differences in leaf gas exchange result in differences in canopy gas exchange which are important in calculating water and carbon cycles at least on a local scale.

Macrophyte Species Changes in the Everglades: Examination along a Eutrophication Gradient

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Macrophyte species distribution in the marsh and slough areas of the northern Everglades were examined along a surface water and soil phosphorus gradient to characterize the effects of nutrient enrichment on the macrophyte community changes in the Everglades ecosystem. Macrophyte species distribution and frequency examined at fifty-one sites located in the Water Conservation Area (WCA-2A) revealed distinct trends in species changes with P enrichment.

We compared the macrophyte species distribution with the soil P contour map of WCA-2A and derived six major categories of P enrichment (labeled 0 to 5) that may be used to adequately describe macrophyte species distribution in the WCA-2A. Soil and surface water P values that correspond to the different P enrichment categories have been estimated. Examination of the relative abundance of the macrophyte species in the six P enrichment categories showed a decline in characteristic slough macrophyte species with P enrichment. Trends in slough macrophyte species changes observed along the eutrophication gradient were also compared to the experimental results obtained from in-situ P-dosing experiments.

Sulfide Effects on Thalassia testudinum Carbon Balance and Adenylate Energy Charge

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The highly organic, low iron, carbonate sediments of tropical seagrass communities facilitate sulfide accumulation, which may be responsible for widespread dieback of Thalassia testudinum in Florida Bay. Root hydroponic chambers were used to determine the effects of different sulfide concentrations (0.0, 2.0, 4.0, 6.0 and 10.0 mM) on ATP, energy charge, growth, and photosynthesis of T. testudinum. Root ATP production and energy charge were significantly reduced ($P < 0.05$) after 2.0 - 10.0 mM sulfide exposures, compared to anoxic controls. Root energy charge declined from 0.78 in the control to a range of 0.63 - 0.59 in the 2.0 - 6.0 mM treatments, and fell to a low of 0.43 in the 10.0 mM treatment. The reduction in available root energy production significantly reduced aboveground growth rates ($P < 0.05$) by an average of 43% in 2.0 - 6.0 mM exposures and 67% in 10 mM exposure. Although root energy charge, ATP production and growth rates significantly declined under root sulfide exposure over a 5 day period, no lethal response was observed even at 10.0 mM concentrations. Leaf photosynthesis was also viable after sulfide treatments, suggesting a resilience of T. testudinum to short-term sulfide exposure.

Oxidized Root Channels by Bulbul Rush Mediated a Micro-environment in Extreme Conditions of Lignite Mining Lakes

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Bulbul rush (Juncus bulbosus L.) is the pioneer species and dominant macrophyte in the Lusatian lignite mining lakes Germany. The extreme and hostile site conditions resulting from the pyrite oxidation suggest the presence of adaptive mechanisms that enable Juncus bulbosus to persist in sediments and water bodies where low pH (2.5 - 3) and concentrations of dissolved iron, manganese and aluminium exceed the levels that would kill off most species.

This presentation explores for the first time the effective interactions of root excreted compounds and micro-organisms beneath an iron plaque formed on roots as key processes enabling the plant to survive in the extreme environment of acidic mining lakes.

Juncus bulbosus was characterized as having an extensive plaque surrounding the roots. Scanning electron microscopy shows that the iron plaques around the root are characterized by the presence of a micro-space between the root and the sand grains. This unusual microenvironment is inhabited by colonies of micro-organisms. Chemical analyses revealed that the iron plaque contains several trace concentrations of roots exudates. The results suggest that there are interactions of the microbial component embedded on the root surface and the root exudates beneath the iron plaque (i.e. micro-space). These microorganisms might metabolize the exudates to different extents and thereby cause an increase in release of carbon dioxide in the in the micro-space which is presumed to be a substantial part of photosynthetically-fixed CO2 evolved from Juncus bulbosus roots. Furthermore energy-despersive X-ray analyses gives evidence of P solubilization and uptake patterns inside the micro-space.

The specific micro-space beneath the iron may aid bulbul rush to avoid inorganic carbon deficiency and phosphorus limitation in man made-ecosystems. This may help explain why Juncus bulbosus is a primary plant colonizer in acid lignite mining lakes in spite of extreme and unfavorable growth conditions.

Seasonal Variation in Iron Deposition on Roots of the Annual Salt Marsh Plant *Salicornia* spp.

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The aim of this study was to examine the development of so-called iron plaque on the roots of *Salicornia* spp. from seedling to maturity, using light microscopy. *Salicornia* spp. was chosen because it is an annual salt marsh plant. Seedlings appear in early Spring (March) and the plants die off in Autumn (November).

Iron deposition occurs in anaerobic environments due to oxidation of ferrous iron to ferric iron. The ferric iron adheres to the root surface and may penetrate into the epidermis and, in some species, into the cortical layer. Using *Salicornia* spp. it was possible to ascertain at which stages in the season iron begins to adhere to the root surface, penetrates the interior of the cell, as well as the effects that the death of the plant has on iron deposition.

