The
First National Conference on Ecosystem Restoration (NCER)

Sustainable Ecosystem Restoration Through Integration of Science, Planning and Policy

December 6-10, 2004

Lake Buena Vista, Florida

US Army Corps of Engineers ®

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Florida Earth Foundation

Welcome to the First National Conference on Ecosystem Restoration!

Restoration of degraded ecosystems has been and continues to be a high priority throughout the nation. Yet, those of us involved in ecosystem restoration have had limited opportunities to interact with our colleagues at the national scale to discuss challenges and opportunities relevant to ecosystem restoration; hence, the need for a National Conference on Ecosystem Restoration. Therefore, the intent of this Conference is to provide a forum wherein all of us 'restoration practitioners' – engineers, managers, planners, policy makers and scientists – can interact in an interdisciplinary setting to share and review *knowledge gained* and *lessons learned* relevant to sustainable ecosystem restoration.

So, where did the idea of a national conference on restoration have its origin? In 2002, Lieutenant General Robert Flowers, Chief of the U.S. Army Corps of Engineers, convened a meeting of his Environmental Advisory Board (EAB). The EAB is a panel screated as a means for the Chief of Engineers to gain outside, expert and independent advice on environmental issues facing the Corps of Engineers. The primary purpose of the EAB's meeting was to provide input on large-scale ecosystem restoration projects, and particularly the Florida Everglades. The EAB noted to the Chief a need for better integration and sharing of scientific information and communication of that information for use in resource management decisions. The Corps and the U.S. Geological Survey recognized a synergy could be obtained by jointly organizing a conference which merged *planning, policy and science*; and the NCER was conceived.

To make this conference as beneficial as possible, the NCER will investigate challenging restoration-related questions, such as:

- How do we effectively integrate planning, policy and science such that each contributes to the other in an effective, relevant and timely manner?
- Are there local, regional and national policies guiding restoration? For restoration projects involving multiple governmental agencies and tribal governments, how do we ensure continuity and completion of large-scale, multiyear restoration projects?
- How do we ensure that restoration policy facilitate integration of new science, new and improved technology, and new and improved modeling into restoration planning and implementation?
- How can the scientific information be used to achieve environmental sustainability in restoration programs? How do we set restoration objectives and define success?
- Are there opportunities for innovative win-win solutions that sustainability integrates humanity and nature in the restored ecosystem?

All of us involved in ecosystem restoration know that going from concept to reality is not an easy challenge. The same is true for this Conference. It took much dedication and many hours of work of the Planning Committee and conference organizers to transform the *"need for better integration and sharing … and communication …"* into a conference that will provide exactly that! We welcome you to this important conference. Together, let us make it a successful 'first'!

You have our Best Wishes and, Many Thanks,

G. Ronnie Best, PhD, PWS
U.S. Geological Survey
Conference Chair

Daniel J. Hayes
US Army Corps of Engineers
Conference Co-Chair

Table of Contents

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Program Agenda

SUNDAY 12/5/04	**WELCOME TO THE FIRST NATIONAL CONFERENCE ON ECOSYSTEM RESTORATION (NCER)**
1:00-5:00	Exhibitors and Vendors Set-up Displays — (*Conference/Exhibition Hall)*
4:00-5:00	SESSION I POSTER PRESENTERS SET-UP DISPLAYS — *Conference/Exhibition Hall*
5:00-7:30	**REGISTRATION OPEN TO CONFERENCE ATTENDEES — *Great Hall Assembly (Lower Level)***
5:30-7:30	EARLY BIRD NETWORKING SOCIAL IN POSTER DISPLAY AREA — (*Conference/Exhibition Hall)*
MONDAY 12/6/04	
7:00-5:00	**REGISTRATION OPEN TO CONFERENCE ATTENDEES — *Great Hall Assembly (Lower Level)***
7:00-1:00	Exhibitors, Vendors and SESSION 1 Poster Presenters Set-up Displays — (*Conference/Exhibition Hall)*
1:00-5:00	**OPENING PLENARY SESSION** *(Great Hall)*
1:00-1:20	*LTG Carl Strock,* Director of Civil Works, US Army Corps of Engineers - and - *Dr. Charles Groat*, Director, US Geological Survey -- Welcome and Opening Remarks
1:20-1:50	*Ms. Colleen M. Castille,* Secretary, Florida Department of Environmental Protection -- Welcome to the State of Florida and Florida's Initiatives on Ecosystem Restoration
1:50-2:20	*LTG Carl Strock,* Director of Civil Works, US Army Corps of Engineers -- Corps of Engineers and Ecosystem Restoration
2:20-2:50	*Dr. Charles Groat,* Director, US Geological Survey -- Science for Ecosystem Restoration
2:50-3:20	BREAK IN POSTER & EXHIBIT DISPLAY AREA
3:20-3:30	*Dr. G. Ronnie Best, NCER Chair, US Geological Survey* and *Daniel J. Hayes, NCER Co-Chair, US Army Corps of Engineers* -- Conference Overview
3:30-3:50	*Dr. Donald Boesch*, President, University of Maryland Center for Environmental Science -- Systems Approach to Ecosystem Restoration
3:50-4:10	*Mr. Richard A. Pettigrew,* Former Chair of Governor's Commission on South Florida Ecosystem Restoration -- Consensus Building Among Stakeholders
4:10-4:30	*Mr. Tom Horton,* Baltimore Sun -- The Challenge of Communicating About Ecosystem Restoration: It's a Two-Way Process
4:30-4:50	*Dr. William L. Graf,* Foundation University Professor and Professor of Geography, University of South Carolina, Chair of the NAS/NRC Committee on Threatened and Endangered Species in the Platte River Basin and member of the Committee on Independent Scientific Review of Everglades Restoration Progress -- Beauty and the Beast: External Review of Restoration Science
4:50-5:00	Closing Comments and Plenary Session Adjourns
5:00-7:00	WELCOME RECEPTION *(Poolside)*
TUESDAY 12/7/04	
7:30-8:30	MORNING REFRESHMENTS IN POSTER & EXHIBIT DISPLAY AREA
8:30-10:20	**Plenary Session -- National Priorities/Planning Restoration (** *Great Hall)*
8:30-8:40	Plenary Introduction -- Don Boesch, Moderator
8:40-9:00	Margaret Palmer -- The State of River Restoration in the United States: Data to Inform Prioritization?
9:00-9:20	Denise Reed -- The Coast at 2100: Prioritizing Ecosystem Restoration Needs
9:20-9:40	Fred Caver -- Concept to Program
9:40-10:00	COL Carpenter and Dennis Duke -- The Challenge of Implementation
10:00-10:20	**Discussion*
10:20-10:40	BREAK IN POSTER & EXHIBIT DISPLAY AREA

TUESDAY 12/7/04	CONCURRENT SESSIONS				
10:40-12:15	**SESSION 1-Planning Restoration: Defining Success and Setting Objectives I**	**SESSION 2-Planning Restoration: The Critical Role of Science**	**SESSION 3- Effective Science Communication: Environmental Reporting PANEL DISCUSSION**	**SESSION 4- National Priorities: Case Studies**	**SESSION 5- Environmental Chemistry and Contaminants**
	Great Hall North	**Great Hall Center**	**Great Hall West**	**Great Hall East**	**Cloister *(upper level)***
10:40-10:45	Session Introduction -- **Joseph DePinto, Moderator**	Session Introduction -- **G. Ronnie Best, Moderator**	Session Introduction -- **Nanciann Regalado, Moderator**	Session Introduction -- **Derek Busby, Moderator**	Session Introduction -- **Greg Allen, Moderator**
10:45-11:00	**John Ogden** -- Defining Success and Setting Objectives: the Everglades Case Study	**Frank Mazzotti --** The Role of Science in Ecosystem Restoration and Management: Foundation or Failure	*Scientists: Nick Aumen,* ***Jack Gentile, Beverley Getzen and Margaret Palmer*** *-- Journalists:* ***Jeff Burnside, Tom Horton, Bob King, Curtis Morgan and Martha Musgrove****. This session will be an interactive discussion between scientists and media personnel.*	**Kenneth Barr --** Upper Mississippi River Navigation Study: Ecosystem Restoration as a project purpose	**David Krabbenhoft** -- Mercury Contamination of the Florida Everglades: A Convergence of External Forces and Natural Ecosystem Sensitivity
11:00-11:15	**Kenneth Tiffan** -- If You Build It, Will They Come? - Use of Paradigms in Justifying Restoration Projects	**Ellis Clairain** -- Science and Technology in Support of the Louisiana Coastal Area Ecosystem Restoration Plan		**Roger Perk** -- The Upper Mississippi River System Environmental Management Program	**William Orem** -- Sulfur Contamination in the Florida Everglades: Where Does it Come From, What is Its Extent, What Are Its Impacts, and What Can We do About it?
11:15-11:30	**Ann Swanson** -- Chesapeake Bay: Restoring the Nation's Largest Estuary	**Reed Noss** -- Integrating Conservation Biology and Restoration Ecology for the Long-term Integrity of Southwestern Ponderosa Pine Landscapes	PANEL SESSION CONTINUES	**Zachary Hymanson** -- Examining the Effects of the Environmental Water Account: A Novel Approach to Species Restoration or the price we pay for peace?	**George Aiken** -- Mercury and Dissolved Organic matter in the Florida Everglades
11:30-11:45	**Joseph DePinto --** Eutrophication in the Great Lakes: The Path to Restoration	**Thomas Armstrong** -- The Effective Application of Science to Management and Political Decision-making in Ecosystem Restoration Efforts	PANEL SESSION CONTINUES	**Edward Mills --** Large Lake Rehabilitation: Lessons from the Lake Ontario Ecosystem	**Gary Rand** -- Ecological Risk Assessment of Contaminants in Sediment from South Florida Aquatic Ecosystems
11:45-12:00	**Angela Sowers** -- Restoration of Island Habitat though the Beneficial Use of Dredged Material: A Community Approach	**Hilary Swain** -- The Reserve: Planning a Major New Restoration Site at Archbold Biological Station, FL	PANEL SESSION CONTINUES	**Robin Craig --** Recent Developments in Marine Restoration: National Policy, Law and Science	**Elly Best** -- Quantifying the Role of Microbes and Plants in Methylmercury Cycling in Coastal Saltmarshes as Basis for Wetland Restoration and Management in the Hamilton Army Airfield on San Pablo Bay
12:00-12:15	**Angela Sowers** -- Poplar Island Environmental Restoration Project, Talbot County Maryland	**Ellen Cummings** -- Ecosystem Performance Measures: Moving Beyond Dollars per Acre	PANEL SESSION CONTINUES		**Eugene Shinn** -- Atmospheric Deposition of African Dust in the Everglades and Florida Bay Ecosystem
12:15-1:30	**BOXED LUNCH PROVIDED**				

TUESDAY 12/7/04	CONCURRENT SESSIONS				
1:30 - 3:05	**SESSION 1- Planning Restoration: Methods and Tools**	**SESSION 2- National Priorities: General Overview**	**SESSION 3- Effective Science Communication: Role in Ecological Restoration I**	**SESSION 4-Planning Restoration: Use of Scientific Models**	**SESSION 5-Science: Water Quality**
	Great Hall North	**Great Hall Center**	**Great Hall West**	**Great Hall East**	**Cloister *(upper level)***
1:30-1:35	Session Introduction -- **David Miller, Moderator**	Session Introduction -- **Bill Hinsley, Moderator**	Session Introduction -- **Russ Mader, Moderator**	Session Introduction -- **Cheryl Buckingham, Moderator**	Session Introduction -- **Barry Rosen, Moderator**
1:35-1:50	**Kim Gavigan** -- On the Edge: Restoration Planning in the Southwestern Desert	**Beverley Getzen --** Linking Ecosystem Restoration with Watershed Management	**William Dennison --** The Role of Effective Science Communication in Restoration Ecology in Chesapeake Bay	**Dominic Kempson** -- Non-Traditional Calibration of Hydrologic Modeling at Lockport Prairie, Illinois using Biological Indicators as a Calibration Tool	**Scott Phillips** -- Factors Affecting Nutrient Delivery to Chesapeake Bay: Implications for Restoring Water-Quality Conditions in the Nation's Largest Estuary
1:50-2:05	**Joe Redican --** The Master Implementation Sequencing Plan and its use as a Planning Tool for Environmental Restoration	**Richard Cole** -- The Need for Improved Program-level Planning to Achieve Sustainable Outcomes from Ecosystem Restoration Projects Planned by the U. S. Army Corps of Engineers	**Troy Constance** -- The Louisiana Coastal Area (LCA) Study: History and Future	**John Hickey** -- The Ecosystem Functions Model: A Tool for Restoration Planning	**Richard Batiuk** -- Defining Restored Water Quality and Allocating Caps on Nutrient and Sediment Loads: Chesapeake Bay Lessons Learned
2:05-2:20	**Mike Donahue --** -A Policy Perspective on Large Scale Ecosystem Restoration Planning: A Great Lakes Case Study	**Joy Mulinex --** Large-Scale Ecosystem Restoration Initiatives and the U.S. Federal Policy Process	**Frances Flanigan** -- Science Communication and Outreach in the Chesapeake Bay Watershed	**Leonardo Frid** -- Guiding Fire and Grazing Restoration in Grasslands National Park of Canada with a Landscape Level Simulation Model	**Mark Clark** -- Hydrologic Restoration of Isolated Wetlands in the Okeechobee Watershed: An Integrated Approach to Reduce Phosphorus Loads to the Lake
2:20-2:35	**Agnes McLean --** The Initial CERP Update: A Collaborative Planning Initiative in Applying Adaptive Management Principles to the Comprehensive Everglades Restoration Plan	**Ellen Cummings** -- The Estuary Restoration Act - Past, Present and Future	**Stan Bronson** -- Establishing Public-Private Partnerships for Effective Communications in Ecosystem Restoration Initiatives	**Bruce Williams** -- Hydrodynamic Simulation for a Mudflat Dominated Coastal Lagoon Restoration Project	**Molly Wood** -- Assessing Restoration Efforts in the Lake Okeechobee Watershed Through a Nutrient Load Monitoring Program
2:35-2:50	**Elizabeth Crisfield** -- Who Gets the Water? Identifying Water for Restoration of the Everglades and Other Purposes: Policy Issues and Technical Procedures	**Marti McGuire** -- The National Estuaries Restoration Inventory (NERI): A Tool for Sharing Information and Tracking Our Progress	**Carl Hershner --** Effective and Ineffective Science Communication in the Chesapeake Bay Program	**Luis Cadavid** -- Recent Enhancements to the South Florida Water Management Model (SFWMM)	**Greg Noe --** Particulate Phosphorus Transport in the Everglades Wetland Landscape
2:50-3:05	**Richard Cole** -- A Proposed Biodiversity-based National Objective for Formulating and Evaluating Ecosystem Restoration Projects Sponsored by the U. S. Army Corps of Engineers	*Discussion*	**R. Michael Hanley** -- The White River Ecosystem Conservation and Restoration Project: An NGO/Federal Partnership	**Kelly Burks-Copes --** The Tres Rios Del Norte Project: Streamlining the Functional Assessment Process to Meet the Ecosystem Restoration Challenge	**Paul McCormick --** Understanding Patterns of Canal-Water Intrusion to Predict the Effects of Everglades Restoration on the A.R.M. Loxahatchee National Wildlife Refuge
3:05-3:25	**BREAK IN POSTER & EXHIBIT DISPLAY AREA**				

TUESDAY 12/7/04	CONCURRENT SESSIONS				
3:25-5:15	**SESSION 1-Planning Restoration: Use of Conceptual and Quantitative Models**	**SESSION 2-Adaptive Management: Monitoring Plan Design**	**SESSION 3- Effective Science Communication: Role in Ecological Restoration II**	**SESSION 4-Planning Restoration: Use of Scientific Models**	**SESSION 5-Integrating Conservation, Mitigation and Restoration**
	Great Hall North	**Great Hall Center**	**Great Hall West**	**Great Hall East**	**Cloister *(upper level)***
3:25-3:30	Session Introduction -- **Fred Sklar, Moderator**	Session Introduction -- **Doug Robinson, Moderator**	Session Introduction -- **JoAnn Hyres, Moderator**	Session Introduction - **Gary Hardesty, Moderator**	Session Introduction - **Dennis Barnett, Moderator**
3:30-3:45	**Jim Henderson** -- Ecosystem Restoration and Conceptual Models -- Making Sense of Complexity and Figuring Out What to do First	**Elmar Kurzbach** -- Development of Monitoring and Assessment Plan (MAP) for Everglades Restoration	**Clifford S. Duke --** Ecological Science and Sustainability for a Crowded Planet: A 21st Century Vision and Action Plan	**James Peterson** -- The Effects of Hydrologic Stressors on Wading Bird Foraging Distributions in the Everglades: Modeling for Adaptive Management in Restoration	**Mark McKevitt** -- U.S. Army Corps of Engineers Ecosystem Restoration Title I Project Authorizations, 1990 – 2000, Costs and Benefits
3:45-4:00	**Fred Sklar --** The Design of Landscape Models for Everglades Restoration	**Stephen Preston** -- Water-Quality and Living-Resources Monitoring to Support Ecological Restoration Efforts in the Chesapeake Bay and Its Watershed	**Jenni Hiscock --** Effective Communication between Science and Project	**Lee Weishar** -- The Relationship Between Hydrodynamic Numerical Models and Adaptive Management in Marsh Restoration Design	**David Heller** -- A Decade of Change: Implementation of an Aquatic Restoration Strategy for Federal Lands of the Pacific Northwest
4:00-4:15	**Jenneke Visser** -- A Conceptual Model to Predict Coastal Wetland Vegetation Composition and Production under Different Management Scenarios	**Joel Trexler** -- Moving from Retrospective to Prospective Monitoring: The Critical Role of Model Development in Designing Efficient Monitoring	**David Szymanski** -- Telling Stories: Using Narrative to Communicate Science	**Christian Langavin** -- Hydrodynamic Modeling Efforts of the U.S. Geological Survey in Support of Everglades Restoration	**Jason Goldberg** -- Coming Together for Conservation: The National Fish Habitat Initiative
4:15-4:30	**Lauren Hastings** -- Using Conceptual Models to Develop an Integrated Regional Restoration Plan: The Sacramento-San Joaquin Delta	**Charles Hall** -- Optimization of Water Quality Monitoring to Achieve Least-cost, Resource-based Objectives	**Piers Chapman** -- Innovative, Integrated Scientific and Technical Research Programs in the Central Gulf Region	**Aaron Byrd** -- Advances to the Model Gridded Surface Subsurface Hydrologic Analysis for Improved Ecosystem Modeling	**Glenn Covington** -- Missouri River Fish and Wildlife Mitigation, Past, Present and Future
4:30-4:45	**Kim Jacobs** -- Conceptual Ecological Models as Restoration Planning Tools for South Florida Restoration	**Tom Philippi** -- Multistage Sampling for Long-term Large-scale Multi-response Ecosystem Monitoring: CERP Trophic Monitoring as a Case Study	**Rhonda Reed** -- The Adaptive Management Forum: A Collaborative Review to Integrate Science and Policy	**Emad Habib** -- Uncertainty Analysis of Selected Hydrodynamic and Ecological Models in the Louisiana Coastal Area Ecosystem Restoration Plan	**Jennifer Macal** -- The Federal Symposium on Coastal Habitat Restoration (FSCHR) -- Initial Reactions and Next Steps
4:45-5:00	**Brenda Mills** -- Application of Conceptual Ecological Models to Everglades Restoration	**April Huffman --** Management Issues in Long-term Large-scale Multi-response Ecosystem Monitoring: Comprehensive Everglades Restoration Program	**David Nemazie** -- Lessons Learned in The Use of Community Based Stakeholders to Determine Strategies for Reducing Nutrient Loads to the Choptank River and Chesapeake Bay	*Discussion*	**Tom Pratt & Bill Cleckley** -- Floridan Aquifer Recharge Area Acquisition as a Means to Secure Water Supply, Restore Native Habitat and Provide Public Recreation
5:00-5:15	**Raymond Kurz** -- Feasibility Study for the Restoration of Oxbows and Wetlands Along the North Fork St. Lucie River, Florida.	**Laurence Fernberg --** Linking Restoration and Success at the Water's Edge	**Mitch Flinchum** -- Wetland Enhancement Decision-Making Tools & Training for Landowners and Technical Service Providers		
5:15-7:00	**POSTER SESSION I & RECEPTION IN POSTER & EXHIBIT DISPLAY AREA**				

WEDNESDAY 12/8/04					
7:30-8:30	MORNING REFRESHMENTS IN POSTER & EXHIBIT DISPLAY AREA				
	Plenary Session -- Adaptive Management *(The Great Hall)*				
8:30-8:40	Plenary Introduction -- Barry Cold, Moderator				
8:40-9:00	William Leary -- Adaptive Management as a National Priority in Ecosystem Restoration				
9:00-9:20	Stu Appelbaum -- Adaptive Management Success in Restoring the South Florida Ecosystem				
9:20-9:40	Denny Fenn -- An Overview of the Glen Canyon Adaptive Management Plan: An Experiment in Collaborative, Science-based Ecosystem Restoration				
9:40-10:00	A.J. McLeod -- Building Adaptive Capacity in the River Murray, Murray-Darling Basin, Australia				
10:00-10:20	**Discussion*				
10:20-10:40	BREAK IN POSTER & EXHIBIT DISPLAY AREA				
WEDNESDAY 12/8/04	CONCURRENT SESSIONS				
10:40-12:15	SESSION 1-Planning Restoration: Defining Success and Setting Objectives II	SESSION 2- Adaptive Management: Success Stories	SESSION 3- Effective Science Communication: Dueling Data	SESSION 4 -- Role of Modeling in Evaluating and Assessing Ecosystem Restoration	SESSION 5-Adaptive Management In Action
	Great Hall North	Great Hall Center	Great Hall West	Great Hall East	Cloister *(upper level)*
10:40-10:45	Session Introduction -- **Jack Manno, Moderator**	Session Introduction -- **Steve Light, Moderator**	Session Introduction -- **Lynette Cardoch, Moderator**	Session Introduction -- **Dave Apple, Moderator**	Session Introduction -- **Lisa Smith, Moderator**
10:45-11:00	**Dan Castleberry --** Ecosystem Restoration in California's Bay-Delta System: A Structured Approach in a Changing Environment	**Charles Simenstad** -- Promise and Follow-Through: Instituting Adaptive Management in Restoration of Puget Sound Nearshore Ecosystems	**Matt Harwell** -- How Do You Resolve Technical Disagreements in Ecosystem Restoration? Examples of Strategies From South Florida	**Donald DeAngelis** -- Synthesis of the Across Trophic Level System Simulation (ATLSS) Program: Design, Application, and Evaluation of an Modeling Project for Restoration	**S. Clayton Palmer --** Using "Surplus" Water to Meet Downstream Environmental Needs in Systems Constructed for Water and Power Benefits
11:00-11:15	**Howard Ernst --** The Political Life of Environmental Goals: Lessons from the Chesapeake Bay	**Kim Taylor** -- Reflecting On Fish Screens: Using Modern Concepts of Organizational Learning to Examine Adaptive Management in CALFED	**Romuald Lipcius** -- Alternative Ecosystem States and the Likelihood of Restoration Success in Chesapeake Bay	**Quan Dong** -- Selection and Application of Ecological Models in Everglades Restoration	**Robert Martinson** -- Construction, Operation and Monitoring of a Delta Building Diversion Located in the Lower Mississippi River Active Delta Region at West Bay
11:15-11:30	**Antisa Webb** -- Lessons Learned from Assessing Ecosystem Restoration Studies Across the Nation	**Richard Batiuk** -- Forget All the Adaptive Management Theory: A Behind the Scenes Look at Science Synthesis for Management Application in Practice	**Mary Doyle** -- Everglades Restoration and Saving the Chesapeake Bay: Comparisons in the Management of Ecosystem Restoration Projects	**Scott Duke-Sylvester** -- Linking ATLSS models with SFWMM hydrology: the ATLSS High Resolution MultiDataset Topography (HMDT)	**Richard Lathrop** -- Restoration of a Wisconsin Seepage Lake by Hypolimnetic Withdrawal
11:30-11:45	**Tim Beechie** -- Process-based Principles for Restoring Dynamic Ecosystems	**Bernice Smith** -- Habitat Conservation Plan Implementation: Keeping Promises for Adaptive Management	**Nancy Peterson** -- Building Consensus around Contention – Florida Natural Resource Leadership Institute	**Ehab Meselhe** -- Use of Hydrologic Numerical Modeling for Ecological Restoration and Management: the Chenier Plain, Louisiana	**Ronald Thom** -- Restoration in a Changing World: Addressing Natural Variability in Tidal Marsh and Seagrass Restoration Project Planning and Performance Assessment
11:45-12:00	**Steven Ritchie** -- The Restoration Planning Process for the South San Francisco Bay Salt Ponds – Opportunities and Challenges: Year 2 of a 5-Year Effort	**Noah Adams** -- Three Dams and Three Different Solutions to Restoring Salmon Populations	**Alfred Light** -- Risk Communication in Community Participation: CERCLA's Lessons for Everglades Restoration in South Florida	**Gary Shenk** -- Community Features of the Chesapeake Bay Program's Phase 5 Watershed Model	**J.D. Wikert** -- Short and Long-Term Salmonid Habitat Restoration in California's San Joaquin River Basin
12:00-12:15	**Lynne Trulio** -- Planning for Ecosystem Restoration: Science Integration for the South Bay Salt Pond Restoration Project	**Kennedy Paynter** -- Oyster Restoration in the Maryland Portion of Chesapeake Bay	**David Hallac** -- A Spatial and Temporal Comparison of Suitability Indices for use in Evaluating Hydrologic Restoration Alternatives for the Comprehensive Everglades Restoration Plan	**Kevin Coulton** -- The Use of Hydrodynamic Models for the Hydraulic and Geomorphic Design of Restoration Projects on the Skagit River, Washington State	**Clinton Hittle** -Using an Integrated Hydrologic Monitoring Network as a Tool to Analyze Everglades Ecosystem Response during CERP Implementation
12:15-1:30	LUNCH ON OWN				

WEDNESDAY 12/8/04	CONCURRENT SESSIONS				
1:30-3:20	**SESSION 1- Planning Restoration: Methods for Evaluation & Selection of Projects**	**SESSION 2- Adaptive Management: Framework for Learning**	**SESSION 3- Effective Science Communication: Integrating Technical Data**	**SESSION 4- Detecting Change: Species as Indicators of Change**	**SESSION 5-Science Synthesis and Scaling**
	Great Hall North	**Great Hall Center**	**Great Hall West**	**Great Hall East**	**Cloister *(upper level)***
1:30-1:35	Session Introduction -- **Robin Dingle, Moderator**	Session Introduction -- **Tom St. Clair, Moderator**	Session Introduction -- **Dan Hayes, Moderator**	Session Introduction -- **John Brawley, Moderator**	Session Introduction -- **Rob Daoust, Moderator**
1:35-1:50	**Lawrence Skaggs** -- Lessons Learned on Applying CE/ICA on the IRL-South Project	**Laura Stroup** -- "Getting the Structure Right": Adaptive Management for the Everglades Restoration	**Shawn Sculley** -- Real-Time Water Management Operations in South Florida: The Role of Science	**Peter Swart** -- Freshwater Signals in Coral Skeletons	**Paul DuBowy** -- Performance Measures, Ecosystem Benefits and Habitat Units: Evaluating Everglades Restoration Alternatives
1:50-2:05	**Sarah Watts** -- The Economics of Restoration: Using Cost-Effectiveness and Incremental Cost Analyses to Evaluate Restoration Alternatives on the Rahway River, New Jersey	**John Scholz** -- Adaptive Governance of Water Conflicts	**Douglas Henderson** -- Revolutionizing Interactive Access to Current Geospatial Data for Large-Scale Ecosystem Managers: An Example Using A Web Atlas	**Jean Sellar** -- Floristic Assessment As an Ecological Restoration Tool	**Kenneth Rice** -- The Role of the American Alligator in Measuring Ecosystem Change in the Everglades
2:05-2:20	**Joy Muncy** -- Cost Risk Assessment for Ecosystem Restoration Projects	**Karl McArthur** -- Adaptive Management: A Three Process Model Framework for Learning	**Suzan Hughes** -- Web Based Data Management: Collaborative Information Access for Environmental Projects	**Eric Milbrandt** -- Sediment Microbial Communities to Assess Restoration Success in Mangrove and Seagrass Habitats	**Donald Herndon** -- Comparing the Flooded-Area Frequency Distributions of Isolated Freshwater Wetlands: A Tool To Assess Wetland Health and Restoration Goals
2:20-2:35	**Mark Kessinger** -- Determining and Evaluating Costs and Benefits for an Ecosystem Restoration Project	**Jana Newman** -- Adaptive Management Applied to Treatment Wetlands Constructed to Remove Phosphorus from Agricultural Runoff in South Florida	**Laura Brandt** -- Assessing Effects of Everglades Restoration and Regional Water Management on the Arthur R. Marshall Loxahatchee National Wildlife Refuge	**Angelikie Zafiris** -- Tracking the Effects of Salt-Water Encroachment on South Florida Coastal Ecotones using Mollusks	**Monica Folk** -- Monitoring Landscape Response to Ecological Process Restoration at The Disney Wilderness Preserve in Central Florida
2:35-2:50	**Scott Miner** -- Formulation of a Multiple-Purpose Project for Hamilton City, California	**Christopher Updike** -- Is this Really Adaptive Management? A Comparative Review of "Adaptive Management" Programs across the USA and Canada	Emitt Witt **-- The National Map: Use of the Strategic On-Line Defense Geography Repository for Ecosystem Restoration**	**Gary Milano** -- Fish Assemblage and Vegetative Monitoring of Restored Mangrove Habitat in Southeast Florida	**David Gilliam** -- Coral Reef Ecosystem Restoration off Southeast Florida
2:50-3:05	**Grace Johns** -- Benefit-Cost Analysis to Develop the Lake Okeechobee Protection Plan	**Steve Light** -- NCER Best Practices for Adaptive Management: Discussion and Introduction to Best Practices Workshop.	**Andrew Warner** -- Getting Ecological Knowledge into Decision Making	**Don Schloesser** -- Restoration of Sentinel Mayfly Nymphs, *Hexagenia* spp., in the Great Lakes: Result of Pollution Abatement	*Discussion*
3:05-3:20	**Lewis Hornung** -- The Use of Multi-objective Cost Effectiveness Analyses in Planning for the Lake Okeechobee Watershed Project	*Discussion*	*Discussion*	**Rochelle Seitz** -- Success of Ecosystem Restoration in Estuarine and Coastal Subtidal Habitats: Benthic Abundance and Diversity in Natural and Degraded Shorelines of Chesapeake Bay	*Discussion*
3:20-3:30	**BREAK IN POSTER & EXHIBIT DISPLAY AREA**				
3:30-5:00	**Best Practices Workshop** -- *Steve Light,* Facilitator *(advance registration NOT required)* **Great Hall North**				
3:30-5:00	**AD HOC MEETINGS and INFORMAL NETWORKING -- POSTER & EXHIBIT HALL OPEN FOR VIEWING** ***(Check with the onsite Registration Staff if you want to organize a private meeting while at the conference. A limited number of meeting rooms are available on a first-come, first-served basis for this purpose.)***				

THURSDAY 12/9/04					
7:30-8:30	**MORNING REFRESHMENTS IN POSTER & EXHIBIT DISPLAY AREA**				
8:30-10:05	**CONCURRENT SESSIONS**				
	SESSION 1-Planning Restoration: Socio-Economic Considerations	**SESSION 2- Adaptive Management: Barriers and Limitations**	**SESSION 3 -- Science Synthesis: Restoration Science**	**SESSION 4- Detecting Change: System Level Monitoring to Detect Change,**	**SESSION 5- Planning Restoration: Urban Ecosystem Restoration**
	Great Hall North	**Great Hall Center**	**Great Hall West**	**Great Hall East**	**Cloister *(upper level)***
8:30-8:35	Session Introduction -- **Carlton Hunt, Moderator**	Session Introduction -- **Jim Vearil, Moderator**	Session Introduction -- **Julio Fanjul, Moderator**	Session Introduction -- **Naomi Duerr, Moderator**	Session Introduction -- **Joe Redican, Moderator**
8:35-8:50	**Gary Machlis** -- The Human Ecosystem as an Organizing Concept in Ecosystem Restoration	**Kent Loftin** -- Kissimmee River Restoration—Overcoming Barriers and Seizing Opportunities	**Walter Boynton** -- Multi-Decadal Efforts to Restore the Patuxent River Estuary: A Synthesis of Research, Monitoring and Management Activities	**George McCaskill** -- Monitoring and Evaluation of Ecosystem Restoration on Longleaf Pine Flatwoods of the Gulf Coastal Plain	**Deborah Roush** -- Urban Stormwater Management and Ecological Restoration Is Not An Oxymoron
8:50-9:05	**Fred Herling** -- Alternative Approaches to Managing Everglades National Park: Working Cooperatively on New Ways to Protect its Natural and Cultural Resources and Provide Quality Park Experiences	**Samuel Luoma** -- Linking the Science Needs of Restoration with Policy: Examples from the CALFED Bay-Delta Program	**Robert Deal** -- The Role of Red Alder in Developing Multi-functional Forests in Mixed Hardwood-Conifer Stands of Southeast Alaska	**John Stevely** -- A Historical Perspective for Determining Changes in the Distribution of Oyster Habitats in Southwest Florida Using Archived Maps and Charts of Federal Agencies	**Jason Kent** -- Streamlining the Environmental Permitting Process – A Case Study in Urban Stream Restoration in Anchorage, Alaska
9:05-9:20	**April Gromnicki** -- Real Estate Considerations Associated with Large-Scale Ecosystem Restoration Programs	**Tim Brown** -- Interagency Coordination – Managing Conflict	**Robin Lewis** -- Restoration of the Tampa Bay Ecosystem	**Christopher Bernhardt** -- Influence of 20th Century Water Management on Plant Communities in the Everglade's Marl Prairies	**Kara Salazar** -- The Lilly ARBOR Project: An Experiment in Urban Riparian Restoration
9:20-9:35	**William Coleman** -- Achieving Multiple Values from Ecosystem Restoration	**Kerri Bentkowski** -- Beyond the Checkbook: A Model for Grantmakers Supporting Ecosystem Restoration	**Mike Pellant** -- Great Basin Restoration Initiative: Integrating Science and Restoration at the Landscape Level	**Jeffrey Dismukes** -- Restoration of Mangrove Forests Impacted by Mosquito Ditching in the Tampa Bay Area	**Scott Stoddard** -- Buried Beneath Downtown: Daylighting Salt Lake City's City Creek
9:35-9:50	**Daniel Childers** -- The Importance of Socio-ecological Research Linkages in the Rehabilitation of Human-dominated Landscapes: Examples from the Florida Everglades	**Wayne Daltry** -- Lee County (Florida) Master Mitigation Plan	**Rey Stendell** -- The Salton Sea Ecosystem: The Role of Science in Restoration	**Keqi Zhang** -- Airborne Laser Mapping of Mangroves on the Biscayne Bay Coast, Miami, Florida	**John O'Meara** -- Urban Lake Restoration - The Return of Newburgh Lake
9:50-10:05	**Peter Leigh** -- The Ecological Challenge, the Human Condition, and Community Based Restoration as an Instrument for its Cure	**John Stevely** -- Long Term Evaluation of Sponge Population Recovery Following a Widespread Mortality: Will We Ever Know When Recovery Has Occurred? Is Restoration Necessary?	**Wm. Michael Turner** -- Green River - Reversing Three Decades of Ecological and Hydrological Impacts, Green River, Kentucky	**Nathan Dorn** -- Monitoring Crayfish Populations in the Everglades: Evaluation of Methods and Long-Term Trends	**John Meeder** -- Historic Freshwater Flow to Biscayne Bay, Florida and the Role of Transverse Glades
10:05-10:25	**BREAK IN POSTER& EXHIBIT DISPLAY AREA**				

THURSDAY 12/9/04	CONCURRENT SESSIONS				
10:25-12:15	**SESSION 1- Planning Restoration: Stakeholder Participation**	**SESSION 2- Adaptive Management: Risk and Uncertainty**	**SESSION 3 -- Science Synthesis: A Birdseye View of Ecosystem Restoration**	**SESSION 4- Detecting Change: Managing Change**	**SESSION 5- Restoring Urban Ecosystems-The Hudson-Raritan Estuary**
	Great Hall North	**Great Hall Center**	**Great Hall West**	**Great Hall East**	**Cloister *(upper level)***
10:25-10:30	Session Introduction -- **Chris Farrell, Moderator**	Session Introduction -- **Todd Hopkins, Moderator**	Session Introduction -- **Mark Musaus, Moderator**	Session Introduction -- **Susan Carsten, Moderator**	Session Introduction -- **Don Richardson, Moderator**
10:30-10:45	**Thomas Barthelmeh** -- Stream and Wetland Restoration in Delaware	**Stan Heller** -- Jackson Hole Restoration Project	**Lyle Maciejewski** -- Creation of an Atlantic Ocean Shore Bird Nesting Island	**Lance Jordan** -- Implications of Natural Variation of Fish Assemblages to Coral-Reef Management	**Roselle Henn** -- Restoring Urban Ecosystems; The Overview
10:45-11:00	**Stephen Williams** -- Stream and Wetland Restoration in Delaware - the Sequel	**Paul Kemp** -- Quantifying and Reducing Uncertainty in Wetland Restoration Forecasts for the Mississippi River Deltaic Plain: The CLEAR Program	**Wolf Mooij** -- Projecting Future Population Dynamics of the Florida Snail Kite in Relation to Hydrology	**Daniel Laughlin** -- Restoring Species Composition with Managed Wildfire in Old-growth Ponderosa Pine Forests	**Ronald Brattain** -- Plan Formulation and Urban Ecosystem Restoration: Issues and Approaches-Hudson-Raritan Estuary, New York, New Jersey
11:00-11:15	**Alicia Kirchner --** Hamilton City: Changing A System One Project at a Time	**Susan Sylvester** -- Dealing With Uncertainty in Realtime Water Management and Future Everglades Restoration Projects	**Gary Williams** -- Initial Responses of Wading Birds to Phase I of the Kissimmee River Restoration	**Douglas Henderson** -- New Monitoring Technology to Quantify Herbicide Efficacy on *Egeria densa*: Results from California Sacramento-San Joaquin Delta Sites	**Ronald Brattain** -- Plan Formulation and Urban Ecosystem Restoration: Issues and Approaches - Hudson-Raritan Estuary, Lower Passaic River, New Jersey
11:15-11:30	**Marc Woernle** -- Integrating Ecological Restoration in Conservation Design of Suburban Communities	**Peter Frederick --** If We Build it, Will They Come? Sources of Uncertainty in Predicting Wading Bird Responses to Everglades Restoration	**Isa Woo** -- The Field of Dreams Dilemma, "Will they stay?" Avian Response to Tidal Marsh Restorations in San Pablo Bay, CA	**Gilbert C. Sigua** -- Lake Dredging and Beyond: Implication to Agriculture and Environment	**Daniel Falt --** Hudson-Raritan Estuary, Hackensack Meadowlands, New Jersey Ecosystem Restoration Feasibility Study
11:30-11:45	**Joseph Makarewicz** -- Remediation and Restoration of Embayment, Rivers and Coastal Regions of New York's South Shore of Lake Ontario – the North Coast Initiative	**Tom Fontaine** -- Measuring Progress and Aquatic Restoration	**Dale Gawlik** -- A Synthesis of the Role of Wildlife Science in Wetland Ecosystem Restoration	**William Orem** -- Water Quality in Big Cypress National Preserve: Present Conditions and Potential Impacts of Restoration Plans	**Daniel Falt** -- Plan Formulation and Urban Ecosystem Restoration: Issues and Approaches - Hudson-Raritan Estuary, Gowanus Bay and Canal, Brooklyn, NY
11:45-12:00	**Lisa Beever --** Integrating Science and Planning with Policy in Southwest Florida	*Discussion*	*Discussion*	**Bruce Molnia** -- Understanding the Role of Natural Processes in Guiding Human Restoration Efforts	**Carl Alderson** and **John Brzorad** -- The Influence of Salt Marsh Restoration in an Oil Spill-Impacted Marsh on Shallow Water Fauna and Wading Birds in the Hudson-Raritan Estuary, Staten Island, New York
12:00-12:15	**Michael Bauer** -- The Restoration of Naples Bay			**John O'Meara** -- Rouge Oxbow Restoration Project: Reestablishing Habitat and Recreation on the River	
12:15-1:30	**BOXED LUNCH PROVIDED**				
1:30-5:00	**Plenary Session -- Ecosystem Assessment: Synthesis *(The Great Hall)***				
1:30-1:40	**Plenary Introduction -- Steve Gilbert, Moderator**				
1:40-2:10	**Richard Batiuk -- Assessing Chesapeake Bay Ecosystem Restoration Over Decadal Scales**				
2:10-2:40	**Matthew Harwell -- A Synthesis of Ecosystem Assessment in the Everglades**				
2:40-3:10	**Alan Steinman -- Ecosystem Restoration Needs for the Great Lakes Region: Detecting Change Across Different Spatial and Trophic Scales**				
3:10-3:30	**BREAK IN POSTER & EXHIBIT DISPLAY AREA**				
3:30-4:00	**Wim Kimmerer -- Assessing the CALFED Bay-Delta Ecosystem Restoration Program: Racing to Catch Up**				
4:00-4:30	**John Barko -- Ecosystem Assessment and Restoration in the Upper Mississippi River System (UMRS)**				
4:30-5:00	**Robert Twilley -- Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) Program**				
5:00-7:00	**POSTER SESSION II & RECEPTION in Poster & Exhibit Display Area**				