Penetration of the epidermis occurs from June, while intercellular spaces in the cortex are starting to fill in with iron from September. From November onwards iron deposits disintegrate, possibly due to chemical reduction of iron driven by degradation of root tissue.

Concurrent Session X – Bigeochemical Indicators of the Ecological Status of the Everglades

Tuesday, July 13, 1999
1:30pm-4:55pm

An Assessment of Six years of Ecological Change in Everglades Communities to Phosphorus Dosing

Curtis J. Richardson and *Panchabi Vaithiyanathan*
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Durham, NC

Jerry Qualls
University of Nevada
Reno, NV

Jan Stevenson
University of Louisville
Louisville, KY

Phosphorus additions at known concentrations of soluble reactive phosphorus (SRP) have been dosed to five channels at two sloughs sites from 1993 to 1998 in WCA2A of the northern Everglades. Response variables to be compared include (1) specific changes in water chemistry, (2) periphyton community structure (3) periphyton mat cover, (4) macrophyte community structure as well as (5) macroinvertebrate populations changes along a P gradient. The relationship of ecosystem responses as indicated by productivity changes and biogeochemical markers to P loadings as well as P concentrations are analyzed both seasonally as well as from year to year for both SRP and total phosphorus (TP).

TP dosing concentrations were uniform over the 6 years of dosing with concentrations ranging from background levels in the controls of 10 ug/L TP, respectively to a high of 146 TP ug/L in the highest treatments. The analysis of the long-term changes in mat cover suggests that concentrations between 10 and 30 ug/L of TP in the water column result in the maintenance of the mat cover. Plant densities of species like Utricularia spp. and Eleocharis spp. decline with increased P additions. A multimetric model of trophic level responses to P additions will be presented as an index of the P threshold for the Everglades.

Spatio-temporal Patterns of Soil Phosphorus Enrichment in Everglades WCA2

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S. Newman
Everglades Systems Research Division
South Florida Water Management District

Phosphorus (P) loading to Everglades Water Conservation Area 2 (WCA2), primarily associated with surface drainage from nearby agricultural lands, has created a gradient of soil P enrichment between the surface water inflow points and the interior regions. The spatial distribution of soil P in WCA2 was mapped in 1990, based on comprehensive sampling of 74 sites on a grid pattern. In 1998, we repeated the grid-based sampling of WCA2 soils, with the intent of comparing the spatial distribution of P in the upper 10 cm of the profile with our 1990 data. Results of the recent sampling event suggest that the "front" of soil P enrichment has migrated toward the interior of WCA2 during the past 8 years, while soil P concentration near the S10 surface water inflows has stabilized, and possibly decreased. Comparison of the two data sets is hampered by the relatively high degree of short-range (relative to our sample spacing) spatial variability in soil P content. This "random" variability contributes to uncertainty in spatially interpolated values for P concentration. Other factors that should be considered when comparing data sets for this site are differences in sampling design, sample collection technique and analytical methods.

Effects of Increased Phosphorus Loading on Water-column Oxygen Dynamics in the Northern Everglades

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Effects of P enrichment on water-column diel dissolved oxygen concentration (DO) profiles were measured along nutrient gradients downstream of agricultural discharges in two northern Everglades marshes and in field enclosures (mesocosms) exposed to different P loading rates. Reference (i.e., water-column TP $\leq$ 10 µg/L) areas in the marsh interior were characterized by strong diel fluctuations in DO, and aerobic conditions generally were maintained throughout the diel cycle. Enriched stations (water-column TP = 12 to 131 µg/L) were characterized by dampened diel fluctuations and reduced DO, and the extent of these changes were correlated strongly with marsh P concentrations. Mean DO declined from between 1.81 and 7.52 mg/L at reference stations to between 0.04 and 3.18 mg/L in highly enriched areas. Similarly, minimum DO declined from between 0.33 and 5.86 mg/L to between 0 and 0.84 mg/L with increasing enrichment, and the frequency of extremely low DO (< 1 mg/L) increased from between 0 and 20% to as high as 100% in the most enriched areas. Diel oxygen profiles in P-enriched mesocosms declined progressively with time; all loading treatments exhibited similar DO during the 1st year of P loading, but concentrations declined significantly at higher loads by year 3.

Reductions in water-column DO with increased P enrichment were associated with reduced oxygen production by submersed periphyton and macrophytes and increased sediment oxygen demand. Increased emergent macrophyte cover in enriched areas likely contributed to these changes by shading the water-column, which inhibited submerged productivity, and by providing inputs of nutrient-rich detritus, which increased oxygen demand. Declines in marsh DO are associated with other ecological changes such as an increase in DO-tolerant taxa of invertebrates and increased anaerobic metabolism. While background oxygen concentrations in wetlands generally are low compared with those in lakes and rivers, declines in water-column DO caused by eutrophication can result in biological impacts similar to those in other aquatic ecosystems.

Phosphatase Activity as an Early Warning Indicator of Wetland Eutrophication: Problems and Prospects

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A phosphorus (P) loading experiment conducted in the oligotrophic P-limited Everglades was used to assess the utility of phosphatase activity (PA) of periphyton as an early warning (EW) indicator of wetland eutrophication. Phosphorus loads of 0, 0.4, 0.8, 1.6, 3.2, 6.4 and 12.8 g P m-2 yr-1 were applied to mesocosms placed in a slough community consisting of Cladium jamaicense Crantz, Eleocharis spp. and calcareous periphyton mats. Phosphatase activity, expressed on a biomass-specific basis, was not a sensitive indicator of P enrichment for epiphytic periphyton growing on acrylic dowels or floating mat periphyton. However, surface-area-specific PA was a sensitive indicator of P enrichment, responding within 2-3 weeks of the initiation of dosing. Surface-area-specific PA of unenriched periphyton ranged from 0.42 to 0.7 nmol cm-2 min-1, while PA of periphyton growing in the highest load (12.8 g P m-2 yr-1), ranged from 0.11 to 0.29 nmol cm-2 min-1. Conclusions drawn from PA analyses were consistent with those obtained from periphyton primary productivity and P content. Phosphatase activity is a potentially valuable EW indicator when used in conjunction with other complementary indicators.

The Distribution and Carbon Isotopic Composition of Dissolved Organic Matter in Florida Everglades

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The distribution and natural carbon isotopic ratios of dissolved organic matter (DOC) reflect the sources and fates of DOC in an ecosystem. In the surface waters in the Everglades area, DOC can come from the historic peat deposits, "modern" wetland vegetation and sugarcane (the dominant agricultural crop in the Everglades Agricultural Area). ???C analyses of DOC, plants and soils collected from the Everglades area indicate that less than 22% of the DOC was derived from sugarcane and the amount of DOC from sugarcane was greater in the dry season than in the wet season. Radiocarbon ages of DOC ranged from "modern" to about 2000 years BP, indicating that DOC was derived from both old peat deposits and modern wetland vegetation. The high molecular weight DOC (>1000 Dalton) had older radiocarbon ages than the low molecular weight DOC (<1000 Dalton), and contained a greater fraction of DOC derived from the old peat deposits. It appears that at least some of the old DOC derived from historic peat deposits was decomposed by microbes during their residence in the canal and in the Water Conservation Area, and the low molecular weight DOC was more microbially labile than the high molecular DOC.

Calcium Carbonate Precipitation in the Everglade Sloughs: Influence of Water Column Phosphorus Concentration

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Factors leading to the calcium carbonate (CaCO3) precipitation by the periphyton and the influence of water column P concentration on the CaCO3 precipitation and phosphate co-precipitation in the Everglade sloughs was examined from field measurements, laboratory microcosm experiments and in-situ mesocosm studies.

CaCO3 saturation indices estimated from the water column calcium (40-85 mg/L) and carbonate alkalinity (200-280 mg CaCO3/L) concentration showed that the slough water was saturated with CaCO3 (SI 0-1) at the normal range of pH (7.5-8.5) and the temperature (15-35(C) observed in the Everglade sloughs. At the elevated pH (9.3) and temperature (36(C) conditions observed on the surface of the periphyton mat calcium carbonate saturation was considerably exceeded (SI>2.0) resulting in its precipitation from the water column.

Experimental results showed that calcium carbonate precipitaion was strongly inhibited at high concentrations of phosphate ions. Inhibition of calcite precipitation by P was also confirmed in the in-situ mesocosm experiments by the strong decrease in the ash content (measure of calcium carbonate content) of the periphyton mat with increase in water column P concentration. Decrease in calcium precipitation may be the primary factor responsible for the fragmentation of the periphyton mat observed in the mesotrophic areas of the Everglades and the complete disappearance of the periphyton mat in the eutrophic regions.

Effects of Four Years of Nitrogen and Phosphorus Additions on Everglades Plant Communities

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David W. Rogers
International Paper
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Curtis J. Richardson
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Nitrogen and phosphorus were applied to sawgrass, mixed and slough communities to evaluate the effects of nutrient additions on biomass production, photosynthesis, nutrient uptake, and species composition. After one year, P additions at the highest rate of 4.8 g P(m-2(yr-1 resulted in increased P uptake by emergent vegetation. In the slough, one year of high P treatments resulted in the disappearance of the Utricularia-periphyton mat, followed by an increase in the macroalgae, Chara. Two years of high P and N+P additions resulted in increased biomass, leaf area, and photosynthesis in sawgrass and cattail.

We observed an enrichment of soil plant available P, Fe- and Al-bound Pi (sawgrass), and Ca-bound Pi (slough) after four years of high P additions. We observed no additional increase in biomass production or tissue P uptake by emergent vegetation above cumulative P loadings of 10 g/m2, suggesting that other factors such as hydroperiod or secondary nutrient limitation also regulate production. Cumulative P loadings as low as 5 g/m2 resulted in near elimination of Utricularia-periphyton. Management strategies for protecting the Everglades need to consider cumulative as well as annual P loadings on the ecosystem.