FRIDAY 12/10/04					
7:30-8:30	MORNING REFRESHMENTS IN POSTER & EXHIBIT DISPLAY AREA				
8:30-1:00	**Adaptive Management Workshop *(Knights Hall - Upper Level)***				
8:30-1:00	*(Participation in this Workshop is limited to those attendees who registered in advance.)*				
8:30-10:05	**CONCURRENT SESSIONS**				
8:30-10:05	**SESSION 1 - Science Synthesis: Restoration of Rivers and Channels**	**SESSION 2 - Science Synthesis: Impacts of Natural Phenomena and Human Activities on Ecosystem Restoration**	**SESSION 3 - Science Synthesis: Evaluation and Assessment of Aquatic Fauna**	**SESSION 4- Detecting Change: High Tech**	**SESSION 5 - Planning Restoration: Partnerships in Restoration**
	Great Hall North	**Great Hall Center**	**Great Hall West**	**Great Hall East**	**Cloister *(upper level)***
8:30-8:35	Session Introduction -- **David Vigh, Moderator**	Session Introduction -- **Reza Savabi, Moderator**	Session Introduction -- **Cecelia Linder, Moderator**	Session Introduction -- **Dave Jasinski, Moderator**	Session Introduction -- **John Burns, Moderator**
8:35-8:50	**Pam Latham** -- Using Vegetation to Establish Minimum Flows for the Alafia River in West Central Florida	**Thomas Cronin** -- Abrupt Climate Change: Implications for Coastal Ecosystem Restoration	**Aaron Adams** -- Developing an Ecological Context for Monitoring Restoration Effects on Fishes	**Sabine Grunwald** -- Spatially-Explicit Modeling of Soil Phosphorus Across the Greater Everglades	**Claire O'Neill** -- Restoration of Freshwater Tidal Wetlands in the Anacostia River, Washington, D.C.
8:50-9:05	**Rebecca Lave** -- Lessons Learned from Assessing River Restoration Projects in California	**Lewis Linker** -- Simulation of Chesapeake Bay Water Clarity and Submerged Aquatic Vegetation	**Pamela Bachman** -- Physiological Performance Measures and Tolerance Limits for Estuarine Indicator Species in South Florida	**Gregory Bruland** -- Statistical and Geostatistical Analyses of Soils Data from Water Conservation Area 3	**Steven Pugh** -- Monitoring and Adaptive Management of Restored Freshwater Tidal Wetlands in the Anacostia River, Washington, D.C.
9:05-9:20	**Ehab Meselhe** -- Hydro-Ecological Modeling of the Lower Mississippi River	**David Rudnick** -- Evaluating the Biogeochemical Effects of Everglades and Florida Bay Restoration	**Andrew Goodwin** -- Coupling 3-D Computational Fluid Dynamics, Water Quality, and Individual-based Models to Decode and Forecast 3-D Use of Aquatic Habitat by Highly Mobile Species	**Shimon Wdowinski** -- Space-based hydrology of the Everglades Wetland	**Robert Boone** -- Partnerships in Planting Seeds of Hope
9:20-9:35	**Stephen J. Miller** -- Integrating Environmental Water Management and Flood Control in Florida's Upper St. Johns River Basin	**Evelyn Gaiser** -- Cascading Ecological Effects of Low-Level Phosphorus Enrichment and Abatement in the Florida Everglades	**Lori Valentine** -- Effects of Estuary Fragmentation and Restoration on Fish Assemblage Characteristics and Secondary Production on Andros Island, The Bahamas	**G. Lynn Wingard** -- Natural Variability versus Anthropogenic Change: A Case Study in Biscayne Bay Florida	**Peter Hill** -- Wild Goose Chase or Addressing the Stressors to Tidal Wetland Restoration Efforts? Developing a Resident Goose Management Plan in a Multi-agency Situation
9:35-9:50	**Michael Pollock** -- Restoration of Incised Streams in the Semi-arid Regions of the Columbia River Basin, USA	**James Jawitz** -- Internal Loads in the Eutrophic Northern Everglades: Large-scale Modeling of Phosphorus Transport	**David Penrose** -- Ecological Functions of Restored Streams using Benthic Macroinvertebrates as Indicators	**Peter Swarzenski** -- Submarine Groundwater Discharge - Its Role in Coastal Processes and as a Potential New Proxy for Ecosystem Restoration	**Hamid Karimi** -- Planning for the Restoration of Highly Degraded Habitat in an Ultra Urban Setting
9:50-10:05	**Michael Schwar** -- Quantifying Hydrologic Restoration Effectiveness in the Illinois River Basin	**Ronald Corstanje** -- Modeling Biotic and Abiotic Interactions under Different Eutrophic Conditions in Subtropical Marsh Systems	*Discussion*	**Arnold van der Valk** -- Creation and Restoration of Tree Islands in The Everglades	**Richard E. Walesky** -- Environmental Restoration of Munyon Island
10:05-10:25	BREAK IN POSTER & EXHIBIT DISPLAY AREA				

FRIDAY 12/10/04	CONCURRENT SESSIONS				
10:25-12:15	**SESSION 1 -- Science Synthesis - Wetland Restoration**	**SESSION 2 -- Greater Everglades Ecosystem Restoration Science**	**SESSION 3 -- Comprehensive Approach to Restoration**	**SESSION 4- Detecting Change: Evaluating Riverine Response to Known Change**	**SESSION 5-Coastal Restoration Science**
	Great Hall North	**Great Hall Center**	**Great Hall West**	**Great Hall East**	**Cloister *(upper level)***
10:25-10:30	Session Introduction -- **Tim Bechtel, Moderator**	Session Introduction -- **Loren Mason, Moderator**	Session Introduction -- **Pervaze Sheikh, Moderator**	Session Introduction -- **Shawn Sculley, Moderator**	Session Introduction -- **Margaret McBride, Moderator**
10:30-10:45	**John Wang --** A Coupled Surface- and Ground-Water Model of the Everglades System for Predicting Flows to the Coast under Existing Conditions and CERP Scenarios.	**Charles Holmes** -- The Effects of Ecological Changes in South Florida: Are These Problems for Restoration?	**Cheryl Buckingham** -- Performance Measures: Integrating Knowledge about Restoration Success	**Teferi Tsegaye** -- Biological Quality of Stream Water in Response to Land Use Practices	**Gary Milano** -- Coastal Habitat Restoration and Science-Based Monitoring Efforts in Southeast Florida
10:45-11:00	**Christa Zweig** -- Tracking and Predicting Vegetation Response to Hydrologic Alternatives across an Everglades Landscape using Artificial Neural Networks	**Krish Jayachandran** -- Development of Strategies to Manage Biological Invasion by Exotic Plant Species in Everglades National Park	**Richard Schroeder** -- Setting Objectives for Ecosystem Restoration: An Examination of National Wildlife Refuge Comprehensive Conservation Plans	**David Colangelo** -- Restoration of the Kissimmee River: Response of River Metabolism	**Angie Ashley** -- Using Community-based and Science-based Methods to Improve Tidal Marsh Restoration in the Chesapeake Bay
11:00-11:15	**Stephen Ailstock --** Helicopter Application of Herbicides to Restore Wetland Biodiversity in Highly Sensitive Areas	**Joel Trexler --** Extinction, Recolonization and Metacommunity Structure in Everglades Wetlands: Spatial Dynamics of Aquatic Communities Driven by Recurrent Disturbance	**Gary Raulerson** -- The (Continuing) Restoration of Sarasota Bay: A Comprehensive Approach	**Steve Bousquin --** Responses of Littoral Vegetation to Restored Flow in the Kissimmee River	**Peter Bergstrom --** Restoration of Aquatic Grass Communities of Chesapeake Bay: How Should We Proceed?
11:15-11:30	**Matthew Cohen** -- Development of a Systems Model to Explore Long Term Ridge-Slough Dynamics	**Jennifer Rehage** -- Impact of Anthropogenic Disturbance on Wetland Communities: Changes in Patterns of Fish and Macroinvertebrate Density as a Function of Distance from Canals	**D. Scott Taylor --** Removing the Sands (sins?) of our Past: Dredge-spoil and Saltmarsh Restoration along the Indian River Lagoon, Florida	**Gregory Steyer --** Response of the Louisiana Deltaic Landscape to Riverine Reintroduction	**Joan Browder --** Epifaunal Distributions and Relationships with Salinity in Western Nearshore South Biscayne Bay
11:30-11:45	**Debra Willard** -- Impacts of Land-Cover and Hydrologic Change on Vegetation of the South Florida Coast	**Brigitte Vlaswinkel** -- Wetland and Tidal Channel Evolution Affecting Critical Habitats at Cape Sable, Everglades National Park, Florida	**Michael Renda** -- Comparing Wildlife Utilization in Natural, Restored and Disturbed Coastal Strand Vegetation	**David Anderson** -- Ranking and Integrating Restoration Expectations for the Kissimmee River, Florida	**Maria M. Criales** -- Modeling Connections between Life Stages of Pink Shrimp in South Florida
11:45-12:00	**Earl McCoy** -- The Influence of Habitat Structure on the Vertebrates of Reclaimed Phosphate Mines in Central Florida	**David Reed** -- Seed Germination and Growth of Four Wetland Tree Species in Response to Environmental Factors in Tree Islands of Northern Shark Slough, Everglades National Park	**Phil Roni** -- Watershed and Habitat Rehabilitation for Fishes: A World Review of Effectiveness of Habitat Restoration Techniques	**Carol Kendall** -- Tracing Sources of Organic Matter and Nitrate in the San Francisco Bay-Delta-River Ecosystem using Isotopic Techniques	**Frank Marshall** -- Effect of Time Scale on Patterns and Processes of Salinity Variation in Florida Bay
12:00-12:15				**Timothy Fobes** -- Side Channel Restoration on the Lower Missouri River and Examples in Adaptive Management	**Frank Marshall** -- Status of Statistical Modeling of Salinity in Florida Bay, Southern Biscayne Bay, and the Southwest Gulf Coast
12:15	**CONFERENCE CONCLUDES**				

Poster Directory of Presenting Authors

Session 1 – Tuesday, December 7, 2004

- On display from 5pm Sunday through 7pm Tuesday, with a formal poster session and reception on Tuesday from 5pm-7pm.

Restoration of Riverine Wetlands: A Long Term Case Study on the Flint River, Georgia – ***Bart Baca***, CSA South. Inc., Wetlands, Dania Beach, FL

Ecological Benefit and Impact Analyses of Alternative Plans for the North Palm Beach Comprehensive Everglades Restoration Project: A Procedural Approach for Restoration Planning – ***Pinar Balci***, Ecology and Environment Inc., West Palm Beach, FL

Detecting Trends in Water Temperatures in the Lower Klamath River, California – ***John Bartholow***, US Geological Survey, Fort Collins Science Center, Fort Collins, CO

Quantifying the Effect of Dam Removal on Water Temperatures in the Lower Klamath River, California, and Implications for Salmon Recovery – ***John Bartholow***, US Geological Survey, Fort Collins Science Center, Fort Collins, CO

Southwest Florida Coastal Conservation Corridor Plan – ***James Beever***, Florida Fish and Wildlife Conservation Commission, Habitat Conservation Scientific Services, Punta Gorda, FL

Jamaica Bay Marsh Island Ecosystem Restoration - Pilot Program Study – ***Brett Berkley***, MATRIX Environmental & Geotechnical Services, Inc., Ecological Services, East Hanover, NJ

Putting Fish Back Into Fish Creek: Creek Restoration in Urban Anchorage – ***Daniel Billman***, HDR, Engineering, Anchorage, AL

An Agency Approach to Watershed Enhancement: Learning from the Past and Planning for the Future – ***James Borawa***, N.C. Wildlife Resources Commission, Division of Inland Fisheries, Asheville, NC

New Technology for Restoration of Sediment-Impacted Streams – ***David Braatz***, Streamside Systems, LLC, Findlay, OH

Synthesis of Land Use Data for the Chesapeake Bay Watershed – ***Sara Brandt***, Chesapeake Research Consortium, Chesapeake Bay Program Office, Annapolis, MD

A Study of Minimum Flows and Levels (MFLs) With Regard to Water Quality Protection and Restoration in the St. Johns River Water Management District – ***John Brawley***, Battelle, Coastal Resource and Environmental Management, Duxbury, MA

Session 1 – Tuesday, December 7, 2004 (continued)

- On display from 5pm Sunday through 7pm Tuesday, with a formal poster session and reception on Tuesday from 5pm-7pm.

Evaluation of Everglades Agricultural Area Storage Reservoirs Using Regional Modeling – ***Lehar Brion***, South Florida Water Management District, Office of Modeling, West Palm Beach, FL

Application of a Decision Support System Model for Drought Management Analysis in a Western River System – ***Sharon G. Campbell***, US Geological Survey, Fort Collins Science Center, Fort Collins, CO

Sheldon Marsh Environmental Restoration (Section 227) Project – ***Shanon Chader***, US Army Corps of Engineers, Buffalo District, Buffalo, NY

Application of SeaWiFS and MODIS Imagery in Monitoring Water Quality of Chesapeake Bay – ***Zhiqiang Chen***, University of South Florida, College of Marine Science, St. Petersburg, FL

Assessing Urban Land Cover Change in the Chesapeake Bay Watershed (1990 - 2000) – ***Peter Claggett***, US Geological Survey, Chesapeake Bay Program Office, Annapolis, MD

"Fine Tuning Everglades Restoration": The Loxahatchee Impoundment Landscape Assessment (LILA) Project – ***Eric Cline***, Iowa State University, Botany, West Palm Beach, FL and South Florida Water Management District

Using Historic Photography as a Resource for Ecological Restoration of the Florida Everglades: the 1940s Photoset and Geodatabase Development – ***Alisa Coffin***, US Geological Survey, FISC, Gainesville, FL

Towards a Healthy Steelhead Population with Watershed Restoration in Washington's Wind River – ***Patrick Connolly***, US Geological Survey, Columbia River Research Laboratory, Cook, WA

Structural vs. Functional Measures in Restoration Projects – ***Ryan C. Davis***, Exponent, Albany, NY

Planning for Mixed Seeding Restoration on Xeric Uplands in Florida – ***Linda Duever***, Conway Conservation, Micanopy, FL

Aiding Rio Grande Restoration by Using Stable Isotope Analyses to Characterizing the Past and Present Condition of the River Food Web – ***Melanie S. Edwards***, University of New Mexico, Department of Biology, Albuquerque, NM

Prioritizing Flood Protection while Restoring Ecological Function in Urban Rivers – ***Theodore Endreny***, SUNY ESF, Ecological Engineering, Syracuse, NY

Session 1 – Tuesday, December 7, 2004 (continued)

- On display from 5pm Sunday through 7pm Tuesday, with a formal poster session and reception on Tuesday from 5pm-7pm.

Enhancing Restoration Through Conservation -- Using the Chesapeake Bay Watershed Resource Lands Assessment to Prioritize Land Protection – *Andrew Fitch*, University of Maryland Center for Environmental Science, Chesapeake Bay Program, Annapolis, MD

Wetland Enhancement Decision-Making Tools & Training for Landowners and Technical Service Providers – *Mitch Flinchum*, University of Florida/IFAS, IFAS Everglades Research and Education Center, Belle Glade, FL

Restoration of Western River Ecosystems: Reality or Rigormortis? – *Marshall Flug*, US Geological Survey, DOI/BRD, Fort Collins, CO

Spatial and Temporal Changes in the Vegetation Community Structure Along the Harney River, Florida – *Ann Foster*, US Geological Survey, FISC, Gainesville, FL

Vic Fazio Yolo Wildlife Area: A Lessons Learned Overview of the Largest Wetland Ecosystem Restoration Project in the Western United States – *Miki Fujitsubo*, US Army Corps of Engineers, Planning Division, Sacramento, CA

Oak Scrub Restoration at Hilochee Wildlife Management Area: A Preliminary Assessment – *Cyndi Gates*, Florida Fish and Wildlife Conservation Commission, Terrestrial Habitat Conservation and Restoration, Clermont, FL

Conceptual Restoration Designs of Riparian Habitat in the Lower Cuyahoga River, Ohio, for Larval Fish – *Michael Greer*, US Army Corps of Engineers, Buffalo District, Buffalo, NY

Wetland and Wildlife Habitat Creation at Opportunity Ponds – *Grant Gurnee*, Walsh Environmental, Ecological Restoration Group, Boulder, CO

The Impact and Recovery of Ice Roads and Ice Pads on Tundra Ecosystems, National Petroleum Reserve, Alaska (NPR-A) – *Scott Guyer*, Bureau of Land Management, Alaska State Office, Anchorage, Alaksa

Illinois River Basin Ecosystem Restoration – *Karen Hagerty*, US Army Corps of Engineers, Rock Island District, Economic & Environmental Analysis Branch, Rock Island, IL

Ecosystem Restoration in the Upper Chariton River/Rathbun Lake Watershed – *Valerie Hansen*, US Army Corps of Engineers, Kansas City District, Kansas City, MO

Restoring the Resacas of the Rio Grande River: Water Quality, Hydrology, and Biodiversity – *Jim Henderson*, US Army Corps of Engineers, Engineer Research and Development Ctr., Vicksburg, MS

Session 1 – Tuesday, December 7, 2004 (continued)

- On display from 5pm Sunday through 7pm Tuesday, with a formal poster session and reception on Tuesday from 5pm-7pm.

The South Florida Information Access (SOFIA) System – *Heather Henkel*, US Geological Survey, Center for Coastal and Watershed Studies, St. Petersburg, FL

Segmentation and Land Use in the Phase 5 Chesapeake Bay Watershed Model – *Kate Hopkins*, UMCES/CBPO, Modeling Team, Annapolis, MD

Integrating Environmental Decision Making into a Framework for Farm Policy – *Glenda Humiston*, University of California, Berkeley, Society and Environment, Richmond, CA

Riparian and Wetland Restoration Projects in the US Army Corps of Engineers Albuquerque District – *Ondrea Hummel*, US Army Corps of Engineers, Environmental Resources Section, Albuquerque, NM

Section 206: Aquatic Ecosystem Restoration of Big Escambia Creek, Alabama and Florida – *Jenny Jacobson*, US Army Corps of Engineers, Planning & Environmental Division, Mobile, AL

Monitoring Evaluation of North Carolina Stream Restoration Projects – *Greg Jennings*, North Carolina State University, Biological & Agricultural Engineering, Raleigh, NC

Riparian Forest Restoration Project – *Rachel Jolley*, School of Forestry & WLSC, Auburn University, Auburn, AL

A Multidisciplinary Assessment of the Effect of the Restoration of a More Natural Hydrologic Regime on the Large Lakes of Voyageurs National Park, Minnesota – *Larry Kallemeyn*, US Geological Survey, Biological Division, International Falls, MN

Cargill's Adaptive Management Approach to Restoration – *Parker Keen*, Cargill Crop Nutrition, Land Management, Riverview, FL

Redefining the San Antonio Channel Improvement Project to Include Environmental Restoration – *Charissa Kelly*, US Army Corps of Engineers, Planning, Environmental, Regulatory Branch, Fort Worth, TX

Green River Lake, KY – Modifying Reservoir Regulation and Operation – *Richard Kessler*, The Nature Conservancy, Kentucky Chapter, Campbellsville, KY

Preliminary Hydrodynamic Modeling of Capitol Lake and the Deschutes River Estuary to Support Restoration Feasibility Assessment – *Tarang Khangaonkar*, Battelle Seattle Research Center, Water Resources, Seattle, WA

Enhancing the Quantification of Fish and Wildlife Habitat Gains in the Great Lakes' Areas of Concern Through the Broader Use of Habitat Evaluation Procedures – *Bruce Kirschner*, International Joint Commission, Great Lakes Regional Office, Windsor, Ontario

Session 1 – Tuesday, December 7, 2004 (continued)

- On display from 5pm Sunday through 7pm Tuesday, with a formal poster session and reception on Tuesday from 5pm-7pm.

Visual_HEA: Habitat Equivalency Analysis Software – *Kevin Kohler*, NSU Oceanographic Center, National Coral Reef Institute, Dania Beach, FL

The Feasibility of Marsh Restoration and Connectivity in the New Jersey Hackensack Meadowlands – *Mark Laska*, Great Eastern Ecology, Inc., New York, NY

Restoration Program Assessment for the National Estuarine Research Reserve System (NERRS) – *Mark Laska*, Great Eastern Ecology, Inc., New York, NY

Restoring Tidal Influences to a Historically Impounded System in Westchester County, **New York – *Mark Laska***, Great Eastern Ecology, Inc., New York, NY

Designing for Ecology and Community: Restoring the Neglected Spaces Enmeshed in Florida's Urban Sprawl – *Dianne Lennon*, Restoration Partners, Inc., Environmental Planning and Design, Jupiter, FL

Urban Watershed Restoration in the Lower Bronx River, **New York: Unique Challenges**, **Partnerships**, **and Technologies – *Cecelia Linder***, NOAA, Restoration Center, Silver Spring, MD

Current Loxahatchee Watershed Restoration Activities - Martin County, **Florida – *Kimball Love***, Martin County, Office of Water Quality, Stuart, FL

The NOAA Community-based Habitat Restoration Program: Partnerships for Success – *Daphne Macfarlan*, NOAA Fisheries, Restoration Center, St. Petersburg, FL

Hydrologic Restoration on Florida's Gulf Coast: An Examination of the Process – *Daphne Macfarlan*, NOAA Fisheries, Restoration Center, St. Petersburg, FL

Effective Communication of Scientific Information: A Case Study in Adaptive Management – *Jana Machula*, California Bay Delta Authority, CALFED Science Program, Sacramento, CA

Community Partnering and Educational Outreach Have Made Ten Mile Creek More Than Just A Restoration – *Doris Marlin*, US Army Corps of Engineers, DP-I, Jacksonville, FL

Population Decline of the Federally Endangered Snail Kite in Florida – *Julien Martin*, University of Florida, Florida Cooperative Fish and Wildlife Research Unit, Gainesville, FL

Restoration of Sod Pastures to Native Vegetation at The Disney Wilderness Preserve – *Chris Matson*, The Nature Conservancy, The Disney Wilderness Preserve, Kissimmee, FL

FIU-Singeltary Restoration Project – *John Meeder*, Florida International University, Southeast Environmental Research Center, Miami, FL

Session 1 – Tuesday, December 7, 2004 (continued)

- On display from 5pm Sunday through 7pm Tuesday, with a formal poster session and reception on Tuesday from 5pm-7pm.

Setting Interim Goals and Interim Targets for the Comprehensive Everglades Restoration Plan – ***Carol Mitchell***, Everglades National Park, South Florida Ecosystem Office, Homestead, FL

Economic Impact Survey of Eurasian Watermilfoil Removal from Houghton Lake – ***Mark Mongin***, SePRO, Aquatic Specialty Business, Carmel, IN

Wildlife Utilization of Phosphate Mined Lands – ***Robin Moore***, University of South Florida, Tampa, FL

Cat Island Chain Restoration, **Green Bay –** ***Rob Nairn***, Baird & Associates, Oakville, Ontario

Restoration of Longleaf Pine Sandhill and Flatwoods in a City Park in North-Central Florida: A Progress Report – ***Geoffrey Parks***, City of Gainesville, Nature Operations Division, Gainesville, FL

Decision Models and Directions for the South West Florida Feasibility Study – ***Leonard Pearlstine***, University of Florida, Ft Lauderdale Research & Education Center, Davie, FL

Integrating Urban Growth Models and Habitat Models for Ecological Evaluation of Landscape Impacts – ***Leonard Pearlstine***, University of Florida, Ft Lauderdale Research and Education Center, Davie, FL

The Biscayne Bay Coastal Wetlands Project: Planning the Restoration of a South Florida Estuary – ***Patrick Pitts***, US Fish and Wildlife Service, South Florida Ecological Services Office, Vero Beach, FL

The Use of Community Metrics and Health Indices to Monitor the Health of Restored Ecosystems and the Use of Adaptive Management Strategies to Promote Future Success – ***John Roebig***, Lawler Matusky & Skelly Engineers LLP, New York, NY

Federal Policy Issues in Large-Scale Ecosystem Restoration Initiatives – ***Pervaze Sheikh***, Congressional Research Service, Resources, Science, and Industry Division, Washington, DC

Development of a Conceptual Model for the Potomac Watershed – ***Stacey Sloan-Blersch***, US Army Corps of Engineers, Baltimore District, Baltimore, MD

Managing Lake Shorelines: How Do We Put It All Back Together? (Restoration of Aquatic Vegetation in Lakes and Reservoirs) – ***Michael Smart***, US Army Corps of Engineers, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX

Primary Dune Species of Barrier Islands (e.g. ***Amaranthus pumilus*****) and the Impact of Increasing Episodic**, **Extreme Stress Events Linked to Global Change –** ***Allison G. Snow***, Wake Forest University, Department of Biology, Winston-Salem, NC

<u>Session 1 – Tuesday, December 7, 2004</u> (continued)

- On display from 5pm Sunday through 7pm Tuesday, with a formal poster session and reception on Tuesday from 5pm-7pm.

Establishment of Poplar Island: A Large Marsh Restoration Project in Chesapeake Bay – ***Court Stevenson***, University of Maryland, Center of Environmental Science, Horn Point Laboratory, Cambridge, MD

Partnering for Success in Submerged Aquatic Vegetation Research, Restoration, and Education in the Chesapeake Bay Watershed – ***Rebecca Thur***, Chesapeake Research Consortium, Freshwater SAV Partnership, Edgewater, MD

Confronting Social Impediments to Adaptive Management, Lessons from the Grand Canyon Ecosystem – ***Christopher Updike***, Northern Arizona University, Center for Sustainable Environments, Flagstaff, AZ

From Design to Maintenance: Case Studies in Adaptive Management for Restoration Success – ***Ron Van Fleet***, Sarasota County, Public Works/Permitting, Mitigation and Restoration, Sarasota, FL

Recharging the Edwards - Cibolo Creek, Texas, Watershed Study – ***Marie Vanderpool***, US Army Corps of Engineers, Fort Worth District, Hydrology and Hydraulics, Fort Worth, TX

National Ecosystem Center of Expertise (ECO-CX) – ***David Vigh***, US Army Corps of Engineers, Mississippi Valley Division, Vicksburg, MS

A Multi-Criteria, GIS Tool for Evaluation of Impacts to Fish and Wildlife When Planning Large Ecosystem Restoration Projects – ***Les Vilchek***, US Fish and Wildlife Service, Ecological Services, Vero Beach, FL

Bird Island Field Pipeline Removal – Kleberg County, Texas – ***Catherine R. Villarreal***, Shiner Moseley and Associates, Inc., Corpus Christi, TX

New Ecosystem Modeling Service Suite for Regional Ecosystem Restoration – ***Dali Wang***, The Institute for Environmental Modeling, University of Tennessee, Knoxville, TN

EXHEP: Expert Habitat Evaluation Procedures (HEP) Software – ***Antisa Webb***, US Army Corps of Engineers, Engineer Research Development Center, Environmental Lab, Vicksburg, MS

Setting a New SAV Restoration Goal for the Chesapeake Bay by Analyzing the Historical Record – ***Howard Weinberg***, University of Maryland Center for Environmental Science, Chesapeake Bay Program, Annapolis, MD

Planning, Design, and Construction of a Tidal Wetland Restoration Project In a Highly Urbanized Estuary, Woodbridge, NJ – ***Craig A. Woolcott***, National Oceanic Atmospheric Administration (NOAA)/National Marine Fisheries Service (NMFS), NOAA Restoration Center, Highlands, NJ

Session 1 – Tuesday, December 7, 2004 (continued)

- On display from 5pm Sunday through 7pm Tuesday, with a formal poster session and reception on Tuesday from 5pm-7pm.

The Proposed Panama City – Bay County International Airport Relocation: Wetland Permitting and Mitigation Aspects – ***Scott Zengel***, PBS&J, North Florida Environmental Services, Tallahassee, FL

Session 2 – Thursday, December 9, 2004

- On display from 7am Wednesday through 12noon Friday, with a formal poster session and reception on Thursday from 5pm-7pm.

Enhanced Monitored Natural Attenuation (MNA): Innovative Remedial Strategy for Sustainable Ecosystem Restoration? – *Marshall Allen*, Florida International University, Hemispheric Center for Environmental Technology, Miami, FL

The US Geological Survey Integrated Hydrologic Monitoring of the Florida's Southwest Coast and Florida Bay: Importance to CERP Monitoring and Assessment Plan Performance Measures – *Gordon Anderson*, US Geological Survey, FISC-WRS, Homestead, FL

Monitoring the Hydrodynamics of the Everglades Mangrove Transitional Zone: Getting the Water Right at the Ecological Ecotone – *Gordon Anderson*, US Geological Survey, FISC-WRS, Homestead, FL

Pilot Study to Quantify Floodplain Soil Phosphorus in the Kissimmee River Restoration Area – *Carmen Baez-Smith*, South Florida Water Management District, Kissimmee Division, West Palm Beach, FL

Assessing the Effect of Hydrophilic Soil Amendments on Riparian Plant Growth and Survival in Western Texas – *Pamela Bailey*, US Army Corps of Engineers, Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS

Use of an Amphibian IBI to Evaluate Success of Constructed Wetlands – *Joe Bartoszek*, Ohio EPA, DSW/WQ, Dayton, OH

Mercury in Mosquitofish: Assessing the Influences of Bioaccumulation and Bioavailability – *Bryan Bemis*, US Geological Survey, Water Resources, Menlo Park, CA

Biscayne Bay Hydrodynamic Data Collection – *Lee Anne Bledsoe*, Biscayne National Park, Resource Managment, Homestead, FL

A Formidable Challenge to Everglades Restoration – Controlling Old World Climbing Fern – *Laura Brandt*, US Fish and Wildlife Service, Senior Wildlife Biologist for A.R.M. Loxahatchee NWR, Boynton Beach, FL

GIS Data Development of Fire History for Everglades National Park from 1948 to 1979 – *Kristy Capobianco*, US Geological Survey, FISC, Gainesville, FL

A Summary of Baseline Vegetation Data for Phase I of the Kissimmee River Restoration Project and Expectations for Wetland Vegetation Recovery in the Restored System – *Laura Carnal*, South Florida Water Management District, Kissimmee Division, West Palm Beach, FL

Management Recommendations for Exotic and Nuisance Plant Species Control in a Disturbed Maritime Hammock Community – *Michelle Carte*, Florida Institute of Technology, Marine and Environmental Systems, Jacksonville, FL

Session 2 – Thursday, December 9, 2004 (continued)

- On display from 7am Wednesday through 12noon Friday, with a formal poster session and reception on Thursday from 5pm-7pm.

Adapting Restoration to Disturbance: Wildfire Impacts on Wetland and Upland Restoration and Invasive Exotic Control – ***Mary Kay Cassani***, Florida Gulf Coast University, College of Arts and Sciences, Ft. Myers, FL

The Roles of American Alligators and American Crocodiles as Indicators of Environmental Change – ***Michael Cherkiss***, University of Florida, FLREC, Davie, FL

A Biological Control Agent for Invasive Plant Species, Old World Climbing Fern ***(Lygodium microphyllum)*** **–** ***Tainya Clarke***, Florida International University, Environmental Studies, Miami, FL

Verification of ATLSS SESI Models Using Species Abundance Data – ***Jane Comiskey***, The Institute for Environmental Modeling, Dept. of Ecology and Evolutionary Biology, Knoxville, TN

Pyrite Oxidation in Dredged Estuarine Sediments: Challenges for Beneficial Use – ***Jeffrey Cornwell***, University of Maryland Center for Environmental Science, Horn Point Laboratory, Cambridge, MD

Conceptual Model for an Ecologically Based Management Plan for Brazilian Peppertree, ***Schinus terebinthifolius*****, in Florida –** ***James Cuda***, University of Florida/IFAS, Entomology & Nematology, Gainesville, FL

The Impact of Stream Nutrient Loading on Filamentous Green Algae in Conesus Lake and the Use of Continuous Flow-Through Incubation Chambers for Measurement ***In Situ*** **of Changes in Biomass –** ***Peter D'Aiuto***, SUNY Brockport, Environmental Science and Biology, Altamonte Springs, FL

The Potential Utility of Apple Snail Egg Clusters in the Context of Ecological Performance Measures – ***Philip Darby***, University of West Florida, Biology, Pensacola, FL

Specific Conductance in the Everglades Agricultural Area – ***Samira Daroub***, University of Florida, Everglades Research and Education Center, Belle Glade, FL

The Results of Monitoring Hard Corals Restored after the Installation of Telecommunication Cables off South Florida – ***Donald Deis***, PBS&J, Environmental, Jacksonville, FL

Transport of Dissolved and Particulate Phosphorus in Canal Waters Downstream of STA-1W – ***Orlando Diaz***, University of Florida, Everglades Research and Education Center, Belle Glade, FL

Effect of Scaling on Hydraulic Conductivity in a Karst Aquifer – ***Vincent J. DiFrenna***, Florida International University, Earth Sciences, Miami, FL

Session 2 – Thursday, December 9, 2004 (continued)

- On display from 7am Wednesday through 12noon Friday, with a formal poster session and reception on Thursday from 5pm-7pm.

The Response of Below and Aboveground Biomass of *Typha* to Harvesting: A Modelling Approach – *Hai Dinh Ngoc*, Saitama university, Department of Environmental Science and Human Engineering, Saitama, Saitama

Chlorophyll *a* as an Indicator of Eutrophication in the Caloosahatchee Estuary and San Carlos Bay, **Florida – *Peter Doering***, South Florida Water Management District, Coastal Ecosystems Division, West Palm Beach, FL

Phosphorus Release and Retention by Soils of Natural Isolated Wetlands in Okeechobee Basin, **Florida – *Ed Dunne***, University of Florida, Wetland Biogeochemistry Laboratory, Gainesville, FL

Fish Assemblages as an Indicator of Biological Function in Aquatic Systems Restored after Phosphate Mining – *Douglas Durbin*, Biological Research Associates, Water Resources, Tampa, FL

Mercury Bioaccumulation Responses to Everglades Restoration – *David Evans*, NOAA, Center for Coastal Fisheries and Habitat Research, Beaufort, NC

Submergence and Salinity Effects on Decomposition of Wetland Plants; Exotic: Purple Loosestrife - *Lythrum salicaria* versus Native: Cattail - *Typha* sp. – *Laurence Fernberg*, Malcolm Pirnie, Inc., Ecorestoration, White Plains, NY

Periphyton Stormwater Treatment Areas: Results of Increased Velocity and Increased Water Depths on Phosphorus Removal Efficiency – *Erin Fogarty-Kellis*, South Florida Water Management District, Everglades, West Palm Beach, FL

The Use of Otolith Microchemistry to Monitor and Evaluate the Movement of Coral Reef Fish in South Florida Waters – *Trika Gerard*, NOAA SE Fisheries/FAMU, Larval Fish Ecology, Miami, FL

Evaluation of Regional Models for Evapotranspiration in the Everglades – *Edward German*, US Geological Survey, Water Resources Division, Altamonte Springs, FL

Use of a Modified Macrohabitat Guild Structure for Assessing Fish Dependence on Off-Channel Habitats in the Kissimmee River – *Lawrence Glenn*, South Florida Water Management District, Kissimmee Division, West Palm Beach, FL

Physiological Effects of Crude Oil and Brine on Loblolly Pine *(Pinus taeda)* – *Dean Goodin*, Shaw Environmental, Inc., Baton Rouge, LA

Seed Germination in Wild Celery, ***Vallisneria americana* Michx. from Lake Okeechobee**, **Florida U.S.A. – *Herbert Grimshaw***, South Florida Water Management District, Okeechobee Division, West Palm Beach, FL

Session 2 – Thursday, December 9, 2004 (continued)

- On display from 7am Wednesday through 12noon Friday, with a formal poster session and reception on Thursday from 5pm-7pm.

Ecosystem Restoration, Coastal Erosion Protection, and Recreational Amenities using Artificial Reef Submerged Breakwaters and Coral Propagation Techniques – *Lee Harris*, Florida Tech, Marine & Environmental Systems, Melbourne, FL

Predicting Wildlife Population Responses by Making Comparisons across a Species' Range: A Case Study between Mangrove and Salt Marsh Diamondback Terrapins *(Malaclemys terrapin)* – *Kristen Hart*, Duke University, Nicholas School of the Environment and Earth Sciences Marine Laboratory, Beaufort, NC

ATLSS Data Viewer: A Tool to Analyze and Display ATLSS Model Outputs – *Steve Hartley*, US Geological Survey, National Wetlands Research Center, Lafayette, LA

Influence of the Form of Dissolved Nitrogen Inputs on Phytoplankton Community Composition in Florida Bay and the Southwestern Florida Shelf – *Cynthia Heil*, Florida Fish & Wildlife Conservation Commission, Florida Water Research Institute, St. Petersburg, FL

Using an Integrated Hydrologic Monitoring Network as a Tool to Analyze Everglades Ecosystem Response during CERP Implementation – *Clinton Hittle*, US Geological Survey, Center for Water and Restoration Studies, Miami, FL

Measuring the Influence of Water Management Infiltration Basins on Water Quality in Neighboring Marshes in Everglades National Park using Midge Bioassessment Methods – *Richard Jacobsen*, Everglades National Park, South Florida Natural Resources Center, Homestead, FL

Development of Invertebrate Performance Measures for Everglades Hydrological Restoration: Chironomid – Hydroperiod Relationships in Everglades National Park – *Richard Jacobsen*, Everglades National Park, South Florida Natural Resources Center, Homestead, FL

Monitoring the Extremes: How a Comprehensive Monitoring and Analysis Program Captured the Affects of Drastically Different Weather in 2002 and 2003 on Chesapeake Bay – *David Jasinski*, Chesapeakebay Program Office, Monitoring, Annapolis, MD

Computational Challenges in South Florida Watershed Modeling for Ecosystem Restoration – *Hsin-Chi Jerry Lin*, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, MS

Long-Term Management of the Kissimmee Chain of Lakes, Florida – *Brad Jones*, South Florida Water Management District, Kissimmee Division, West Palm Beach, FL

Characterizing Important Spatial Scale Lengths of Florida Everglades Vegetation for Hydrologic Model Parameterization and Restoration Monitoring – *John Jones*, US Geological Survey, Eastern Region Geography, Reston, VA

Session 2 – Thursday, December 9, 2004 (continued)

- On display from 7am Wednesday through 12noon Friday, with a formal poster session and reception on Thursday from 5pm-7pm.

Relating Water Depth, Hydroperiod, and Flows with Elevation Differences in the Everglades Ridge and Slough Community – *Eric Jorczak*, University of Florida, Soil and Water Science, Gainesville, FL

Nekton Habitat Use and Responses to Wetland Restoration in the Mississippi River Delta – *Frank Jordan*, Loyola University New Orleans, Biological Sciences, New Orleans, LA

Characterization and Selection of *Uniola Paniculata* L. Genotypes for Enhanced Dune Restoration – *Mike Kane*, University of Florida/IFAS, Environmental Horticulture/IFAS, Gainesville, FL

Effects of Canal-Water Intrusion on C and N Biogeochemistry and Isotopes at the A.R.M. Loxahatchee National Wildlife Refuge – *Carol Kendall*, U. S. Geological Survey, WRD, Menlo Park, CA

Estimating Missing Rainfalls in South Florida Using Neural Networks-Based Classification – *Tae-Woong Kim*, National Park Service, South Florida Ecosystem Office, Homestead, FL

Fish Introductions into Everglades Wetlands: An Unforeseen Consequence of Restoration – *Jeffrey Kline*, Everglades National Park, South Florida Natural Resources Center, Homestead, FL

Habitat Use by Wetland Fish Assemblages: Establishing Baseline Community Conditions for Wetland Restoration in Tampa Bay, Florida – *Justin Krebs*, US Geological Survey, St Petersburg, FL

A New Aerial Survey Method to Monitor the Response of Manatees to Restoration of the Florida Everglades – *Catherine Langtimm*, US Geological Survey, Florida Integrated Science Center, Gainesville, FL

Modeling the Water Flow of the Biscayne Bay Coastal Wetland Watershed System for Ecosystem Restoration – *Hsin-Chi Jerry Lin*, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, MS

Success and Limits of a Marine Protected Area: the Blue Crab in Chesapeake Bay – *Rom Lipcius*, College of William and Mary, Virginia Institute of Marine Science, Gloucester Point, VA

Can Restoration Change the Role of Everglades Karst Holes as Sinks for Aquatic Animals? – *William Loftus*, US Geological Survey, Florida Integrated Science Center, Homestead, FL

Between the Rock and a Wet Place: Restoration of the Rocky Glades – *William Loftus*, US Geological Survey, Florida Integrated Science Center, Homestead, FL

Session 2 – Thursday, December 9, 2004 (continued)

- On display from 7am Wednesday through 12noon Friday, with a formal poster session and reception on Thursday from 5pm-7pm.

Establishing Baseline Data for Mangrove Forest Fishes in the Everglades: How Important is Hydrology? – ***Carole McIvor***, US Geological Survey, Center for Coastal & Watershed Studies, St Petersburg, FL

Phosphorus Estimation in Isolated Wetlands of Lake Okeechobee Sub-basins using GIS, Remote Sensing and Classification Trees – ***Kathleen McKee***, University of Florida, Soil and Water Science, Gainesville, FL

Water Quality in South Florida's Arthur R. Marshall Loxahatchee National Wildlife Refuge ---Trends and Spatial Characteristics of Selected Constituents – ***Benjamin McPherson***, US Geological Survey, WRD, Tampa, FL

Freshwater Discharge Required to Re-Establish Biscayne Bay Coastal Wetlands and Nearshore Estuarine Zone – ***John Meeder***, Florida International University, SERC, Miami, FL

Assessment of Soil Salinity and Moisture Fluctuations in the Bald Cypress Floodplains of the Loxahatchee River Watershed – ***Amanda Mortl***, University of Florida, Agricultural and Biological Engineering, Homestead, FL

Age and Growth of Florida Gar, a Top Predatory Fish in Southern Florida – ***Debra Murie***, University of Florida, Fisheries and Aquatic Sciences, Gainesville, FL

Hydrology, Ecology, and Simulation of the Six Mile Cypress/Ten Mile Canal Watershed System – ***John Murray***, Florida Gulf Coast University, Computer Science, Fort Myers, Florida

Habitat Requirements of Three Species and Their Responses to Translocation to Reclaimed Phosphate Mined Land – ***Henry R. Mushinsky***, University of South Florida, Department of Biology, Tampa, FL

Cottonwood Management and Regeneration along the Missouri River – ***Kristine Nemec***, US Army Corps of Engineers, Planning Branch, Omaha, NE

Historic Changes in the Everglades Ridge and Slough Patterned Landscape – ***Martha Nungesser***, South Florida Water Management District, Everglades Division, West Palm Beach, FL

Determining the Condition of Northern Everglades Tree Islands Impacted by Hydrology and Invasive Exotic Species – ***Pamela Pannozzo***, University of Florida, Wildlife Ecology and Conservation, Ft. Lauderdale, FL

Hydrologic Changes Following Removal of Invasive Plants at Prairie Creek, Midewin National Tallgrass Prairie – ***Geoffrey Parish***, Graef, Anhalt, Schloemer & Associates, Environmental Division, Milwaukee, WI

Session 2 – Thursday, December 9, 2004 (continued)

- On display from 7am Wednesday through 12noon Friday, with a formal poster session and reception on Thursday from 5pm-7pm.