Influence of Phosphorus Enrichment on N Transformations in Northern Everglades Soils

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The northern Everglades ecosystem has been affected by phosphorus (P) loading from agricultural drainage waters resulting in a distinct eutrophic gradient with high total soil P in areas proximal to surface water inflow points. In addition, the vegetative community has shifted from a sawgrass (*Cladium, sp*)-open water system to dense, monotypic cattail (*Typha, sp*.) vegetative community. These effects have been observed in Water Conservation Area 2A (WCA-2A) of the Everglades.

Microbial processes and associated gradients can be good candidates as indicators of ecological integrity in wetland systems. Changes in microbial mediated processes can provide a warning signal for change or instability in ecosystem function at fundamental levels. Shifts in soil microbial activity can alter nutrient availability, plant growth and water quality of the associated ecosystem.

In particular, we investigated the influence of P on the biogeochemical cycling of nitrogen (N) along the eutrophic gradient. The availability and cycling of N in wetlands can directly affect ecosystem productivity and water quality. Rates of organic N mineralization, nitrification, and denitrification were measured on soil collected from three depths at eight sites along eutrophic gradient. A series of laboratory and field studies were conducted to discern the influence of P on the biogeochemical cycling of N.

Organic N mineralization was significantly increased with P additions in both short term (days) and long term (months) studies. Aerobic mineralization rates were two times higher than rates measured under anaerobic conditions. The size/activity of the microbial pool was significantly increased by P loading, leading to an increase in inorganic N release. Initial nitrification rates appeared to be regulated by O_2 availability, while potential rates were influenced both by the microbial pool size and substrate concentration. The activity of denitrifying enzymes in the soil was found to be influenced by nitrate concentrations. However, denitrifying potential was higher in soils with higher total P concentrations.

The results of laboratory and field studies indicate that mineralization, or the net release of inorganic N is affected by P availability to the microbial pool. Potential rates of denitrification also appeared to increase with increasing P concentration, however only after the NO_3^- limitation was exceeded. The increased concentrations of NH_4^+ may provide a stimulatory effect on the growth of macrophytes in the wetland. Greater macrophyte growth may then alter both ecosystem structure and function by continually cycling N back into organic forms (macrophytes) and re-releasing the inorganic N through decomposition.

Concurrent Session XI – Phosphorus Transformations

Wednesday, July 14, 1999
8:30am-10:10am

Characterization of Dissolved Organic Phosphorus Compounds in the Florida Everglades by Ultrahigh Resolution Fourier Transform Ion Cyclotron Resonance Mass Spectrometry

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In this presentation we summarize the results of experiments on high molecular weight (> 1000 Da) dissolved organic matter isolated from several sites within the Everglades Experimental Nutrient Removal (ENR) Project. These experiments included both single- and multi-stage Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS) with positive ion electrospray ionization. After a barium precipitation procedure that isolates organic-P from most of the background DOC, ultrahigh resolution single stage FT-ICR MS (m/?m > 106) was used to identify prominent peaks that contained phosphate. These organophosphate compounds were catalogued according to their occurrence and persistence in the ENR site. Several of the peaks which exhibited distinct spatial trends were then further analyzed by the multistage MS/MS scheme. This procedure allows the chemical formulae and structures of these high molecular weight DOP compounds to be estimated with a high degree of confidence. One interesting result to emerge from initial analysis of molecular weights is that most DOP compounds are less than 1000 Da, in spite of the fact that they have been isolated by ultrafiltration with a 1000 Da membrane. This suggests that many DOP compounds are weakly attached to larger humic-like molecules.

Phosphorus Fractions and Incorporation in Sewage-impacted Wetland Sediments

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Sediments were collected from two sites along a sewage-impacted wetland, one above (pre-) and the other immediately downstream (post-) from the confluence, where an adjacent natural wetland provides a sustainable input of iron to the sewage wetland. Collected sediments were sequentially extracted into inorganic and organic phosphorus fractions. Phosphate incorporation into these fractions was also investigated by adding carrier-free phosphate (32P) to sediments which had been equilibrated under different pH (5.5, 6.5 and 7.5) and phosphate concentrations (0, 2.5 and 5 g P m-3). Occluded aluminium (Al) and iron (Fe)-P fraction represented a significant proportion (28%) of total P in the post-confluence sediment, attributing to the oxidation of soluble ferrous (Fe2+) to crystalline ferric (Fe3+), as a result of water mixing and aeration at the upstream confluence. In both sediments, >80% of added 32P were incorporated into the Pi of the pre- and post-confluence sediments over a 15-20 day period, regardless of pH or added phosphate concentrations. Most of the 32P (83-90%) incorporated into the Pi pool was accounted for in the non-occluded Al/Fe-P and carbonate-P fractions, suggesting that Pi incorporation into the weakly bound Al and Fe oxides is probably the most important process in retaining P in the studied wetland.

Bioavailability of Dissolved Organic Phosphorus in the Florida Everglades: Evaluation with Native Bacterial and Reference Enzymes

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In order to determine whether dissolved organic phosphorus (DOP) entering the Everglades from the Everglades Agricultural Area is bioavailable, we conducted assays on water samples, collected in December, 1998, from the Everglades Nutrient Removal (ENR) site and from the Water Conservation Area 2 (WCA-2) site. Samples were assayed for total bacterial abundances and native bacterial phosphatase activities. In addition, potentially bioavailable DOP was evaluated with reference enzymes, alkaline phosphatase (monoesterase), phytase (monoesterase) and phosphodiesterase. DOP ranged from 220-310 nM in the ENR to 460-600 nM in the WCA-2. Bacterial abundances ranged from 1.5 x 106 to 3.7 x 106 cells/ml across both sites. Native phosphatase activities ranged from 7-12 picomoles PO4 hydrolysed/ml/min in the WCA-2 and were 3-4 times higher in the ENR, suggesting some DOP consumption in both systems. More importantly, a larger pool of potentially bioavailable DOP may exist at both sites. In the WCA-2, up to 20% (ca 84-113 nM) of the DOP and, in the ENR, up to 27% (ca 124-163 nM) of the DOP, is hydrolyzable by monoesterases alone or combinations of diesterases and monoesterases. This study suggests that the ENR and WCA-2 is storing bioavailable DOP which may be later released into the Everglades.

Hydrologic Influence on Stability of Organic Phosphorus in Detrital/Floc Material of a Constructed Wetland

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Accretion of organic matter in productive natural and constructed wetlands is as high as 1 cm year-1 and its role in nutrient storage and cycling could be substantial. To study phosphorus (P) mobilization in recently accreted organic matter, detrial/floc material (derived primarily from Typha sp., detrital tissue) was collected from the Everglades Nutrient Removal Project, a constructed wetland currently being used to treat agricultural drainage water in the northern Everglades. The floc material was subjected to different periods of draw-down and consecutive re-flooding under laboratory conditions. The study showed that relative compositions of different organic P compounds were affected by draw-down of floc material. The 31P Nuclear Magnetic Resonance Spectroscopy (31P NMR) analysis revealed that sugar phosphate, glycerophosphate, polynucleotides, and phospholipids (glycrohposphoethanolamine and glycerophosphocholine) were the major forms of P in the detrital/floc material. After 30 days of draw-down, polynucleotides were reduced to traces, whereas sugar phosphate, glycerophosphate, and phosphocholines had remained the major fractions of organic P.

At the end of 30-day re-flooding period, cumulative P flux to water column from floc was at 3% of the total P ((15-day draw-down) and further decreased to 2% at 30-day draw-down, but increased to 8% at 60-day draw-down. Most P flux into water column occurred within 3 days of re-flooding. Thereafter, P was immobilized for up to 30 days of re-flooding at all draw-down periods (0-, 7-, 15- and 30-day), however, at 60-day draw-down, P flux steadily increased during first three weeks of re-flooding. Moreover, the draw-down ((30 days) not only reduced P flux into water column, but also increased the humification and microbial immobilization of P. Excessive draw-down (60 days), however, triggered the release of P into water column as the water content of floc decreased from 95 to 11%.

Algal-induced Calcite and Phosphorus Coprecipitation in Created Freshwater Marshes

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In addition to direct uptake of phosphorus, water column productivity can induce P coprecipitation with calcium carbonate in hardwater aquatic systems, which can be a significant P sink. This study examines coprecipitation as a potential P sink in wetlands. To determine whether diurnal calcite precipitation occurred in the Olentangy River Wetland Research Park, water samples were taken approximately once a month from June-December 1998. Measurements were taken at dawn, dusk, and the following dawn for pH, dissolved Ca, orthophosphorus, total P, and other parameters. Similar measurements were carried out in twenty 400-L experimental mesocosm tanks, where ten mesocosms were stocked with algae from the wetlands while ten were covered with opaque cloth to inhibit algal production. Data were analyzed to detect diurnal changes as well as site (basin inflow vs. outflow) and mesocosm treatment (algae vs. control) differences. Significant diurnal changes were observed for temperature, dissolved oxygen, pH, and conductivity in both basins and mesocosms. While no significant diurnal effects were observed for P and Ca levels, both were significantly lower at the outflow of the wetlands and in the algae mesocosms, indicating they were being removed from solution. Sediment and algal mat analysis will be completed in spring.