Modeling Hydrologic Events in a Post-Wildfire Watershed Restoration Environment Using the MIKE-SHE Model – ***Boris Poff***, USDA Forest Service, Rocky Mountain Research Station, Flagstaff, AZ

Restoration of Floodplain Marsh Along the St. Johns River in Brevard County, **Florida –** ***Kimberli Ponzio***, St. Johns River Water Management District, Water Resources, Palatka, FL

Using Natural Chemical Tracers to Evaluate Point-source and Non-Point Sources of Freshwater Inputs to Biscayne Bay – ***Rene Price***, Florida International University, SERC and Earth Sciences, Miami, FL

Mitigation of a S.E. Florida USA Coral Reef Damaged by the Grounding of a Nuclear Submarine: Results of a Hypotheses-Based Restoration Study – ***Patrick Quinn***, Oceanographic Center, Nova Southeastern University, Dania Beach, FL

Are Manatee Over-Wintering Strategies and Restoration Efforts Compatible in the Northwestern Everglades Region? – ***Jim Reid***, US Geological Survey, Center for Aquatic Resource Studies, Sirenia Project, Gainesville, FL

Disturbance: Tree Island Spread v. Exotic Plant Invasion – ***Amy Renshaw***, Florida International University, Southeast Environmental Research Center, Miami, FL

Habitat Assessment for Hatching American Crocodile in the C-111 Wetland Basin and Florida Bay Wildlife Protection Area Based on Monthly Salinity Contouring Analysis from 1996 to 2003 – ***Amanda Rice***, US Geological Survey, FISC-WRS, Homestead, FL

Use of Amphibian Communities as Indicators of Restoration Success in the Everglades – ***Amanda Rice***, US Geological Survey, NA, Homestead, FL

Application of Soil Mapping and Modeling Efforts in WCA-2 Integrating GIS, **Geostatistics and Remote Sensing Techniques –** ***Rosanna Rivero***, University of Florida, Department of Soil and Water Science/Urban and Regional Planning, Gainesville, FL

History of Phosphorus Accumulation in Soils along a Nutrient Gradient in Water Conservation Area 2A, **South Florida –** ***John Robbins***, National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory, Ann Arbor, MI

Habitat Relationships of Fish and Shrimp in Southern Biscayne Bay – ***Michael Robblee***, US Geologial Survey, c/o Everglades National Park, South Florida Natural Resources Center, Homestead, FL

Quantifying the Effects of Nutrient Reduction on Growth Rates of Phytoplankton in Kings Bay, **Florida –** ***Darlene Saindon***, University of Florida, Dept. of Fisheries and Aquatic Sciences, Gainesville, FL

Session 2 – Thursday, December 9, 2004 (continued)

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Modeling the Effect of Soil Amendments (Composts) on Water Balance and Water Quality – *Reza Savabi*, USDA-ARS, SHRS, Everglades AGro-Hydrology Proj, Miami, FL

Aspects of Oyster Ecology and Their Utility in the Design of Estuarine Restoration Projects in the Greater Everglades: Example from Southern Golden Gate Estates – *Michael Savarese*, Florida Gulf Coast University, Coastal Watershed Institute, Fort Myers, FL

Sheet Flow Velocity in Everglades National Park, **Florida – *Raymond Schaffranek***, US Geological Survey, WRD/NRP, Reston, VA

Model for Simulation of Surface-Water Flow and Transport through Freshwater-Wetland and Coastal-Marine Ecosystems in Everglades National Park, **Florida – *Raymond Schaffranek***, US Geological Survey, WRD/NRP, Reston, VA

Restoration of the Florida Mouse to Native and Reclaimed Mined Sites: Assessing Habitat Quality to Improve Translocation Success – *Dan Schmutz*, Berryman & Henigar, Water Resources & Environmental Sciences, Orlando, FL

Oyster Reef Restoration – *Bruce Schwenneker*, Malcolm Pirnie, Newport News, VA

Linkage Between Microbial Metabolic Diversity and Restoration Age in the Hole-in-the-Donut, **Everglades National Park – *Kanika Sharma***, University of Florida, Soil and Water Science Department, Gainesville, FL

Natural Plant Pathogens of Brazilian Pepper (*Schinus terebinthifolius* Raddi) in the Everglades National Park: Potential for Biological Control – *Kateel G. Shetty*, Department of Environmental Studies and Southeast Environmental Research Center, Florida International University, Miami, FL

Techniques for Restoring Gorgonians to Coral Reef Injury Areas – *Lauren Shuman*, National Coral Reef Institute, Nova Southeastern University Oceanographic Center, Dania Beach, FL

Unraveling Trophic Interactions Between the Periphyton Mat Complex and Consumers in the Florida Everglades – *Shawn Smith*, Florida International University, Department of Biological Sciences, Miami, FL

Influence of Porewater Salinity and Nutrients on Seedling Recruitment of Mangroves and Invasive Exotic Plants across a Mangrove - Marsh Ecotone on the Harney River, **Everglades National Park – *Thomas Smith III***, US Geological Survey, Florida Integrated Science Center, Saint Petersburg, FL

Session 2 – Thursday, December 9, 2004 (continued)

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Trajectories of Mangrove Forest Recovery in the Southwest Everglades a Decade Following Hurricane Andrew: Variable Patterns of Recruitment, Growth, and Mortality – ***Thomas Smith III***, US Geological Survey, Florida Integrated Science Center, Saint Petersburg, FL

Response of Muhly Grass to Different Seasons of Prescribed Fire in Southern Florida – ***Jim Snyder***, US Geological Survey, Florida Integrated Science Center, Ochopee, FL

Spoil Island Renovation – ***Julia Stack***, The Florida Aquarium, Horticulture/Biological Operations, Tampa, FL

Modeling Manatee Response to Hydrologic Restoration in the Ten Thousand Islands and Everglades National Park – ***Brad Stith***, US Geological Survey, Center for Aquatic Resources Studies, Sirenia Project, Gainesville, FL

The Relationship Between Soil Moisture and Nutrient Availability in Tree Islands of Shark Slough, Everglades National Park – ***Elizabeth Struhar***, Florida International University, Environmental Studies, Miami, FL

Effect of Surface Cover on Surface Radiation Balance in the Florida Everglades – ***David Sumner***, U. S. Geological Survey, Water Resources Division, Altamonte Springs, FL

Using a Hydrologic/Ecological Model Linkage to Evaluate the Influence of Ecosystem Restoration on Everglades Fish Population – ***Eric Swain***, US Geological Survey, Center for Water and Restoration Studies, Miami, FL

Fast Growing Tree Bridge Crops for Ecological Restoration of Phosphate Mined Lands – ***Bijay Tamang***, University of Florida, School of Forest Resources and Conservation, Gainesville, FL

Is Roller Chopping an Alternative Management Practice to Fire in Restoring Dry Prairie? – ***George Tanner***, University of Florida/IFAS, Wildlife Ecology and Conservation, Gainesville, FL

Benthic Periphyton Recovery and Phosphorus Dynamics upon Artificial Flooding in a Newly Burned Freshwater Marl Prairie (Everglades National Park, FL, USA) – ***Serge Thomas***, SERC/FIU, Periphyton Group, Miami, FL

Permanent Habitat Changes on Cape Sable, Everglades National Park – ***Ginger Tiling***, US Geological Survey, Geology, St. Peterburg, FL

Assessment of American Crocodile Populations of Southern Florida: Trends in Population and Reproduction Rates – ***William Tucker***, MACTEC Engineering and Consulting, Inc., Water Resources, Newberry, FL

Session 2 – Thursday, December 9, 2004 (continued)

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The Spatial Distribution and Relative Abundance of Larval Dragonflies (Anisoptera) Found in the Freshwater Marshes of the Florida Everglades – *Raul Urgelles*, Florida International University, Biological Sciences, Miami, FL

The Role of Oysters, Oyster Reef-Associated Organisms, and Adaptive Resource Management in Setting Water Quality Targets in the Caloosahatchee Estuary, Florida – *Aswani Volety*, Florida Gulf Coast University, Ecological and Social Sciences, Fort Myers, FL

The Importance of Flow in Restoring and Maintaining the Ridge-Slough-Tree Island Landscape Pattern in the Florida Everglades – *John Volin*, Florida Atlantic University, Biological Sciences, Davie, FL

Environmental Alterations in Florida Bay in the Past 3000 Yrs Based on Diatom Assemblages Extracted from Sediment Cores – *Anna Wachnicka*, Florida International University, Southeast Environmental Research Center, Miami, FL

Threats to Amphibian Populations in South Florida – *Hardin Waddle*, University of Florida, Florida Co-Op Fish & Wildlife Research Unit, Ochopee, FL

Addressing Data Needs for Ecosystem Management: Enhancing an Existing Long-Term Water Quality Monitoring Network for the Northern Everglades – *Mike Waldon*, US Fish and Wildlife Service, A.R.M. Loxahatchee National Wildlife Refuge, Boynton Beach, FL

Surface Water Quality Monitoring in Everglades, Florida – *Qingren Wang*, Tropical Research and Education Center, University of Florida/IFAS, Homestead, FL

Forest Structure and Vital Rates of Mangrove Communities in the Everglades: Implications for Restoration – *Greg Ward*, Computer Science Corporation, US Geological Survey - Florida Integrated Science Center, Homestead, FL

Growth Curve Estimates of *A. germinans*, *L. racemosa*, and *R. mangle* in Relation to Salinity and Nutrient Gradients Across the Mangrove Intertidal Zone – *Greg Ward*, Computer Science Corporation, US Geological Survey - Florida Integrated Science Center, Homestead, FL

Changes in Groundwater Influence Soil Surface Elevation in a Mangrove Forest along the Shark River, Everglades National Park – *Kevin Whelan*, US Geological Survey, Florida Integrated Science Center, Miami, FL

TAME Melaleuca: An Integrated Pest Management Approach for Control of *Melaleuca quinquenervia* – *M. Scott Wiggers*, USDA-ARS, Invasive Plant Research Laboratory, Fort Lauderdale, FL

Session 2 – Thursday, December 9, 2004 (continued)

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Recent Changes to an Estuarine-Marine Ecosystem: Using Benthic Foraminiferal Assemblage Data toward a Predictive Model of Ecosystem Change, **Central and Southern Biscayne Bay**, **Florida –** ***Christopher Williams***, Southern Illinois University Carbondale, Geology Department, Carbondale, IL

Evaluating the Effects of Everglades Restoration Scenarios by Linking the Local-Scale Southern Inland and Coastal Systems (SICS) Model to the Regional South Florida Water Management Model (SFWMM) – ***Melinda Wolfert***, US Geological Survey, FISC-Water and Restoration Studies, Miami, FL

Applying the Penman-Monteith Equation in the Everglades to Calculate the Actual Evapotranspiration in Order to Improve Predictions for Restoration Scenarios – ***Melinda Wolfert***, US Geological Survey, FISC- Water and Restoration Studies, Miami, FL

Patterns of Movement of Florida Gar ***(Lepisosteus platyrhincus)*** **in the Everglades Revealed by Radio Telemetry –** ***Lawrence Wolski***, Florida International University, Biological Sciences, Miami, FL

Mangrove Assessments as an Indicator of Restoration Success in Die-Off Areas Located Adjacent to Development – ***Kathy Worley***, The Conservancy of Southwest Florida, Environmental Science, Naples, FL

Modeling Three-Dimensional Coastal Water Quality with a General Paradigm – ***Gour-Tsyh (George) Yeh***, University of Central Florida, Civil and Environmental Engineering, Orlando, FL

Nutrients Inputs along Coastal Transects within Everglades National Park, **Florida –** ***Mark Zucker***, US Geological Survey, Water, Miami, FL

Conference Abstracts

Listed alphabetically by presenting author.
Presenting authors appear in **bold**.

Developing an Ecological Context for Monitoring Restoration Effects on Fishes

Aaron J. Adams, *R. Kirby Wolfe* and *Margaret E. Newton*
Mote Marine Lab, Charlotte Harbor Field Station, Pineland, FL

Restoration of estuarine wetlands and their associated upland drainages is a worthwhile endeavor, but is incomplete without data on the efficacy of the restoration in achieving expected results. The Florida Department of Environmental Protection, Charlotte Harbor Aquatic and State Buffer Preserve (Preserve) is engaged in restoration of altered upland and wetland habitats to historical freshwater flow conditions. Prior to alterations, gentle, low, flat slopes allowed slow overland sheet flow of surface waters, which were retained for extended periods in wetland depressions within wet and mesic slash pine flatwoods. These isolated wetlands were connected during high water periods, and in areas with upstream drainage basins surficial flows were concentrated into tidal creeks that provided an important salinity and water chemistry gradient to the estuary. These conditions were significantly altered by ditching for drainage and mosquito control, digging of water retention ponds, placement of physical barriers to surficial flow, agricultural activities, and recent residential development. The expected results of this restoration are that native fish species that depend on the creeks that receive drainage from restored areas will benefit. However, it is essential to implement an appropriate monitoring program that includes a before-after time series and within and outside the restoration area to accurately determine how creek fish assemblages are affected by such restoration.

Mote Marine Lab, in collaboration with the Preserve, has been monitoring creeks within the Preserve since November 2002 to develop a pre-restoration baseline, and will continue monitoring after restoration. Restoration will take place in winter 2004-2005. Two types of creeks (two study creeks per creek type) with altered drainages are being sampled every other month - creeks to be restored (“restoration creeks”) and creeks that will not be restored (“impacted creeks”). Differences in fish assemblages between the creek types are already evident. On average, more species and higher abundances of fish are captured in restoration creeks, and the majority of invasives (primarily Mayan cichlid, *Cichlasoma uropthalmus*) are captured in impacted creeks. It appears the differences in fish assemblages result from existing differences in upland drainages: restoration creek drainages are bisected by mosquito ditches (which will be filled during restoration), but are otherwise pervious surfaces; impacted creek drainages have been platted for development so have extensive impervious surfaces and flood control ponds. Pre-restoration monitoring is quantifying the range in fish assemblages associated with ‘impacted’ creeks (i.e., both creek types are defined as having impacted drainages) that will be valuable in assessing the relative effectiveness of this restoration strategy. Since no creek habitats in Charlotte Harbor are truly unimpacted, it is important to place restoration in the context of the range of impacted habitats to truly measure the effectiveness.

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Three Dams and Three Different Solutions to Restoring Salmon Populations

Noah S. Adams, *Russell W. Perry*, *Kenneth M. Cash*, *Patrick Connolly* and *Dennis W. Rondorf*
US Geological Survey, Columbia River Research Laboratory, Cook, WA

Man-made barriers have significantly altered the ecosystem of the Columbia River basin. About 80% of the rivers and streams that lie within this 673,400 square kilometer basin have been impounded, mainly by hydroelectric facilities. These facilities have caused the destruction of spawning and rearing habitat, altered water quality, and are barriers to the migration of juvenile and adult salmon. Since their construction, salmon and steelhead populations have steadily declined to about 25% of their historic levels. No single approach will likely restore these populations. In this paper we describe three barriers to salmon migration and describe the different approaches that are being implemented to aid in the recovery of threatened and endangered salmon populations in the Columbia River Basin.

At large main-stem dams on the Snake and Columbia rivers, surface bypass is one option being tested which may improve juvenile salmonid survival and therefore be a better alternative passage route to conventional spill, turbines, and bypass systems. Previous studies have shown that out-migrating fish pass through surface water passage structures at higher percentages per percent of water discharged than relatively deeper turbine or spillway routes. This, together with information gathered on the vertical distribution of out-migrating fish indicates that near-surface flows may be an effective passage route. In 2003 we evaluated the performance of a surface bypass structure called a Removable Spillway Weir (RSW) at Lower Granite Dam, Washington. Our data showed that 9.1:1 fish were passed per percent of discharge through the RSW. In contrast, 1.7:1 fish were passed per percent of discharge through spill. The relative success of the RSW has lead to plans for construction and installation of similar structures at three additional dams on the Snake River in the next 4 years.

At one of the newest dams in the region, Cowlitz Falls Dam, 20th century know-how was used in the construction of the surface collection system and juvenile fish handling facility. Construction and completion of the dam in 1996 was supported due to the potential to restore salmon to 322 km of relatively pristine tributaries. Key to the restoration strategy is the effective collection of out-migrating smolts for transportation around downstream impounds. These collection efforts have not met the desired goals. During 2003, we evaluate the effectiveness of increasing flume discharge, and thereby the zone of influence, for attracting juvenile salmonids to enter the surface collection system. Our results indicated that discharge and entrance configuration were critical factors in designing a more effective fish collection system.

At one of the oldest dams in the basin, Condit Dam, studies have shown that the best alternative for restoring fish population to 32 km of habitat in the White Salmon River basin is to remove the 91 year-old dam. It would cost 30 million dollars to renovate the 38 m high dam to allow adequate adult and juvenile passage in and out of the upper watershed.

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Mercury and Dissolved Organic Matter in the Florida Everglades

George Aiken
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Mercury (Hg) remains an important environmental problem in many ecosystems, including the Florida Everglades. Interactions of Hg with dissolved organic matter (DOM) play important, albeit poorly defined, roles in controlling reactivity, bioavailability and transport of Hg in aquatic systems. In this paper, the results of experiments designed to provide important fundamental information about the potential role of DOM-Hg interactions in controlling Hg concentrations and reactivity in the Everglades will be described. The information resulting from this research is directly applicable to the effective management of the Everglades, and has important implications for planners of the Everglades restoration program.

The strength of direct binding of Hg to DOM obtained from the Everglades was measured by determining conditional distribution coefficients (K_{DOM}') using an equilibrium dialysis ligand exchange method. Very strong interactions ($(K_{DOM}') = 10^{23.2}$ L kg^{-1} at pH = 7.0 and I = 0.1), indicative of Hg-thiol bonds, were observed at Hg/DOM ratios below approximately 1 µg Hg per mg DOM. These results suggest that the binding of Hg to DOM under conditions in the Everglades (approximately 0.02 ng Hg per mg DOM) is controlled by a small fraction of DOM molecules containing reactive thiol functional groups, and, in the case of fully oxygenated Everglades waters (sulfide-free), DOM-Hg complexes are favored over Hg complexes formed with inorganic ligands.

DOM-Hg interactions were also studied by cinnabar (HgS; an insoluble solid) dissolution and precipitation experiments. In the dissolution experiments, a significant amount of Hg was solubilized from HgS in the presence of Everglades' DOM. In the precipitation experiments, precipitation of HgS was strongly inhibited in the presence of low concentrations (<3 mg C/L) of DOM. In both the dissolution and precipitation experiments, organic matter rich in aromatic moieties was more reactive with HgS than less aromatic fractions. These results suggest that DOM can also influence the geochemistry and bioavailability of inorganic complexes of Hg in the Everglades, especially HgS, by strong Hg-DOM binding and/or colloidal stabilization.

Wetland enclosure (mesocosm) experiments were designed to directly study the influences of DOM-Hg interactions on the reactivity of Hg. In these experiments, mesocosms amended with reactive organic matter from the Everglades contained higher concentrations of total dissolved Hg, an important indicator of both biotic and abiotic reactivity, than control enclosures containing less reactive DOM. The DOM amended enclosures were also found to have enhanced methylation of Hg, greater Hg bioaccumulation, and enhanced photo-oxidation of methylmercury relative to the controls.

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Helicopter Application of Herbicides to Restore Wetland Biodiversity in Highly Sensitive Areas

M. Stephen Ailstock
AACC Environmental Center, Arnold, MD

Patsy Kerr
Langley Air Force Base, Langley, VA

Helicopter application of herbicides to control invasive species in wetlands provides a precise method of delivery that can be used to restore biodiversity to large acreages. Yet, many areas identified for potential restoration are constrained by combinations of water/land management concerns and by the biological sensitivity of the systems to be treated. Inclusion of real time GPS records of flight paths and chemical delivery, coupled with computer controls to limit application to predefined locations, can alleviate objections to the use of chemicals in these wetlands restoration projects. This paper reports on two such projects. The first, defines a restoration protocol used for the application of the herbicide Rodeo to control the invasive wetland weed, *Phagmites australis*, impacting both endangered and rare animal and plant species at Cove Point Marsh, Maryland, a wetland adjacent to a large natural gas import and distribution facility defined as protected air space. The second describes a process for aerial applications of herbicide to control *Phagmites* in wetlands owned by the U.S. Department of Defense in the southern regions of the Chesapeake Bay that are adjacent to high-density military complexes. These sites also occupy protected air space and many are adjacent to intensely developed urban areas. Both protocols describe the utility of GPS coordinated low-level applications for meeting operational concerns, coordinating efforts to minimize operational restrictions, communicating project overview and for protecting the integrity of the biological systems in these sensitive areas. Communication networks and processes for obtaining the various approvals necessary for project implementation are also described.

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The Influence of Salt Marsh Restoration in an Oil Spill-Impacted Marsh on Shallow Water Fauna and Wading Birds in the Hudson-Raritan Estuary, Staten Island NY

John Brzorad
Forsyth Technical Community College, Winston-Salem, NC

Carl W. Alderson
NOAA Restoration Center, Highlands, NJ

In January of 1990, 2.5 million liters of No.2 fuel oil spilled into the Arthur Kill, a tidal straight that separates Staten Island, NY and New Jersey. The fuel oil caused catastrophic damage, including the mortality of 684 birds and the destruction of 8 ha of *Spartina alterniflora* (Salt Marsh Cordgrass). In 1994 the Salt Marsh Restoration Team of the New York City Department of Parks & Recreation replanted 2.4 ha of the denuded marsh with nursery-grown *Spartina alterniflora*. We report on the influence of this activity on the abundance of shallow water fauna, and the activity of piscivorous wading birds (egrets) that occupied the restored (planted) and unrestored habitats. Using standard fish sampling techniques, (minnow traps) we compared the abundance and size of fish, shrimp, and gastropods at restored and unrestored sites in the Arthur Kill in 1995, 1996 and 1998, from 29 August to 16 October. Mummichogs (*Fundulus heteroclitus*) were more than 4 times more abundant, and Atlantic Silversides (*Menidia menidia*) 3 times more abundant, at the Restored than at the Unrestored Site. Dog Whelks (*Ilyanassa obsoleta*) became more abundant from 1995 to 1998, at both sites, but their abundance rose faster and higher at the Restored than at the Unrestored Site. We also examined results from the entire season (25 March to 16 October) in 1996 and 1998. The abundance of Mummichogs and Dog Whelks rose sharply from March to October at the Restored Site, but remained low at the Unrestored Site. Shrimp (*Palaeomonetes sp.*) abundance rose from 1996 to 1998 at the Restored Site but declined in the same period at the Unrestored Site. We also monitored a reference site that was undamaged by the oil spill and were able to compare all three sites throughout the entire season in 1998. Mummichog abundance peaked in late summer at all 3 sites but was greatest at the Reference Site and lowest at the Unrestored Site. The same trend was seen among Striped Killifish (*Fundulus majalis*), but abundance was far greater at the Reference Site at the end of the summer than at either the Restored or Unrestored Site. Silverside abundance was greater in the early autumn at the Reference Site than at the other two sites. Shrimp and Dog Whelks were more abundant at the Restored Site than at either the Unrestored or Reference Sites. Using standard observation techniques (close range observation under camouflage with binoculars) we were able to compare foraging behavior of Snowy Egrets (*Egretta thula*) and Great Egrets (*Casmerodius albus*) at Restored and Unrestored sites in 1995 and 1996 (22 April to 19 August). There were no significant differences in egret strikes per min., prey captured per min., or successful strikes per min. (captures/strike) between the Unrestored and Restored Sites. Yet egrets did strike every 3.8 min. and 2.3 min. at the Unrestored and Restored Sites, respectively. Moreover, egrets spent significantly more time per visit at the Restored Site (21.1 min.) than at the Unrestored Site (8.7 min.). Since significant differences in prey capture did not exist between the sites, differences in vegetation structure may account for the extended stays of birds at the Restored Site.

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Enhanced Monitored Natural Attenuation (MNA): Innovative Remedial Strategy for Sustainable Ecosystem Restoration?

Marshall Allen
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There are few sites throughout the U. S. Department of Energy (DOE) facilities free of subsurface contamination from hazardous or mixed wastes. Volatile organic compounds (VOCs), metals, and radionuclides were released to the environment as a result of past nuclear production practices conducted at these sites. Many of these contaminants are persistent and toxic and represent a long-term risk to human health, groundwater quality and ecosystem health. To reduce risk, restore ecological health and improve the environmental quality, researchers at Florida International University (FIU) are working with the DOE to develop strategies that rely on monitored natural attenuation (MNA) to remove or contain contaminants. Studies are currently being carried out to better understand key natural attenuation (NA) processes occurring at DOE sites and to show that MNA is a viable, cost-effective ecological restoration tool for the clean up of contaminated soils and groundwater. Sorption, volatilization, biodegradation, and phytoextraction are some of the NA mechanisms under investigation.

FIU researchers are currently performing laboratory-scale and batch-scale studies to 1) determine the ability of natural and man-made wetlands to remove organic contaminants from groundwater before they reach the surface water, 2) identify strategies for injecting nutrients into contaminated aquifers to accelerate the biodegradation of TCE in groundwater by enriched microbial consortia, 3) investigate the use of spray irrigation systems coupled with phytoremediation plantations to maximize the extraction and destruction of contaminants from soils and groundwater, and 4) study factors influencing rate of attenuation of trichloroethylene (TCE) by volatilization and sorption in surface waters. Additionally, mechanisms for the attenuation of toxic metals and radionuclides in soil and groundwater are being investigated to aid DOE personnel in determining the potential efficacy of natural attenuation as a remedial option. Ways of addressing the widespread contamination of mercury in soil, sediment, water, building debris, and air at some DOE sites are being investigated. Innovative remedial solutions being studied include improved management of mercury-contaminated materials and a study of the physical, chemical, and microbial processes influencing the speciation and hence mobility of mercury in a contaminated stream system. There is also ongoing research into the use of natural attenuation processes, including phytoextraction, to minimize the leaching of arsenic and selenium from coal fly ash stockpiled at some DOE sites. Innovative autonomous groundwater monitoring systems are also being developed and deployed to assist in monitoring the success of long-term MNA processes.

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Ranking and Integrating Restoration Expectations for the Kissimmee River, Florida

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Increasingly, restoration projects adopt broad goals such as the reestablishment of ecosystem health and ecological integrity. Evaluating the success of such projects requires the use of multiple criteria, which raises two important issues: the reliability of different criteria and their integration as a measure of success. This presentation will use restoration expectations for the Kissimmee River to illustrate approaches for ranking success criteria by relative reliability and integrating multiple criteria. The Kissimmee River restoration project in central Florida has the goal of reestablishing ecological integrity to the river-floodplain ecosystem, and the success at achieving this goal is being evaluated with 42 restoration expectations. These expectations describe the anticipated responses by major abiotic components of the ecosystem (hydrology, water quality, and geomorphology) and by major biological communities (e.g., plants, invertebrates, fish, and birds) in both the river channel and floodplain. Most biological expectations describe responses by communities or guilds although a few are for single species that have threatened or endangered status. These expectations were developed using the best available reference conditions, which included pre-channelization data for the Kissimmee River, data from other reference rivers and wetlands, and best professional judgment. Because the expectations differ in the attributes described and the reference conditions used, they were expected to vary in reliability. Differences among expectations were assessed by scoring each expectation with 13 criteria (e.g., type of reference condition, quantity of reference data, and variability). Total scores ranged from 27 to 51 out of the possible range of 13 to 65 and were used to rank the expectations. Total scores formed a nearly continuous distribution, which may reflect an initial screening of candidate indicators before the expectations were developed. The restoration expectations were integrated using several approaches that conveyed different amounts of information about attaining the ecological integrity goal. The simplest approach was to track the number achieved relative to a timeline for anticipated achievement. Another approach was based on a mechanistic understanding of how the restoration project (i.e., reestablishing flow conditions) would drive the anticipated responses for each expectation. Substituting expectations for mechanism steps mapped the relationships among expectations, so that the evaluation of the expectations also provides insight into the reestablishment of these relationships. Thus, it is possible to assess the reliability of different expectations and to combine them to assess the progress of the restoration project.

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The U.S. Geological Survey Integrated Hydrologic Monitoring of the Florida's Southwest Coast and Florida Bay: Importance to CERP Monitoring and Assessment Plan Performance Measures

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In the mid-1990's, U.S. Geological Survey (USGS) water and biological divisions pursued three independent studies to address the limited knowledge of hydrologic dynamics across the Everglades coastal estuaries and the mangrove-marsh transitional zone or ecotone. These three studies are: (1) Freshwater Flows into Northeastern Florida Bay, initiated in 1994; (2) The Southwest Florida Coastal and Wetland Systems Monitoring, started in 1996; and (3) The Dynamics of Land Margin Ecosystem: Historical Change, Hydrology, Vegetation, Sediment and Climate, incorporated into the USGS in 1994. These hydrologic networks are now integrated to create a, real-time regional scale coastal estuary and mangrove transitional zone hydrologic network of 42 monitoring sites. The network primarily monitors the hydrologic parameters of water flow/discharge (25 sites), salinity (42 sites), water levels and tidal stage levels (42 sites), and shallow groundwater levels (17 sites). Two assets of the regional hydrologic network are that all stations are based on a common vertical datum (NAVD 88) and that real-time access of these data are possible via satellite or radio. For additional details and technical results of the individual hydrologic networks, see Hittle, Patino, Anderson, et al, (these proceedings).

The U.S. Geological Survey regional-scale coastal estuary and mangrove-marsh ecotone hydrologic network is uniquely designed to provide the baseline hydrologic data needed to assist CERP/RECOVER Monitoring and Assessment Plan (MAP) system-wide performance measures. This is especially true for the following Greater Everglades performance assessments: (1) Monitoring the status and recovery of tidal creeks (GE-A4); (2) Evaluate primary productivity and soil dynamics of coastal mangrove forests (GE-A11); (3) Track freshwater flows, volume, timing, and distribution in coastal estuaries, and monitor for predicted sea level rise (GE-A12); (4) Observe and report change coastal wetlands surface-water salinity to maintain no more than a 25% increase in surface-water conductivity above natural seasonal and annual variation (GE-A17); and (5) Provide assessment of salinity volatility in the northeastern Florida bay (SE-A2).

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Monitoring the Hydrodynamics of the Everglades Mangrove Transitional Zone: Getting the Water Right at the Ecological Ecotone

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The interface of the Everglades freshwater-wetland and coastal ecosystem is a dynamic region with high primary productivity. Because understanding the hydrologic processes affecting this transitional zone are vital to Everglades restoration, the Comprehensive Everglades Restoration Plan (CERP) has set monitoring and assessment goals to evaluate restoration performance measures (section A.3.7).

The U.S. Geological Survey 's (USGS) Land Margin hydrologic monitoring network is well placed to provide important hydrologic assessments of the Everglades mangrove-marsh transitional zone. The hydrologic monitoring stations are located along three primary CERP coastal gradient transects: Shark Slough-Shark/Harney River; Lostman Slough-Lostman River; and C-111 Wetland Basin-Northeastern Florida Bay. Three hydrologic permanent monitoring stations are located along each transect in the following order: (1) a sawgrass oligotrophic site; (2) a sawgrass-mangrove oligohaline site; (3) and a mangrove mesohaline-marine site. Each site has both a surface and shallow ground-water monitoring well in which water levels, salinity, and temperature are monitored. The combination of a surface and shallow ground water provides for vertical and horizontal analyses along the coastal gradient transect. These hydrologic stations are linked by a common vertical reference (NAVD 88) and are a subset of the USGS regional Everglades coastal hydrologic monitoring network.

Several elements of the USGS network design and data collection are unique for the monitoring and assessment of restored water flows across the Everglades coastal gradient transects: The monitoring of surface- and ground-water salinity; especially across the oligotrophic-oligohaline zones; and 8 years of surface- and ground-water hydrologic data at 16 sites. These data are now available for restoration model calibration of the USGS Tides and Inflows in the Mangrove of the Everglades (TIME) model and other CERP restoration models and assessment needs.

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Adaptive Management Success in Restoring the South Florida Ecosystem

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The Comprehensive Everglades Restoration Plan (CERP) is a 35-year, $8-billion program comprised of approximately 60 water-management projects designed to assure local water supplies while re-establishing natural flows to the Florida Everglades. Land use and water management practices over the past 100 years in south Florida have resulted in either the loss or extensive alteration of the defining characteristics of the pre-drainage ecosystem. Protection and restoration of the natural water resources in south Florida is one step towards moving the region in the direction of ecosystem recovery. A unique aspect of CERP is that adaptive management principles (i.e., monitoring and assessment) were incorporated into the enabling legislation as the common thread that links the individual components into a large-scale restoration program covering the lower third of the Florida peninsula.

The CERP adaptive management program is intended to guide the implementation of the Plan and serve as the platform for ensuring restoration success. The adaptive management program will be used to assess the responses of the South Florida ecosystem to the Plan and to determine whether these responses match expectations, including anticipated performance levels. In essence, the adaptive management program for CERP will provide an opportunity to use scientific learning gained through monitoring and assessment efforts to manipulate project operations and influence program management decisions to achieve restoration success.

The CERP includes a program known as Restoration Coordination and Verification (RECOVER) that is designed to organize and provide quality scientific and technical support to ensure that a system-wide focus is maintained throughout the implementation of the Plan. The RECOVER team has been assigned the challenge of developing the adaptive management program for CERP. For the past eighteen months a Planning Group of interagency personnel have been laying the foundation for the adaptive management program through a series of workshops designed to achieve the following:

- Develop an adaptive management decision-making process to achieve long-term CERP goals
- Create durable involvement, communication, relationship and decision-making channels between scientists and managers
- Identify the key issues for anticipated future scenarios
- Begin the process of building an adaptive management culture throughout CERP

To date, the team has developed a framework for the adaptive management program and is in the process of finalizing the strategic plan that will guide its implementation.

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The Effective Application of Science to Management and Political Decision-making in Ecosystem Restoration Efforts

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Ideally, ecosystem restoration is driven by sound science, intimately coupled with long-term monitoring and predictive modeling, which conveys pertinent information to resource managers for use in effective adaptive assessment and implementation. In reality, political and economical factors such as industrial and agricultural vitality, tourism, sports recreation, and urban growth are all major influences in determining the course and ultimate outcomes of restoration efforts such as Greater Everglades, Chesapeake Bay, and Tampa Bay. Compounded by communication barriers between scientists and decision-makers in articulating the import of science and management needs, many restoration science projects are consequently compartmentalized and subjugated to addressing the management "issue du jour". Inadequate thought is given to how these projects fit into the strategic vision of developing a comprehensive understanding of ecosystem functions and processes; a prerequisite towards effective restoration at any scale. Effective use of science in support of restoration efforts requires: 1) A cogent science plan that can articulate the strategic vision of multivariate ecosystem functions and processes while accurately describing the role of the science at all scales and levels of management decision-making; 2) A communication strategy that promotes and utilizes an effective communication process between the scientific, managerial, public, and political interests so that each group clearly understands all of the various factors that influence the restoration decision-making process and subsequent implementation efforts; 3) A restoration adaptive management plan that utilizes the strategic science plan and clearly lays out the specific restoration activities for successful implementation; 4) A well-defined and effective set of implementation performance measures; 5) A financial plan that accurately lays out costs for specific activities with reasonable timelines for their completion and the delivery of related products. This should also include projected costs for conducting multiphase science, monitoring, and modeling activities through the adaptive management plan- a cost that is dangerously ignored or short-changed in many current major restoration efforts.

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Using Community-based and Science-based Methods to Improve Tidal Marsh Restoration in the Chesapeake Bay

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Since the late 1990s, the National Aquarium in Baltimore (Aquarium) has been building a multi-faceted community-based marsh restoration program aimed at increasing the connection of residents of the Chesapeake Bay watershed to the beauty and value of the Bay's tidal wetlands. A cornerstone of this program is demonstrating the effectiveness of the beneficial use of dredged material for marsh creation. Over the past several years, in partnership with the Army Corps of Engineers, Fish and Wildlife Service, National Oceanographic and Atmospheric Administration (NOAA), universities and others, the Aquarium has created or restored over 40 acres of tidal marsh at five sites, with at least another 20 acres of restorations at three additional sites planned for 2004-2005. We have worked closely with community groups to establish long term, high quality, science-based volunteer monitoring of all restoration and creation sites.

We have clearly demonstrated the effectiveness of our model to bring together government and non-governmental partners to use dredge material to create wetlands in the Chesapeake. Such habitats have been in steep decline for decades and their restoration is a key piece in restoring the Bay as a whole. These restored sites are young and it is too early to tell when or if they will achieve true functional equivalency to natural salt marshes. However, early results are encouraging. The sites clearly provide some level of habitat function where open water and an eroding shoreline previously existed. Where erosion is successfully reduced by energy dissipating structures, planted marsh grasses grow well and quickly become established. Typical marsh fauna recruit to the sites and will likely continue to do so over time. We have in place an infrastructure for long-term monitoring of these sites and will continue to assess their stability and trajectory toward function equivalency.

In addition, we have been pursuing many other activities under our Chesapeake Bay initiative. For example, the Aquarium has developed a tidal wetland nursery program in schools and created state-of-the-art multi-media educational tools that connect a broader community to our many on-the-ground planting events. Finally, the Aquarium has woven the restoration story into exhibitory at the Aquarium itself, introducing the program to the Aquarium's 1.7 million annual visitors. Together, these projects demonstrate a unique collaboration between a public aquarium, state and federal partners, and the public to restore, monitor, and encourage stewardship of wetlands. The Aquarium's Chesapeake Bay conservation program can serve as a model for restoration in other areas.

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Restoration of Riverine Wetlands: A Long Term Case Study on the Flint River, Georgia

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The Flint River starts under the Atlanta Hartsfield International Airport and runs for 220 miles, ultimately merging with the Apalachicola River, Florida. It is one of the longest unimpeded rivers in the U.S., and is constantly threatened by development along its basin. A serious threat, 2 miles from its source, came in 1989 when a developer illegally rerouted (straightened and deepened) a ¼ mile section of it and cleared and filled six acres of riverine, forested wetland. The final restoration plan involved restoration of wetland topography, plant installation, and stream enhancement. Before earthwork, tree seedlings and cuttings were removed from unfilled edges of the site and placed in an on-site nursery. The nursery was planted with bare-root saplings of river birch (*Betula nigra*), cottonwood (*Populus deltoides*), laurel oak (*Quercus laurifolia*) and others, plus cuttings of Carolina ash (*Fraxinus caroliniana*), black willow (*Salix nigra*), and others. Planting used three sources: 1) saplings collected from unfilled areas on site, 2) cuttings from existing trees on site, and 3) saplings purchased from nurseries. Besides trees, a thriving marsh of soft rush (*Juncus effusus*) occurred on an unfilled, cleared area of the site, and this was replanted throughout the restored site to keep weedy vegetation under control. The growth of cottonwoods and willows along the edge of the river was also enhanced by plantings. Stream restoration tested the addition of large rocks and gabions (wire basket filled with stones) along the course of the river. However, pre-restoration invertebrate sampling indicated the river contained very few invertebrates, and water testing indicated hydrocarbon contamination.

The project was monitored for three years, during which trees grew rapidly, especially in areas “protected” by the soft rush marsh and in areas lowest in elevation.. The worst problem early on was deer grazing of the nursery site. Also, dense weeds growing in non-marsh, dryer areas were accidentally mowed at one time, which destroyed the trees planted there. Trees were replanted with purchased laurel oaks. Rock and gabion placement in the river failed as smaller rocks and ripped-open gabions were washed downstream by torrential rains and the increased velocity in this artificially straightened portion of the river. However, invertebrates continued to increase, as streamside vegetation added habitat and water filtration functions.

In one of the longest studies following riverine forest restoration, twelve years after restoration (2004) finds a riverine wetland with good survival and spread of planted and recruited vegetation. Mean tree height was 50 feet for planted cottonwoods and 32 feet for planted river birch. Willows planted from cuttings grew to an average of 55 feet, with some approaching 70 feet. Average growth in feet per year was 4, 2.7, and 4.6 for cottonwoods, birch, and willows, respectively. The understory includes hydrophytic shrubs and saplings, with soft rush dominating in many areas. In summary, the results of this long-term study show promise for riverine forest restoration using fast-growing, pioneering trees and herbs taken from the site.

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Physiological Performance Measures and Tolerance Limits for Estuarine Indicator Species in South Florida

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Florida Bay is habitat to a vast and diverse assemblage of organisms. Species that occupy higher trophic levels are often used as indicators of environmental change. Higher Trophic Level species (HTLs) are environmentally, economically and socially important to Florida Bay, and Everglades National Park. Their significance ranges from supporting commercial and sport fisheries to aesthetics.

Salinity is a limiting factor in the physiology and distribution of estuarine species. Components of the Comprehensive Everglades Restoration Plan (CERP) will act to restore more natural freshwater flows to northeastern Florida Bay, thus altering the present salinity regime in the area. Timing, volume, delivery and quality of freshwater to Florida Bay can affect the structure and functional aspects of the diverse fish communities in the bay. We have chosen to work with four species of small fish that are key food resources (and thus critical to the survival and reproduction) to many species in the Bay, particularly wading birds.

Our studies focus on the following central theme and hypotheses: **Biological performance measures (i.e., growth, reproduction, survival) of estuarine fish will be controlled by changes in salinity and water quality that will occur as a result of the restoration of freshwater flow to the bay.**

A series of acute and subchronic physiological/behavioral toxicity studies were conducted to determine the effects of salinity changes on the life stages (embryo/larval, juvenile, adult) and fecundity of four native estuarine fish (*Cyprinodon variegatus, Floridichthys carpio, Poecilia latipinna, and Gambusia holbrooki*). Wild caught fish were bred in the laboratory using both artificial insemination (for livebearers) and artificial fertilization (for egglayers). Fish were exposed to six salinity concentrations (30, 15, 8, 4, 2, 0 ppt) based on salinity profiles in northeastern Florida Bay and adjacent Everglades areas. Growth (length, weight), abnormalities, survival and hematological endpoints (hematocrit, plasma osmolality) were measured after each salinity trial. Salinity trials included both rapid and gradual change events. Results show negative effects of acute, abrupt salinity changes on fish survival, development and reproductive success as a result of salinity stress. Our studies target reproduction and critical embryo-larval development as key areas for detecting long-term population effects of salinity change in Florida Bay.

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Pilot Study to Quantify Floodplain Soil Phosphorus in the Kissimmee River Restoration Area

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The Kissimmee River was channelized in the 1960s, draining approximately 12,000 – 14,000 ha of the system's floodplain wetlands, the majority of which were converted to agriculture. These changes resulted in severe ecological degradation, including changes to water quality facilitated by direct entry of nutrients from surrounding agricultural lands. The Kissimmee River restoration project is expected to restore thousands of hectares of floodplain wetlands that were lost following channelization. Restoration of sloughs and marshes along the river may increase retention of phosphorus originating from upland watersheds and headwater lakes. Since phosphorus is one of the key elements affecting wetland ecosystem productivity and perhaps the key nutrient in most freshwater ecosystems, a pilot study of the most common floodplain soil series was undertaken to make preliminary evaluations of soil phosphorus characteristics.

Soil survey maps revealed that Manatee-Floridana-Tequesta (MFT; high phosphorus retention properties), Basinger-Placid (BP; low phosphorus retention properties), and Udorthents (UD; spoil material, low phosphorus retention properties), all Mollisols, were the dominant floodplain soil series. Various forms of P were analyzed for 26 soil samples (16 MFT; 6 BP; 4 UD). Total phosphorus averaged (± SD) 548.88 ± 643.97 mg/kg, 140.83 ± 55.65 mg/kg, and 117.00 ± 15.34 mg/kg in MFT, BP, and UD soils, respectively. Total organic phosphorus (TOP) averaged 86.97 % of total soil phosphorus content. Mean TOP values were 439.16 ± 410.89 mg/kg, 126.44 ± 44.38 mg/kg, and 106.56 ± 14.25 mg/kg in MFT, BP, and UD soils, respectively. Labile inorganic phosphorus averaged 0.67 ± 1.64 mg/kg, 3.10 ± 2.48 mg/kg, and 0.70 ± 0.51 mg/kg in MFT, BP, and UD soils, respectively. In summary, soil phosphorus concentrations measured in this pilot study were highly variable and ranged from levels characteristic of natural land cover to those of intensive cattle operations.

Accurate estimates of key soil phosphorus components will contribute to an assessment of the role of floodplain soils in watershed-level phosphorus dynamics. While soil P levels varied widely, levels in some of the samples collected in the grazed floodplain were high; however, aqueous phosphorus concentrations in this reach of the river have been moderate. Moderate concentrations of aqueous P also have been measured on the inundated floodplain following Phase 1 of the restoration project. While firm conclusions cannot be drawn from this limited sample, further work should be considered to determine the effects that the Kissimmee River restoration project will have on nutrient retention and release from floodplain soils.

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Assessing the Effect of Hydrophilic Soil Amendments on Riparian Plant Growth and Survival in Western Texas

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The U.S. Army Engineer Research and Development Center, Environmental Laboratory (ERDC-EL) is currently conducting an investigation on Dyess Air Force Base (DAFB), near Abilene, TX, to explore a variety of methods for revegetating riparian areas along a series of drainage ditches. The climate at DAFB is a warm-temperate steppe with mild dry winters and hot humid summers with little precipitation, making revegetation efforts difficult without irrigation. A demonstration project area was planted during Winter 2004 within a 1250' long, 45' wide riparian buffer strip using native plant species. Objectives are to investigate the influence of commercially-available hydrophilic soil amendments (Terrasorb® and Driwater®) on plant survival and growth in the demonstration area, compare costs associated with irrigation versus the use of the soil amendments, and design and implement a monitoring program for the project. Within the demonstration plot, we planted 8 native tree and shrub species and applied varying combinations of hydrophilic soil amendment products, traditional irrigation, and a control, to determine the most efficient and cost effective methods for establishing the native plants. Results of the demonstration will be incorporated into a larger revegetation project encompassing all the major drainage ditches on the base during the next 2 years. The goals of the overall riparian revegetation project include establishing native plant buffer strips to trap overland flow of sediments and pollutants, provide a cost effective, feasible approach to revegetation, improve wildlife habitat on the installation, and implement a long term riparian vegetation monitoring program.

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Ecological Benefit and Impact Analyses of Alternative Plans for the North Palm Beach Comprehensive Everglades Restoration Project: A Procedural Approach for Restoration Planning

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The Comprehensive Everglades Restoration Project (CERP) is an 8 billion dollar restoration effort designed to improve hydrologic flows and deliveries to the Everglades system. The CERP planning process is providing the opportunity to investigate and evaluate the opportunities to enhance or restore the hydrologic regimes on the impacted wetland areas within the North Palm Beach- CERP project study area. During this plan formulation process, several alternative plans will be developed and analyzed to determine which plan provides the best opportunity for environmental restoration and water supply. Selecting the plan with the best opportunities for restoration requires quantification of ecological benefits that could be used to conduct cost effectiveness and incremental cost analyses. In order to determine ecological benefits and possible impacts associated with the natural systems of the project area, the Wetland Rapid Assessment Procedures (WRAP, Miller and Gunsalus, 1997) was utilized to assess the current functional condition of the proposed ecosystems. The current functional conditions are then used for quantitative evaluation of benefits ("lift") achievable with the different alternatives, and for evaluation of possible impacts of alternatives on non-target communities and environmental quality. In essence, the functional assessment provided the basis to determine restoration selection criteria and screen alternatives in terms of effective and efficient restoration benefits.

This presentation 1) describes the approach and processes developed to determine whether proposed alternatives would maintain, enhance or diminish ecosystem health 2) discusses a case study of Loxahatchee River watershed wetlands. The proposed evaluation methodology incorporates LIDAR elevation data, rainfall, wetland hydropatterns, baseline wetland functional assessments and watershed hydrologic modeling utilized by GIS analysts, wetland scientists, watershed managers and modelers.

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Ecosystem Assessment and Restoration in the Upper Mississippi River System (UMRS)

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Since 1986 Congress has recognized the UMRS as a nationally significant ecosystem, as well as a nationally significant commercial navigation system. For more than 200 years the UMRS has been regulated for purposes of improving navigational efficiency. The environmental consequences of river regulation have been many; these include altered hydrology, loss of connectivity with the floodplain, backwater and side channel isolation/sedimentation, altered geomorphology, and habitat fragmentation. Thus, the environmental character of the UMRS is a national concern, and plans for environmental improvements have recently been drafted by the USACE for review. The "Preferred Plan" includes a $5.3 billion long-term (50 year) framework for ecosystem restoration. If restoration of the UMRS is approved, proposed actions over the next 50 years are intended to modify hydrologic regimes, reduce sedimentation, restore tributary confluences, restore isolated floodplain areas, and improve habitat connectivity.

Assessment of UMRS restoration efforts will require detailed attention, through both monitoring and numerical modeling, to selected end points and performance measures as recommended recently by an Environmental Science Panel. Resource monitoring activities will focus on the outcomes of ecosystem restoration actions. Issues of proper scale and sample design, as well as data collection, management, and reporting will need to be addressed in this monitoring program. Both risk and uncertainty will be important considerations in decision-making with respect to the selection of ecosystem restoration and management approaches. Conceptual and simulation models will be developed and applied within a broader framework of adaptive management process to: 1) characterize the current state of the system; 2) create a holistic reference system; and 3) predict system-level outcomes of alternative actions and policies.

Models will be hierarchically organized to effectively describe the range of natural and anthropogenic factors that shape the condition of the UMRS ecosystem at several relevant scales. At the river basin and tributary watershed scales, models of sediment and nutrient transport and fate processes in the drainage network will be linked with river and reservoir water quality models to examine the ecological implications of material loadings to the river. At the navigation pool scale, channel and floodplain models of geomorphic response to sediment loadings will provide an improved basis for forecasting future geometry of the system. Models of biological production, population and community dynamics, and limiting factors will enable selection of the most appropriate and ecologically effective habitat restoration projects. The effectiveness of restoration actions will also be examined over larger system scales through the application of regionally scaled ecological models.

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Upper Mississippi River Navigation Study: Ecosystem Restoration as a Project Purpose

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The Upper Mississippi River - Illinois Waterway System Navigation Study was formulated to address both the Waterway transportation and ecosystem restoration needs of 1,200 miles of large river-floodplain ecosystem located within five states and containing over 200,000 acres of U.S. Fish and Wildlife Service National Wildlife Refuge System. The Upper Mississippi and Illinois Rivers were modified in late 1930s for shallow draft navigation by building 37 Dams with navigation locks. Dam construction and impoundment aging over 60 years has contributed to the loss of ecosystem diversity and limits the natural restorative processes of the large river system.

The preferred plan for ecosystem restoration is designed to restore and maintain a healthy and sustainable Upper Mississippi River System. The plan recommends actions necessary to operate and maintain the rivers both for navigation and the environment. The plan is predicated on science based adaptive management principles and acknowledges the collaborative integrated planning and implementation required to realize the system goals.

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Stream and Wetland Restoration in Delaware

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Delaware has developed a variety of innovative wetland restoration and construction techniques. Significant resources have been dedicated toward the development of these techniques, all of which aid in jumpstarting restoration projects. Employing construction techniques which replicate natural wetland systems has resulted in the establishment of many demonstration/education sites in excess of 200 acres. These wetland projects have been constructed with minimal engineering and in many cases have utilized "in the field engineering" practices. Emphasis has been placed on irregularly-shaped perimeters with micro and macro topography a must. Trees ranging in diameter from one to six inches have been relocated into wetlands with a backhoe or hydraulic excavator. Coarse woody debris has been added to provide habitat structure, long-term carbon source and basking/loafing areas for reptiles and waterfowl. Straw and horse manure have been added to provide organic matter as a substrate for macro invertebrates. The surrounding upland areas have been seeded with warm season grasses for buffers, filter strips and to provide additional wildlife habitat. Routinely, deserving/special projects are planted with nursery stock to further promote diversity. This special care provides opportunities for groups to participate in planting events and reinforce and apply their classroom lessons in the field.

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Detecting Trends in Water Temperatures in the Lower Klamath River, California

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The Klamath River, California, once was the second largest producer of anadromous salmon on the West Coast of the coterminous United States. However, production of salmon has fallen in recent decades, most likely for the conventional "4-H" reasons: habitat, hydropower, hatcheries, and over-harvest. Water quality, particularly water temperature, has been viewed as a critical habitat component and has been implicated as a factor limiting the recovery of anadromous salmonids in the Klamath Basin.

The upper portions of the Klamath Basin are isolated from moderating coastal weather such that summer water temperatures downstream are elevated with a greater frequency, and remain elevated for a longer time, than waters in adjacent coastal basins. These high temperatures are known to be stressful for cold-water salmon, and place the Klamath on an ecological "edge" in terms of salmon tolerance. Any increase in temperatures would be problematic for salmon recovery.

This poster reviews evidence of a multi-decade trend of increasing temperatures in the lower mainstem Klamath River. Based on model simulations, there is a high probability that water temperatures have increased approximately 0.5°C per decade (95% CI = 0.42 to 0.60°C/decade) since the early 1960s. The season of high temperatures stressful to salmonids has lengthened by about one month over the period studied and the average length of mainstem river with cool summer temperatures has declined by about 8.2 km per decade. Water temperature trends appear unrelated to small changes in mainstem water availability, but are consistent with measured basin-wide air temperature increases.

Uncertainties in quantifying the temperature trend are discussed, including statistical power, analysis period and length, and reliance on a simulation model to fill and extend measured water temperature data.

Implications for salmon life history are explored, with particular reference to adult spawning migrations, egg incubation, fingerling growth, and juvenile outmigration. Warming trends may or may not continue into the future. If warming continues, the likelihood of maintaining viable mainstem populations of naturally reared anadromous salmonids in the Klamath Basin will diminish.

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Quantifying the Effect of Dam Removal on Water Temperatures in the Lower Klamath River, California, and Implications for Salmon Recovery

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The Klamath River, in Oregon and California, once supported large runs of anadromous salmon. Water quality, and in particular water temperature, is influenced by multiple mainstem impoundments that support hydroelectric generation and irrigation. Elevated water temperatures may be one factor among many responsible for reducing Klamath salmon stocks. Dam removal is one option being considered by some parties to the Federal Energy Regulatory Commission (FERC) relicensing currently underway for these hydropower facilities.

We used a decision support tool, the Systems Impact Assessment Model (SIAM), that combined a network water quantity model (MODSIM) and a reservoir and river water quality model (HEC-5Q) to quantify the effect that removing the series of dams might have on water temperatures in the spawning and rearing portions of the mainstem Klamath. These models were calibrated, validated, and applied for a 40-year post-dam period using measured hydrology and meteorology. Then we hypothetically removed the mainstem impoundments from the SIAM model and re-estimated the river's water temperatures.

Removing the dams and impoundments in the simulation model did not appreciably change the absolute magnitude of high summer temperatures below the lowest dam site. Instead, the main thermal effect of dam removal is a more rapid adjustment of the river to ambient air temperatures, restoring the timing of the river's seasonal thermal cycle by shifting it 18 days earlier in the year on the average. The 18-day shift is roughly equivalent to the reservoirs' combined hydraulic retention times.

Such a shift would likely improve thermal conditions for adult Chinook (*Oncorhynchus tshawytscha*) during their upstream spawning migration by restoring cooler temperatures in the fall. Early egg incubation might also be improved for the same reason. In contrast, during the spring and early summer, the earlier temperature cycle might potentially harm Chinook salmon rearing in the mainstem and during their outmigration period because river temperatures would be warmer without the impoundments in place.

For most of the year, temperature effects due to dam removal would only be obvious for small distances downstream (~30 km). However, during the fall when tributary accretions are low and day-to-day air temperatures are cooling rapidly, dam removal could affect the river's thermal regime up to 200 km downstream.

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Use of an Amphibian IBI to Evaluate Success of Constructed Wetlands

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High species diversity in natural, established wetlands suggests that amphibians have a preference for natural wetlands over newly created wetlands. In an experiment conducted by Laan and Verboom (1990) it was found that all established pools supported amphibian populations, whereas 90% of the newly created pools supported amphibians. The number of individual amphibians sampled in established wetlands was also higher in seven out of eight of the species sampled. Pechmann *et al*. (2001) conducted a long-term study with the goal of determining the effectiveness of mitigation to compensate for wetland loss. It was found that the community structure of amphibians, including frogs and salamanders, was significantly different between the reference and created wetlands ($p<0.0001$, Pechmann *et al*. 2001). Salamanders, a biologically sensitive species and indicator of good health, were found in high numbers (4-5 different species) in the reference wetland. They found that even after 7 or 8 years, mitigation wetlands do not support sensitive species, like salamanders.

In April 2002, Micacchion published an amphibian index of biotic integrity (AmphIBI) based on monitoring of 67 natural emergent, shrub, and forested depressional wetlands in glaciated Ohio. These were monitored during the amphibian breeding season between the years 1996-2000. He developed wetland amphibian tolerance coefficients for 16 species. He used the tolerance coefficient to calculate the Amphibian Quality Assessment Index (AQAI), one of the five metrics that make up the AmphIBI. We modified the Micacchion coefficients of tolerance to include the cricket frog giving it a value of 6.

Reference wetlands generally scored highest in both the AmphIBI and the AQAI. The wetlands that contained the more diverse salamander communities were the highest metric scorers. The highest scoring wetland was the reference wetland that is forested and bordered by a railroad track, consistently scoring a 43. This pool tends to go dry in some summers, has no fish population, and has a good population of fairy shrimp and ambystomatid salamanders. It has few tolerant amphibians. The AmphIBI scores these types of wetlands highest and is less discerning for constructed wetlands. Most of the constructed wetlands had a score of zero with some at three. This set of metrics may be a good starting point, but more modifications should be made to better evaluate constructed wetlands.

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Assessing Chesapeake Bay Ecosystem Restoration Over Decadal Scales

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The Chesapeake Bay Program is the unique regional partnership that's been directing and conducting the restoration of the Chesapeake Bay since the signing of the historic Chesapeake Bay Agreement of 1983. The Chesapeake Bay Program partners include the states of Maryland, Pennsylvania and Virginia; the District of Columbia; the Chesapeake Bay Commission, a tri-state legislative body; the U.S. Environmental Protection Agency, representing the federal government; and participating scientific, citizen and local government advisory groups.

Assessment of ecosystem restoration within the Chesapeake Bay estuarine system and across the 64,000 square mile watershed rests heavily on a series of increasingly integrated monitoring networks focused on nontidal and river input water quality, tidal water quality, lower trophic level biological resources (plankton, benthos, underwater grasses), and baywide fisheries independent monitoring. Year by year accounting of on-the-ground implementation of agricultural and urban best management practices, riparian forest, stream and wetland restoration and point source treatment technology upgrades supplement the environmental monitoring networks by providing the basis for estimating near-term and future stream and tidal water delivered loads through model simulation. The partners are continuing to building cross-agency and institutional structures for integrated analyses of the wealth of generated data, simulated outputs and information. Partner and public assess to this primary data and interpreted information is being provided through the Chesapeake Information Management System, a network system of servers located across the watershed.

The partners have institutionalized common, agreed to ‘scales’ at which change through time will be assessed. Within the tidal waters, water quality conditions are assessed against a set of water quality criteria (being adopted as state water quality standards) by designated use habitats nested within 78 segments arrayed across the tidal waters. Biological indicators of ecological integrity are being evaluated at scales dictated by the spatial and temporal sampling networks. Within the watershed, a new nontidal monitoring network is being established to assess status and trends at the scales of the more than 40 tributary strategy sub-basins, where local actions are directed towards achieving allocated numerical caps on nutrient and sediment loads.

A select set of example of synthesis and information integration efforts leading to management decisions and significant policy agreement will be highlighted. Lessons learned regarding building in political opportunities for factoring in new scientific findings and technical assessment findings and adapting management approaches will be recommended.

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Forget All the Adaptive Management Theory: A Behind the Scenes Look at Science Synthesis for Management Application in Practice

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The Chesapeake Bay Program is the unique regional partnership that's been directing and conducting the restoration of the Chesapeake Bay since the signing of the historic Chesapeake Bay Agreement of 1983. The Chesapeake Bay Program partners include the states of Maryland, Pennsylvania and Virginia; the District of Columbia; the Chesapeake Bay Commission, a tri-state legislative body; the U.S. Environmental Protection Agency, representing the federal government; and participating scientific, citizen and local government advisory groups.

Over the past two decades of restoration efforts under the direction of the Chesapeake Bay Program partnership, a dozen key lessons have been learned are applicable to the management and restoration of watershed and coastal-oriented ecosystems:

1. Begin with comprehensive scientific studies that combine theory, detailed knowledge, monitoring and modeling.
2. Involve the highest levels of leadership possible.
3. Embrace clear, strong, specific, comprehensive and measurable goals.
4. Encourage the participation of a broad spectrum of participants.
5. Provide incentives and methods for institutional cooperation.
6. Inform and involve the public.
7. Develop a balanced set of management tools.
8. Choose pollution prevention before restoration or mitigation.
9. Test scientific theories and management approaches on a small scale.
10. Focus on integration of governmental agencies.
11. Conduct regular reassessments of goals and progress.
12. Demonstrate and communicate results.

Several examples-two technical syntheses of seagrass habitat requirements leading to adoption of water quality standards, establishing nutrient and sediment reduction goals, integrated watershed-wide monitoring network entering the third decade of data collection-will be used to illustrate these lessons learned. Real examples of where science synthesis and adaptive management have been put into practice will be described.

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Defining Restored Water Quality and Allocating Caps on Nutrient and Sediment Loads: Chesapeake Bay Lessons Learned

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The Chesapeake Bay Program is the unique regional partnership that's been directing and conducting the restoration of the Chesapeake Bay since the signing of the historic Chesapeake Bay Agreement of 1983. The Chesapeake Bay Program partners include the states of Maryland, Pennsylvania and Virginia; the District of Columbia; the Chesapeake Bay Commission, a tri-state legislative body; the U.S. Environmental Protection Agency, representing the federal government; and participating scientific, citizen and local government advisory groups.

With the adoption of the Chesapeake 2000 Agreement came an unprecedented opportunity to use decades of estuarine research and monitoring data to define restored Chesapeake Bay water quality and establish far reaching nutrient and sediment reduction goals. The resultant Bay specific water quality criteria-dissolved oxygen, water clarity and chlorophyll-along with tidal habitat defined designated uses are being adopted by Maryland, Virginia, Delaware and the District of Columbia as water quality standards. Using a unique integration of monitoring data and model simulated outputs, caps on nutrient and sediment loads required to achieve the Bay criteria were allocated to 44 sub-basins across the 7-state, 64,000 square mile Chesapeake watershed. The critical roles played by estuarine science, estuarine scientists and resource managers in deriving these precedent setting criteria and allocation the nutrient and sediment loading caps will be illustrated.

Over the past two decades of restoration efforts under the direction of the Chesapeake Bay Program partnership, a dozen key lessons have been learned that should be applicable to management and restoration of coastal ecosystem in New Jersey as well:

1. Begin with comprehensive scientific studies that combine theory, detailed knowledge, monitoring and modeling.
2. Involve the highest levels of leadership possible.
3. Embrace clear, strong, specific, comprehensive and measurable goals.
4. Encourage the participation of a broad spectrum of participants.
5. Provide incentives and methods for institutional cooperation.
6. Inform and involve the public.
7. Develop a balanced set of management tools.
8. Choose pollution prevention before restoration or mitigation.
9. Test scientific theories and management approaches on a small scale.
10. Focus on integration of governmental agencies
11. Conduct regular reassessments of goals and progress.
12. Demonstrate and communicate results.

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The Restoration of Naples Bay

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Naples Bay is a relatively narrow and shallow estuary ranging in width from 100 to 1500 feet, and in depth from 1 to 23 feet. Prior to development, the Bay drained about 20 square miles, but currently, it is the receiving body from approximately 120 square miles due to the construction of the Golden Gate Canal system. Natural water inlets have been altered by urban infrastructure that has virtually eliminated historic flowways and impacted its water and biology. Development has created stormwater inflows laden with fertilizers, pesticides, heavy metals, and petroleum.

In late 2002, a group of people convened to address the Bay's problems. This group included staff from city, state, and local government, environmental groups, and the private sector. They identified three major problems facing the Bay:

- Stratification of the water column,
- Stormwater runoff , and
- Loss of intertidal habitat.

A short time after the group began meeting, the South Florida Water Management District (District) approached them, identified a number of projects designed to address these problems, and asked them to rank the projects, which they did, as follows:

1. Mapping and Modeling of Naples Bay,
2. Implementation of the Gordon River Basin Stormwater Management Master Plan,
3. Modification of canal weirs,
4. Restoration of submerged aquatic vegetation, oyster reefs, and mangroves, and
5. Development of a Gateway Triangle Stormwater Management Plan.

In May of 2003, the Rookery Bay National Estuarine Research Reserve put on a workshop for elected officials, and Naples Bay was used as a case study. Subsequently, the Collier County Board of County Commissioners and the Naples City Council passed resolutions advocating the inclusion of Naples Bay in the state Surface Water Improvement and Management Program. The Southwest Florida Watershed Council, the Conservancy of Southwest Florida, and Collier Audubon Society wrote letters in support of SWIM designation to the District. In August of 2003, the District authorized the development of a SWIM Plan for Naples Bay.

On February 14, 2004, the first Naples Bay Day celebration was held under the theme of "Love Your Bay Day." The public enjoyed exhibits, food, live music, and free boat rides.

This year, the Florida Legislature provided over $2 million to fund the restoration projects identified by the Naples Bay group.

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Process-Based Principles for Restoring Dynamic Ecosystems

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Process-based restoration focuses on re-establishing natural rates and magnitudes of physical, chemical, and biological processes that sustain biodiversity and productivity in dynamic ecosystems. It contrasts with attribute-based restoration, which focuses on creating specific habitat characteristics that meet perceived “good” habitat conditions or uniform habitat standards. Process-based restoration relies on the understanding that local populations or communities are adapted to natural habitat conditions within their range, and that those habitats vary in space and time. Disturbance processes (e.g., fire, storms) create patchy environments at many scales, and recovery processes (e.g., colonization, succession) support diverse and productive biological communities within those environments. Restoration efforts that re-establish natural rates and magnitudes of system processes promote sustainable ecosystem recovery, and help avoid common pitfalls of attribute-based restoration such as creating habitats that are outside the range of a site’s natural potential, fixing habitats in space and time, and building habitats that are ultimately overwhelmed by untreated system drivers. Fundamental principles underlying process-based restoration are: (1) restoration must address processes that drive ecosystem change, and (2) scale of restoration must be relevant to landscape and biological process scales. Consideration of these principles in ecosystem restoration will help re-establish the natural range of habitat conditions to which biological communities are adapted.

Process-based restoration is compatible with many land uses and ecosystems, but certainly not all. In the management of watersheds and riverine ecosystems, for example, many forestry and agricultural land uses can be retained while restoring supply of sediment to streams, riparian functions, and river-floodplain processes. However, in heavily developed areas, certain ecosystem processes (e.g., flooding) may not be conserved without causing socially unacceptable consequences. Focused analysis of land use influences on these processes identifies specific locations on the landscape where adjustments to land uses can restore processes, as well as broad areas of the landscape where land uses can proceed with relatively little impact on riverine ecosystems. Restoring such processes allows dynamic riverine ecosystems to express their natural potential, which generates spatial and temporal variation in habitat characteristics and supports diverse biotic communities. Non-point processes (e.g., erosion) often require restoration at the scale of watersheds to effectively restore lotic ecosystems, whereas reach-level processes (e.g., maintaining floodplain connectivity) can be effective at smaller spatial scales. Life-history scales of migratory animals may be larger than the scale of watershed processes (e.g., anadromous salmon), requiring a strategic approach to restoring suites of habitats throughout river networks. We illustrate application of these principles in both semi-arid and humid river ecosystems of the Pacific Northwest, USA.

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Southwest Florida Coastal Conservation Corridor Plan

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The Southwest Florida Coastal Conservation Corridor Plan (CCCP) is a detailed planning and protection initiative from Crystal River to Everglades National Park's Shark River Slough and east to the Lake Wales Ridge. The CCCP compiles, maps, and gathers biological, ecological, and hydrological data on natural lands critical for endangered species and habitat conservation. The CCCP has two phases: Scoping and Final Product. Work began in March 2000 and wil be completed July 2004. During Scoping, we compiled regional information from over 35 agencies and published reports. The Nature Conservancy's knowledge of private land natural resource values formed a component of the analysis. The Final Product is a detailed GIS-based map series with narrative descriptions of the natural resources, and other site attributes. The CCCP encompasses all existing conservation lands, proposed conservation lands; County platted ownerships, existing public access points, existing conservation easements, and metadata of ownership information. The CCCP analysis of the map series and concomitant data layers generates a conservation corridor system along Florida's west coast including estuarine bays, lagoons, and tributaries. CCCP partners will work to implement the corridor system through various fee simple and less-than-fee conservation methods to sustain Southwest Florida's biological diversity, estuarine hydrology, watershed quality, and estuarine fisheries.

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Integrating Science and Planning with Policy in Southwest Florida

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The Southwest Florida Regional Restoration Coordination Team (RRCT) was established by the Everglades Restoration Working Group to identify restoration and research priorities in southwest Florida. The RRCT is a coalition of federal, state, water management district, regional, County, City, private non-profit, and partnership organizations which include private for-profit representation. The organization includes primarily scientists and planners. In 2003, the RRCT identified 4 restoration research priorities (out of over 60 identified research needs) and 16 restoration priorities (4 for each of the 4 watershed basins in the study area).

The priorities were arrived by consensus and are advocated by the RRCT members through various methods and forums. Through this network, the priorities are being implemented. Because of the multiple voices emphasizing these priorities, funding and effort has been invested in each of the research priorities. The South Florida Water Management District (SFWMD) is funding components of estuarine mixing model. The Charlotte Harbor National Estuary Program (CHNEP) hosted a Water Budget Workshop. The Conservancy of Southwest Florida, Inc. is investigating the importance of short hydroperiod ephemeral wetlands.

Restoration needs were identified through various processes including the RRCT, the Southwest Florida Coastal Conservation Corridor Plan (CCCP), the Estero Bay Agency on Bay Management, CHNEP, and the Lee County Mitigation Plan. These partnerships compiled restoration needs under the auspices of the Southwest Florida Regional Planning Council in a Geographic Information System (GIS) map with linked database. Many of the 16 priority restoration projects are being implemented because of the unified voice of scientists, planners, and elected officials.

One such priority is the Babcock Ranch environmental acquisition and is one of the more ambitious restoration priorities at over 91,000 acres. This project will link an 89,000 acre complex of connected state parks and wildlife management areas to a 211,000 acre complex of preserved conservation land and ranchlands and the largest lake in Florida. Currently, the SFWMD entered into an option with the Babcock Florida Company to prepare an acquisition agreement and funding strategy on behalf of a large coalition of counties, cities, state, regional, private sector, and citizen interests.

The relationship of the overall watershed restoration strategy to several other restoration priorities currently being implemented will be discussed.

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Information Scale, Reporting and Assessment: Performance Measures for Biscayne Bay Fish Communities

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Currently there are a variety of reporting and assessment needs for the Comprehensive Everglades Restoration Plan as well as other Ecological Restoration Projects. It is critical to evaluate the use and need for the reporting tool in order to properly apply data and understand which monitoring information best suits the need. Data is reported for various reasons. Data that is scientifically valid and useful is not necessarily the best data for reporting to justify funding which must be done on an annual scale. Scientific data can be difficult to communicate and may not be particularly useful from a 'project marketing' perspective. If the reviewing body is determining project merits based on scientific value alone often this information is not particularly interesting to the general public or lawmakers who must fund these projects. Likewise projects must show changes over the time scale for the project review. Reporting information to justify funding on organisms that change over the course of multiple years in response to climate patterns of drought and flood cycles is not as useful as those organisms which show meaningful change over annual cycles. In order for these descriptions to be meaningful to the audience of educated lay people they must also be interesting. Thus plankton would be less 'marketable' than shrimp or crocodiles. Questions that must be asked to ensure that performance measures are scaled and targeted appropriately include: What it is?; What does it include?; What is the rate and scale of change?; and finally What is the output and what format it is in? Using fish communities and historic fish distributions, Biscayne Bay is a good example of this information both for scientific and public reporting. Data is analyzed for the bay from 1895 to present for historic fish and fishery community distribution and performance measures and reporting information described.

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Mercury in Mosquitofish: Assessing the Influences of Bioaccumulation and Bioavailability

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Eastern mosquitofish (*Gambusia holbrookii*) is an important sentinel species used to monitor mercury contamination of the aquatic ecosystem in the Everglades. Like other freshwater fish, the primary route of mercury uptake into mosquitofish tissues is through diet as bioavailable methylmercury (Spry and Wiener, 1991). Yet, it is unclear whether variations in mosquitofish mercury observed across the Everglades are due primarily to differences in bioaccumulation (i.e., increase of mercury at higher trophic levels) or abundance of methylmercury available to the food web base. We use isotopic methods to investigate the importance of these two controls on mosquitofish mercury at the landscape scale.

As part of the USEPA REMAP project, mosquitofish and periphyton were collected during September 1997 from over one hundred sites throughout the Everglades and analyzed for mercury concentration. The USGS analyzed splits of the samples for nitrogen ($\delta^{15}N$) and sulfur ($\delta^{34}S$) isotopic composition. Mosquitofish were analyzed as composites of 5-10 fish and periphyton samples were analyzed in bulk. Tissue $\delta^{15}N$ is widely used to estimate the relative trophic positions of organisms in a food web, and should correlate positively with tissue mercury if bioaccumulation is an important control on mosquitofish mercury concentration. Tissue $\delta^{34}S$ values potentially indicate the extent of dissimilatory sulfate reduction in sediments, a process used by sulfate-reducing bacteria (SRB) during conversion of inorganic Hg(II) to bioavailable methylmercury. Because this process increases the $\delta^{34}S$ value of remaining sulfate (assimilated by the food web base), mosquitofish $\delta^{34}S$ should show positive correlations with SRB activity, methylmercury production, and mosquitofish mercury concentrations.

Mosquitofish and periphyton isotopes are significantly correlated ($\delta^{15}N_{Mosq}$ vs. $\delta^{15}N_{Peri}$, $\delta^{34}S_{Mosq}$ vs. $\delta^{34}S_{Peri}$), indicating that a component of the bulk periphyton analyzed in this study is part of the mosquitofish food web. Mosquitofish mercury does not correlate significantly with tissue $\delta^{15}N$ or the $\delta^{15}N$ difference between mosquitofish and periphyton ($\Delta\delta^{15}N_{Mosq-Peri}$). Thus, differences in trophic level (and bioaccumulation) among the fish do not contribute a detectable influence on mercury variations in the samples studied. This conclusion is supported by the results of a previous study that found no significant correlation between gut contents measures of trophic position and mercury in the same mosquitofish specimens (Trexler and Loftus, 2001). In contrast with the $\delta^{15}N$ results, mosquitofish mercury levels show strong positive correlations with mosquitofish $\delta^{34}S$ and $\Delta\delta^{34}S_{Mosq-Peri}$. This suggests that during the period studied, mosquitofish mercury concentrations in the Everglades ecosystem were primarily influenced by the bioavailability of mercury, rather than by varied trophic position.

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Beyond the Checkbook: A Model for Grantmakers Supporting Ecosystem Restoration

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The Chesapeake Bay Trust, a private, non-profit, grantmaker, serves a unique role in bridging the activities of local watershed organizations and environmental educators with regional watershed restoration goals. As a funding institution, the Trust provides a broad array of programs and communication tools that link restoration and protection policies, with the needs and desires of local organizations and schools that are dedicated to bringing back the Bay.

In 2000, the Chesapeake Bay Program reaffirmed its commitment to improving the health of the Bay by establishing a new strategy called the Chesapeake 2000 Agreement (C2K). The C2K established more than 100 commitments, many of which require watershed groups and education institutions to take action at the local level to accomplish Bay-wide ecosystem goals. The Trust recognized the opportunity to show grantees, such as watershed associations, community organizations, and schools, how they could contribute and participate in achieving C2K goals. Recognizing this opportunity, the Trust adapted its funding philosophy to better support Chesapeake Bay-wide management policies.

The Trust, which provides $1.8 million in funding per year, has adapted its grantmaking and outreach programs to support Bay-wide goals by: 1) aligning its grant priorities with the six main goals of the Chesapeake 2000 Agreement; 2) providing targeted grant programs that directly support established Bay restoration goals, 3) supporting and developing innovative partnerships to strengthen project implementation at the local level, 4) developing and practicing a grantee-centered communication philosophy, and 5) restructuring internal grant administration processes to measure the impact of Trust grants on achieving Bay-wide goals.

For instance, in response to the Chesapeake 2000 Agreement directive to provide every child with a meaningful Bay experience (MBE) by 2005, the Trust developed the Meaningful Bay Experience grant program that resulted in more than $450,000 for schoolyard habitat programs across Maryland. The Trust encouraged innovative partnerships between scientists, educators, funders, and schools and targeted its outreach to assist with the achievement of the MBE goal.

The Trust has demonstrated the ability to effectively communicate with grantees by understanding their challenges and limitations and providing them with hands-on attention. As a result, the Trust has established a reputation as a supportive grantmaker, one that advances Bay-wide goals while nurturing beneficial practices at the local level.

The Chesapeake 2000 Agreement provides a sound science and policy based context for the Trust's grant giving priorities. This presentation will highlight practical examples and the lessons the Trust has learned in bridging the restoration policies, with the actions and directions of local groups and educational institutions that are committed to environmental protection.

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Restoration of Aquatic Grass Communities of Chesapeake Bay: How Should We Proceed?

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Chesapeake Bay has historically supported extensive aquatic grass meadows (>240,000 ha). However, water quality degradation from increased sediment and nutrient inputs has reduced the aerial coverage and depth penetration of aquatic grasses, with <15% of historical distributions remaining (24,348 ha; 1985-1996 mean). Chesapeake Bay aquatic grasses are comprised of a variety of freshwater angiosperms and marine seagrass species. These various species form different communities, largely related to salinity (Moore *et al*, 2000), which have different environmental factors limiting their effective restoration. While water quality has impacted all regions, freshwater mixed communities are primarily limited by grazing pressure, low salinity *Potamogeton* and *Ruppia* communities by variable water quality and high salinity *Zostera* communies by propagule availability.

Concerted efforts by scientists, managers, politicians and the general public have attempted to protect, preserve and restore aquatic grass within Chesapeake Bay (Orth *et al*, 2002). These efforts have been severely compromised by continued water quality degradation, resulting in phytoplankton and leaf epiphytes along with suspended sediments that have reduced the light available to aquatic grasses (Kemp *et al*, 2004; Dennison *et al*, 1993).

Inter-annual variability of freshwater flows leads to large fluctuations in aquatic grass distributions. For example, a 266% increase in freshwater flows from 2002 to 2003 decreased Chesapeake Bay aquatic grass area by 28%. These changes were differently expressed between the different aquatic grass communities. Longer time scale changes in aquatic grass distributions have also been observed. For example, water quality improvements in the Potomac, Patuxent and Severn Rivers have resulted in re-establishment of extensive aquatic grass meadows. These examples suggest that once water quality is amenable for aquatic grass growth, restoration is not necessary for re-establishment of Chesapeake Bay aquatic grasses.

This raises the question of the effectiveness of active aquatic grass restoration efforts, compared with developing a focus on improving water quality to allow natural re-establishment. Thus, aquatic grass restoration efforts in Chesapeake Bay should be carefully targeted and placed in the context of the natural variability of both water quality and aquatic grass communities.

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Jamaica Bay Marsh Island Ecosystem Restoration

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The Jamaica Bay Marsh Islands are the heart of a complex, urban ecosystem in Jamaica Bay, New York. The marsh islands are part of the Gateway National Recreation Area and as such are under the jurisdiction of the National Park Service (NPS). Despite their inclusion in the National Park system and strong regulatory protections, the inter-tidal marsh islands of Jamaica Bay lack stability and have experienced significant losses in area and function over the last 80± years.

Historic data collected by the NPS, the New York State Department of Environmental Conservation (NYSDEC) and the New York City Department of Environmental Protection (NYCDEP) indicate that the marsh islands are disappearing at an alarming rate. NYSDEC tidal wetland mapping data recorded 4,457-acres of wetlands in 1974 in the Jamaica Bay Watershed (including the marsh islands); as of 1999, the acreage was reduced to only about 2,266-acres, including mainland fringe marshes and the marsh islands. Of the nearly 2,472-acres of marsh islands present in 1924, approximately 928-acres currently remain. Of those that remain, all are fragmented to some degree.

In response to the alarming rate of loss, the ACE is planning a large-scale restoration program, the Jamaica Bay Marsh Islands Ecosystem Restoration Project. This project plans to restore approximately 250± acres of inter-tidal (*Spartina alterniflora)* salt marsh, approximating the 1974 configuration, on two islands in the bay; Elders Point Marsh and Yellow Bar Hassock. The objectives of the project are to restore a significant acreage of former inter-tidal salt marsh, stabilize the remaining salt marsh acreage and increase overall functionality of the marsh islands and the estuary. In order to determine the most effective manner of achieving these objectives, the ACE developed a pilot restoration program for two (2) marsh islands consisting of three (3) test plots. The islands were selected due to the fact that they are targeted for restoration, the differences in the nature of the salt marsh loss, the differences in substrate composition and the construction logistics. The primary objectives of the pilot program were 1) to determine optimal plant sources and planting methods; 2) to determine critical planting elevations to create ideal establishment and growth conditions for *S. alterniflora*, and 3) to determine the best and most cost effective methods of construction and permanent erosion control. The pilot program (summer 2004) tested three planting treatments and two erosion control treatments. The results of this pilot program along with the results from other restoration initiatives and studies, including the National Park Service's Big Egg Marsh Pilot Program (summer 2003) will factor into the USACE's large-scale project which will target approximately 250-acres of salt marsh restoration.

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Influence of 20th Century Water Management on Plant Communities in the Everglade's Marl Prairies

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Marl prairies of South Florida are a seasonally wet, sparsely vegetated, low relief landscape where grasses are the dominant vegetation. The Cape Sable seaside sparrow (*Ammodramus maritima mirabilis),* an endangered subspecies, nests in these grasses during the dry season. Concern over potential changes in hydroperiod, specifically increased water levels during nesting season, has influenced plans to manage hydrology to maintain sparrow habitat. However, the historic distribution and plant community composition of this habitat prior to monitoring efforts that began in mid-20th century has been unknown. Given the dramatic changes in vegetational distribution throughout the Everglades during the 20th century, a longer-term perspective on the distribution of marl prairies and associated animal communities is appropriate.

We analyzed pollen, plant macrofossils, and calcareous microfossils from sediment cores collected from solution holes within the marl prairie landscape in Big Cypress National Preserve (BCNP) to obtain a paleoecological record of the community. Age control relies on pollen biostratigraphy, particularly the abundance of Australian pine pollen (*Casuarina equisetifolia).* Paired analyses of ^{210}Pb and pollen from numerous sites throughout the South Florida peninsula date *C. equisetifolia* first occurrence in sediments as 1910+/- 15 years; it becomes common after 1940.

The reconstruction of past vegetational communities is based on the comparison of fossil assemblages to modern assemblages from surface samples collected in several different wetland communities throughout the Everglades. Results indicate pollen assemblages from sediments deposited before 1900 AD indicate wetter than modern conditions. Post-1930, marl content increases in sediments and pollen assemblages indicate drier conditions. In particular, the greater abundance of Poaceae (grass) pollen in post-1930 sediments indicates that the present marl prairie vegetation has occupied these sites for the last several decades. The timing of this vegetational change corresponds to construction of water control structures and roads, such as the Tamiami Trail, in the early 20th century.

These data suggest that the present distribution of marl prairies of the western Everglades is due in part to water diversion during the 20th century. Before water diversion, wetter conditions and sawgrass marsh vegetation growing on peat soils occupied the region. Further analyses of other sites in both the eastern and western Everglades can clarify the 20th century distribution of the marl prairie plant community.

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Quantifying the Role of Microbes and Plants in Methylmercury Cycling in Coastal Saltmarshes as Basis for Wetland Restoration and Management in the Hamilton Army Airfield on San Pablo Bay

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Plans are underway to restore tidal wetland habitat on 203 acres of the former Hamilton Army Airfield (HAAF) on San Pablo Bay, using dredged material from Oakland Harbor and navigable parts of the Bay area. The re-establishment of wetlands in the San Francisco Bay/Delta System using dredged material from the bay has the potential for mobilizing mercury in the sediments. The origin of this contamination in the Bay System is largely from the historic mining of mercury in the nearby coastal mountains. Methylmercury (MeHg) can be produced from inorganic mercury by certain bacteria in anoxic sediments. MeHg is highly toxic and can accumulate in food webs. Other bacteria in turn can demethylate MeHg, decreasing the MeHg pool available for uptake by other organisms and for transport from the wetland. The potential for coastal wetlands to act as a source or sink for MeHg has to be assessed and management measures to minimize MeHg production evaluated. Our objectives are to quantify the roles of microbes and plants in MeHg cycling in two nearby tidal wetlands, considered as representative for the restoration site, using a mass balance approach.