Concurrent Session XII – Nitrogen Transformations

Wednesday, July 14, 1999
10:25am-12:00pm

Dynamics of Nitrate Loss in Emergent Wetlands

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In addition to serving as a principal source of organic carbon, wetland vegetation influences the physical and chemical characteristics of wetland sediments and overlying waters, including temperature and oxygen availability. Through a combination of direct and indirect effects, emergent vegetation can significantly influence the complex biogeochemical transformations involved in the nitrogen cycle. Results from experimental mesocosms confirm the capacity of wetlands for nitrate removal and demonstrate the effects of emergent vegetation and litter on nitrate loss. As vegetation and litter densities increase, so does the capacity of wetlands as nitrate sinks, but only to a point. This is illustrated by yearly increases in nitrate removal capacity in experimental wetland mesocosms in the first few years after establishment, a pattern also observed in full-scale treatment wetlands. There is obviously an upper limit to the increase in capacity as wetlands develop, but increases in capacity can probably be expected during at least the first few years of development of newly established wetlands or in zones of established wetlands where vegetation and litter densities are increasing following periods of loss.

N Dynamics of Grass and Forested Riparian Wetlands in Agricultural Landscapes of Western Oregon

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Nitrogen cycling in hydromorphic soils of western Oregon is poorly understood.. This information has direct implications to ground and surface water quality, and the functioning of riparian zones in improving water quality. The objective of this research was to determine net rates of mineralization, nitrification, and denitrification in soils of a poorly drained grass riparian zone, a well drained forest riparian zone, and adjacent farmland. Net mineralization and nitrification were estimated using the in situ buried bag method. Denitrification was measured using both in situ and in vitro acetylene block methods. Denitrification and greater mineralization than nitrification rates coincided with lower soil nitrate concentrations in soil and shallow groundwater of the poorly drained grass zone. In contrast, soil N mineralization and nitrification of the forest riparian zone coincided with higher soil and shallow groundwater nitrate concentrations. Denitrification in the forest zone may have a smaller role in processing nitrate compared to the poorly drained grass riparian zone. We attribute the riparian zone differences in N processing to differences in soil redox potential and dissolved organic carbon levels as established by hydrologic conditions and biological factors.

Factors Affecting the Nutrient Trapping Capacity in Riparian Wetlands

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Long Nguyen
National Institute of Water and Atmospheric Research
Hamilton, New Zealand

Nutrient processing capacities in riparian wetlands intercepting nutrients exported from pastures receiving regular fertiliser nitrogen and phosphorus applications were compared with those in wetlands receiving lower nutrient inputs from mature pine forests or untouched native bush. Soil cores, taken from three depths in each riparian wetland in spring, summer, autumn and winter, were assayed for nitrification-denitrification potential and phosphorus retention capacity. Dissolved nutrients passing through the wetlands were also measured. Results obtained show that different land uses had no significant effect on soil nitrification-denitrification and phosphate retention capacities in the riparian wetlands. Both these capacities showed marked seasonal variations at all sites with nitrification-denitrification capacity highest in summer and soil phosphorous retention capacity peaking in winter. At all sites denitrification potentials were 50 times higher than nitrification potentials, suggesting that riparian soils are much more efficient at removing nitrate than ammonium or dissolved organic nitrogen. The absence of consistent trends in dissolved nutrients suggests factors such as hydrology may have an important influence on nutrient removal efficiency.

The Function of Cyanobacterial Mats in Wetlands of Belize Assessed through Field Sampling and a Nutrient Enrichment Experiment

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Ceské Budejovice

Cyanobacterial mats are important components of oligotrophic, phosphorus-limited wetland ecosystems in the limestone-based regions of the Caribbean.
Our goals were to: (1) Assess the contribution of cyanobacterial mats to the total ecosystem primary productivity, quantify the extent of nitrogen fixation, and evaluate the potential role of alkaline phosphatase; (2) Record changes in these variables following nutrient additions. The mat biomass ranged from 200 to 700 g m-2 AFDM, with the epipelon contributing up to 87% of the total. Tissue nitrogen was similar in all marshes (1.1 to 1.5%), while tissue phosphorus was extremely low (0.0055 to 0.0129%) and it correlated well with the N:P ratio in water. Primary production, measured with the 14C method, extended from 2 to 7 µgC cm-2 h-1. Nitrogen fixation expressed as nitrogenase activity was high in some marshes (17.5 nmol C2H4 cm-2 h-1) and low (< 5 nmol C2H4 cm-2 h-1) in others depending mainly on the proportion of heterocyst-forming cyanobacteria (Stigonematales) in the mat. Alkaline phosphatase activity was positively correlated with the N:P ratio of the mat. Experimental addition of phosphorus resulted in a significant increase in primary production and nitrogen fixation. APA activity seemed to be suppressed by P addition.

Concurrent Session XIII – Wetlands and Water Quality – II

Wednesday, July 14, 1999
8:30am-12:00pm

Benthic Nutrient Fluxes in Florida Bay's Mangrove Ecotone

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Freshwater flow through the Everglades and into Florida Bay is being changed as part of a large environmental restoration effort. To understand the ecosystem-level effects of this change, we measured in situ nutrient fluxes in and near the mangrove ecotone of Florida Bay. For all sites, N release from sediments was surprisingly low relative to O2 uptake. Mean O:N molar ratios ranged from 50 to 320. Inorganic P fluxes were nearly zero at all sites. Ammonium release by the benthic community was lower at sites closest to mangrove wetlands than at more offshore bay sites. Sediments in a mangrove wetland pond were a net N sink, despite having the highest sediment N concentration of any site. While sediments from all sites were a sink for nitrate+nitrite, small mangrove (Rhizophora) islands in the wetland near the pond were net producers of nitrate+nitrite, especially during the dry season. This seasonality may be a function of temperature and salinity. However, benthic metabolism and nutrient flux were only closely correlated with temperature and not salinity. These results indicate that increasing freshwater flow from the Everglades may decrease nitrification in the mangrove wetland and thus decrease N removal from the system by sediments.