This study evaluated the methylation and demethylation rates in sediments to quantify marsh standing pool sizes of MeHg, using a stable isotope approach. Mean concentrations ranged from 0.79 to 1.80 ng MeHg/g sediment DW. MeHg concentrations in the plants usually exceeded those in sediments. Mean MeHg concentrations in plants varied from 1.08 ng/g DW in stems to 5.59 ng/g DW in roots of Pacific cordgrass (*Spartina foliosa*). Overall, rates of Hg methylation in sediments showed a large variability within and among sites. Methylation rates in sediments decreased in the order epipelic algae>plant-vegetated >non-vegetated, and mean values varied between 0.12 and 6.01 % of Hg per 12 h. Daily methylation rates were 1.47 and 1.82 ng/g DW in sediments vegetated by cordgrass and pickelweed (*Salicornia virginica*), respectively, and 1.43 ng/g DW in non-vegetated sediment. Daily demethylation rates were 0.59 and 0.26 ng/g DW in sediments vegetated by cordgrass and pickleweed, respectively, and 0.59 ng/g DW in non-vegetated sediment. Because the methylation:demethylation ratio's exceeded 1, these marshes are sites of net MeHg production. Studies are underway to evaluate net marsh MeHg production, potential for export into the Bay, and fate and effects in the food web. This study will provide site-specific information, needed as a basis for wetland design and management in the San Francisco Bay area.

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Putting Fish Back Into Fish Creek: Creek Restoration in Urban Anchorage

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Founded in 1922, the young city of Anchorage, Alaska has grown rapidly into the largest city in the state. During its period of most rapid growth between the 1950s and 1970s city development filled wetlands, channelized creeks, and buried stream sections in pipes. The creeks suffered and fish populations declined as urban impacts increased. Fish Creek was no exception: its 1,000-acre watershed was nearly 80 percent developed and almost a quarter of its channel piped. To many the creek had been lost. In 1989 record rains in Anchorage brought large-scale flooding and a wake up call that the city's creeks needed repair.

After the floods in 1989 HDR Alaska, Inc. (HDR) began working with the Municipality of Anchorage Project Management and Engineering Department (PM&E) on a program to reduce flood risks in the city. Realizing that the entire Fish Creek system needed significant improvement, PM&E and HDR developed a watershed approach to improving the creek. This approach has focused on the placing the creeks aesthetic, habitat, and social values at the same priority as its use for flood conveyance. Over the past 15 years PM&E has invested over $15 million conveyance and creek improvement projects including daylignting piped sections of creek, purchasing creek easements, replacing culverts with bridges, construction storm water treatment systems, and purchasing and demolishing buildings. These efforts have been successful in restoring creek functions, increasing public support for such efforts, and vastly reducing flood risks. The work is ongoing with $10 million in additional work planned in the next 3 years. With these efforts the creek habitat has improved and fish are returning to the creek.

This presentation will cover the project history, describe the types of projects undertaken and their results, and discuss the political and social context of the project and how these factors have affected its outcomes. It turns out the political and social factors encountered in ecosystem restoration are more difficult to solve that the technical and scientific issues.

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Biscayne Bay Hydrodynamic Data Collection

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Currently, Biscayne National Park, Miami-Dade County and United States Army Corp of Engineers are involved in updating the existing hydrodynamic and salinity transport model. The hydrodynamic data collection program has been developed to better understand circulation patterns within Biscayne Bay as part of the Comprehensive Everglades Restoration Plan (CERP). The data collected is being used in the validation and verification of the TABS-MDS model for the CERP- Biscayne Bay Coastal Wetlands Project and as a monitoring tool for the RECOVER monitoring and assesment plan. There are 37 sampling stations instrumented with YSI 6-series data sondes. Fourteen of these stations are equipped with data sondes at the surface and at the bottom while the remaining 23 have bottom units only. In addition to these sites, there are three data sonde profilers and two current meters also collecting data for this project. Data collection sites were chosen by looking at various contributing factors such as navigational channels, canals and inlets, and freshwater inflow. At sites instrumented with YSI data sondes temperature, pressure, and salinity are being monitored at 15-minute intervals to determine current velocities, water levels, and salinity regime. This is especially important in the near-shore area as freshwater inflow has significant effects on biota, benthic communities, and the health of Biscayne Bay. The revised hydrodynamic model will more closely reflect three-dimensional salinity conditions and will in turn help to determine the importance of stratification and freshwater inflow on salinity and circulation patterns in Biscayne Bay.

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Partnerships in Planting Seeds of Hope

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The Anacostia Watershed Society, (AWS), a ‘social-profit’ environmental organization based in Bladensburg, Maryland, in partnership with the U.S. Army Corps of Engineers, Baltimore District, U.S. Environmental Protection Agency and the District of Columbia Office of Watershed Protection, has developed a unique community-based wetland restoration program called Rice Rangers. During colonial times, it is estimated that the tidal Anacostia River was bordered by 2,500 acres of freshwater wetlands. Today, there are fewer than 200 acres, with most of these having been re-created in the past decade by the Corps. Early records and photographs show wild rice (Zizania aquatica) as a dominant keystone plant in the Anacostia, providing cover, food for wildlife and nutrient uptake services to the river.

The Rice Rangers program involves public school students, as well as members of the general public, in the propagation and restoration of wild rice and other emergent plants into the Corps of Engineers’ newly created wetlands, on the Anacostia River in Washington, DC and Maryland.

The Rice Rangers program has been built on the shoulders, so to speak, of the Corps of Engineers Section 1135 program to restore wetlands in the Anacostia River. Mud flats created by high sediment transport in this urbanized watershed were not sustaining emergent plant life due to low elevation and tidal erosion. In response, the Corps designed and implemented a dredge and deposition schedule for river sediments, which, when dewatered, provide low, mid and high level elevations conducive to emergent plant growth.

When the Corps began implementing the project, AWS began an instructional program involving local schools in the collection of seeds from emergent plants and wild rice, and in the building of ‘wet beds’ to propagate these plants. When ready, these plants are transplanted into the open wetland areas, or, in certain situations, seeds are broadcast in the fall and early spring directly onto the mud flats. These efforts successfully complement the Corps’ project.

The propagation cells are thriving in the Anacostia’s nutrient rich tidal sediments. A fencing process to create ‘goose exclosures’ provides protection from an overpopulation of resident Canada geese, which, if left unchecked for a season, would decimate the plants and root base through over-grazing. Efforts are underway to create a goose management plan, led by the District of Columbia government, the National Park Service, and the USDA Wildlife Services.

Involving members of the community in this exciting restoration project serves to build ownership and stewardship of these natural resources and provides students with the opportunity to develop an interest in careers associated with ecosystem restoration. Typical wetland restoration by government contractors does not involve schools or community groups. The Rice Rangers program model provides hands-on service learning opportunities for students and a venue for wetland education, all of which helps build a feeling of connection to the river.

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An Agency Approach to Watershed Enhancement: Learning from the Past and Planning for the Future

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The North Carolina Wildlife Resources Commission's (WRC) stream restoration program evolved during the 1990s as a way to repair degraded stream channels and improve aquatic habitat. It became a self-supporting program in 1998, when the WRC was granted a $3 million contract by the North Carolina Department of Transportation (NCDOT) to provide 60,000 linear feet of stream restoration. This restoration was necessary to meet mitigation needs for road construction. The WRC also received $2 million in grants from the Clean Water Management Trust Fund (CWMTF) to purchase easements and restore riparian areas for purposes of improving water quality. While these projects were to be carried out in targeted geographical areas, they were not based on completed watershed assessments. As a result, general landowner recruiting efforts have resulted in a patchwork of restored sites. The CWMTF grants expired in mid-2004 and we expect to fulfill our NCDOT responsibilities in 2005. Due to changes in the NCDOT mitigation program and increased competition and requirements for CWMTF grants, funding of this nature will be more difficult to obtain without advanced planning.

Expiration of the grants and fulfillment of the contracts necessitated planning for the program's future. Representatives from the divisions of Conservation Education, Engineering Services, Inland Fisheries and Wildlife Management examined the existing program. Their charge was to determine the best options for improving the operational function of the program that would result in improved biological function while maintaining cost effectiveness. They reviewed the existing program goals and objectives, assessed the potential to integrate all divisions into the program, and identified issues critical to implementing the recommendations.

A key change to the program's goal was to embrace a watershed-based concept that considers both fish and wildlife habitats within the riparian corridor and incorporates existing WRC management objectives. This complements existing upland wildlife management programs and results in an ecosystem approach. The heightened emphasis on the ecosystem approach led to consensus that biologists should lead restoration projects and that primary responsibility for them should remain in the Inland Fisheries Division. Engineering Services could assist in stream restoration design, construction, and maintenance. Wildlife Management could provide input into management of riparian areas, recruiting landowners, and integrating existing WRC wildlife programs. Conservation Education Division's key role would be to assist in marketing and promoting the program. Critical issues in determining the watershed enhancement programs future include identifying new funding sources, lands acquisitions, and developing or improving partnerships with other government and non-government agencies. A first step in implementing this plan will be to complete a statewide watershed prioritization study and establish baseline measures of program improvement.

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Responses of Littoral Vegetation to Restored Flow in the Kissimmee River

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Prior to channelization, the extent and species composition of littoral plant communities in the Kissimmee River were typical of a low-gradient river environment. Aquatic vegetation was limited, likely primarily by flow, to narrow littoral zones dominated by emergent species. After completion of canal C-38 and diversion of flow to the canal in 1971, remnant channels became virtually stagnant pools. Littoral vegetation beds expanded toward mid-channel areas and cover of floating and mat-forming species increased relative to cover of emergent species. To monitor responses of littoral vegetation to restored flow, we collected plant species composition data and vegetation bed measurements twice annually (winter and summer) from 1998-2003 at transects in a control area and in channels slated for restoration of flow. Reference data collected in a semi-restored channel in 1998 allowed specific predictions of responses to restored flow. Following restoration of flow, mean vegetation bed widths on two channel curvature categories (inner bends and straight reaches) and mean vegetated percentage of channel declined substantially and significantly. The species composition of littoral areas converted from communities co-dominated by floating/mat-forming species and emergent species to communities heavily dominated by emergent species.

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Multi-Decadal Efforts to Restore the Patuxent River Estuary: A Synthesis of Research, Monitoring and Management Activities

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The Patuxent is a tributary of Chesapeake Bay and, while smaller than several better known and larger Chesapeake tributaries, it's importance as a restoration system is large. There has been long term and clear public recognition that excessive nutrient inputs have degraded the system and research and monitoring records have documented these impacts during the past 50 years. Considerable legislative and regulatory attention has focused on this tributary because of successful legal challenges to earlier water quality plans and because of it's proximity to the nation's capital. The Patuxent basin is entirely within Maryland, a situation that simplifies jurisdictional complications, and because of this, and the extensive record of ecosystem performance, it has often been used as a model for the restoration of Chesapeake Bay.

Observations concerning the Patuxent survive from the early 19th century and more modern records date from the late 1930's. These early observations suggest a clear water estuary, with intense benthic activity including extensive SAV communities. Regular monitoring programs began in the late 1970's and indicate that the estuary is quite different than in earlier times.

Nitrogen (N) and phosphorus (P) loads at the fall line increased rapidly from at least 1960 and load increases followed the pattern of rapid population growth, sewage treatment plant expansion, loss of forested lands and intensification of agriculture. Loads at the fall line continued to increase until the mid-1980's for P and the early 1990's for N when sewage treatment plants began removing these compounds in significant quantities. Declines in SAV communities, changes in the magnitude and pattern of community metabolism, the magnitude and duration of algal blooms and extent of hypoxic bottom waters all appear to be related to changes in nutrient loads. More detailed analyses of N and P during the last 15 years indicate the following: N and P loads vary by a factor of 2-3 between wet and dry years; diffuse loads are dominant, especially in moderate to wet years; large amounts of N (45% of inputs) are lost in the tidal fresh-oligohaline portion of the estuary; this loss of N can be accounted for by long-term burial and denitrification, particularly in tidal marshes; and there is a relatively small loss of N from the Patuxent to Chesapeake Bay on an annual basis, although importation of N in deeper waters occurs during summer months.

While N and P load reductions have been accomplished for portions of the watershed, it appears that additional reductions will be needed to eliminate large algal blooms, low dissolved oxygen conditions and poor SAV coverage in much of the estuary. The strategy for accomplishing these reductions involves further improvements in sewage treatment plant operations, cover crops for agricultural areas, improved storm water management, continued expansion of riparian buffers and upgrades to septic systems.

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New Technology for Restoration of Sediment-Impacted Streams

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Erosion and sedimentation prevention and control issues sustain thousands of companies and their products. Sedimentation has been the subject of decades of research; hundreds of billions of dollars of expenses and impacts; the promotion of numerous BMP's; and countless federal, state, municipal, and industrial regulations and standards. Nevertheless, sedimentation impacts remain one of the primary impairments to surface waters throughout the United States. As measured by the continuing degraded status and losses of aquatic resources, our focus largely on prevention has been a failure. The health of the river - the resource itself - must be our measure of success in addressing erosion and sedimentation issues. When preventive measures are so obviously inadequate, and sediment impacts to surface waters continue, it is long past time that we start to mandate high quality restoration.

To date, there have generally been inadequate, inappropriate, or counterproductive responses after excess sediments enter a stream. Fines in the absence of restoration are merely a measure of how cheaply we sell the destruction of our waters; fifty years from now, to say "Well, we lost all of our quality rivers, but we collected $50 billion dollars in fines" warrants shame, not pride. Attempts at sediment removal by digging it out or by dredging will frequently aggravate the damage to surface waters by direct biological impacts, increased turbidity and other water quality impacts, habitat impacts from unselective removal of coarse substrate materials, and morphological impacts that can cause headcutting.

New technology is available to selectively remove fine silts and sands, to prevent their downstream movement, and to restore a clean native substrate of gravel and cobble. A case study is presented for Boyden Creek, Michigan, where the sluice gate for an upstream dam failed, releasing lake sediments and covering the stream bottom with 6 to 18 inches of silt and sand. A Magnum Sand Wand, from Streamside Systems, LLC, used a combination of water jet and suction to flush and selectively remove the impacting fine sediments, and to clean the streambed. Mussels, and even empty, relic shells, were unaffected (other than having the silt removed). Additional case studies are reviewed, indicating that this restoration method has potential widespread application to sediment impacts in many streams, rivers, and ponds across the country. In combination with Streamside Systems' passive collectors, which prevent downstream sediment impacts, this technology is scalable to any size river, and can effectively restore sediment-impacted habitats. This demonstrates that we CAN restore our rivers. Additional applications for this equipment for restoration of sediment-impacted habitat include removal of sediments from municipal stormwater systems, reduction of reservoir sedimentation, protection and restoration of habitat for salmonid spawning and for endangered mussels, prevention of sediment impacts below dam-removal projects, and even beach nourishment.

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Assessing Effects of Everglades Restoration and Regional Water Management on the Arthur R. Marshall Loxahatchee National Wildlife Refuge

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Restoration of the Everglades requires a regional approach to improving hydrologic and water quality conditions. Embedded within the regional approach are site-specific water management actions. Both scales of actions have impacts at local and regional scales. The challenge is to balance regional water management with site specific needs so that the goals of restoring, preserving and protecting the natural system while providing for other water related needs can be met at regional and local scales.

Everglades restoration activities include projects designed to improve water quality and hydrology. Included in those are storm water treatment areas (STAs), changes in inflow and outflow locations, improved water regulation schedules, and additional water storage reservoirs. Each of these projects has been developed to achieve benefits for overall restoration. As these projects are implemented it is important to evaluate both their regional and site-specific benefits and costs.

The Arthur R. Marshall Loxahatchee National Wildlife Refuge is the northern most part of the remaining Everglades ridge and slough. The majority of the refuge is Water Conservation Area 1 (WCA1), a 57,212 hectare impounded area that is managed under a water regulation schedule for the purposes of water supply, flood protection, and wildlife habitat. Although current restoration plans include no major structural changes to the refuge canal and levee system, there are a number of restoration projects that will or are affecting the refuge.

Changes in the Lake Okeechobee regulation schedule and operational plans for water management in WCA2 & 3, and Everglades National Park influence how much water enters or leaves the refuge. The creation of two STAs, and the rerouting of water from the S-6 pump station, while providing cleaner water to the refuge have changed the patterns, location, timing, and amount of inflows to the refuge. Legal mandates related to water quality and to water supply, that were developed independently, must now be reconciled. To date no comprehensive assessment has been conducted on the cumulative effects of the above changes or how proposed future regional water management will affect the refuge. We provide a preliminary assessment of the effects of the changes that have occurred to date and make recommendations for future research, monitoring, and synthesis that should occur in order to ensure that regional and local water management and restoration activities are complementary.

The views and opinions expressed herein are those of the authors and do not necessarily state or reflect those of the United States government or any agency thereof.

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A Formidable Challenge to Everglades Restoration -- Controlling Old World Climbing Fern

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Restoration activities within the Everglades have focused predominantly on improving hydrology and nutrient concentration. Even if these issues are properly addressed there is yet another significant obstacle to restoring the system, the encroachment of exotic invasive plant species. The loss of habitat due to exotic plants rivals that of human development. As a consequence of Florida's tremendous level of human transit and subtropical climate, exotic plant species within its borders are introduced regularly and flourish. Consequently, the problem of exotics in Florida is the most serious in all of the United States, second only to Hawaii.

One exotic species that is of particular concern within the Everglades ecosystem is Old World Climbing Fern (*Lygodium microphyllum*). This native of the old world tropics (Africa to Australia, Asia, and Melanesia) was first found in a nursery in South Florida in 1958 and a naturalized population was subsequently discovered in 1965. Today *L. microphyllum* has altered vast expanses of precious habitat. In the northern region of the Everglades landscape, Arthur R. Marshall National Wildlife Refuge has been greatly impacted by *L. microphyllum*. As of 2003, up to 19,425 hectares were infested at various intensities. The rapidity of this exotic's invasion can be explained by its efficient reproductive strategies. Spores are released from fronds high in the tree canopy and dispersed mainly by wind. *L. microphyllum* plants produce tremendous amounts of spores, each leaf has on average 100 sori, each sorus has approximately 200 spores, and each fertile leaf has the potential to produce 20,000 spores. Because a single spore can grow to become a reproducing adult, the ramifications for the Everglades' native habitats are overwhelming. Entire tree islands are destroyed as the blanket of *L. microphyllum* fronds smothers and crushes native vegetation. Tree islands are a critical component to the proper function of the Everglades system and provide much of the system's biocomplexity. Tree islands support habitat for endangered species such as the wood stork and Everglades snail kite.

To address *L. microphyllum* infestation within A.R.M Loxahatchee National Wildlife Refuge, a model is being developed that will facilitate better decision-making regarding the most efficient and effective treatment of *L. microphyllum*. The Optimal Control Model will allow managers to pose questions and acquire output detailing the future result of proposed treatment strategies. To accomplish this, the model synthesizes information relating to spore dispersal patterns, distribution and levels of infestation, treatment strategy, costs, and effectiveness. The model will serve as a valuable tool that will aid in the allocation of resources in addressing the threat of *L. microphyllum* to native habitat within the refuge and also have possible applications to the greater Everglades restoration.

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Synthesis of Land Use Data for the Chesapeake Bay Watershed

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The Chesapeake Bay Program Phase 5 Watershed Model simulates nutrient and sediment loads to the Bay's tidal waters from the 64,000 square mile drainage basin. The model uses approximately 300 land segments, based on county boundaries, and simulates 20 different land uses. Spatially consistent and detailed time- varying land use data is needed across the entire Chesapeake Bay watershed for model calibration. Accuracy in the agricultural acreage is essential in order to accommodate management scenarios and to reflect management decisions and implementation of BMPs.

The Regional Earth Sciences Application Center (RESAC) at the University of Maryland developed the base 2000 land cover, as well as 2000 and 1990 impervious surface data sets from LandSat scenes. RESAC land cover and impervious surface data are used to determine the acreage of agricultural land, forest, urban, extractive, barren, grass, and open water. Due to the need for greater accuracy of agricultural land use acreage, as well as detailed crop ratios, agricultural land acreage from the USDS Agricultural Census are substituted for RESAC data on a county scale. Individual crop acreages from the Census were aggregated into 12 Phase 5 agricultural land uses based on similarities in land management, nutrient loading, and BMP application. Ag Census data are adjusted to fill data gaps and correct for doublecropped acres. County agricultural land acreage from RESAC data is modified to match the Agricultural Census. All other land use classes are adjusted to keep the total county area fixed. The amount that a land cover class is adjusted in a county is based on the likelihood that the satellite-interpretation has confused another land cover class with agricultural land. A pixel-by-pixel analysis was conducted to determine the edge of agricultural field land cover class confusion.

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Plan Formulation and Urban Ecosystem Restoration: Issues and Approaches: Hudson-Raritan Estuary, New York, New Jersey

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The Hudson-Raritan Estuary (HRE) is defined by the general boundaries of the Port of New York and New Jersey, comprised of a 25-mile radius from the Statue of Liberty. The study area includes: the Hudson River to Croton Bay, the Upper Bay, the East River, the extreme western end of Long Island Sound, Newark Bay, the tidal Passaic and Hackensack Rivers, the Kill van Kull, the Arthur Kill, Lower Bay (to the Rockaway-Sandy Hook transect) and the tidal Raritan River encompassing approximately 2,000 square miles.

The estuary has been subjected to repeated degradation and continual losses to natural floodplains as a result of historic and ongoing urbanization, specifically, the industrial and commercial activities within the estuary. Significant losses include fish spawning habitat, benthic habitat, wetlands, waterfowl nesting areas and other valuable fish, aquatic and terrestrial habitat areas. In addition, the natural hydrologic regime of the estuary has been altered by the construction of numerous flood control projects within the estuary. Water and sediment quality have been severely degraded by decades of point and non-point source pollution.

This unique urban estuary's survival is critical to the continued viability of New York Harbor maintaining a world-class status. The estuary supports one of the most densely populated regions in the world, the greater New York City area. A few of the significant planning constraints faced in formulating ecosystem restoration within this complex urban environment include: multi-jurisdictional boundaries, extensive existing infrastructure, an interdependent system of varied ecosystems, and the cumulative deleterious effects of more than three centuries of industrialization.

The overarching approach to restoring the HRE, relies on an adaptive management cycle whereby the focus of the study is to develop a watershed management plan for coordinating the restoration efforts in the Port of New York and New Jersey on a system-wide basis; accomplishing this through developing a comprehensive and cumulative analysis of the impacts and benefits to the function of the overall system as individual sites within the estuary are being restored. The crux of this study effort is being modeled as a watershed management plan that provides the guidance for future restoration activities within the estuary. The study is being cost-shared by the Port Authority of New York and New Jersey with an estimated cost of $19,000,000. Preliminary problems, needs, opportunities and restoration screening criteria are being developed to guide the study, with a view toward meeting challenging planning objectives and constraints.

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Plan Formulation and Urban Ecosystem Restoration: Issues and Approaches: Hudson-Raritan Estuary, Lower Passaic River, New Jersey

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The Lower Passaic River consists of the seventeen-mile stretch beginning at the Dundee Dam in Garfield to the river mouth in Newark Bay at Newark, New Jersey. The watershed study area covers approximately 173 square miles in a highly developed urban area of Bergen, Essex, Hudson, and Passaic counties in northeastern New Jersey. The Lower Passaic River once supported extensive tidal wetlands and significant benthic habitat.

In the past, wetlands and underwater lands were filled during the construction of water-dependent industrial facilities and transportation infrastructure. The banks of the Passaic River were extensively developed and now consist of miles of hardened shoreline, with limited public access to the river. The river and its watershed have a long history of industrialization and development, dating back two centuries. By the turn of the 20th century, Newark was the largest industrial-based city in the United States, with well-established industries, such as petroleum refining, shipping, tanneries, metal recyclers, and manufacturers of rubber, textiles, paints, and other chemicals. In the 21st century, many of these sites were abandoned or underutilized and continue to be sources of contaminants. In recent years as little as 45 acres of riparian wetlands remained from over 4,000 acres that existed in 1940.

Water and sediment quality problems within the estuary are also extensive. The Hudson-Raritan Estuary, into which the Passaic River flows, has among the highest levels of polychlorinated biphenyls (PCBs) and includes a dioxin Superfund site and many other pollutants that found their way into the river; therefore it is not surprising that the area suffers from depressed ecological productivity. The Lower Passaic River has been under a fish and shellfish ‘do not eat’ advisory since 1983.

This study has been identified through the Urban Rivers Restoration Initiative as 1 of 8 pilot projects to foster the commitment by both the USACE and the EPA to concurrently remediate and restore identified superfund sites that were traditionally treated as separate projects.

The study is being cost-shared by the New Jersey Department of Transportation, Office of Maritime Resources with an estimated cost of $9,000,000 and completion in 2008. The overall study cost, including the remediation being funded by the EPA is $19,000,000. Preliminary problems, needs, opportunities and restoration screening criteria are being developed to guide the study, with a view toward meeting challenging planning objectives and constraints.

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A Study of Minimum Flows and Levels (MFLs) With Regard to Water Quality Protection and Restoration in the St. Johns River Water Management District

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Water quality dynamics in freshwater aquatic systems are significantly influenced by frequency and duration characteristics of the hydrologic regime. For example, nutrient dynamics (i.e., losses and transformations) between contributing watersheds, land-riparian margins, and aquatic environments respond to biogeochemical processes that are directly governed by physical processes such as flows and levels. Alterations in these physical processes, such as through human water uses (consumption, irrigation, industry), have direct impacts on nutrient and pollutant dynamics in streams, rivers, lakes, springs, and wetlands. Therefore, alterations in the hydrologic regime can have potentially adverse consequences on water quality and ecosystem response. The St. Johns River Water Management District (SJWMD) is initiating studies on the relevance of established minimum flows and levels (MFLs) of water on nutrients, various pollutants, and overall water quality. A series of methods and thresholds have been reviewed that can serve to (1) protect existing water quality and ecosystems from future hydrologic alterations and (2) to study ways to restore systems that have been degraded due to hydrologic changes.

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Evaluation of Everglades Agricultural Area Storage Reservoirs Using Regional Modeling

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The Everglades Agricultural Area (EAA) Storage Reservoir is a critical element of the Comprehensive Everglades Restoration Plan (CERP) being jointly implemented by the United States Corps of Engineers (USACE) and the South Florida Water Management District (SFWMD). The project purposes are to improve environmental conditions in Lake Okeechobee by reducing harmful high and low water levels; reduce the frequency of damaging flood releases from Lake Okeechobee to the estuaries; provide agricultural flood protection and water supply in the EAA; improve the performance of the large constructed wetland treatment systems (storm water treatment areas) by attenuating inflows; and improve the timing of environmental water deliveries to the Everglades. Because the EAA is centrally located within the massive Central & South Florida water management system and the EAA Project is addressing multiple goals, extensive computer modeling is needed to simulate different water management alternatives. The South Florida Water Management Model was used to simulate major hydrologic/hydraulic processes, including overland, canal, and groundwater flows, water control structure operations, and evapotranspiration. Model results are used to evaluate alternative plans using evaluation criteria that address benefits/impacts to Lake Okeechobee, the estuaries, agricultural and environmental water deliveries, and performance of storm water treatment areas. The results of the hydrologic modeling were applied to evaluation criteria and interpreted using Criterium Decision Plus, a multiple criteria decision support model. A summary of alternative descriptions, evaluation criteria, and the approach used to compare alternatives and select the preferred plan is presented.

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Establishing Public-Private Partnerships for Effective Communication in Ecosystem Restoration Initiatives

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Over the next 30 years, the world's largest ecosystem restoration effort will occur in South Florida. The Comprehensive Everglades Restoration Plan <http://www.evergladesplan.org> (CERP) is an $8 billion initiative to capture, store and distribute 1.7 billion gallons of water currently delivered to tide per day. The 68 projects which compose CERP will provide the correct quality, quantity, timing and distribution of water to South Florida's natural system and built environment. With the doubling of the region's population in the next few decades, the success of this program is critical to the sustainability of this vibrant part of the state. In May of 2002, over 70 partners in Everglades restoration efforts chartered the Florida Earth Foundation as a vehicle to do education, outreach and research programs and projects that could best be facilitated by a non-profit format. FEF provides opportunities for people to learn about the far-reaching aspects of Everglades restoration and how this affects life in South Florida. Florida Earth Foundation, a public-private partnership, provides a myriad of natural resource educational programs and opportunities through in-house initiatives. It also provides funding support for other worth-while ecosystem restoration educational efforts. The Foundation's membership programs provide an opportunity for public and private organizations and individuals, in partnership with FEF, to strengthen regional efforts for sustainable natural systems, while simultaneously enriching and helping maintain south Florida as a desirable place to live and work.

Science is communicated through FEF's joint venture with the University of Florida, called the Florida Earth Project, which has an graduate level course offered in the summer and training modules on ecosystem restoration available to the general public. FEF also has a program which organizes and delivers forums on CERP for various levels of decision makers. The Foundation has the ability to be a grant maker for programs and projects proposed by interested parties. Other communication vehicles include a magazine for the Foundation being developed by the University of Miami's School of Journalism and a program under development with UNESCO-IHE, a university in Delft, Holland, which specifically deals with water-related disciplines. IHE graduate students will be coming to South Florida to study ecosystem hydrology and restoration.

Through FEF's corporate and individual membership and partnership programs, it is able to engage core constituents in restoration efforts, bring together agencies, educational institutions, industry and not-for-profits as a balanced source of education, outreach and research initiatives. Interest has been expressed by different regions in using FEF as a template for duplicating this communications tool in other regions that have ecosystem restoration projects underway or contemplated.

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Epifaunal Distributions and Relationships with Salinity in Western Nearshore South Biscayne Bay

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The epibenthic faunal assemblage of the western nearshore zone of Biscayne Bay between Shoal Point and Turkey Point was characterized in terms of spatial and temporal variation and examined in relation to salinity. The purpose of the study was to acquire the data necessary for developing performance measures for use in guiding and evaluating restoration activities. Three types of gear were applied to the same stratified random sampling design. The commercial trawl samples in water > 1 meter deep, the pull trawl samples in water < 1 meter deep, and the 1-meter throw trap samples in both depth zones. Habitat information (i.e., seagrass type, density, etc) was collected in conjunction with throw-trap sampling The sampling strata consist of three salinity zones (1=low, 2=medium, and 3=oceanic) and two geographic (north and south of the Black Creek jetty) zones. Salinity and habitat were critical features in sampling design. Salinity is a critical factor organizing estuarine and marine ecosystems and is likely to be affected by restoration efforts while seagrass/algal habitat represents essential habitat for the fish and invertebrates susceptible to the throw-trap. The information will be used to help design and monitor the Comprehensive Ecosystem Restoration Program.

Relationships with salinity varied with time, by species, and by gear. Examples from the trawl sampling follow. Fourteen taxa, including pink shrimp (*Farfantepenaeus duorarum*) were the dominant representatives of the fauna in October 2002 trawl samples. Two-way ANOVAs indicated that salinity zone was a significant variable (P<0.05) for one species, pink shrimp, and geographic zone was a significant variable for five species. In one-way ANOVAs in which each combination of salinity zone and geographic zone was treated as a distinct strata (i.e., 1S, 2N, 2S, 3N, 3S), strata was a significant variable for seven taxa. Twelve taxa, including pink shrimp, represented the dominant fauna in trawl samples in December 2002. In two-way ANOVAs, salinity zone was a significant variable for four taxa, and geozone was a significant variable for six taxa. In the separate analysis by strata (i.e., 1S, 2N, 2S, 3N, 3S), Tukey tests showed significant differences between pairs of strata for only a few species. Strata 3S (salzone 3, geozone S) had significantly lower densities of all but one taxa. Brittlestar density was significantly greater in 3S. General linear models corresponding to the ANOVAs on the December samples indicated that five 2-variable (salzone and geozone) equations and five 1-variable (strata) equations were significant at P<0.05 or better. Equations that included salinity and latitude as continuous variables were significant for three taxa at P<0.01 and an additional two taxa at P<0.05. Our conclusion from analyses of trawl data was that the strata delineations of the sampling design were useful for describing variation in faunal density. Trawl sampling was continued into a second year to confirm seasonal patterns and compare peak density between years. The pull net was added near the end of the first year to sample the shallow zone inaccessible to the trawl. Throw-trap data are being analyzed in relation to habitat and salinity.

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Interagency Coordination - Managing Conflict

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Conflict exists in every environment, and the world of water management is no exception. Improved communication is an essential component to resolve interagency coordination issues and manage conflict. Resource Managers in different agencies are challenged by differing rules, regulations, interpretations and mission responsibilities. A survey of Kellog Executive Program's Team Building for Managers revealed, "team conflict is one of the top three concerns of team management" (Thompson 2001). A water manager should not be so naïve as to think that conflict will never occur. Realizing that conflict is unavoidable is crucial if interagency coordination is to be effective. The lack of informal communication between agencies can attribute to conflict arising from differing organizational cultures or at the least encumber conflict resolution.

Thompson, et al. lists the following as useful guidelines to follow when managing conflict (Thompson 2001). Some of the tips have been altered to specifically apply to agency conflict resolution.

1. Deal with one issue at a time.
2. Timing is important. Choose the right time for conflict resolution. Individuals have to be willing to address the conflict.
3. Interagency coordination should not be rushed.
4. Unanimous agreement is not possible for all water management issues.

Improving communication is an essential component to managing interagency coordination issues and controlling conflict. Components that add value to communication such as integrity, information exchange and responsiveness should be a part of every water manager's professional toolbox. Integrity should be placed at the forefront of any coordination effort between agencies.

A compounding factor in water management operations is the inherent uncertainty that can never be eliminated by strict adherence to the operational guidance of regulation schedules and water control plans. The uncertainty is not only a factor of the realtime nature of project operations which include weather, antecedent conditions, construction activities, design deficiencies and environmental factors, but also the result of inherent uncertainty in the modeling and development of water control operational criteria, regulation schedules and water control plans.

- *The views and opinions expressed herein are those of the authors and do not necessarily state or reflect those of the United States government or any agency thereof.*

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Statistical and Geostatistical Analyses of Soils Data from Water Conservation Area 3, South Florida

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The Florida Everglades represent one of the largest and most distinct freshwater marshes in North America. Wetland conversion, hydrologic modifications, landscape fragmentation, and nutrient-rich runoff have significantly impacted the ecology of this region. Three Water Conservation Areas (WCAs) located to the south of the Everglades Agricultural Area (EAA) and to the north of the Everglades National Park (ENP) are currently used for water storage during dry seasons and for flood control during wet seasons. While WCA-3 is the largest (232,600 ha), it has been studied much less than WCA-1 or WCA-2. Soil is critical to the functioning of this ecosystem, and its assessment can provide feedback on both the ecosystem status and the effects of management. The objectives of this study were threefold: (1) to use analysis of variance (ANOVA) to determine whether differences existed in the mean values of soil properties from different soil layers and zones of WCA-3; (2) to use Classification and Regression Tree (CART) analysis to determine which soil properties best distinguished the different layers and zones; and (3) to quantify and compare spatial distributions of soil properties.

We used a stratified-random sampling design to collect over 300 soil samples from the floc, 0-10 cm, and 10-20 cm soil depths in WCA-3 in 2003. These soil samples were analyzed for soil properties such as bulk density (BD), total phosphorus (TP), inorganic phosphorus (TPi), nitrogen (TN), carbon (TC), calcium (Ca), and magnesium (Mg). As WCA-3 is divided by two interior levees into WCA-3A to the north and WCA-3B to the south, we stratified our data accordingly. Furthermore, we divided WCA-3A into two zones, WCA-3AN (the area to the North of Interstate 75), and WCA-3AS (South of I-75).

Analysis of variance indicated that WCA-3AN had a significantly higher mean TP value in the upper 0-10 cm (495.1 ± 156.9 SD $mg \cdot kg^{-1}$), than WCA-3AS (405.4 ± 127.6 $mg \cdot kg^{-1}$) and WCA-3B (349.4 ± 150.6 $mg \cdot kg^{-1}$). The mean TP value for WCA-3AS was also significantly higher than that of WCA-3B. Mean Ca was significantly higher in WCA-3B than in 3AN or S in all layers while Mg was significantly higher in 3AN and 3B than in 3AS. The CART analysis indicated that best variables in distinguishing the soils of the three zones were Mg, BD, and Ca. Tree-based models were also used to rank variables of importance. Geostatistical analysis indicated that the highest levels of TP were generally located in the northern and eastern parts of 3AN, 3AS, and 3B. While there was some spatial continuity in TP between 3AN and S, there was less between 3AS and 3B. To our knowledge, this is the first spatially-explicit study of soil properties in WCA-3, and the combination of analyses we employed will provide exciting insights into ecosystem dynamics in WCA-3 and guide future management and restoration.

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Performance Measures: Integrating Knowledge about Restoration Success

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Creating performance measures for an ecosystem restoration project focuses a team to decide what the important elements that characterize restoration are and how successful restoration of these elements will be measured. This process is harder than it seems. Various agencies and stakeholders involved will have different mandates and individuals will have different priorities. Using goals and objectives as an outline, projects usually create a very large list of important measures to accommodate everyone, a list that must, painfully, be reduced to a manageable size. Endangered species, water quality, and recreation opportunities can all be included, but in a large list, single elements are lost, weighting is difficult, double counting is possible and, most importantly, monitoring becomes impossible because the budget would be astronomical. Instead, teams should create a “parsimonious” list of measures suitable for both for planning and for monitoring the success of the plan once it has been built.

Good performance measures should pass the following test. First, each one should represent an important element of the system. Focusing on ecosystem performance measures, each should represent a defining characteristic of the ecosystem. Second, each performance measure should be fairly well understood. Measures with a base of readily available knowledge should be chosen over those that may be desirable, but about which little is really known. Scientists will quickly tell you, regardless of what it is, that there is not enough information. Planners will be just as quick to rush in and say there is. Keeping the importance of restoring the ecosystem in mind, the two camps must strike a balance. Third, performance measures should be measurable. Preferably models or statistical relationships can be developed to predict and quantify their response to the plan ahead of time. They should also be capable of being measured in the field so they can be monitored in the future. Measures that can be both predicted and monitored are best: they will show the clearest effects of restoration plans. Forth, they need to be elements of the system that are expected to respond cleanly to the restoration plan. Elements with responses compounded by weather or human-based pressure, for example, will be unreliable predictors of the plan’s success. Fifth, performance measures should have a numerical restoration target, even if that target is a range. A target is not directional. The temptation is to say “increase” or to “improve” something. Unfortunately, a tiny improvement can then be said to be “success”. Quantifying targets, particularly for wildlife species, is a real challenge, but teams should rise to the occasion, use best available knowledge, and set them. When a project is underway and funding gets tight, directional targets are not robust enough to justify a continued funding stream.

In summary, performance measures are an excellent tool for driving restoration planning. By developing them, teams must reach consensus on what they are planning to restore and to decide when goals have been reached. Once these important decisions are agreed upon, planning to meet the goals can be a much clearer process.

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The *Tres Rios Del Norte* Project: Streamlining the Functional Assessment Process to Meet the Ecosystem Restoration Challenge

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Throughout the arid southwest, ongoing U.S. Army Corps of Engineers (USACE) studies are focused on intensive riparian zone restoration activities geared to re-establishing ecosystem functions and ecosystem services. Often these studies must grapple with ephemeral systems experiencing extreme flash flooding conditions on a regular basis - a critical component that must be incorporated into every facet of riparian ecosystem design in the region. The *Tres Rios del Norte* study will be presented as a showcase example of one of Los Angeles District's ongoing ecosystem restoration efforts designed to create, restore and preserve wetlands in this dynamic environment.

A streamlined functional assessment was used to quantify ecosystem restoration benefits generated by proposed design alternatives for the study. The assessment was designed to evaluate the future changes in quantity (acres) and quality (functional capacity) of arid riparian ecosystems. Outputs were calculated in terms of annualized changes anticipated over the life of the project. Early in the evaluation process, an interagency Ecosystem Assessment Team (E-Team) was convened. Scientists from the U. S. Army Engineer Research and Development Center, Environmental Laboratory (ERDC) facilitated the efforts. Representatives from Planning Section C, the Los Angeles District proper, U.S. Fish and Wildlife Service (USFWS), and the Arizona Department of Fish and Game (ADFG), actively participated in the assessments.

Models for ten functions were developed and used in the assessment to capture the functional capacity of the Arizona riparian ecosystem setting. These models focused on maintenance of characteristic channel dynamics, dynamic surface water storage and energy dissipation, long term surface water storage, dynamic subsurface water storage, nutrient cycling, removal and/or detention of imported elements, detention of particulates, maintenance of characteristic plant communities, maintenance spatial structure of habitat, and the maintenance of corridors for interspersion and connectivity. ERDC facilitated a series of workshops, beginning in the spring of 2002 and continuing through the fall of 2003, in which the E-Team was asked to develop future projections for the study's site. The results of the analyses were compared using the USACE standard cost analysis techniques, and the biologically productive, cost-effective alternative designs were revealed. The results of the study will be presented in detail, including the plan formulation process, the evaluation and comparison of the No Action alternative and the 10 alternative designs formulated, and the cost analyses.

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Advances to the Model Gridded Surface Subsurface Hydrologic Analysis for Improved Ecosystem Modeling

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The model Gridded Surface Subsurface Hydrologic Analysis (GSSHA) is a detailed finite-difference model that simulates the various factors that influence runoff; including infiltration, evapotranspiration, groundwater and surface water flows. GSSHA is directly geared at evaluating the effects of land use scenarios as well as and engineered hydrologic scenarios. GSSHA robustly simulates the movement of water within the watershed, whether below the ground in a saturated or unsaturated manner, or above the ground as overland sheet flow or stream flow, all at fine resolutions. Cell resolutions of current simulations range from 30 meters to 150 meters. The availability of water is a primary driving force in throughout ecosystems. GSSHA is able to provide information about water in a watershed setting through all stages - soil moistures and groundwater levels, surface retention, and runoff in both the overland flow field and stream level settings.

The information that GSSHA is able to provide is one of the primary data needs when evaluating ecosystem needs and modeling responses. Recent and ongoing improvements are being added to GSSHA to more robustly provide data for evaluating ecosystem response. These include the ability to better simulate the hydrologic response of wetlands as well as nutrient (N, P, and C) cycles throughout the watershed, at the individual cell level. These new tools will allow a wider range of physical settings and engineering alternatives to be accurately evaluated with respect to their actions upon ecosystems.

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Recent Enhancements to the South Florida Water Management Model (SFWMM)

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Different versions of the South Florida Water Management Model have been used throughout the years as the prime regional modeling tool to support planning efforts undertaken by the U.S. Army Corps of Engineers (USACE), the South Florida Water Management District (SFWMD) and other agencies. Applications of the SFWMM have supported long term projects such as the Restudy, the Lower East Coast Water Supply Plan, development of operational protocols for Lake Okeechobee, and more recently the Comprehensive Everglades Restoration Project (CERP). The SFWMM have been also used to provide modeling support to short term operational planning efforts such as the Interim Structure and Operation Procedures (ISOP), the Interim Operation Procedures (IOP), the Combined Structure and Operation Procedures (CSOP), among others. Since the end of 1999, the SFWMM has come to play a constant role in the Operational Planning of the system through the execution of monthly Position Analysis simulations.

The SFWMM is a regional-scale daily time step hydrologic model that simulates water levels and flow rates for the region from Lake Okeechobee to Florida Bay (7600 mi^2). The model uses a regular mesh of 2 mi x 2 mi cells. It includes inflows from the Kissimmee River and runoff and demands for the Caloosahatchee River and St. Lucie Canal basins. The model accounts for and simulates the major components of the hydrologic cycle in south Florida, including rainfall, evapo-transpiration (ET), infiltration, overland flow, groundwater flow, canal flow, canal-groundwater seepage, levee seepage and groundwater pumping. The SFWMM incorporates current or proposed water management control structures and current or proposed operational rules. Continuous simulation of the interactions between surface and groundwater and the ability to simulate water shortage policies affecting urban, agricultural, and environmental water users in south Florida are major strengths of the model

The SFWMD has documented the development of the SFWMM through internal technical memoranda and publications, and conference articles, presentation and posters. This presentation will focus on recent model enhancements geared towards improving regional modeling for CERP support. It describes input data review and extension, improvement of ET and irrigation demand computation, simulation of basins surrounding Lake Okeechobee, calibration and verification for the natural areas, the Everglades Agricultural Area and the Lower East Coast Urban areas, simulation of canal flow and improved estimation of parameters, among others. The end result is V5.4 of the SFWMM which is currently being used to produce the Initial CERP Update Simulations.

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Application of a Decision Support System Model for Drought Management Analysis in a Western River System

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Water supply and allocation alternatives for the Klamath River, OR and CA were evaluated using the Systems Impact Assessment Model (SIAM), a decision support system developed by U.S. Geological Survey. SIAM is a set of models with a graphical user interface that simulates: water supply and delivery in a managed river system, water quality, and fish production. The Klamath River Basin has experienced drought conditions in three of the past twelve years (1992, 1994, and 2001). Threatened and endangered (T&E) species issues for native lake suckers in Upper Klamath Lake and anadromous fish in the mainstem Klamath River are major drivers for water resource management decisions. Application of the decision support system model can allow resource managers and users to understand the implications of specific water management alternatives for T&E species prior to implementation.

Results indicate that adequate water does not exist in low flow years to meet target water storage levels on Upper Klamath Lake for endangered lake suckers, to satisfy minimum recommended instream flows below Iron Gate Dam for anadromous fish, and supply other traditional and contractual water deliveries (e.g., agriculture). The simulations also provide quantitative information that rejects a common belief among many resource conservationists in the Klamath Basin that increasing mainstem flows will automatically improve water quality conditions for salmonids. Results for the drought conditions and scenarios indicate that higher summer instream flows may actually increase predicted mean daily temperature, and several other water quality metric measures below Iron Gate Dam. The effect is attenuated downstream, but may persist as much as 60 km downstream to Seiad Valley. The simulation results illustrate the need for analysis with respect to the spatial and temporal extent of water quantity and quality impacts, as some areas may experience improved conditions while conditions either upstream or downstream, or during other seasons in the year, are less desirable.

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GIS Data Development of Fire History for Everglades National Park from 1948 to 1979

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Since 1948 the Everglades National Park has been accumulating vast amounts of fire history data. These data are in the form of paper records, mylar maps and hand drawn maps of the fire perimeters that occurred for each year. All types of fires were documented, whether they were prescribed, suppression, fire use or incendiary and are included in this project.

The purpose of this project is for the U.S. Geological Survey to use the paper records and hand drawn maps from the Everglades National Park to develop Geographic Information System (GIS) data layers in ArcGIS 8.3 of the fire history. These data layers will be created in accordance with the National Fire Standards of the National Park Service (NPS). The creation of the layers is done by extracting vital information from the records and building a geodatabase from the attributes gathered. The next step is using the paper maps to digitize polygons for each fire perimeter. These polygons are created by using the best available source of data, which in most cases is obtained from the maps that were within the fire report. A point data layer will also be produced for each fire to represent the location at which the fire began.

When this project is complete this dataset can play a significant role in park planning of fire management activities, fire ecology studies and many other issues concerning the behavior of wildfires.

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A Summary of Baseline Vegetation Data for Phase I of the Kissimmee River Restoration Project and Expectations for Wetland Vegetation Recovery in the Restored System

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The historic Kissimmee River floodplain consisted of approximately 15,769 ha of wetland plant communities, including about 11,000 ha in the area designated for restoration. Historically, broadleaf marsh, wet prairie, and wetland shrub were the dominant plant communities. Due to channelization of the river and subsequent maintenance of stable water levels, most of the wetland plant communities on the floodplain were either drained and converted to pasture, or covered with spoil material from excavation of the C-38 canal. Restoration is expected to reestablish plant communities similar to those present on the historic floodplain. Photointerpretation of aerial photography will be used to delineate landscape scale floodplain vegetation communities of the baseline (post-channelization/pre-restoration) period and of various stages of the restoration/recovery process. These data will be compared with historic data sets to evaluate the success of wetland plant community restoration.

Baseline vegetation data for the Phase I project area (river channel and floodplain flanking 7.5 miles of C-38 canal) indicate that remnant wetland plant communities covered 1657 hectares (32.7% of historic) prior to restoration activities. Based on reference (pre-channelization) data, wetland plant communities are expected to eventually cover approximately 3923 hectares on this restored section of floodplain.

Aerial photography acquired in 2003 will be mapped to determine initial responses of wetland plant communities within the Phase I project area. Casual observations in the years following the completion of Phase I indicate that wetland vegetation is rapidly re-colonizing the restored area, responding to more natural inundation characteristics of the floodplain. Field surveys of vegetation at 18 permanent ground and surface water well stations were conducted biannually (dry and wet seasons) within the restored area from May 2002 - October 2003. Of the eleven sites located on the previously drained floodplain, ten that were dominated by pasture grasses or other upland plant species prior to restoration had shifted to dominance by either wet prairie species, such as *Panicum hemitomon* and *Polygonum punctatum,* aquatic species such as *Limnobium spongia* and *Salvinia* spp*.*, or at one location, *Chephalantus occidentatlis* a native wetland shrub. One site at the periphery of the floodplain was dominated by dead *Paspalum notatum*, an upland pasture grass, by the end of Oct 2003. These preliminary data suggest that floodplain vegetation is transitioning toward dominance by wetland plant species.

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Management Recommendations for Exotic and Nuisance Plant Species Control in a Disturbed Maritime Hammock Community

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The Environmentally Endangered Land (EEL) Program was established in Brevard County in 1990 by a voter's referendum to protect and restore environmentally sensitive lands and biodiversity within the habitats associated with these lands. Pepper Cove, the location of the Barrier Island Ecosystem Center (BIEC), was donated to the EEL Program by the Richard King Mellon foundation. The site is located three miles north of Sebastian Inlet and is bounded by the Atlantic Ocean to the east and Indian River Lagoon to the west. Natural communities at the site include ocean beach and dunes, maritime hammock, and mangrove marsh. Anthropogenic disturbances to the site, however, have altered these natural systems. The focus of this study was the management of exotic and nuisance plant species in the disturbed maritime hammock of Pepper Cove with minimal adverse affects to adjacent vegetation. Brazilian pepper is an invasive exotic plant species known to grow quickly and develop a dense canopy that suppresses native vegetation. It reduces the kinds and total numbers of wildlife, and weakens shorelines due to its shallow root system that facilitates erosion. Papaya is a nuisance exotic plant species that establishes itself in disturbed areas. While it does not take over areas like Brazilian pepper, it is not part of the natural landscape of a maritime hammock on barrier islands and serves to compete with native vegetation for sunlight and nutrients. In disturbed areas, native vines can also be considered nuisance species. They experience uncontrolled growth when the forest canopy is disturbed and often take over native plants reducing their viability.

Five management techniques were applied to Brazilian pepper and papaya plants. There were two manual removal techniques, pulling and stabbing, and three herbicide removal techniques, foliar, basal, and hack and squirt applications. Nuisance vines growing over native plants were treated with manual removal or application of herbicide. Two-meter round plots were set up with a target plant (i.e., Brazilian pepper, papaya, or vine covered native plant) as the center. Three replicate plots of each of the five treatments were set up for Brazilian pepper and papaya and three replicate plots were set up for the two vine removal treatments. Treatments were applied in April and the plots were monitored for four months. This was done during the growing season when plants are metabolically active. Four of the five treatment techniques (all but stabbing) were 100% successful in causing Brazilian pepper and papaya mortality. The pulling technique, however, had the longest treatment time thus making it a less desirable means of controlling exotics. The hack and squirt treatment had the least adverse effects on adjacent vegetation for Brazilian pepper and papaya and is therefore the recommended means for controlling these exotic species at Pepper Cove. Manual and herbicide vine removal were 100% successful in removing the vines. Manual vine removal with a machete had the longest application time, but less adverse affects on adjacent vegetation. Herbicide vine removal, however, had slower vine re-growth than manual vine removal. Management recommendations for optimum vine control should include mechanical removal of vines and herbicide treatment to freshly cut vines at the beginning of the growing season and every four months thereafter.

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Adapting Restoration to Disturbance: Wildfire Impacts on Wetland and Upland Restoration and Invasive Exotic Control

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Florida Gulf University opened in 1997 on a 760 acre in Lee County, Florida. Over 400 acres of the campus are wetland or upland preserve. The preserve areas are an on-going restoration project focusing on removal of the invasive exotic *Melaleuca quinquenervia.* Restoration approaches vary from hand removal and herbicide application in areas of low infestation with significant native vegetation remaining, to areas of complete infestation requiring total biomass removal and replanting of native vegetation. Both introduced biological control agents, the snout weevil (*Oxyops vitiosa*) and the psyllid fly (*Boreioglycaspis melaleucae*) are present on campus and appear to be effectively reducing seed crops.

In May 2004 a wildfire burned approximately 300 acres of the campus. We established transects through four severely burned areas: 1) a wetland/upland ecotone with low infestation; 2) a wetland with high infestation; 3) a restored wetland with previously high infestation that had been replanted following exotic removal, and 4) a restored wetland/upland ecotone with mature native vegetation remaining after exotic removal. We report on the: variations in severity of five impacts, recovery of native vegetation, reinvasion of exotics, and re-establishment of biological control agents during the first six months of recovery. This is a unique opportunity to investigate the effect of intense fire on *Melaleuca quinquenervia* invaded lands following establishment of biological control agents and on the succession of restored habitats.

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Ecosystem Restoration in California's Bay-Delta System: A Structured Approach in a Changing Environment

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In August 2000, the CALFED Bay-Delta Program issued a Programmatic Record of Decision that set fourth a 30-year plan to address ecosystem health and water supply reliability problems in California's San Francisco Bay/Sacramento-San Joaquin Delta system. The Program addresses four interrelated, interdependent resource management objectives concurrently: Water Supply Reliability, Water Quality, Levee System Integrity, and Ecosystem Restoration. The Program's four objectives are further addressed through 11 major program elements as a way of sustaining the CALFED Plan's balanced and comprehensive approach. In 2003, the State of California formed a new state agency, the California Bay-Delta Authority, to oversee and coordinate balanced implementation, integration, and continuous improvement in all program elements. The Authority's enabling legislation codified much of the CALFED Program's existing structure, including Federal agency participation, a Bay-Delta Public Advisory Committee, an Independent Science Board, and a lead scientist.

In addition to this institutional structure, the planning documents for the Ecosystem Restoration Program (ERP) element alone identify six goals, 32 objectives, and more than 300 targets and 600 programmatic actions. Successful implementation of the ERP is important to achieve ecosystem restoration goals and to sustain programmatic State and Federal Endangered Species act compliance for all Program elements. To ensure that the ERP was implemented in a manner and to an extent sufficient to sustain programmatic compliance, the State and Federal ESA regulatory agencies identified 119 milestones, largely derived from the ERP targets and actions, which defined an adequate manner and level of ERP implementation.

These same documents and agencies also emphasized an adaptive management approach and allowed for adjustments to the targets, actions, and milestones consistent with this approach. The agencies responsible for implementing the ERP and the California Bay-Delta Authority are working together with advice from stakeholders and independent scientists to assess progress and refine their approach to implementation.

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Critical Water Resources Challenges

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The nation faces a number of critical water resources challenges. Finding solutions to these challenges requires serious reflections on national programs and policies with a focus on the responsibilities of all the various levels of government from federal to state to Tribal to local. The Corps is poised to contribute constructively to the dialogue on addressing these challenges and assisting in finding solutions to them. The Corps' Civil Works Strategic Plan focuses on five goals that will strengthen the Corps' stewardship and management of the nation's water resources. One major goal is to seek environmentally sustainable solutions, using the principles of integrated water resources management. Further, the Corps is committed to repairing past environmental degradation and preventing future environmental losses. The existing portfolio of projects managed by the Corps will be re-evaluated to ensure that they are operated to meet new and emerging needs. National security issues require the Corps to prepare for the safety and security of water resources and to respond to natural and manmade disasters. Achieving these goals will also contribute to the overall goal of maintaining our capabilities and expertise. The Corps' commitment to environmental goals is also demonstrated by the Environmental Operating Principles that are embedded in all Corps' programs and activities. However, addressing critical issues and meeting the strategic goals is only achievable by working effectively in collaborative partnership with other agencies, non-governmental organizations, interest groups and the public. Only by acting together in open, constructive dialogue, using the best available information, can we meet these water resources challenges.

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Sheldon Marsh Environmental Restoration (Section 227) Project

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The U.S. Army Engineer Research and Development Center is coordinating the National Shoreline Erosion Control Development and Demonstration Program. Congress authorized the Program under Section 227 of the Water Resources and Development Act of 1996 and appropriated funding to initiate the program in fiscal year 2000. The focus of Section 227 is the demonstration of prototype-scale "innovative" or "non-traditional" methods of coastal shoreline erosion abatement, construction methods, and materials usage.

Sheldon Marsh Nature Preserve is located in the southwestern end of Lake Erie near Sandusky Bay, Ohio. The project area consists of a 1.8 km- long eroding barrier beach that rises 2.1m to 2.4 m above LWD and fronts a wetland nature preserve. The marsh is one of few remaining Lake Erie coastal wetlands not restricted by a system of dikes for water level management. The marsh contains many types of habitats such as old-field, hardwood forest, woodland swamp, cattail marsh, barrier sand beach and open water. Restoration and protection of the barrier beach is essential to the survival of plant and animal communities whose natural habitat has been severely restricted by urbanization and development along the Lake Erie shore. The nearshore zone is comprised of a thin patchy sand layer resting on a clay and peat base. There are currently no shore protection structures on the barrier; however, stone seawalls protect a NASA pump station located at the east end of this site and a condominium development just west of the site. Sheldon Marsh receded extensively during the high-water years between 1972 and 1998 at rates up to 19 m per year totaling approximately 370 m. Storm waves superimposed on 0.6- to 0.9- m storm surges generated by northeast storm winds readily overtopped the existing low lying dunes, sweeping sand across the barrier into the wetland. Recession of the barrier is further aggravated by impoundment of littoral sediments at the Huron Harbor complex 4.8 km east (updrift) of the site. Continued recession of the barrier is threatening the preserve’s 1.9 km^2 of wetlands.

A submerged, segmented rubblemound breakwater system is proposed for the site and is being tested using a fixed bed physical model at the Engineering Research and Development Center (ERDC), Vicksburg, MS. The proposed projects intent is to stabilize the existing barrier beach, minimize overwash and sand loss while minimizing impact on the existing surroundings. The model tests to date have demonstrated that the structures reduced incident wave height at the shore by 20-50% depending on incoming wave conditions and existing water levels.

Since Section 227 is a demonstration program, the Sheldon Marsh project will be monitored for approximately three years after construction to determine the overall success of the design. Based on monitoring results, the project design will be considered as an alternative under the Section 1135 Program for implementation along the entire 1830 m site length.

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Innovative, Integrated Scientific and Technical Research Programs in the Central Gulf Region

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Although the past twenty years have seen much research activity aimed at reducing or reversing the loss of coastal wetlands in southern Louisiana and Mississippi, only recently has there been a concerted effort to bring together the multiple groups involved in this critical work. Ongoing development of a comprehensive ecosystem-level restoration plan for the entire lower Mississippi River deltaic system (the Louisiana Coastal Area restoration plan, or LCA) has obviated the need for researchers to collaborate on integrated studies.

Beginning in 2002, the Coastal Restoration and Enhancement through Science and Technology (CREST) Program and the Louisiana Governor's Applied Coastal Science Program (GACSP) have developed a partnership by which to involve university groups and others throughout the region in applied research of direct importance to the implementation of restoration projects. Funding for CREST is from federal sources, while GACSP is supported by the State of Louisiana. Both programs have been active in coordinating, prioritizing and funding research; reporting the results of such research to the community at large; and staging workshops that allow regional managers and scientists to benefit from research carried out elsewhere.

The two programs are demonstrating that university, state and federal agencies can partner effectively to inform and enhance restoration science. Collaboration has included joint funding of projects, while the use of peer-review and independent advisory panels enhances the integrity of both programs. We believe that the value of such collaborative activities will become increasingly apparent as the LCA restoration plan matures.

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Application of SeaWiFS and MODIS Imagery in Monitoring Water Quality of Chesapeake Bay

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Satellite ocean-color imagery provides large-scale, synoptic information on coastal water quality, yet its operational use has been limited in the past due to concerns about sensor resolution, radiometric characteristics, and algorithm artifacts. For Chesapeake Bay and adjacent coastal zones from 1997-2003, we have examined the time-series of ocean-color data from the SeaWiFS and MODIS sensors and used *in-situ* observations to study chlorophyll concentration and particle concentration as indices of water quality. Using empirical and semi-analytical algorithms, we derived SeaWiFS images of chlorophyll concentration and the optical backscattering coefficient at 400 nm [b_{bp}(400), a potential proxy for total suspended solids, TSS]. The accuracy was assessed using concurrent (±2 hours) *in-situ* measurements. While SeaWiFS chlorophyll values were often overestimates, SeaWiFS b_{bp}(400) was positively correlated with TSS. Correlation coefficients are not strongly dependent on sampling location or time of year, possibly due to (1) sensor/algorithm artifacts, (2) uncertainties in the *in situ* measurements, and (3) different sampling scales between satellite and *in situ* measurements. Nevertheless, because the almost daily, multi-year satellite data were collected with one instrument and processed with the same algorithm, the imagery provides provisional, yet consistent, water-quality maps that complement the views afforded by scattered *in-situ* sensors and occasional monitoring cruises.

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The Roles of American Alligators and American Crocodiles as Indicators of Environmental Change

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Alligators and crocodiles once occupied all wetland habitats in South Florida-from sinkholes and ponds in pinelands to the brackish water portion of mangrove estuaries inhabited by crocodiles. Land development and water management projects designed to accommodate a rapidly growing human population have reduced the spatial extent and changed the hydropatterns of these wetland habitats. As a result of these habitat alterations, alligators are now less numerous in marl prairies, rocky glades, and oligohaline mangrove areas. Loss of habitat along coastal areas of Palm Beach, Broward, Dade, and Monroe counties principally affected the nesting range of crocodiles, restricting it to a small area of northeastern Florida Bay and northern Key Largo by the early 1970's.

Restoration of hydrologic patterns and ecological function in the Everglades is now underway. Due to the ecological importance of crocodiles and alligators and their sensitivity to changes in hydrology, salinity, and ecosystem productivity, these species have been chosen to provide a quantifiable measure of restoration success. Determination of trends and year-to-year variations in population parameters are a critical part of an expanded monitoring program to support development of ecological indicators and success criteria for the restoration effort. A number of biological attributes (relative density, relative body condition, growth, survival, nesting effort, and nesting success) can be measured, standardized methods for monitoring have been developed, and historical information exists for populations in the Everglades. These attributes are essential for constructing ecological models used to predict restoration effects and can be used to determine success at different spatial and temporal scales. Research and monitoring will be essential to evaluate the response of these species as restoration proceeds.

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The Importance of Socio-ecological Research Linkages in the Rehabilitation of Human-dominated Landscapes: Examples from the Florida Everglades

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The maturing field of ecological economics bridges the gap between biophysical and social science viewpoints. The valuation of ecosystem goods and services is an example of this interdisciplinary coupling. The concept of ecosystem services is particularly relevant to efforts to restore or rehabilitate human-dominated systems. These projects are driven by important societal choices based on expectations for [real or presumed] ecosystem services to be delivered by the restored or rehabilitated ecosystem. We argue that quantifying these ecosystem services-before, during, and after restoration-should be viewed as a critical component of these projects. Furthermore, the valuation of ecosystem services goes beyond traditional economic cost-benefit analyses most often conducted as part of rehabilitation efforts.

The restoration, or rehabilitation, of the Florida Everglades provides an excellent case study for how the valuation of ecosystem services can aid the project itself by bringing together social and biophysical scientists. A key goal of this restoration project is to assure ample fresh water for a growing human population in south Florida. The roughly 6 million people currently living in south Florida consume about 1 billion m^3 of water annually. 95% of this water comes from the Biscayne Aquifer via shallow wellfields along the western boundary of human development and the Everglades. This aquifer is largely recharged by the Everglades, and we argue that this purveyance of fresh water is the most important ecosystem service being provided by the Everglades. The current plan for Everglades restoration is based on providing up to 3 billion m^3 of fresh water per year to a projected population of 15 million people by 2050. The plan places considerable importance on other water sources and storage mechanisms, suggesting the expectation that the Everglades alone will not be able to provide this ecosystem service to the future human population.

We propose that several socio-ecological questions should be asked about the Everglades rehabilitation project (and about all major restoration or rehabilitation programs). These include: 1) What are the values of ecosystem services that could be provided by a healthy Everglades? 2) What is the current and projected value of the fresh water supplied to human society by the Everglades? 3) If fresh water is a limiting resource in south Florida, then what human population can be sustained by a healthy, rehabilitated Everglades providing this ecosystem service? 4) What are the tradeoffs of and consequences for sustaining a rehabilitated Everglades if future human population is much larger than this? These and other questions are best answered [and asked] by an interdisciplinary approach that includes sociologists, economists, geographers, anthropologists, ecologists, and physical scientists. We suggest that these socio-ecological analyses should be part of adaptive management of the Everglades Restoration project, and of any rehabilitation or restoration effort.

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Science and Technology in Support of the Louisiana Coastal Area Ecosystem Restoration Plan

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Louisiana has experienced dramatic coastal wetland losses during the last century. Wetland losses as high as 90 km^2 per year have been reported. Although considerable efforts have been underway to curb these losses over the last two decades, losses have continued at a significant rate, computed to be about 62 km^2 per year during the last 10 years. In an effort to more aggressively address the loss of this national resource, Federal and state agencies have developed the Louisiana Coastal Area (LCA) Ecosystem Restoration Plan (LCA Plan), an integrated strategy to address this concern during the next 30 years. One component of this strategy is a Science and Technology Plan (S&T Plan) to address scientific uncertainties and enhance project success. The objectives of the S&T Plan are to provide a strategy, organizational structure, and processes to facilitate integration of science and technology into the decision-making process. Implementation of this S&T Plan will ensure that the best available science and technology are used to design, construct, and operate LCA Plan projects.

The need for a sound scientific foundation to support system-scale ecological restoration has been broadly recognized through similar programs and in statements of agency leaders. However, there is often a disconnect between societal and management needs for ecosystem restoration and scientific investigation and understanding.

The science of ecosystem restoration is evolving rapidly through theoretical and applied research. The body of scientific knowledge and data for coastal Louisiana has advanced enough to provide a sound basis for implementation of restoration projects incorporating a number of technological and engineering solutions with imbedded continuous learning and method improvement. However, certain aspects require increased data and monitoring, modeling, and research and experimentation to decrease uncertainties, especially in the area of predicting ecosystem response to the restoration projects. The S&T Plan will support the restoration efforts on both fronts.

This presentation will discuss the scope and organizational structure of the proposed LCA S&T Plan. It will also discuss some of the priority efforts to execute the S&T Plan and mechanisms for integration of science and technology into early project planning and execution and into management decisions.

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Hydrologic Restoration of Isolated Wetlands in the Okeechobee Watershed: An Integrated Approach to Reduce Phosphorus Loads to the Lake

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Nutrient criteria of 40 ppb phosphorus in Lake Okeechobee will require an estimated reduction in watershed phosphorus load from 550 to 140 metric tons. Best Management Practices (BMP) on Dairy, Cow/Calf, Citrus and other agricultural operations, as well as urban areas within the watershed are being implemented in hopes of meeting this target. One of the BMPs being considered at different scales and intensities is the use of Wetlands. Constructed Stormwater Treatment Areas as well as more intensive Aquatic Plant Management Systems are being proposed for large scale bottom of catchment applications. However, enhancing existing wetlands within the watershed may also provide a significant phosphorus sink if hydrologically restored.

Presently, 18% of the land area within the four priority basins of the Lake Okeechobee watershed is wetland, of which 41% is riparian and 59% is isolated. Extensive ditching and drainage of isolated wetlands to improve forage condition has significantly reduced the aerial extent of these wetlands. A survey of 118 wetlands within the four basins conducted in 2003 indicates a significant difference in surface soil phosphorus storage capacity between inner “core” zones and perimeter “edge” wetland areas. The difference in phosphorus between these zones appears to be associated with increased organic matter content of the soils. Differences in soil phosphorus content were $17 g/m^2$ and $25 g/m^2$ within the upper 10cm of soil in edge and core zones respectively. These findings suggest hydrologic restoration of these wetlands resulting in a larger core wetland area could significantly increase the total P storage potential in the landscape. Even a 10% increase in wetland area would result in over 1250 hectares of additional wetlands within the basin and an equivalent increase in core wetland area having higher soil P storage capacity.

Potential loss of existing forage areas resulting from hydrologic restoration is a concern of ranchers and inundation tolerant forage grasses are being evaluated for planting within the area around the wetland that will become inundated. A four year evaluation of the benefits of hydrologic restoration is underway comparing two paired wetlands on two ranches within the Okeechobee basin. After one year of preliminary monitoring, one wetland in each pair will be hydrologically restored and phosphorus budgets of all wetlands will be monitored to determine efficacy of hydrologic restoration. Intensive monitoring of vegetation litter and soil components under hydrologically restored conditions will be used to determine mechanisms of increased phosphorus assimilation. Use of existing isolated wetlands dispersed throughout the watershed may provide a low modification BMP to assist in reducing phosphorus loads to Lake Okeechobee.

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A Biological Control Agent for Invasive Plant Species, Old World Climbing Fern (*Lygodium microphyllum*)

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One of the greatest threats to the native ecosystems in any part of the world is invasion and permanent colonization by non-native species. Florida is no exception to this biological invasion, and currently colonized by an extensive variety of exotic plant species. The unrestricted growth of many of these nonnative plants jeopardizes the survival of an array of native plants in Florida. Originally imported from Asia over thirty years ago, Old World Climbing Fern (*Lygodium microphyllum*) has become one of the most invasive and destructive weeds in southern Florida. To date different effective control measures of its growth and spread has not been successful. Fire and herbicide application is currently in practice, however they are not cost effective and environmentally friendly approach. In light of the highly delicate ecosystem effected by *Lygodium microphyllum*, we explore that a biological paradigm is a more ecologically sound approach to the containment of this obnoxious weed. We have identified sicklepod fungus *Myrothecium verrucaria*, as a possible bioherbicide against *Lygodium microphyllum*. Series of greenhouse studies demonstrated that *Myrothecium verrucaria* serves as an effective biocontrol agent against *Lygodium microphyllum*. This type of biocontrol strategy to restore native ecosystems is cost effective and environmentally friendly.

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Floridan Aquifer Recharge Area Acquisition as a Means to Secure Water Supply, Restore Native Habitat and Provide Public Recreation

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Much of Bay County, FL (located in the central panhandle) receives water for public supply, industrial and commercial uses from Deer Point Reservoir. Deer Point Reservoir, with a surface water basin area of 442 square miles, receives considerable inflow from Econfina Creek. Econfina Creek is deeply incised into the Sand Hill Lakes physiographic subdivision of the Dougherty Karst District. It has a mean annual flow of about 540 cfs (350 Mgal/d). As many as 30 Floridan Aquifer springs can be found along the central reach of Econfina Creek. Although no individual spring is greater than second magnitude, ground water discharge accounts for about two-thirds of total Econfina Creek flow.

Floridan Aquifer recharge rates in the adjacent Sand Hills are estimated to be on the order of 30 to 40 inches per year. Much of the District's land acquisition activity has been focused on this area. Beginning in 1992, the District acquired its first spring parcel consisting of 223 acres. Over the next 12 years the District was able to increase protection of the Econfina Creek corridor from its Jackson County headwaters to Deer Point Reservoir by acquiring approximately 10,000 acres. More importantly, in 1997, the District was able to acquire and protect an additional 30,000 acres of adjacent xeric uplands within the core of the Econfina Recharge Area from future development and land use conversion.

In addition to water resource protection, the District is also charged with restoring and maintaining habitats to their natural state and condition on the 40,000-acre property, as well as, providing resourced-based recreation opportunities to the public. This is a continuing challenge as the District is required to convert approximately 25,000 acres of non-native sand pine plantation to a xeric upland sandhill vegetation community, i.e. longleaf pine/wiregrass habitat. Public recreational issues are just as daunting as the recharge area contains over 50 karst lakes and ponds, ranging in size from one to 600 acres. In addition to being a potable water supply, Econfina Creek is also a State Designated canoe trail. A critical segment of the Florida National Scenic Trail follows its upper reaches and traverses a central portion of the recharge area.

Recharge area acquisition at this scale has allowed the District to secure the perpetual maintenance of both the quantity and quality of water discharged into Econfina Creek, and hence into Deer Point Reservoir. To the author's knowledge, the area is also the second largest longleaf pine/wiregrass habitat restoration project in the southeast. Protecting the recharge area's water resources, restoring habitats and providing resource-based recreational opportunities for the public will be a complex balancing act in the years to come.

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"Fine Tuning Everglades Restoration": the Loxahatchee Impoundment Landscape Assessment (LILA) Project

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Everglades restoration is an enormous effort including many projects and activities outlined in the Comprehensive Everglades Restoration Plan (CERP). The framework of CERP is built on the interpretation of performance measures designed to monitor an individual project's success. A series of assessment studies at the Loxahatchee Impoundment Landscape Assessment (LILA) project located at the Arthur R. Marshall Loxahatchee Wildlife Refuge will assist in developing performance measures for Everglades restoration. LILA consists of four 17-acre replicated macrocosms sculpted to mimic the key landscape features of the Everglades and will be used to test the response of tree island and ridge and slough communities to changing hydrologic treatments. Water depth, velocity, and flow rate will be manipulated using a controlled water delivery system allowing scientists to study restoration plans on a small scale before applying them to the natural system. LILA provides a unique opportunity to fill key information gaps of CERP and to provide the public with a rare opportunity to see restored Everglades habitats. What really sets LILA apart from other approaches is that the hydrology is controlled and replicated, producing much less variability than what is found in the natural system. A second strength of LILA is that the collective assessment studies provide a multidisciplinary package of scientific information whose worth is much greater than the sum of the individual studies. By using reliable science, LILA will test the success of the restoration process.

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Using Historic Photography as a Resource for Ecological Restoration of the Florida Everglades: the 1940s Photoset and Geodatabase Development

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Historic aerial photographs of the south Florida landscape are a source of valuable information of pre-drainage land cover and land use patterns in the Everglades. The U.S. Geological Survey, in partnership with other agencies, is creating a digital archive of historic aerial photography of this area spanning 75 years from 1927 through 1992. Work on the digital archive has progressed with the creation of two open file reports publishing maps from 1927 - 1935 and imagery from 1940. Additional imagery has been scanned but is not yet published.

The 1940 photoset includes approximately 930 unique high quality panchromatic images of south Florida. The 1:40,000-scale photography covers an extensive area south of Lake Okeechobee. This published unreferenced imagery (300 dpi) can be accessed via the Internet at URL: <http://sofia.usgs.gov/publications/ofr/02-327/>. We are now in the process of georeferencing higher resolution imagery from this set. The entire set of 1940s geotiff imagery should be available in the near future.

When complete, the digital referenced imagery will constitute a broad-scale, high-resolution image of the Everglades landscape that spans over seven decades. It will form the basis for detecting changes in land use and land cover using geographic information systems and spatial analysis methods. To test these methods, we selected a limited area comprised of the Southern Inland and Coastal System of the Everglades to create a geodatabase of historic photography. This pilot project includes georeferenced raster images from 1940, 1952, 1964, 1987 and 1995, which we will use to conduct a spatial analysis of changes in vegetation patterns.

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Development of a Systems Model to Explore Long Term Ridge-Slough Dynamics

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Changes in water management have long term impacts on the ecosystem mosaic in the southern Everglades. This study presents a dynamic model of direct competition between ridge and slough communities, and explores the potential for biotic feedbacks to drive the observed landscape mosaic. In particular, we integrate community processes over long periods (~ 100 years) to examine the effects of differential litter recalcitrance and hydroperiod on soil accretion and consequent effects on community selection. We first provide a model adjacency matrix that presents both positive and negative feedback that may influence the persistence of one community or the other. Then we develop a dynamic simulation model to synthesize observational data and explore scenarios for the influence of water management on the relative abundance of ridge and slough communities.

Internal model rate parameters are calibrated based on literature estimates and field observations. Soil accretion rates are inferred from Pb^{210} dating of soil cores; litter recalcitrance is measured using extended *in situ* litter bag experiments; vegetative production rates are computed from field observations of above and below ground biomass changes. The model includes rate estimates of peat and marl accretion, and consequent effects on relative elevation. The impacts of changes in elevation on hydroperiod are derived from statistical analysis of available stage data from proximate observation stations.

The model illustrates the complex feedbacks between community composition and carbon dynamics in this landscape mosaic. In particular, we demonstrate that the long term persistence of slough communities is dependent on maintenance of elevated water levels; as nominal water levels decrease, ridge vegetation is able to colonize and outcompete slough vegetation, which leads to conditions that reinforce ridge community selection. However, when nominal water levels are high, internal feedbacks can reinforce the conditions that select for species typical of slough vegetation. The stochastic and systemic effects of fire and nutrient enrichment are also explored.

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Restoration of the Kissimmee River: Response of River Metabolism

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Metabolism estimates are often used to classify river ecosystems because gross primary productivity (GPP) and community respiration (CR) are determinants of biomass and trophic structure within a system. Additionally, metabolism estimates can be used to indicate changes in the health of rivers (Bunn *et al.* 1999). Therefore, metabolism measurements should be useful in evaluating restoration and recovery of degraded ecosystems such as the Kissimmee River. The Kissimmee River was once a 166 km long, free flowing, low gradient, blackwater river, but was channelized and impounded between 1962 and 1971. Channelization eliminated 12,000-14,000 ha of floodplain wetlands and severed the connection between the river and its floodplain. In 1992, Congress authorized the Kissimmee River Restoration project. Phase I of the Kissimmee River restoration project began in June 1999, was completed in February 2001 and reestablished flow through 24 km of continuous river.

The single station diel oxygen curve method was used to determine the metabolism of the Kissimmee River before and after restoration. Gross primary productivity, CR, the ratio of GPP/CR (P/R) and net daily metabolism (NDM), were estimated before and after canal backfilling, spoil removal and restoration of continuous flow to the river channel. Restoration of flow through the river channel significantly increased reaeration rates which caused an increase in mean DO concentrations from < 2 mg L^{-1} before restoration of flow to 2.90 mg L^{-1} - 5.92 mg L^{-1} after flow was restored. Annual GPP and CR rates were 1.14 g O_2 m^{-2} day^{-1} and 3.53 g O_2 m^{-2} day^{-1} respectively, before restoration of flow. After restoration of flow, annual GPP and CR rates increased to 4.76 g O_2 m^{-2} day^{-1} and 9.67 g O_2 m^{-2} day^{-1} respectively. The ratio of P/R increased from 0.30 during the baseline period to 0.50 after flow was restored, indicating an increase in autotrophic processes in the moderately heterotrophic restored river channel. Net daily metabolism values became more negative after flow was restored, signifying a shift from primarily autochthonous carbon sources to primarily allochthonous sources. The shift in primary carbon source suggests that the connection between the river channel and floodplain has been reestablished. After flow was restored, metabolism parameters were generally similar to those reported for the Ogeechee River, a relatively pristine, low-gradient, sub-tropical, blackwater river system, signifying that the Kissimmee is on a trajectory toward recovery.

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A Proposed Biodiversity-Based, National Objective for Formulating and Evaluating Ecosystem Restoration Projects Sponsored by the U. S. Army Corps Of Engineers

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Because of its leadership in ecosystem restoration, the public investment evaluation process of the U. S. Army Corps of Engineers is a model for others to consider and might become the basis for more effective interagency integration of restoration actions in pursuit of national ecosystem restoration objectives. However, this study concludes that Corps planning guidance leaves the Corps' national objective, and project contributions to that national objective achievement, too vaguely stated to effectively integrate diverse restoration projects toward achievement of a national restoration goal.

Corps guidance for project planning indicates that "the objective of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition". It also indicates, under description of the Federal objective, that: "The Corps objective in ecosystem restoration planning is to contribute to national ecosystem restoration (NER)". Those contributions to NER are measured using non-monetary units that indicate "increases in the net quantity and/or quality of desired ecosystem resources" resulting from "improvement in habitat quality and/or quantity". The extent to which desirable ecosystem resources are restored enough to justify an investment is indicated by the significance of the output response (significant effect) that results from the restoration action.

Unfortunately, ecosystem resources come in a wide variety of forms and function (their biodiversity), and planning guidance offers little help for comparing the relative contribution of different significant effects on form and function to national ecosystem restoration objective achievement, either within or across restoration agencies. Neither does planning guidance provide a practical means for integrating across the ecosystem restoration objectives of different restoration agencies. While some aspects of ecosystems are identified as especially significant, such as scarce resources and connecting habitat, no measure is identified that allows for comparison of contributions to a national goal to eliminate ecosystem resource degradation.

I reviewed Corps policy and numerous ecological concepts in search of the most suitable measure of NER contributions and concluded that the single most meaningful indicator of national ecosystem restoration objective achievement is a condition of nationally secure biodiversity for all of the Nation's ecosystems. To achieve this national objective, project investment priorities are based on projected scarcity of species and community-level biodiversity independent of demand for resource use that can be valued economically (e.g., recreation, food). A preliminary concept of a planning framework and an index to national biodiversity security is presented here based on ecosystem resource uniqueness and vulnerability to extinction.

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The Need for Improved Program-Level Planning to Achieve Sustainable Outcomes from Ecosystem Restoration Projects Planned by the U. S. Army Corps of Engineers

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Recent reviews of water resource development policies and ecosystem restoration efforts lead us to conclude that ecosystem restoration outcomes from most civil-works projects are of doubtful long-term sustainability because of inadequate program-level planning. This inadequacy results primarily from guidance that focuses too exclusively and incrementally on project-affected area and relies on overly simplistic forecasting assumptions about ecosystem influences on the forecasted project-affected condition.

Corps planning guidance advocates formulation of ecosystem restoration plans in a “systems context” to “improve the potential for long-term survival” of ecosystems restored to self-regulating function. But, other than placing it in a watershed perspective, planning guidance provides little insight in how to translate concept into practice. The Corps traditionally operates in the watershed and coastal ecosystem context emphasizing plan formulation based on the history of hydrologic system performance at the project site, including responses of flow and closely associated land forms. The traditional hydrologic trend extrapolation is insufficient, however, for all ecosystem restoration needs. All trends in significant ecosystem influences on hydrologic and ecologic process-including possible land use and climate change-need to be considered to fully evaluate their cumulative effects on the sustainability of project benefits.

A comprehensive analysis anticipates that the future project area and its systems context are not precisely predictable and therefore considers alternative futures and appropriate adaptive management as future conditions reveal themselves. Because this approach is impractical for each and every new restoration project, achieving sustainable restoration of ecosystems requires a more proactive strategic analysis of regional ecosystem resources and their responses to various possible land and water conditions. Project planning would proceed with respect to that programmatic analysis.

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Achieving Multiple Values from Ecosystem Restoration

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Decision makers investing in ecosystem restoration have been seeking more easily understood, quantifiable measures of costs, benefits and overall net value. In part, the emergence of markets for a new set of commodities - ecological assets - has helped demonstrate the value of eco-restoration efforts.

Ecological assets are sustainable goods and services arising from the voluntary preservation, enhancement, restoration or creation (PERC) of ecosystem services. They generate value by reducing costs and increasing income the same way traditional commodities do. Because these assets are relatively new, stakeholders often miss opportunities to fully leverage their potential value. For example, restoration that improves habitat can increase terrestrial and aquatic populations to a quantifiable extent, generating combined value from endangered species restoration, watershed enhancements, recreational consumptive use and from tourism/aesthetic appreciation. The market value of these results can be tallied. Cost savings can accrue from efficiency improvements as well as from a reduction in liabilities. Income growth can result from the sale of renewable eco-asset products and services such as wetland credits.

Over the past decade, markets have emerged for resource conservation (species restoration) resource extraction (transferable fishing quotas), and pollution prevention (emission reduction credits). Derived from innovative property rights theory, eco-asset ‘paper’ is now available in the form of bonds, credits, allocations, certificates, rights and other definitive units of measure that can be bought, banked, traded and sold. Although this is a potentially rich menu of options for stakeholders, successfully achieving measurable value depends on well conceived eco-restoration efforts, adapting to the uncertainty of still-developing markets, leveraging multiple assets from a project, and controlling transaction costs.

This paper presents several visual models describing the relationship of ecological assets to more traditional asset types. Case studies will also be presented to describe how ecosystem restoration managers, in cooperation with agencies, public interest groups and other stakeholders, have overcome market issues to achieve quantifiable value from strategically planned restoration projects. Recommendations will also be provided for future work to improve the measurable value of ecosystem restoration, hence the market presence of ecological assets.

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Verification of ATLSS SESI Models Using Species Abundance Data

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A primary product of the U.S. Geological Survey's Across Trophic Level System Simulation (ATLSS) project is the set of Spatially-Explicit Species Index (SESI) models. These models are designed to assess the relative potential for breeding and/or foraging success of modeled species across the Greater Everglades Landscape under a variety of proposed hydrologic scenarios. SESI models incorporate information relating suitable conditions for these species to localized habitat conditions and year-to-year hydrology dynamics, producing yearly performance values between 0 and 1 for each 500x500-m cell in the model area. SESI models have been applied to provide a relative assessment of species' responses to alternative water-management scenarios as part of the Comprehensive Everglades Restoration Plan (CERP).