Root Proliferation by Mangroves in Decaying Roots and Old Root Channels: A Nutrient Conservation Mechanism?

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Peat soils on mangrove-dominated islands in Belize were characterized by numerous old root channels and decaying roots (~2 % of total soil volume) that were filled with living and highly-branched roots of Rhizophora mangle and Avicennia germinans. Channel diameter ranged from 0.5 to 3.5 cm, reflecting the size variation of mangrove roots. The proportion of roots growing inside channels varied from 9 to 24 % of total live root mass and was significantly higher than would be expected by chance. A manipulative experiment demonstrated that proliferation of live roots inside channels was caused by presence of organic matter, rather than simply a response to greater space or reduction in physical impedance to root growth. When artificial root channels (PVC pipe) were buried in the peat for two years, those filled with organic matter had six times more roots than sand-filled or empty channels, which were not significantly different. Decaying roots may provide enriched microsites relative to bulk soil, and the strategy of root proliferation inside dead roots may aid nutrient conservation in this oligotrophic environment. Improved efficiency of nutrient acquisition by selective exploitation of enriched microsites at the individual plant level has implications for nutrient economy at the ecosystem level.

Bottom-up Linkages between Fringe Mangroves and Seagrasses in a Bahamas Tropical Lagoon

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Chris Madden
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We characterized primary productivity and nutrient patterns in a Bahamas tropical lagoon to test whether fringe mangroves provide bottom-up controls on seagrass primary production. Sediment, surface water, and Thalassia testudinum (leaf, root, rhizome; where present) nutrient content was determined at 5 sites from the mangroves to the tidal channel. Community production of seagrass and mangrove prop-root algae was measured using light and dark chambers, while phytoplankton and epiphyte primary production was determined in light-dark bottle experiments. Sediment P and N decreased from 0.24±0.04 to 0.09±0.01 and 3.23±1.01 to 1.44±0.69 mg g-1 dry wt from the fringing mangrove to seagrass channel site, respectively. Surface water nutrients and plant tissues followed similar trends. Leaf, root, and rhizome C:P molar ratios at the mangrove site (641±30, 1208±385, 595±71) indicate that Thalassia may be receiving mangrove nutrient subsidies compared to the lagoon (761±70, 2220±463, 1137±289) and channel (953±42, 2177±349, 2003±293) sites. Seagrass gross community production dominated and tended to be higher at the mangrove site, however community respiration rates were 2-fold greater, resulting in similar net community production rates among sites. Thus, fringing mangroves facilitate P sequestering in seagrasses, and may be important in gross production of tropical lagoons.

Impact of Logging on a Mangrove Wetland: Cost/Benefit by Soil Use Change Analysis

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The analysis of the environmental modification in a logged mangrove, the plant sucession and the cost/benefit ratio were carried out. The forest included Rhizophora mangle, Laguncularia racemosa and Avicennia germinans before being logged with a production of wood and of organic matter of 3.9 g/m2/d and 164 m3/ha respectively, and an exploitation of 3.5 ton wood/yr. After logging the temperature increased 13°C in the soil and 11°C in the air, the salinity was 52 psu in the dry season, 3000 m2 were eroded by the river and this increased the proportion of sand. The peasants obtained a low corn harvest (2,555 kg/yr) of only $ 84 dlls. When people abandoned the adyacent area a sucession of halophytes, facultative and glycolitic plants appeared with 30 kinds of species. Fisheries and fauna diminished (32%) as a consequence of silted shelter areas and the loss of habitat. The cost/benefit analysis showed a 32:1 ratio. Degradation resulted in a ratio of 246:1 considering that the wetland has recuperated only 30%.

Quantifying the Effects of Enhanced Water Inflows on Wetlands throughout the Southern Everglades

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Ongoing Everglades restoration efforts are increasing water inputs to wetlands of the Southern Everglades, via removal of a major canal levee in the ENP Panhandle and greatly enhanced canal pumping in Taylor Slough. We are monitoring effects of these changes by quantifying a number of ecosystem parameters in Southern Everglades wetlands in an integrated research effort. In both basins, we are sampling transects parallel to overland flow; the transects run from canals to Florida Bay. Along each, we are sampling waterborne nutrient concentrations, periphyton and macrophyte dynamics, and soil processes. We measure large-scale water chemistry changes with continuous sampling at stations along all transects. In the ENP Panhandle, we are quantifying immediate responses using throughflow flumes constructed at the canal-wetland interface (including zones dominated by periphyton and sawgrass marsh). 1998 flume sampling showed ammonium and DOC uptake, and TOC release, by both zones. The periphyton zone imported TN, while nitrate-nitrite flux was dominated by marsh dynamics. We are also quantifying periphyton dynamics by combining whole system metabolism data with short-term productivity incubation experiments. These show a significant water source effect on periphyton taken from the marsh far from canal influences. We are quantifying sawgrass productivity and soil processes at numerous marsh sites as long-term indicators of changing nutrient status.