We herein address the specialized problems of verifying index models using recent observation data for the modeled species. SESI models cannot be strictly calibrated to distribution and abundance data in the manner of more complex population or individual-based models that incorporate a wider range of biotic and abiotic factors. The relative importance of factors other than hydrology determines the degree to which SESI outputs can be expected to reflect observed abundances and distributions of modeled species. The reliability of SESI models can nonetheless be evaluated by comparing year-to-year trends in SESI outputs with recent species observation data by using calibration hydrology input that simulates historical water depths and considering the degree to which observed abundances reflect hydrologic factor.

Progress is being made toward a system-wide synthesis of monitoring surveys conducted by state and federal agencies in south Florida. Systematic Reconnaissance Flight (SRF) observation data are available over much of the model area for wading birds, alligators and white-tailed deer. We compare observed yearly population trends with trends in SESI potential by interpolating SRF transect data into a model-area grid and scaling to provide relative abundance counts. We compare trends in SESI index values with observation data using time series analyses for landscape subregions of interest. Results are evaluated over the range of hydrologic conditions, comparing the direction and magnitude of year-to-year variation. In addition to considering chronological order, years are sorted in a dry-to-wet sequence to facilitate comparison of model results and observed abundances over the range of hydrologic conditions.

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Towards a Healthy Steelhead Population with Watershed Restoration in Washington's Wind River

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Adult returns of wild anadromous rainbow trout *Oncorhynchus mykiss* (steelhead) declined to perilously low levels by the late 1980s in the Wind River, a 603 km^2 watershed in the Columbia River Basin (Washington, USA). Since 1992, biologists from federal, state, county, and tribal entities have joined together to investigate the decline in adult steelhead returns and to coordinate restoration efforts. This group has secured funding to conduct watershed assessments, identify and prioritize habitat restoration projects, and to engage the public through forming of a watershed council and conducting outreach activities. Using the assessment data for decision making, changes in fisheries management have been made and numerous cooperative watershed-scale restoration projects have been implemented.

Restoration projects have resulted in reconnecting 1.8 km of an old growth stream channel to the historic stream network, decommissioning a river dike to reconnect the historic flood plain, reconstructing the natural sinuosity of 16 km of alluvial streams, and adding over 3,400 pieces of large woody material. In riparian areas, 486 riparian hectares have been reforested and over 245,000 conifers have been planted along 24 km of stream to restore natural species composition, increase bank stability and stream shade, and provide future large woody material. To reduce peak flows, erosion, and landslides, 20% of the roads in the watershed have been decommissioned.

In addition to extensive physical habitat monitoring, fish assessment efforts have been conducted annually to track the response of multiple life-history stages of steelhead, including the number of returning adults, location and density of spawners, density and growth rate of parr, and number of smolts emigrating from the watershed. Recently, we have documented seasonal limitations of key nutrients (i.e., nitrogen and phosphorus) in several streams within the watershed. In response, we have initiated a nutrient enhancement and ecosystem response study to determine if fish production could be enhanced with tailored fertilization efforts. Our coalition of folks with diverse expertise in watershed restoration, fisheries management, research, and community outreach has proven to be highly effective in changing management practices and guiding restoration efforts.

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The Louisiana Coastal Area (LCA) Study: History and Future

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In the past 75 years, more than one million acres of Louisiana's coastal plain have become submerged or eroded into the Gulf of Mexico. A little more than a third of a million acres could be lost by 2050. This wetland loss is the result of human intervention and natural processes, including: 1) efforts to maintain commercial navigation channels; 2) flood and storm damage reduction in coastal plain communities; 3) oil and gas development; and 3) natural subsidence and erosion of the deltaic lands. The affected area supports a complex coastal wetland and barrier island ecosystem, an environmental resource of national significance.

Restoration in Louisiana gained significant momentum in 1990 with passage of the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), an annual funding source averaging $50 million. It created a federal Task Force of five agencies that sponsor projects under the program. CWPPRA is currently working on nearly 150 projects at a total cost of $1.7 billion. Unfortunately, these projects address less than 25 percent of the state's wetland loss. As a result, the Coast 2050 Plan was initiated. The plan, completed in 1998, identified solutions across the state's coastal area, and ultimately served as the reconnaissance study for the Louisiana Coastal Area (LCA) Ecosystem Restoration Feasibility Study in 2002. LCA was instrumental in obtaining federal recognition of the enormity of the problem and resulted in the necessary funding to support a comprehensive, large-scale plan.

In 2004, the Corps issued a draft report that identified the most critical ecological needs and a near-term program of cost-effective projects to address them. The report highlighted the key long-term scientific uncertainties and engineering challenges facing the effort to protect and restore the ecosystem, and proposed demonstration projects and studies to help resolve those uncertainties. The recommended project focused on the specific coastal areas that require the most immediate attention and the best way to sequence the proposed work over the next 10 or so years. The Corps and state developed studies of potentially promising, long-term ecosystem restoration concepts, with the objective of determining whether they would provide a cost-effective way to create coastal wetlands. This enormous undertaking is estimated to cost $1.9 billion.

To facilitate this effort, the study team formed a management program consisting of interagency, decision-making and execution teams, as well as a robust science and technology team. This coordinated approach to restoration combines a commitment to address the highest priority needs with a search for innovative solutions. It also ensures that the coastal Louisiana restoration effort will, in the long-term, be able to adapt and evolve as needed, based on the best available science.

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Pyrite Oxidation in Dredged Estuarine Sediments: Challenges for Beneficial Use

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The formation of iron sulfides, both monosulfides (FeS) and pyrite (FeS_2) is ubiquitous in estuarine and marine sediments. Anaerobic oxidation of organic matter uses sulfate as a terminal electron acceptor and iron sulfides are generally formed in the top few centimeters of estuarine sediments. Pyrite is the dominant form of iron sulfide in most estuarine sediments and its formation if often limited by the amount of detrital iron deposited from fluvial and shoreline sources. It's formation results in a net flux of alkalinity from sediments. Under anaerobic sediments, pyrite is stable indefinitely; upon exposure to atmospheric oxygen, pyrite is oxidized, with the formation of iron oxides and sulfuric acid. This process is similar to that from acid mine drainage.

In the Chesapeake Bay, the maintenance of dredged shipping channels requires an annual average 3 million cubic meters of sediment to be removed from the channels. The placement of dredge sediment is a contentious issue, and the previous practice of depositing "clean" dredge sediment deeper waters has been legislatively removed as a disposal option. With the exception of utilization of dredge sediment for marsh creation, most options available require the placement of sediment in confined upland facilities. These facilities dewater and oxygenate the sediment in order to compact the sediment and efficiently use capacity. Other options, such as use for farm soil amendments, are problematic because of the presence of pyrite.

At the confined sediment facility at Hart-Miller Island, the creation of shallow water habitat on dredge sediment is challenged because of the underlying contamination of Baltimore Harbor sediments and low pH from pyrite oxidation. We are following the development of a shallow water pond at this site, and have observed a large increase in pH from the original pH's observed upon flooding (generally < 5). While large parts of the pond have pH's that now exceed 6, low pH water is found within some locations in the pond, suggesting a shallow groundwater source. Despite pH problems, algal production and macrophyte production appear to be doing well in this pond. The chief remedy for low pH should be reestablishment of anaerobic conditions within the pond; increased anaerobic metabolism will occur as autochthonous organic matter accumulates in the sediment. We are continuing the study of this rapidly changing system to determine if internal processes are sufficient to overcome the initial low pH problems.

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Modeling Biotic and Abiotic Interactions under Different Eutrophic Conditions in Subtropical Marsh Systems

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Eutrophication of wetland ecosystems can lead to extensive displacements of vegetative communities and as a result changes in overall environmental conditions. This has generated a demand for a set of sensitive indicator(s) that prelude the structural changes in vegetative communities in response to nutrient enrichment. In this study, we used the extensive data base collected by researchers at the Wetland Biogeochemistry Laboratory over two wetland systems in Florida: i) along the eutrophic gradient in the Water Conservation Area 2A (WCA 2A), the Everglades and ii) contrasting nutrient impacted and unimpacted areas in the Blue Cypress Marsh Conservation Area (BCMCA), located in the Upper St. Johns River Basin, Florida. This study had two objectives, i) to determine the biogeochemical measures that are most responsive to ecosystem dynamics and ii) to quantify and model the relationships among sensitive indicators.

Initial analysis was executed on the WCA 2A dataset. We found that when we used a comprehensive set of soil physico-chemical variables, observations clustered naturally in multivariate groups that, with some misclassification, coincided with eutrophication grades. Stepwise discrimination of physico-chemical soil characteristics resulted in two discriminant functions that best described eutrophication. We then projected microbiological soil characteristics on the physicochemical clusters, selecting microbial indicators that best predicted impact classes from which the observations originated. The discriminant functions as well as the variables selected to form these discriminant functions can therefore be applied as indicators. Discrimination by microbial parameters generally is moderately successful when contrasted to soil chemical variables and function more as integrative functions with associated stability and robustness. We were also interested in understanding the relationships between the soil physico-chemistry and microbiological characteristics. Biogeochemical processes and the multiple constituent measures are complex and often show non-linear responses. One can view the physico-chemical environment characteristics as the driving factors and the soil biogeochemical processes indicators as responses in a factor-response model of the system's response to management changes. To that effect we constructed a series of models associating the physico-chemistry to the microbiology using confirmatory factor analysis or structural equation modeling. The results of the modeling efforts were validated in BCMCA.

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The Use of Hydrodynamic Models for the Hydraulic and Geomorphic Design of Restoration Projects on the Skagit River, Washington State

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Over the past century, construction of an extensive levee system along the Lower Skagit River has degraded or eliminated much of the prime anadromous fish habitat and floodplain connectivity along the river corridor. This confinement has also limited nearly all opportunities for ecosystem restoration or river enhancement. However, recent efforts have been undertaken to restore relatively natural fluvial features, remaining inside of the levees, and to restore more degraded areas, by modifying the levee system. This presentation describes the application of numerical modeling as a fundamental tool in the hydraulic and geomorphic design of these restoration projects. The Edgewater Park project is located on a reach of the Skagit River in Mt. Vernon, Washington and involves the restoration of a side-channel slough. The Wiley Slough project is located farther downstream along the South Channel of the Skagit River at Fir Island. Both projects benefited from the availability of a hydraulic model of the entire lower river system, prepared by the Corps of Engineers as part of a regional flood management investigation. This one-dimensional model was adapted for both projects and modified to better simulate local conditions and address specific design issues. For the Edgewater Park project, a two-dimensional model was constructed from the Corps model data and local field survey data to simulate pre- and post-project habitat conditions—depth of water and flow velocity—under varying river discharges. The model was also used to guide the design and placement of log structures and establish the hydraulic geometry of a geomorphically stable side-channel slough. For the Wiley Slough Project, a one-dimensional hydrodynamic model has been applied to evaluate the restoration of the historic tide channel network, the design of tide gates, and their combined effect on sediment transport and deposition in this estuarine portion of the river system. Technological advances in computer modeling and mapping now allow the presentation of design concepts through three-dimensional and animated methods and examples will be provided for these projects. These visualization techniques have proven to be extremely valuable for disseminating otherwise obscure technical data in a familiar visual manner to effectively inform the public and decision-makers on the anticipated outcome of constructed projects.

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Missouri River Fish and Wildlife Mitigation, Past, Present, and Future

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The Missouri River Fish and Wildlife Mitigation Project is designed to mitigate, or compensate, for fish and wildlife habitat losses that resulted from past channelization efforts on the Missouri River. The project extends from Sioux City, Iowa to the mouth of the Missouri River near St. Louis, a length of 735 river miles. The purpose of this mitigation effort is to acquire, restore, and preserve aquatic and terrestrial habitat on individual sites along the river throughout the project area. New wildlife areas are being created, existing areas are being improved, and at select areas historic river features are being restored. This project is authorized to develop approximately 166,750 acres of land along the river in Nebraska, Iowa, Kansas and Missouri. Preservation or restoration is being accomplished by acquiring land from willing sellers and restoring fish and wildlife habitat by vegetative management, restoring historic river features, and wetland restoration or construction. Currently, approximately 40,000 acres of fish and wildlife habitat have been restored or preserved. This presentation will focus on the current status of the mitigation program and what the future looks like in terms of land changes and habitat improvements.

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Recent Developments in Marine Restoration: National Policy, Law, and Science

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Marine restoration is becoming an ever more prominent topic in law, policy, and science throughout the world. Many countries of the world, including Australia, Canada, New Zealand, and the United States, and the European Union have committed themselves to establishing systems of marine protected areas in order to protect representative marine ecosystems and to restore both imperiled marine ecosystems - such as coral reefs and kelp forests - and the fisheries that marine ecosystems support. Australia in particular is using its national system of marine protected areas to fulfill its obligations under the Biodiversity Convention with respect to restoring and maintaining marine biodiversity. Scientists also increasingly support the use of marine protected areas, and in particular marine reserves, to restore damaged marine ecosystems. In addition, they have increasingly documented the fact that the United States' marine ecosystems have been damaged and are in need of restoration.

However, the response of law and policymakers in the United States to the increasingly evidence of the need for marine restoration has been lukewarm, although there are signs that marine restoration may move into the national spotlight. President Bill Clinton issued both the Northwestern Hawaiian Islands Ecosystem Reserve executive order and the Marine Protected Area executive order, but of which were designed in part to serve a restoration function, but progress under both executive orders stalled in the wake of the 9/11 terrorist attacks. In 2000, Congress enacted the Oceans Act, creating the United States Commission on Ocean Policy to comprehensively review the country's marine-related laws and policies. While the Commission has not yet issued its final report, its preliminary documents indicate that marine protected areas and marine restoration should be an integral part of the United States' marine policies and laws. In addition, the private Pew Oceans Commission has similarly indicated that marine restoration and marine protected areas need to become part of this country's law and policies.

On other fronts, marine restoration is also being integrated into existing laws and policies. Pursuant to its authority under the Clean Water Act, for example, the U.S. Environmental Protection Agency has been pursuing marine restoration in targeted ecosystems, such as the Gulf of Mexico and the Chesapeake Bay. The Endangered Species Act and the Magnuson-Stevens Fisheries Conservation and Management Act are also driving specific efforts to restore marine environments to protected imperiled, overhunted, and overfished species.

This oral presentation would survey the integration of marine restoration science into the United States' ocean law and policy, building on my extensive work in this area of law.

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Modeling Connections Between Life Stages of Pink Shrimp in South Florida

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Within the NOAA-South Florida Ecosystem Restoration Prediction and Modeling (SFERPM) program we are developing a pink shrimp (*Farfantepenaeus duorarum*) simulation model and performance measure to evaluate the impact of upstream water management changes on Florida Bay. The model will be used to predict ecological effects of planned changes in water management with implementation of the Comprehensive Everglades Restoration Plan (CERP) and to interpret results of follow-up monitoring. Life history stages of the pink shrimp are spatially separated; therefore, the development of scientific knowledge about this species must include the physical and biological processes affecting movements and transport during different life stages. Females spawn offshore in the Dry Tortugas along the SW Florida shelf, and planktonic stages migrate into the nursery grounds of Florida Bay where they settle and reside for several months before entering the adult population. We investigated the transport mechanisms of planktonic stages using field data and simulations of transport. Postlarvae were collected for four consecutive years at channels that connect the NW border of Florida Bay with the Florida shelf of the Gulf of Mexico and channels that connect the Bay with the Atlantic Ocean. A lagrangian trajectory model was developed using a current field derived from ADCP data time series. The model simulated particles traveling at night over a 30-day period to fit the estimated development time of pink shrimp before settlement. Results indicated that the main transport pathway for planktonic stages is across the SW Florida shelf and pointed to the importance of tidal currents and behavior to transport. Results of simulations suggested that only planktonic stages that are able to recognize and act upon changes in the direction of the current reach the nursery grounds in 30 days. Simulations also demonstrated a distinct annual cycle caused by the covariance between tidal motion and diel vertical migration that supports the marked summer peak of near-settlement-stage pink shrimp postlarvae observed every year at the NW border of the Bay. Therefore, young pink shrimp and other coastal species may use the summer tidal cycle to increase their chance of successfully reaching their coastal nursery habitats. The interactions between advection, vertical migration, and environmental cues still need to be better understood with respect to immigration of early planktonic stages. The question still to be answered is “Do pink shrimp begin life with a diel vertical migration and switch from a diel to a tidally synchronized mode during their first 30 days, and, if so, exactly when does this happen and what triggers the change? The postlarval immigration model will be used in conjunction with a simulation model of growth and survival to predict recruitment to the Tortugas fishery and to variation in juvenile pink shrimp densities in Florida Bay in relation to water management changes.

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Who Gets the Water? Identifying Water for Restoration of the Everglades and Other Purposes: Policy Issues and Technical Procedures

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Restoration of the Florida Everglades presents several unique challenges. One challenge is meeting the requirements set forth in the framework of federal and state laws that both facilitate and constrain attainment of the ecological goals of the Comprehensive Everglades Restoration Plan (CERP). This challenge is reflected in the development of technical procedures for the identification of water for natural systems and for other water-related needs.

Congress approved CERP in the Water Resources Development Act of 2000 (WRDA 2000) as "a framework . . . to restore, preserve, and protect the South Florida ecosystem while providing for the other water-related needs of the region. . . ." The CERP consists of 68 separate components, which have been combined into multiple projects to be implemented over a 40-year implementation period. WRDA 2000 contained a requirement for the Secretary of the Army to issue programmatic regulations (with the concurrence of the Secretary of the Interior and the Governor of Florida) to ensure that the goals and purposes of the comprehensive plan are achieved. The programmatic regulations became effective on December 12, 2003 and required specific procedures to be developed for the approval of CERP projects. The State of Florida has also enacted several laws in Chapter 373 of the Florida statutes establishing evaluations to be undertaken and criteria to be met in order for the state to commit funds as the non-federal sponsor and 50% cost-sharer with the Federal Government for implementation of the CERP.

Collectively, these laws have created several requirements for the protection of water for the natural system and for other water-related needs. Of particular interest, WRDA 2000 requires that CERP project implementation reports identify the appropriate quantity, timing and distribution of water dedicated and managed for the natural system, and that this water be protected from other uses through a state process known as a reservation. An interagency team is developing detailed guidance for CERP project planning teams, including procedures to be followed for the identification of the quantity, timing, distribution, and quality of this water. The development of these procedures required consideration of existing federal and state laws, stakeholder expectations, existing hydrologic planning and modeling tools, and project planning team resources. This presentation will describe how these elements were incorporated into procedures that satisfy legal requirements and scientific standards.

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Abrupt Climate Change: Implications for Coastal Ecosystem Restoration

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Abrupt climate change represents an extreme, non-linear mode of climate variability in which a threshold is reached, leading to large-scale changes in regional or global temperature and precipitation occurring over years to decades. Although the causes of abrupt climate changes are not understood, paleoclimatic data show that they can result in regional temperature changes of as much as 10 °C, extreme changes in mean annual or seasonal precipitation, and large changes in ecosystems. Given the likelihood that abrupt climate changes may occur in the future, it is important to consider their potential impacts on ecosystems and the implications for ecosystem restoration and management.

We will present evidence for abrupt climate changes in coastal ecosystems of Chesapeake, Florida and Biscayne Bays from paleoecological (microfaunal assemblages) and geochemical (oxygen and carbon isotopes and trace elemental compositions of calcareous shells) analyses of sediment cores. Emphasis is placed on reconstructing patterns and ecological impacts of climate variability during the late Holocene intervals known as the Medieval Warm Period (MWP, ~9-14th centuries) and the Little Ice Age (LIA, 15th - 19th centuries). These analyses provide insight into baseline levels of variability in ecosystems prior to extensive human disturbance of terrestrial and aquatic environments.

Evidence from Chesapeake Bay suggests that the mid-Atlantic region was significantly cooler (2 - >4 °C) and wetter (10 - 15% higher mean annual precipitation) during the LIA than during the MWP. In addition to large-scale changes in mean conditions, both the MWP and LIA were punctuated by abrupt (<20-40-year) shifts towards higher bay salinity due to the influence of sustained droughts on precipitation and river discharge. In South Florida, coastal ecosystems also were influenced by climatic forcing at interannual and decadal timescales by El Niño-Southern Oscillation and centennial timescales during the LIA. The greatest impact of climatic variability is its effect on salinity, which leads to large changes in species diversity, the composition of benthic assemblages, and the distribution of submerged aquatic vegetation. During late Holocene climatic extremes, coastal ecosystem variability sometimes exceeded that observed in monitoring records of the past 30 years. The evidence that past abrupt climatic changes have disrupted coastal ecosystems suggests that future climatic changes should be factored into long-term planning and modeling simulations for ecosystem restoration.

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Conceptual Model for an Ecologically Based Management Plan for Brazilian Peppertree in Florida

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Brazilian peppertree, *Schinus terebinthifolius* Raddi (Anacardiaceae), is a non-native perennial woody plant that has become one of the most invasive weeds in Florida. The plant was introduced from South America as a landscape ornamental in the late 19th century, eventually escaped cultivation, and presently dominates entire ecosystems in central and south Florida, and most notably within large areas of the Everglades. Brazilian peppertree readily invades disturbed sites and natural communities where it displaces native vegetation and alters biodiversity. It is a state listed prohibited plant and noxious weed, and is considered a Category I invasive natural area weed by the Florida Exotic Pest Plant Council. Conservation organizations and land managers in south Florida consider the management of Brazilian peppertree a high priority because it poses a significant threat to regional Everglades restoration efforts authorized by CERP.

Permanent suppression of Brazilian peppertree in Florida will require the development and implementation of an ecologically based management plan. The goal of this management plan will be to provide land managers with a predictable strategy for addressing the Brazilian peppertree problem. A basic tenant of the management plan is that the plant communities invaded by Brazilian peppertree are unique, dynamic and will require the application of various technologies (e.g., chemical, cultural, and mechanical controls, as necessary) to enhance the natural processes and mechanisms that direct vegetation change in a particular community. Natural regulating factors such as plant competition, flooding, and allelopathy will be manipulated to increase their impact on Brazilian peppertree control, and host specific biological control agents will be introduced to restrict seed production and reduce the vigor of new seedlings and regrowth from treated stumps.

In order to implement a site-specific management plan for Brazilian peppertree, the critical ecological processes that direct plant community dynamics to the detriment of Brazilian peppertree in a particular ecosystem must be identified and manipulated (Sheley and Krueger-Mangold 2003). Those processes with the highest probability of causing change in the desired direction will be modified to produce predictable results. This approach, which is referred to as ‘successional weed management’, requires a basic understanding of the three general causes of plant succession: disturbance, colonization and species performance (Rosenberg and Freedman 1984). Three different management scenarios for Brazilian peppertree in Florida are presented. In each management plan, the key elements of the successional weed management model- designed disturbance, controlled colonization, and controlled species performance-are applied by taking into account not only the extent of the infestation but also the type of habitat invaded.

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Ecosystem Performance Measures; Moving beyond Dollars per Acre

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Within the Federal Government there is an increasing emphasis on the use of performance criteria to establish priorities. Since passage of the Government Performance and Results Act, agencies have increasingly faced the challenge of measuring the performance of the non-monetized outputs of ecosystem restoration projects. In the past few years, there have been attempts to use the cost per acre of wetlands restoration to compare the effectiveness of various Federal programs. In an effort to recognize the quality of restoration in addition to the costs, the Corps developed eight performance measures for use in preparation of its FY 06 ecosystem restoration budget. These components address scientific and technical issues as well as collaboration, a key element in the Corps strategic plan. An attempt has been made to identify "nationally significant" restoration projects using these measures. The measures and the initial results of their use will be discussed. This is an evolving process and we expect changes based on our experience and from what we learn from other agencies and organizations facing the same task.

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The Estuary Restoration Act - Past, Present and Future

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Enacted on November 7, 2000, the Estuaries and Clean Waters Act is the result of several years of effort on the part of many advocates to make restoration of our nation's estuaries a national priority. After passage of the Act, the working group representing the various agencies on the Estuary Habitat Restoration Council and the Council approached the difficult task of turning a law into a functioning program. This paper provides a brief review of the Act's history, the provisions of the Act, the many positive outcomes, including the significant contributions of the other member agencies, and some ideas as to the future of the Estuary Habitat Restoration Program. Building upon the language in the Act, the work group has developed criteria for evaluation of project proposals and the Council identified nine potential projects for funding. Four of these projects are currently underway. In addition, the broader contributions of the Corps toward meeting the goal of restoring one million acres of estuary habitat by 2010 will be highlighted.

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The Impact of Stream Nutrient Loading on Filamentous Green Algae in Conesus Lake and the Use of Continuous Flow-Through Incubation Chambers for Measurement *In Situ* of Changes in Biomass

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The abundance of filamentous green algae (FGA) in Conesus Lake has reached unprecedented levels. This dramatic increase has altered the ecological state of the littoral zone and may have cascading effects on the lake's ecosystem. Stream effluent entering the lake contains high concentrations of soluble reactive phosphorus and nitrate. The hypothesis that stream effluent was having a positive effect on the biomass of FGA was tested using continuous flow-through incubation chambers. FGA responded in a significant positive manner when exposed to stream effluent. Analysis of nutrient concentrations determined throughout the incubation chamber experiments and results of an enrichment experiment, suggest that FGA in Conesus Lake is limited by phosphorous and not nitrate.

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Lee County Master Mitigation Plan

Wayne Daltry and *Roland Ottolini, et al*
Lee County Board of County Commissioners

Restoration of ecosystems without an understanding of the role and capacity of local governments is commonly doomed to failure. In virtually all areas of the United States, local governments are the public's vehicles for economic change, development and community growth. The regulatory scheme of a city, township or county determines the quality of construction and the impacts of land alteration. The budgeting programs of the local government determine the attention given to mitigation, restoration, and preservation of ecosystems. Our example is Lee County, Florida.

Lee County Florida has for over four decades been one of the fastest growing communities in the United States, growing from 25,000 persons in 1950 to 500,000 persons in 2003. As such it has been in the forefront of the various debates over growth and the environment. As is the case for most growing communities, the most egregious alterations occurred before the County had the political sophistication to act "smarter." Lee County has responded to individual problems in ways that in hindsight are disconnected. The County is initiating a program that examines the County as a whole, and as a component of a greater region. This program is the Lee County Master Mitigation Plan, the result of a collaborative effort by many entities, public and private.

The Master Mitigation Plan examines the County's needs for water quality improvements, improved surficial and groundwater storage, and interconnected habitat. It also examines the County growth and areas prepared for future growth. It examines the expected increase in population (estimated buildout of 1.5 million people) and the related capital improvement needs of this population growth, as well as remedial action resulting from poor practices in the past. It also brings in the goals of the Everglades Restoration program, the Charlotte Harbor National Estuary Program, the USACOE EIS on Growth in Southwest Florida, and various related environmental management programs.

The result of this analysis has proposed a means by which growth will fund some components of environmental infrastructure preservation, as well as mitigation. This in turn supports the programs needed for restoration and remediation of past practices. The resulting program, estimated currently to be $30 million a year but for certain peak transportation projects may climb to $50 million, will fund water quality remediation work; land preservation efforts; and habitat and water storage restoration projects. These projects are within a program with geographic/mapped outcomes, and an annual monitoring program for water quality, storage, and habitat.

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The Potential Utility of Apple Snail Egg Clusters in the Context of an Everglades Restoration Performance Measure

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As the restoration of the Greater Everglades Ecosystem (G.E.E.) proceeds, there have been calls for a variety of ecologically based performance measures that could indicate whether or not restoration targets have been achieved. The endangered Florida snail kite has received considerable attention because it depends on G.E.E. for its sole source of food, the Florida apple snail. As the hydrology of some key wetland units is altered (e.g., Water Conservation Area 3A), there are likely to be direct (e.g., recruitment) and indirect (e.g., changes in habitat structure) impacts on apple snail populations. As such, it would valuable to have some measure of apple snail relative abundance in order to document their response to the restoration activity.

Darby et al. (1999) described several ways of extracting apple snails from 1-m^2 throw traps in wetlands in order to obtain a density estimate. The process is labor intensive and a large number of traps (40-100) are needed to obtain reasonable precision. Darby et al. (1999) found that the number of eggs clusters did not correlate well with snail density. However, their correlation was based on egg cluster data that were collected from a single or limited number of time points. The clusters of ~25 white eggs are easily observed on emergent plants above water level; as such there is still appeal in exploring their potential as an index of snail abundance. We have since realized that apple snail egg cluster production occurs primarily in March - June, with a peak typically occurring in April or May and is followed by a post-reproductive die off Darby et al. 2003). Given the more recent information on life history and a better understanding of temporal variation in egg cluster production, we wanted to further explore the potential to use egg clusters as a tool to monitor trends in snail abundance.

In Spring 2004, we estimated snail density using throw traps from 14 sites in WCA3A, WCA1 (A.R.M. Loxahatchee National Wildlife Refuge) and Lake Kissimmee. We also established one or two transects along a sawgrass-wet prairie ecotone (WCA3A and WCA1) or along a patch of *Scirpus validus* (Lake Kissimmee) in each of these sites. We have continuous monthly counts for 7 of the sites from February through June. We consider the data preliminary at the time of this writing, because we need to audit the existing data and we plan to sample again in subsequent months. However, preliminary analyses indicate that even if the entire season of egg cluster production (i.e., including the initiation, peak, and decline in production) were correlated to snail density, the relationship is still very weak (r_{12}=0.22, P=0.60). We will also present information on within site differences in egg production and temporal variation within and between sites in terms of the initiation and peak period for egg laying. We will also explore the many factors that cause egg cluster production to vary even among snail populations of similar size. We see no potential to use egg clusters as an index of relative snail abundance over a range that would be significant from the perspective of a snail kite or other predator (i.e., snail density estimates ranging from 0.1 to 1.0 snails/m^2).

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Specific Conductance in the Everglades Agricultural Area

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The Everglades Forever Act of 1994 mandated a research and monitoring program on the evaluation of water quality standards in the Everglade Agricultural Area (EAA) that included specific conductance (Chapter 40E-63). Specific conductance was monitored since 1997 at ten representative farms in the EAA. All data were collected using Hydrolab DataSonde®, multi-parameter water quality data loggers. Weekly grab samples were taken in 2001 and 2002 and analyzed for ionic composition.

Potential sources of specific conductance were evaluated. These included geological influences, drainage pumping, irrigation water and fertilizer application. Summary statistics of the specific conductance during 1997-2002 showed that mean specific conductance above 1.275 mS/cm occurred at only two out of the ten farms monitored. It was found that shallow ground water hydrology and quality has a major impact on specific conductance in the EAA. Higher concentrations of sodium (Na^+) and chloride (Cl^-) were also observed at these two farms. The Na/Cl ratio in EAA canal water was close to the ratio in seawater (0.55).

The effect of drainage pumping on specific conductance was variable and site specific. There was a low correlation between drainage pumping and specific conductance. Statistical analysis of the daily average specific conductance at three intensively monitored farms indicated that drainage pumping increased specific conductance at two of the four discharge sites. Irrigation water had low negative correlation with specific conductance. It was evident that the sites that received irrigation water via secondary or branch canals had relatively higher mean specific conductance values. Impact from fertilizer application was negligible as it was shown the KCl fertilizer application in one of the high conductance farms contributed less than 6.5% of the total dissolved solids in the drainage water.

Yearly trend analysis, conducted on each site over the monitoring period, showed a decreasing trend of specific conductance in three farms and an upward trend in one farm. This implies that the implementation of farm level P lead reduction BMPs in the EAA since 1995 have had no measurable impact on specific conductance in canal water at the majority (seven of the ten) farms monitored. It was the conclusion of this study that no further BMPs can be identified by additional research that would provide abatement of specific conductance for farm discharge waters of the EAA. The currently employed P load reduction BMPs had no obvious impact on specific conductance at the ten farms, so we conclude that further BMPs that target specific conductance will not be effective or practical. Specific conductance in the EAA is primarily affected by geological influences and additional farm management practices will have minimal effect on specific conductance.

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Structural vs. Functional Measures in Restoration Projects

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Performance criteria (also called "success criteria") for restoration projects are often based on attainment of habitat-specific ecological functions, but current practices and policies rely heavily on the measurement of physical and biological structure to document habitat conditions and make inferences about the habitat's functions. Examples of existing policy and procedural guidance include EPA's Rapid Bioassessment Protocol, National Oceanic and Atmospheric Administration's Restoration Guidelines; Hydrogeomorphic Method Guidance documents, and Habitat Suitability Indices. A Corps of Engineers' review of 39 restoration projects confirmed that monitoring techniques relied almost exclusively on structural parameters, even though many of the projects had goals stated in terms of functional performance of the restored ecological system. Most monitoring programs have focused primarily on structural parameters for three important reasons. First, the difficulty and expense of monitoring ecosystem functions directly requires that structural attributes of habitats and biological communities generally be used to evaluate success of restoration efforts. Second, providing the proper physical habitat for establishment of aquatic, wetland, and riparian vegetation with cover, species composition, and architecture similar to comparison systems is a primary criterion for judging the success of most restoration projects in vegetated habitats. Third and perhaps most importantly, physical structural parameters are the variables that can reasonably be designed, manipulated, and managed as part of the habitat restoration and creation efforts, and therefore provide a direct link from initial design to final post-construction monitoring. We present data from the scientific and grey literature describing the most commonly measured structural parameters from recent restoration projects, and discuss how these parameters were used to indicate "functional success."

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The Role of Red Alder in Developing Multi-functional Forests in Mixed Hardwood-Conifer Stands of Southeast Alaska

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Red alder (*Alnus rubra* Bong.) appears to influence the productivity and structural diversity of young-growth conifer forests and affect the major resources (timber, wildlife, and fisheries) of forested ecosystems in southeast Alaska. Stand dynamics were evaluated in mixed red alder-conifer forests of southeast Alaska by assessing stand development, tree density, total basal area, and diameter distribution of live and dead trees in 40-year-old red alder-conifer stands that developed following logging. Forty-five plots were established in nine mixed stands that ranged from 0-86% alder. Conifers were primarily Sitka spruce (*Picea sitchensis* (Bong.) Carr.) and western hemlock (*Tsuga heterophylla* (Raf.) Sarg.). Alder height growth was initially rapid then slowed considerably, whereas conifer height growth was initially slow then rapidly increased with conifers now being 4-9 m taller than associated alders. Most alder diameters were 20-30 cm and conifer diameters were small (3-10 cm) with a few large (> 25 cm) trees. Total stand basal area significantly decreased ($p = 0.013$) with increasing proportions of alder but density of live and dead trees was not closely associated with alder composition.

We measured understory biomass and net production in each stand on a species-specific and plant part-specific basis and estimated carrying capacity for black-tailed deer (*Odocoileus hemionus sitkensis* Cowan) with a food-based habitat model. Significant correlations ($P < 0.002$) were found between red alder basal area and total understory biomass, net production of shrubs and herbs, and summer carrying capacity for deer. Ecologically, the high correlation between red alder and herbaceous production is important, because herbs are least abundant and most difficult to maintain for in young-growth conifer forests of this region. Red alder offers prospects for increasing biodiversity, wildlife habitat value, and diversified wood products when included as a hardwood overstory species in mixed hardwood-conifer, young-growth forests.

Overall, these mixed red alder-conifer stands provided more heterogeneous structures, multiple canopy layers and greater diversity and abundance of understory plants. Headwater streams with more riparian alder also provided more invertebrates and supported more downstream fish biomass than those basins with little or no riparian alder. Red alder may serve as an effective tool for improving terrestrial and aquatic habitat and for restoring important ecosystem functions in regenerating forests following timber harvesting. Well-planned silvicultural systems that include a mixture of red alder-conifer compositions could provide trees for timber production and also improve forest resources that are often compromised in pure conifer young growth forests in the region.

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Synthesis of the Across Trophic Level System Simulation (ATLSS) Program: Design, Application, and Evaluation of an Modeling Project for Restoration

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The U. S. Geological Survey's Across Trophic Level System Simulation (ATLSS) Program has produced a set of models of spatially explicit species index, population demography, and ecosystem process models, which were designed to evaluate the effects of hydrologic scenarios on selected Everglades biota. The program also supported field studies that produced data relevant to model construction and validation. Here we present a brief synthesis of the ATLSS Program to date, described in five parts.

First, the overall organization of the program is described as well as the motivation behind the modeling tools produced. This includes the reasons for the specific modeling approaches used, and criteria for selection of biological taxa.

Second, we describe the challenges involved in implementing the ATLSS modeling tools. Two major difficulties faced the initial development of models of Everglades biota. The first was to meet the computational demands for simulating complex dynamics on daily time steps for 31 years on a 500 x 500 array of 111,000 cells across the landscape. Another was to develop landscape hydrology at a finer spatial resolution than the available hydrologic models provided. The first of these challenges required ATLSS to develop software and hardware approaches for doing large number-crunching that were and still are at the frontiers of quantitative ecology.

Third, we describe the application of the ATLSS models to the Restudy in 1997-98 and subsequent scenario evaluations. In this process complex model output had to be generated quickly to meet deadlines, and it had to be interpreted and communicated to teams of scientists who were evaluating alternative Restudy scenarios. We provide some lessons learned from this complex process.

Fourth, we describe the steps taken to upgrade and extend the ATLSS models, including a vegetation succession model, using new empirical information. Continuing technical improvements have included the model visualization tools of the ATLSS Data Viewer and the development of the first-ever grid-computing methodology accessible to managers via a web-interface.

Finally, comparisons are made with similar programs around the world, and the capability of applying models of this type to other problems. The ATLSS models were far ahead of other efforts and have stimulated interest in similar approaches elsewhere.

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The Results of Monitoring Hard Corals Restored after the Installation of Telecommunication Cables off South Florida

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The installation of seven telecommunication cables at two sites off south Florida caused the dislocation of coral colonies from the hard bottom reef surface. These dislodged colonies and other, non-related detached coral colonies (e.g. by boat anchors), found along the cable corridor were repaired. Monitoring of the repaired coral colonies, as required by state and local environmental permits, has focused on survivorship. Survivorship considers the successful reattachment to the substrate and the effects of detachment and repair on the overall health of the colony, particularly in light of the recent decline in overall health of corals worldwide. Factorial experimental designs were used to examine the effects of repair on the incidence of disease and mortality in the coral colonies. The studies examined the potential differences between the reef systems, which occurred at different depths; the individual cables; and corals dislocated by the cables compared to those dislocated by other means. Repaired coral colonies were compared to corresponding reference corals and examined over several years. ANOVA and MANOVA were used to understand the significance of any differences between the observations.

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The Role of Effective Science Communication in Restoration Ecology

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Effective communication is an important component of conducting science, especially restoration ecology. However, traditional scientific training is focused on the technical and analytical skills needed to obtain and interpret data. Typically, the minimal training that is devoted to communicating science is generally focused on communication to peer scientists. Effective restoration ecology requires community involvement, and consequently effective communication to a non-peer audience. Good science communication produces content-rich, jargon-free, communication-based materials. Content-rich refers to communication which is replete with synthesized data and ideas. Jargon-free refers to the elimination of shorthand notation that scientists use to communicate within their peer groups; writing out acronyms, and maintaining a common language basis for explanation of concepts. Communication-based refers to a focus on the intended audience as well as providing a broader base of accessibility for a more general audience.

Synthesis, visualization, and context are key elements of effective science communication. Data that has been analyzed, interpreted, and synthesized is needed for meaningful science communication products. Visualization is key, as the audience must be able to see the who, what, where, when and how of the data that is used to support the ideas in the science communication product. The audience needs access to the data to make their own interpretations-they can be guided through the data, but need to know that the data exists. Appropriate context provides answers to these important questions: Why should the audience care? Or more simply, so what? Context includes using comparative data or relevant examples.

Attention to the communication aspects can improve the science that is conducted. Envisioning the ‘story’ that is being conveyed can lead to a more comprehensive research program, in which each element of the story is addressed. Identifying linkages and developing spatial and temporal comparisons can also lead to important new insights.

Conceptual diagrams are an effective tool for enhancing science communication. Using symbols arranged in a conceptual diagram, or “thought drawing”, is an excellent means to portray complex processes. The use of standardized symbol libraries have made it possible to generate conceptual diagrams without graphic art training or specialized equipment: <http://www.ian.umces.edu >

Restoration ecology inevitably requires changes in both attitude and behavior. Common understanding, resulting in change can only happen with good and effective communication of scientific knowledge. The tools and approaches discussed can be effective in facilitating those changes.

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Eutrophication in the Great Lakes: The Path to Restoration

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In 1972 the United States and Canada signed a landmark agreement known as the Great Lakes Water Quality Agreement (GLWQA). The overall goal of the Agreement was to “restore and maintain the chemical, physical, and biological integrity of the Great Lakes Basin Ecosystem.” One of the major thrusts of the original agreement, and especially its 1978 revision, was to solve the problem of eutrophication and its environmental consequences.

The 1978 revision of the GLWQA was preceded by considerable research and monitoring through the 1960s and early 1970s that identified excessive phosphorus loading to the lakes as the cause of their eutrophication symptoms. In spite of their impressive size (~20% of the world’s surface fresh water), the enormous population around their shorelines (over 40 million residents within the basin at that time) and their associated municipal, industrial, recreational, commercial, and agricultural use of the water had led to a concomitant deterioration of Great Lakes water quality. Having the smallest volume, the largest drainage basin to water surface ratio, the largest population density, and the largest percent of land use in agriculture, Lake Erie understandably received most of the attention in the war on eutrophication.

To reverse the eutrophication trend in the Great Lakes, the GLWQA contained a specific objective that phosphorus concentrations “…should be limited to the extent necessary to prevent nuisance growths of algae, weeds and slimes that are or may become injurious to any beneficial water use.” To achieve these goals, which were quantified in terms of chlorophyll *a* targets for each lake, basin or embayment, the 1978 Agreement established target loads of phosphorus to each of these parts of the system and recommendations for load control actions to achieve those target loads. The establishment and confirmation of those target phosphorus loads were informed by what at the time were the most sophisticated nutrient-eutrophication models available. This presentation will present the process by which restoration endpoints were established, the analysis that was used to set control strategies to achieve those endpoints, and the response of the system to the successful implementation of those control strategies.

Overall the Great Lakes eutrophication restoration process was a great success, because target phosphorus loads were achieved and the lakes responded to the load reductions as the models had predicted. We will present model post-audits that confirm this restoration success.