Biogeochemical Cycling in a “Hyperventilating” Shallow Estuarine Environment on Diel Time Scales

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A diel biogeochemical study was performed to assess the influence periods of elevated biologically activity has on the biogeochemical cycling of macronutrients and redox-sensitive elements in a natural estuarine environment. Dissolved oxygen values in Azevedo Pond, Elkhorn Slough, California can range from highly oxic (> 560 µM O2 (> 250% saturation)) during sunny days to suboxic conditions (< 5 µM) at night during periods of low tidal flushing. A diel sampling event was conducted over a 26-hour period, where O2 concentrations ranged from 346 µM to sustained non-detectable levels in the night time hours. In concert with the DO fluctuations, diel phosphate cycling was on the order of 4 µM in response to biological assimilation and regeneration. The IO3-/I- redox couple quickly responded to suboxic conditions in the water column by a marked increase in I- concentrations and corresponding depletion of IO3-. The extreme fluctuations of the p(in the water column resulted in diel dissolved Mn2+ variations of nearly 5µM, with observed Mn-oxidation rates on the order of 1µM h-1. The elevated biogeochemical cycling of nitrogen, phosphorus, iodine, manganese, and iron found in this study suggest that nutrient-enriched estuarine systems can play a significant role in supplying these substrates to coastal ecosystems.

Impact of Marsh Impoundment Water Management on Indian River Lagoon Water Quality

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Marsh impoundments located at Kennedy Space Center Florida/Merritt Island National Wildlife Refuge are exposed to a variety of water management strategies. Some impoundments are flooded for as long as 8-10 months (WAM), while others are open to the lagoon and flooded infrequently (2 months). We are examining the impact these water management schemes on the adjacent Indian River Lagoon (IRL) water quality in comparison to a restored marsh where the impoundment dikes have been removed. In six impoundments (3 WAM and 3 Open) water is collected on the marsh surface (25 m from the culvert), adjacent to culverts in the perimeter ditch and the IRL, and at a station located in the IRL approximately 150 m from each impoundment culvert. Preliminary data show that PO43-, NO3- and NH4+ in the perimeter ditches was elevated relative to IRL water. Within 24-hrs after opening culverts in WAM, IRL values of these variables increased significantly. Additionally, turbidity and total suspended solids were significantly greater in the IRL than pre-opening. Maximum values in the IRL were observed 96 hrs post-opening of the culvert impoundments. Four months after opening the culverts, water quality in the IRL and in the perimeter ditches were similar.

Effect of Sediment Grain Size on the C:N:P Ratios in a Coastal Wetland

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CNP atomic ratios have been used frequently to determine the origin of matter in aquatic environments. However, this is difficult in coastal sedimentary environments as a result of the diversity of sources of OM and of physico-chemical factors in the sediment. These two conditions constitute the purpose of this research which took place in a coastal wetland in NW Mexico. Results show that sediment grain size indirectly but precisely modifies the content of carbon, nitrogen and phosphorus and, thus, the CNP ratios, making it difficult to determine the origin through this technique. Sandy environments were poor in nitrogen (CNP=31-60:1-4:1) whereas muddy or fine sand environments had a greater content of nitrogen (128-206:8-17:1) with no association with any type of local vegetation.

Nutrient Dynamics in the Newly Created Shallow Lake Agmon (Hula), Israel

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Lake Agmon (volume - 106 m3; surface-110 ha; mean depth-0.7 m) is part of the Hula Project system aimed at improving agricultural crops, enhancement of land owners income and protecting Kinneret water quality by nutrients removal. Drainage waters from peat soils are stored in Lake Agmon and diverted from the Kinneret loads together with the creation of recreational attraction. Trophic status of Lake Agmon is eutrophic with dense populations of native and introduced floral and faunal organisms. Two major water/nutrient input sources are River Jordan and the drainage Canal-Z. Additional sources are drainage waters from eastern and western peat blocks and bottom advections. Phosphorus cycle is mostly macrophyte mediated and therefore the outflow is slightly higher than inflow. Dissolved P flux from bottom sediments is probably low. Nitrogen inflow is higher than outflow due to coupled, partly plant mediated, nitrification-denitrification process and sedimentation. Sulfate is intensively flushed from gypsum dissolution in the peat soil with fast declining. The availability of P for plants, especially Typha spp., is a growth limiting factor and highly related to the content and degradation level of the organic matter in bottom sediments. Nutrients removal by the Agmon system from the Kinneret loads was successfully implemented.