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Transport of Dissolved and Particulate Phosphorus in Canal Waters Downstream of STA-1W

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Treated water from the Storm-water Treatment Areas (STAs) discharges into an extensive network of canals for distribution throughout the Water Conservation Areas (WCAs). The ultimate goal of the STAs is to deliver water of low phosphorus (P) concentration to the downstream ecosystems. In view of the low P concentrations that will be delivered into these canals, questions have been raised on the possibility of the release of internal P load and particulate P resuspension and transport as water moves from the STAs to downstream ecosystems. The objective of this study was to evaluate the potential mechanisms for total dissolved P (TDP) and particulate P (PP) transport in WCA canals downstream of STA-1W. This study included three sampling locations in the canals (L7 and L39) downstream of the outlet of STA-1W. The selected sampling locations provided approximately 14 miles of canal that are being used to transport treated water discharged from STA-1W. At each location, hourly-discrete water samples were collected two feet below the water surface, mid depth of the water column, and two feet above the bottom sediment surface during the major discharge events of the 2002 wet season. Depending on the frequency of the drainage events, attempts were made to collect samples every two weeks or when the amount of water discharged from STA-1W was significant.

Average P concentrations during flow events in the canal water downstream of STA-1W over the study-period were 35 µg/L for TDP and 12 µg/L for PP. This study gave evidence of a significant interaction between the canal system with both dissolved and particulate P species. The canal systems appeared to have an effect on a net reduction of TDP and a net contribution of PP downstream of STA-1W. On average, over the 14-mile distance that constituted the sampling reach, TDP concentration decreased 0.46 µg P/mi, while the PP concentration increased 0.25 µg P/mi. The net reduction of TDP was hypothesized to result from biological activity in the canals and their floodplains, and appeared to be a function of time-in-season, higher in late summer (1.295 µg P/mi) when water temperatures are highest and lower during the spring and autumn (0.253 µg P/mi) when there is a decrease in biological activity as the water temperatures decrease. The net contribution of PP was hypothesized to result from remobilization of biological generated particulate matter that had accumulated in the canals during the quiescent dry season. As the pumping season progressed this accumulation was subject to washout, so early in the period mobilization was high (1.074 µg P/mi), while at the end of the period there was essentially no contribution by the canal systems. Expected higher flows from other operational STAs can increase the potential of resuspension and transport of the unconsolidated sediment material stored in these canals to downstream-protected areas. Future studies should include both dry and wet seasons phenomena and focus on the interaction between the canal/floodplain sediments and the water column.

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Effect of Scaling on Hydraulic Conductivity in a Karst Aquifer

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The intent of this study is to determine the effect, if any, of scaling on hydraulic conductivity in a karst aquifer. Testing will be done on three formations in the Biscayne Aquifer of South Florida, a highly transmissive karst aquifer. The Biscayne Aquifer is the dominant aquifer underlying the Everglades, and understanding it's properties is imperative to the Everglades Restoration effort. Models generated for this effort will benefit from accurate hydraulic conductivity values.

Scales to be used are 20 cm and 30 cm cubes, slug tests, and possibly a tracer injection test. Slug tests have been conducted in nine 2-inch wells in the Miami Oolite Formation of the Biscayne Aquifer at the Homestead General Airport (HGA). During the tests head level measurements were taken every .02 seconds. Data points were normalized, plotted, and matched to curves, using the Butler spreadsheets for high hydraulic conductivity aquifers to determine hydraulic conductivity (Butler and Garnett 2000). Hydraulic conductivity values for wells tested at the HGA ranged from 341 ft/d to 661 ft/d with a mean of 541.8 ± 83 ft/d. These values fall within the range of hydraulic conductivity values of 100 ft/d to >1000 ft/d for Miami Oolite with apparent solution holes reported by Fish and Stewart (1991). The HGA is adjacent to Everglades National Park and in the vicinity of projects conducted as part of the Everglades Restoration.

Hydraulic conductivity testing of the 20 cm and 30 cm cubes in a permeameter is in progress. Results will be compared for differences amongst different sized cubes, amongst cube and slug test results, and amongst formations. These results will provide water managers associated with the Comprehensive Everglades Restoration Project with an understanding of the variations of hydraulic conductivity of the Biscayne Aquifer.

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The Response of Below and Aboveground Biomass of *Typha* to Harvesting: A Modelling Approach

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A dynamic growth model was developed for *Typha*, to examine the effects of latitudinal changes in temperature and radiation on the partitioning of total biomass into rhizomes, roots, flowering and vegetative shoots, and inflorescences during the growing season. After validating the model with field data from growth studies of *Typha*, it was then used to study the dynamics of above and belowground biomass response to different harvesting regimes at three latitudes, 30, 40 and 50 degrees.

If aboveground biomass is harvested just once, both the above and belowground biomass decrease in the first year then gradually recover year by year unless harvesting is repeated, reaching a stable value, which is determined by the balance between total production and total respiration and metabolic losses, in 3, 4 and 5 years at 30°, 40°, and 50° respectively. However, if the aboveground biomass is harvested annually, then both above and belowground biomass in the *Typha* stand decrease gradually year by year until the sum of production prior to harvesting and after harvesting balances the annual respiration, metabolic and harvesting losses of the whole plant. The rate of recovery is dependent on environmental factors such as temperature and radiation at the local site. The results showed that the rate of recovery is fastest in low latitudes and slowest in high latitudes. This result suggested that the stands in low latitudes have a higher ability to tolerate harvesting and similar disturbance.

The model could be used to predict the potential recovery of growth of *Typha* in given conditions over a wide range of latitudes and is useful in practical applications such as wetland management or wastewater treatment systems using *Typha*, as well as for understanding the responses of *Typha* to harvesting or other disturbances.

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Restoration of Mangrove Forests Impacted by Mosquito Ditching in the Tampa Bay Area: Forest Structure, Sediment Dynamics and Hydrologic Change

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Intertidal vegetative communities, such as salt marshes and mangrove forests, once covered extensive areas around Tampa Bay. Today only about one-third of the historical acreage remains. The communities comprise important habitats for commercially and recreationally important fishes, and for wading birds and other wildlife. Historically, however, these areas have been drained for development or otherwise altered for mosquito control management. Beginning in the late 1940's, wetlands around Tampa Bay were cross ditched as part of a massive project undertaken in a failed attempt to control mosquitoes by enabling enhanced tidal flushing within the estuarine wetlands. Today, as a result of the project's failure and the development of more effective mosquito control regimes, the ditches have not been maintained and many of these lands have been targeted for restoration in mitigation or conservation efforts.

One such property is a 26 acre undeveloped wetland known as the Gateway Tract located at the western end of the Howard Franklin Bridge (I-275), crossing Tampa Bay. The Gateway Tract is bordered by office and apartment complex developments. It is currently being restored via the SWIM program as mitigation for expanding an interchange and widening of I-275. Extensive changes are being made to restore the tract, including the dredging of large water conduits that connect newly dug ponds. Enhancement of existing mangrove forest has been facilitated with hydro leveling of spoil piles and back-filling of mosquito ditches. Final stages of the restoration will include replanting of a variety of marsh and mangrove habitats.

Because very little is known about the effectiveness of these enhancements, particularly the hydro leveling, this study focuses on a before/after - control/impact analysis of the mangrove enhancement aspects in the Gateway restoration project.. Specifically, we are 1) attempting to establish historic impact from mosquito ditching on the ecology and morphology of the forest, 2) monitoring long-term health, growth and productivity of the mangroves, and 3) monitoring changes in sediment elevation and hydrology within the mangrove stands. Preliminary results indicate that: 1) mangrove forests are generally taller adjacent to ditches and mangroves have invaded salt marshes along the ditch banks; 2) the ditches and associated spoil piles appear to have caused erosion of adjacent wetland surfaces; and, 3) hydro-leveling has successfully moved sediment into nearby wetlands and increased the sediment surface elevation.

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Chlorophyll *a* as an Indicator of Eutrophication in the Caloosahatchee Estuary and San Carlos Bay, Florida

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Nutrient over enrichment caused by human activities is one of the major stresses impacting coastal ecosystems today. Environmental effects are primarily mediated through the rapid production and accumulation of plant biomass that enrichment fuels and the subsequent decay of this organic matter. In estuaries and other aquatic systems, excessive nutrient inputs are commonly expressed as phytoplankton blooms. These blooms are associated with (1) reduced light penetration which restricts the depth distribution of seagrass and other benthic vegetation and (2) depressed oxygen concentrations which can result in mortality of fish and other fauna. Blooms also can impact aesthetics, creating unsightly, mephitic water or human health, if for example the bloom is a red tide. Because chlorophyll *a* links nutrient enrichment with environmental impact, it is commonly included in water quality monitoring programs and employed as an indicator of eutrophication. Water quality criteria or standards for chlorophyll *a* are sometimes viewed as a necessary component of an effort to set bounds on nutrient inputs to estuaries.

The Caloosahatchee estuary is located on the southwest coast of Florida. The major source of freshwater and nutrients is the Caloosahatchee River, which runs 65 km from Lake Okeechobee to the head of the estuary at the Franklin Lock and Dam (S-79). Geographically, the estuary extends about 40 km downstream to Shell Point where it empties into San Carlos Bay.

Using data from several monitoring programs, we examine potential use of chlorophyll *a* as an indicator of eutrophication. We evaluate (1) the relationship between nutrient loading and chlorophyll *a* (2) the role of chlorophyll *a* in light attenuation (3) the relationship between chlorophyll *a* and dissolved oxygen concentration. The relationship between nutrient loading and chlorophyll *a* varied spatially, being negative at the head of the estuary and positive in San Carlos Bay. In the estuary, color and/or total suspended solids explained most of the variability in light extinction, while chlorophyll *a* was most important in San Carlos Bay. In estuarine segments, high chlorophyll *a* was associated with lower dissolved oxygen in bottom waters at lag times of one or two months. Chlorophyll *a* appears to be a good indicator of the impacts of eutrophication in the Caloosahatchee. Because of spatial variability in the relationships between chlorophyll and nutrient loading and light attenuation, the implications of nutrient load reductions may be different for different regions of the Caloosahatchee system.

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A Policy Perspective on Large Scale Ecosystem Restoration Planning: A Great Lakes Case Study

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Expansive and intensively used, the binational Great Lakes- St. Lawrence System enjoys global prominence. It contains some 65 trillion gallons of fresh surface water, a full 20 percent of the world's supply and 90 percent of the United States' supply. Its component parts - the five Great Lakes - are among the fifteen largest fresh water lakes in the world. Collectively, the lakes and their connecting channels comprise the world's largest body of fresh surface water. They lend not only geographic definition to the region, but help define the region's distinctive socio-economic, cultural and quality of life attributes as well.

The complexity of the physical ecosystem is rivaled only by the complexity of the "institutional ecosystem" established for basin management. A multitude of governmental jurisdictions and nongovernmental interests establish or otherwise influence the development and implementation of resource policy, an exercise complicated by the vastness of the resource, its binational character, and its intensive, multiple use properties. Reconciling political and hydrologic boundaries is the essence of the management challenge. Long regarded as the world's largest fresh water laboratory for scientific experimentation, the Great Lakes-St. Lawrence System is now rightfully regarded as the world's largest fresh water laboratory for institutional experimentation.

A decades-old legacy of misuse and abuse has compromised the "greatness" of the Great Lakes-St. Lawrence System. Chemical and biological contaminants, as well as ill-advised, unsustainable resource use practices, have impaired a range of beneficial uses and the ecological, economic and quality of life benefits associated with them. And, while considerable progress has been made since the 1960s and 70s when the lakes were declared "dead or dying", such progress has been slow and sporadic, and lacking a cohesive, ecosystemic focus. Dissatisfaction with the rate of progress, as well as well as with the overall approach to resource stewardship, has prompted unprecedented interest in, and movement toward a large scale ecosystem restoration, protection and sustainable use initiative. Recent years have seen, for example, numerous Great Lakes restoration bills introduced in Congress, major studies by the U.S. General Accounting Office, priority setting exercises by the region's governors, an Executive Order of the president and, more generally, dramatically heightened interest and awareness among the region's policymakers, opinion leaders and stakeholders. Expectations remain high that the coming years will yield a consensus-based restoration strategy- and the requisite laws, programs and funds- needed to produce measurable and sustainable improvements in the resource.

The ultimate success of a restoration, protection and sustainable use initiative for the Great Lakes-St. Lawrence System is fundamentally dependent upon a multitude of factors that include broad political support and a willing champion; broad -based institutional and public support; a plan with environmental, economic and social dimensions; a compelling argument for national and international relevance; a clear vision and measurable milestones, outcomes and benefits; sound science; a compelling argument for prompt action; and relentless advocacy. The unique physical, socio-economic, and institutional characteristics of the system speak to the magnitude of the challenge, and will help shape an equally unique approach. Substantial "building blocks" are available to inform the process, including a multitude of plans, programs and institutions presently in place, as well as "lessons learned" from other large scale ecosystem restoration initiatives.

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Selection and Application of Ecological Models in Everglades Restoration

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Ecological models are indispensable tools for ecological restoration. A variety of types of models exist. They are designed, for certain purposes, to represent particular parts of the whole system at a particular level of details, and to address specified questions. Each type of models has its own strength and weakness when it is applied to address a restoration issue. The uncertainty of model output depends on model structure and model input, and can vary significantly among models.

The comprehensive Everglades restoration plan (CERP) is a massive effort to restore the south Florida's ecosystem. Dozens of ecological models have been developed and have been suggested to be used in CERP planning and evaluations. Some models are simple and some are complex, ranging from the habitat suitability indices to the process-based ecosystem models and individual-based models. Many participants and stakeholders of CERP are potential clients of ecological models. For these clients, how to select and apply ecological models is not a trivial question.

CERP features a large number of engineering projects, diverse stakeholders and participants, and multiple objectives and goals. Some of these objectives and goals may conflict. The stakeholders have their own issues, concerns and foci, which often differ significantly from each other. They hold doubts at various degrees or in different kinds about each ecological model and its application. Further, the ecosystems are complex and potentially multitudinous, unintended, ecological consequences could appear. Historically, the Everglades ecosystem showed integrity and maintained an intricate balance among diverse components that sometimes display seemingly conflicting requirements of environmental conditions. How do we select and apply ecological models that focus on a few components and are mostly designed for few specific purposes to meet very diverse needs in a comprehensive restoration effort? It is a challenging task.

I propose to use hierarchical approaches, a suite of more than 10 ecological models, and a combination of index, analytical and simulational approaches, to guide planning and evaluations of major CERP projects. Models focusing at critical levels in spatial, temporal, engineering, and ecological hierarchies together depict ecological effects in entirety. Important species, critical trophic structures, fundamental ecosystem processes, and significant landscape elements altogether give more complete pictures about the ecosystems, and particularly about the ecological integrity and balance. Their models as a whole address broad questions and meet diverse needs. The different modeling approaches complement each other and improve our understanding, confidence, and interpretation of model output. Also the review and evaluation of models by peers need to have a comprehensive plan and be conducted with a hierarchical framework.

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Monitoring Crayfish Populations in the Everglades: Evaluation of Methods and Long-Term Trends

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Monitoring of important floral and faunal components of the Everglades ecosystem is a critical aspect of the Comprehensive Everglades Restoration Plan (CERP) and a key starting point is assessment of monitoring methodologies. Crayfish are important faunal components of the Everglades, providing food for wading birds, and other animals, and have been identified as targets for Performance Measures used to assess CERP success of restoration of ecosystem function. Currently there is no basis for choosing among sampling methods in the Everglades or other vegetated wetlands.

A major hurdle toward obtaining good population or biomass-density estimates is verifying the accuracy of the sampling method. For monitoring, the choice of sampling methods depends critically on the ability of the method to reflect differences in population densities and assemblage structure in space and time. We evaluated active and passive methods of sampling crayfish in a freshwater slough habitat. In order to determine which method would best reflect changes in density of the slough crayfish (Procambarus fallax), we constructed an experimental density gradient of marked crayfish using 10 m^2 enclosures and sampled them with a 1-m^2 throw trap (active area sampler) and baited minnow traps (passive sampler).

The throw trap performed consistently well in two separate trials. Linear regressions predicting the mean density estimates from the actual crayfish density had significant positive slopes (R^2 = 0.96) in both trials. Furthermore, the slopes were close to 1 (0.89 and 0.82), indicating nearly proportional sampling across the gradient. When the relationship was adjusted to account for clearing efficiency of the throw trap, the slopes were not significantly different from 1 in either trial. The throw trap captured a wide range of crayfish sizes that accurately reflected the size distributions stocked into the enclosures. Baited minnow traps performed inconsistently between the two trials. Catch-Per-Unit-Effort (CPUE) and density had a non-significant slope in Trial 1 and a positive slope (R^2 = 0.82) in Trial 2. The slope in the Trial 2 (0.62) was significantly less than 1. Minnow traps were biased towards capturing large male crayfish, but the relationship between CPUE and density did not improve by using only large male CPUE in the regressions. These results indicate that the use of active sampling methods like the 1-m^2 throw trap will give good population estimates in vegetated slough habitats and provide further cautionary evidence regarding the use of passive techniques like minnow traps for quantitative measurements of crayfish populations.

We are currently analyzing collections of crayfish taken from throw traps in Everglades National Park and the Water Conservation Areas 3A and 3B from 1996 through 2003. Temporal changes in crayfish density will be presented and discussed with reference to hydrology.

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Everglades Restoration and Saving the Chesapeake Bay: Comparisons in Management of Ecosystem Restoration Projects

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The history, organization, science and politics of each large ecosystem restoration project are unique. However, these projects do present common themes, upon which comparisons can be made. Such comparisons can be useful and instructive to scientists and policymakers responsible engaged in these complex efforts.

Three common themes predominate in organizing a comparative analysis of ecosystem restoration projects. The first concerns the role of science in the project. Questions include: How is communication between scientists and decision-makers organized and carried out? How effective is that communication? How do scientists help decision-makers act under conditions of uncertainty? Are the scientists understanding of the political challenges that must be met by decision-makers to keep the project moving forward? How is peer review of project science conducted and disseminated?

The second important common theme is the challenge of defining success. Does the project have a clearly defined, mutually agreed upon set of goals and timetables? If not, how are its goals delineated? Have project decision-makers promulgated interim goals and timetables? Are these interim goals readily measurable and effectual? How are the project goals enforceable? What are the consequences of failing to meet stated goals? Is there scientific and political agreement that the goals may need to be altered from time to time? This last question relates to the difficult theme of practicing adaptive assessment in the face of new scientific understanding, a process that is as yet largely untested.

A third theme concerns conflict management. All large ecosystem-wide restoration and conservation projects are marked by chronic and complex conflicts among stakeholders, government entities, scientists and policy-makers. Does the project have a process for categorizing and then handling conflicts as they arise? How successful have been the means used to manage or resolve conflict? In particular, has the project engendered litigation? If so, has litigation been helpful or harmful overall in achieving progress? Is conflict useful in inspiring forward motion, or harmful in causing delay and deadlock?

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Performance Measures, Ecosystem Benefits and Habitat Units: Evaluating Everglades Restoration Alternatives

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Wetland ecosystem restoration includes a complex integration of ecological and economic analyses to develop realistic project outcomes. With this in mind, the U.S. Army Corps of Engineers has developed an iterative process based on hydrological and ecological models to evaluate Everglades restoration alternatives that allows for discernment of ecosystem and economic goals among project outcomes.

Performance measures (ecological, hydrological, water quality) assess project alternatives in terms of single-factor wetland services recreated or enhanced as part of the restoration process in comparison to without-project baseline conditions. As such, performance measures indicate proximity to restoration targets or goals. By extension, ecosystem benefits are defined as the summation of performance measures and are used to compare and contrast project alternatives with respect to baseline conditions. Consequently, ecosystem benefits can be viewed as a multidimensional hypervolume that encompasses wetland structure and function. In contrast, the development of habitat units allows for a spatially-explicit quantification of ecosystem benefits, which is necessary for the economic analysis of project alternatives, given that USACE's planning and programmatic regulations and plan formulation stipulate that quantified ecosystem benefits are necessary in order to do cost-effectiveness analyses.

The Comprehensive Everglades Restoration Plan is an integrated set of over 60 projects with the goal of returning south Florida to some semblance of pre-drainage conditions. As such, it is the first large-scale comprehensive program that integrates these ecological and economic processes in a unified manner to achieve ecosystem targets.

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Planning for Mixed Seeding Restoration on Xeric Uplands in Florida

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Although sowing seed mixes is an established restoration strategy elsewhere, this approach is seldom applied in Florida, where most projects focus on reestablishing ecosystem processes, rather than biodiversity. On xeric uplands, this typically involves planting longleaf pine seedlings and wiregrass to assure flammable groundcover.

Reestablishment of the community's driving forces is critical, but full restoration cannot be achieved unless propagules for the entire range of species are available. The assumption that fire causes an array of long-lost plants to spring from the seed bank has not proven valid on highly disturbed lands. Giving wiregrass a head start over less competitive species by planting plugs at the density to carry a fire may permanently preclude the development of normal groundcover diversity.

Mixed seeding has shown great potential in the few instances where it has been tried in Florida. This paper reviews the successes the authors have had in using this strategy to restore diverse flammable groundcover to flatwoods, sandhills, and red oak woods restoration areas in central Florida. By sowing seed mixes containing ample quantities of *Eragrostis*, *Panicum*, and other fast-growing native grasses along with wiregrass and a wide variety of forbs, we have been able to restore both ecosystem processes and biodiversity. By incorporating species from across the successional spectrum into our mixes, we have set the stage for both quick establishment of flammable native groundcover and longterm succession towards a highly diverse plant community incorporating numerous uncommon, habitat-endemic, and/or slow-growing species.

To refine this approach for cost-effective application in a wide variety of situations, we should draw upon the lessons learned by midwestern prairie restorationists, who have been doing mixed seeding for decades. We need to develop species-specific databases and community-specific restoration guidelines like those they have come to rely on.

We will have to assemble the following information on each species in the flora of the target community: Is it an annual, biennial, or perennial? What is its growth form? How tall? Caespitose, rhizomatous, stoloniferous, or clonal? What is the bloom and seed maturation and germination phenology timeline? How are the seeds dispersed? What is its successional position relative to the target ecosystem? C value? (How common/weedy vs. rare and habitat-specific is it?) We also need to know enough about its habitat requirements to plant it in the right place; we must understand its hydrological needs, fire regime, substrate/pH/nutrient requirements, shade tolerance, and disturbance resistance.

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Ecological Science and Sustainability for a Crowded Planet: A 21st Century Vision and Action Plan

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An era of unprecedented environmental change demands immediate and unparalleled efforts so that ecological science can fully employ its capacity to solve or ameliorate problems at a global scale. This requires environmental knowledge, technology, and computational tools, and stimulating cooperation among diverse groups of researchers, managers, and policy makers. The Ecological Society of America's (ESA) "ecological visions" project identifies a set of actions required to realize such an agenda. With support from USGS and other federal agencies and foundations, a committee of scientists from universities, government agencies, and the private sector has been engaged in an 18-month effort to identify actions that would contribute the most to advancement in critical research areas and in reaching those policy makers and agencies most involved in environmental issues.

The Visions Committee's recommendations are broadly grouped into three visionary areas: informing decisions with ecological knowledge; advancing innovative and anticipatory research; and stimulating cultural changes for a forward-looking and international ecology. Informing decisions with ecological knowledge includes actions to (a) integrate advances in ecological knowledge into policy and management decisions and (b) foster a thoughtful public that can use ecological knowledge to inform individual choices about sustainability. Advancing innovative and anticipatory research includes actions to (a) enhance the intellectual and technical infrastructure for ecology, (b) create new incentives to recognize and encourage innovative and anticipatory research, and (c) promote standardization of data collection, documentation, and sharing. Finally, stimulating cultural changes encompasses efforts to (a) understand and communicate how to promote successful collaboration, (b) broaden the diversity of the ecological science community, and (c) forge international linkages and globalize access to ecological knowledge.

The Ecological Visions Report, issued in May 2004, is intended to inspire action, motivate new programs, and support the development of current ones, and is available to the public at www.esa.org/ecovisions.

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Challenges of Implementation

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The Comprehensive Everglades Restoration Plan (CERP) was approved in the Water Resource Development Act of 2000 as the centerpiece of an overall plan to restore the south Florida ecosystem. This $7.8 Billion, 37-year plan was conceived to restore more natural water conditions in south Florida where past water management activities have greatly altered the quality, quantity, timing, and distribution of water throughout southern Florida. The overall plan involves 68 components ranging from construction of storage reservoirs to pump stations, from building new levees and canals to tearing down existing ones, as well as incorporating innovative technology in the solution to complex water management issues. All of this is over an area covering some 16,000 square miles, which is also home to 68 endangered species and a truly unique ecosystem.

The overall size of the restoration program combined with the many varied and competing demands has created a complex working environment to achieve implementation. Beyond the sheer challenge of planning, designing, and constructing the largest restoration project ever attempted as envisioned by the Comprehensive Plan, there are institutional challenges that stem from legal standing and long term policy and technical challenges stemming from the application of new and/or developing technology, as well as the inherent bias and fears of such a large change. The sum of all of these factors have created an enormous challenge to the implementing agencies to achieve restoration while addressing the concerns, needs, and requirements of the many stakeholders involved. This presentation will focus on the main challenges encountered in the implementation process and the steps taken to overcome these challenges.

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Linking ATLSS Models with SFWMM Hydrology: The ATLSS High Resolution MultiDataset Topography (HMDT)

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Meaningful and useful models for Everglades restoration are dependent on appropriately linking the population and individual dynamics of the flora and fauna to the physical processes within their environment. In the Everglades, hydrology is the most important physical environmental factor affecting many species. The spatial distribution, timing and quantities of water strongly affects a variety of life history processes including reproduction, foraging and predator-prey interactions for all Everglades inhabitants.

A significant challenge in Everglades modeling is providing hydrology data to models at a spatial resolution that is relevant to ecological processes. The primary source of hydrologic projections for the region is the South Florida Water Management Model (SFWMM). This model is used to estimate potential hydrologic conditions for a variety of restoration scenarios. The spatial resolution of this model is 2x2 miles; that is, the model provides a single estimate for hydrologic variables for each 2x2 mile plot on the landscape. While this resolution is appropriate for the task of managing hydrology in South Florida, it lacks sufficient detail for modeling the impacts of hydrology planning on Everglades ecology.

To address this problem the Across Trophic Level System Simulation (ATLSS) project has developed an approach for estimating water depths at a 500x500 meter resolution from high resolution topography data and the 2x2 mile hydrology available from the SFWMM. High resolution topographic data are based either on topographic data recently collected by the US Geological Survey (USGS) or the ATLSS high resolution topography model. These topographic data sets can be used alone or in conjunction with each other. Emphasis in our approach is placed on preserving the integrity of the basic assumptions within in the SFWMM by preserving total water volume in each 2x2 mile cell on a daily basis. Our approach provides estimates of water depth at a 500x500 meter resolution with variation in water depth between 500x500 meter cells both within and across 2x2 mile cells. This process provides local variation in water depths, which is an important component in modeling the response of Everglades species to various restoration scenarios.

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Phosphorus Release and Retention by Soils of Natural Isolated Wetlands in Okeechobee Basin, Florida

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Phosphorus (P) loads to Lake Okeechobee exceed desired levels. Artificially drained isolated emergent marsh wetlands that are within cattle pastures in Lake Okeechobee Basin may provide an assimilative capacity for P. This study compared P release/retention rates by two isolated wetland (IW) soils during a 60-day flooding period and determined the effect of antecedent hydrological conditions on P release and retention during two 28-day flooding periods. Soils columns were collected from two sites for initial characterization and soil/water column studies. Wetland soils at Larson Dixie had four to five times the total inorganic P (TP_i) and total P (TP) content of Beaty soils. During the 60-day column study, Larson Dixie soils released the highest amounts of soluble reactive P (SRP) to overlying waters. This implies that sites at higher nutrient status release P at higher rates during this period. Between the first and second 28 day flooding periods, water column SRP decreased from (mean and standard error) 170 ± 7 mg P m^{-2} to 106 ± 4 mg P m^{-2} for both sites. Pre-flooded columns spiked at 1 mg SRP l^{-1} had similar P retention rates, while pre-flooded soils at Larson Dixie had lower P release rates than pre-saturated or pre-dry soils during the first 28-day flooding period. Relative P stores in soil and overlying waters governed P release and retention rates. Equilibrium P concentrations (EPC_w) ranged from 0.12 to 1.3 mg SRP l^{-1} during the two 28 day flooding periods at both sites.

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Fish Assemblages as an Indicator of Biological Function in Aquatic Systems Restored after Phosphate Mining

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Phosphate mining is a major industry in South-Central Florida and results in impacts to natural wetlands and other surface water features. State law requires that such impacts be offset through reclamation and restoration in order to maintain or improve the function of the biological systems present prior to mining. The permitting process associated with mining impacts and the subsequent reclamation has traditionally addressed replacing particular wetland or water body types (e.g., herbaceous wetlands, forested wetlands, streams), and focused largely upon mimicking the hydrologic character and vegetative cover of the impacted systems, with associated components of aquatic system function presumed to follow through natural succession.

As a mid-level trophic component of an aquatic ecosystem, the fish community can serve as an indicator of the degree of function being provided by a restored system. If the species assemblages in wetland and stream systems constructed in mined areas is comparable to those in analogous natural systems, it can be assumed the functions necessary for those species to be present are being provided (e.g., sufficient water quality and food base), and that any functions resulting from the presence of those species are similarly being provided (e.g., predator food base).

Fish were collected from a series of wetlands created in mined and reclaimed areas of the Peace River basin using seines, cast nets and electrofishing equipment. Collections were also made in natural wetlands and streams in the same watershed for comparison. A total of 22 species was obtained from the restored systems, while 26 were captured in the natural systems. Twenty-four of the 29 total species encountered were native and five were exotic. Of the species not collected from restored sites, one was exotic and the remainder generally inhabit larger stream habitats than those represented in the restored areas.

This suggests that aquatic system restoration techniques associated with mine reclamation can provide habitat for at least the same biodiversity within the fish community as is present in analogous natural systems. Specific consideration of fish in the restoration planning and implementation process may further enhance the habitat value of restored systems for this community. Such considerations include microhabitat requirements (e.g., structure, substrate and refuge areas) and the possibility of stocking certain species in restored wetlands to facilitate their early colonization of such sites.

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Aiding Rio Grande Restoration by Using Stable Isotope Analyses to Characterizing the Past and Present Condition of the River Food Web

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Obtaining information on the pre-disturbance condition of altered ecosystems is often difficult. A lack of this type of information can hinder ecosystem restoration efforts. The Rio Grande of New Mexico has been severely altered, and is in dire need of restoration or rehabilitation. The aim of our research is to provide information on the prior condition of the Rio Grande aquatic food web. Because no reference systems exist for the Rio Grande, we developed an alternative method for assessing change over time in the food web. We are using stable isotope analyses of museum preserved fish specimens, along with analyses of recently collected fishes, to construct a timeline of change in the Rio Grande food web. Results of the first step in this research, which indicated that formalin-induced changes in carbon, nitrogen, and sulfur isotope values of fish tissue are small (less than 1.5 per mil) compared to changes expected from natural fractionation processes that are of interest in ecosystem studies, will be presented. Upon completion of this phase of the project, we performed stable isotope analyses (C, N, and S) on preserved fishes from 1940 to present in order to observe changes in the aquatic food web of the Rio Grande. Additionally, we analyzed many components of the current food web, including invertebrates, plants, and fishes. The preliminary results of this study of the past and present Rio Grande food web will be presented, along with causal factors that may have contributed to these changes. We will also address the possible effects of restoration on the Rio Grande food web.

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Prioritizing Flood Protection while Restoring Ecological Function in Urban Rivers

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Urban rivers have been degraded as the result of development along floodplains that satisfied social needs, including transportation, water supply, and flood protection. Ecological restoration of degraded urban rivers remains constrained by flood protection, and possibly integrates with terrestrial connectivity theory different than the river continuum concept and flood pulse concept. Ecological river restoration often attempts to reconnect channel and floodplain by manipulating the frequency of bankfull discharge, yet this research identifies limits to the geomorphic and ecological benefit of floodplain building in Syracuse, NY's armored and channelized Onondaga Creek. The study reach of 300 meters, classified as Rosgen G4 that departed from a reference C3, has an estimated bankfull discharge of 31 $m^3 s^{-1}$ yet was channelized to contain flows up to 85 $m^3 s^{-1}$. While bankfull flow in rural areas builds and colonizes floodplain, such work is in conflict with, and undermined by, urban property, infrastructure, and emergency management objectives and activities. Urban restoration that abandons lateral migration must still use bankfull estimates to address sediment transport and fish passage, as well as avoid aggradation due to Onondaga Creek's upstream mud boils that can generate up to 27E3 kg of daily sediment loads. Unfortunately, urban geomorphic assessment of bankfull flow, the upper limit to prevent flooding, was difficult due to the absence of traditional indicators. Bankfull regional curves are useful in checking site estimates, however constructed curves from USGS gages provided limited insight due excessive scatter, possibly caused by storm sewer drainage, combined sewer overflows, and daily inter-basin transfer of 1.5E5 m^3 of drinking water. Alternative terrestrial connectivity models that are sensitive to bankfull uncertainty and flood risk have been identified to ensure that riparian vegetation and in-channel large woody debris are available for food, habitat, and hydraulic needs.

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The Political Life of Environmental Goals: Lessons from the Chesapeake Bay

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Resource managers have been discussing and setting goals for the Chesapeake Bay since the early 20th century. The region's first bi-state environmental meeting occurred in 1924 when the governors of Virginia and Maryland met to discuss the management needs of the Bay's declining blue crab population. Since then, there have been a steady flow of Bay-wide initiatives designed to assess the overall health of the ecosystem and to plan a course of action to protect its natural resources. These initiatives include: A 1933 meeting that brought together government officials from four Bay states and the District of Columbia; two comprehensive studies of the Bay completed by the Corps of Engineers in 1973 and 1977; a seven-year, $27 million study of the Bay completed by the EPA in 1983; and three Chesapeake Bay Agreements (1983, 1987, and 200).

Today the Chesapeake Bay Program (an EPA program created in 1983) heads the Chesapeake Bay restoration. It brings together federal officials and resource managers from the key Bay states, serving as the implementation arm of the Chesapeake Bay Agreements. Its committees cover the full gamut of the Bay's environmental problems with each committee responsible for various aspects of the 105 commitments that comprise the 2000 Bay Agreement. Its non-regulatory approach, coupled with stakeholder involvement and collaborative decision-making, has gained the program international acclaim.

In recent years, however, the program has come under increased criticism for failure to meet its environmental objectives. Critics of the program cite the Bay's collapsed oyster industry, declining crab harvests, loss of underwater grass, low oxygen levels, sediment plumes, nutrient pollution, and the prevalence of toxins and new and little understood diseases in some of the Bay's remaining fisheries**.** They argue that the Bay Program's reliance on non-regulatory, voluntary programs has delayed the implementation of necessary and enforceable rules.

This presentation places the Bay Program in the larger political context, showing how the Bay Program has been severely constrained by a number of structural and contextual factors including: its strict adherence to a non-regulatory regime, lack of adequate funding, inter-state economic pressures, lack of adequate oversight and meaningful accountability, and most importantly, its insulation from the very political actors who are empowered to fulfill its goals. The presentation reveals how goals, placed within an organizational structure that lacks the power to achieve them, can be co-opted by political actors, rather than drive the policy process. Several meaningful reforms are explored to retain the Bay Program's considerable technical expertise while breathing life into the policy relevance of its goals.

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Mercury Bioaccumulation Responses to Everglades Restoration

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Implementation of the Comprehensive Everglades Restoration Plan (CERP) will modify water flows within south and central Florida. A broad array of ecological changes are anticipated to accompany these modifications. Mercury bioaccumulation in upper trophic level fish and other top predators is already known to be of concern in much of the freshwater Everglades and is also of concern in some of the coastal marine areas where sampling has occurred. The degree to which mercury bioaccumulation is the result of current water management practices is not fully known and the possible changes accompanying Everglades restoration cannot be currently predicted.

Extensive sampling in Florida Bay, at Florida's southern tip has identified the bay's northeastern corner as a zone of high methylmercury bioaccumulation in fish, leading to consumption advisories. This knowledge led EPA to identify Florida Bay as one of two "hotspots" of mercury bioaccumulation in fish within the Gulf of Mexico, although no known industrial or other anthropogenic sources can be identified. Northeastern Florida Bay is the major site of freshwater runoff from the Everglades to the bay. This initially suggested that this runoff could be the source of the enhanced mercury bioaccumulation. A series of cooperative studies among the National Oceanic and Atmospheric Administration (NOAA), the South Florida Water Management District (SFWMD) and the United States Geological Survey (USGS) found that Everglades runoff contributed some mercury to the bay. This source was not adequate to explain the patterns and concentrations of methylmercury accumulating in fish. Additional sources of methylmercury production were observed within the sediments of the bay, probably depending on inorganic inputs from the atmosphere. Other such areas of methylmercury production may exist in coastal Florida where restricted circulation and oligotrophic conditions are present.

Monitoring of mercury in fish is planned throughout the coastal region of south Florida as part of the Monitoring and Assessment Plan (MAP) of CERP's REstoration COordination & VERification (RECOVER) program to establish a baseline of mercury concentrations in fish. Concentration patterns may be related to regional hydrologic and ecological conditions, as they are in Florida Bay. Periodic sampling in following years will permit identification of trends over time that can be assessed with respect to CERP restoration activities as they are implemented.

Ecosystem models are being developed which couple food web structure and methylmercury assimilation and excretion to simulate methylmercury bioaccumulation under different environmental conditions. These models will be tested through localized sampling in the coastal area receiving runoff from the Shark River Slough in south Florida where gradients of runoff influence, nutrient inputs, and productivity exist. This should allow a better assessment of the impacts of modified freshwater flows on mercury bioaccumulation during restoration.

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Hudson-Raritan Estuary, Hackensack Meadowlands, New Jersey Ecosystem Restoration Feasibility Study

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The Hackensack Meadowlands, located in Bergen & Hudson Counties, New Jersey is an integral part of the New York-New Jersey Harbor estuary. Prior to occupation by European immigrants, this area consisted of nearly 20,000 acres of tidal estuarine and freshwater wetland habitat, including an extensive white cedar swamp. Today though, only approximately 8,450 acres of wetlands still remain, and the Meadowlands is the largest remaining brackish tidal wetland complex in the estuary. These wetlands and open spaces are especially significant for concentrations of waterfowl, wading birds, shorebirds, raptors, anadromous fish, estuarine fish, and terrapins. Many of the remaining wetland areas are now degraded due to filling or otherwise altering the natural hydrologic connections, and also the ubiquitous presence of invasive *Phragmites*. Leachate contamination is also prevalent, with extensive landfills in the area. Water and sediment quality in many areas have also been severely degraded by urban stormwater runoff from developed areas, highways and numerous other point and non-point sources.

The US Army Corps of Engineers, New York District and The New Jersey Meadowlands Commission are jointly conducting a 5 million dollar feasibility study to identify major opportunities for ecosystem restoration. The primary focus of this study is on large undeveloped, but degraded, areas of the Meadowlands, recognizing the intricate interdependence of these areas with the highly urbanized portions of the Hackensack River and the systems approach that must be employed to attain National Ecosystem Restoration benefits. The study will yield a comprehensive watershed restoration plan and site specific recommendations for restoration. It is anticipated that highly productive and sustainable wetland areas can be created with the careful removal of undesirable fill and *Phragmites*, coupled with the restoration of more natural tidal flows. Preliminary screening criteria are being developed to guide the study, with a view toward meeting challenging planning objectives and constraints.

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Plan Formulation and Urban Ecosystem Restoration: Issues and Approaches Hudson-Raritan Estuary, Gowanus Bay and Canal, Brooklyn, NY

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Prior to the 1860s, long before industrial users sprawled the shoreline and the term “brownfield” defined the area, the Gowanus Creek was a tidal inlet that flowed into Gowanus Bay and then into Upper New York Bay. It was a thriving salt-water marshland with meadows, fish and other wildlife. Oysters were abundant, and early settlers packed large numbers of them in crates to be shipped overseas, making them Brooklyn’s first export. Between 1860 and 1881, The City of New York built the Gowanus Canal to accommodate burgeoning industry and commercial shippers, and to drain the surrounding wetlands for development. The Canal soon became an active waterway, with factories and residential communities spreading rapidly. Industrial activities along the canal included oil refineries, coal gas manufacturers, chemical plants, ink and dye manufactures, and many others. The urbanization, growth and development of the canal area drained and filled the salt marshes and mud flats and hardened most of the shoreline. These impacts coupled with inadequate systems for sewage disposal and unlimited discharges of raw sewage and industrial pollutants directly into its waters, transformed this waterway into a polluted, stagnant, and profoundly degraded ecosystem.

In 1911, in response to increasing levels of water pollution, the City built a “flushing tunnel" under the streets of Brooklyn, using a propeller to draw water from the Buttermilk Channel to the head of the Canal, flushing it out along its length. The tunnel functioned until 1961 when mechanical failure caused the flushing tunnel to shut down until 1998. The system is currently supplying approximately 200 million gallons per day into the canal. Currently, there are no tidal wetlands in the Canal, and timber bulkheads line the shoreline.

The U.S. Army Corps of Engineers and the New York City Department of Environmental Protection are now jointly conducting a 5 million dollar feasibility study to assess the ecological water resources problems of the Canal and to determine potential solutions to restore the ecological health of this vital urban watershed. This study area has also been designated as an Urban River Restoration Initiative site by the Environmental Protection Agency, marking significant recognition of the value of urban restoration. This study is examining the extensive habitat loss and degradation that have reduced the functional and structural integrity of the surrounding ecosystems. Preliminary improvement alternatives are being screened with a view toward meeting challenging planning objectives and constraints.

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An Overview of the Glen Canyon AMP: An Experiment in Collaborative, Science-based Ecosystem Restoration

Dennis B. Fenn
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The Colorado River ecosystem from the forebay of Glen Canyon Dam to the upper reach of Lake Mead harbors significant physical, biological, cultural and recreational resources. Although it is the longest riparian segment in the United States free of development, the Colorado River ecosystem today differs significantly from its natural character. Glen Canyon Dam, completed in 1963, has had dramatic impacts on downstream resources within the Glen Canyon National Recreation Area and Grand Canyon National Park.

As directed in the Grand Canyon Protection Act of 1992 and in response to the findings of the Operations of Glen Canyon Dam Final Environmental Impact Statement and the subsequent Record of Decision, an Adaptive Management Program (AMP) for Glen Canyon Dam and the Colorado River ecosystem was been established in 1996. The AMP is comprised of an Adaptive Management Work Group (AMWG) that operates under the Federal Advisory Committee Act and advises the Secretary of the Interior on operating Glen Canyon Dam, a Technical Work Group (TWG) that provides technical support to the AMWG, the Grand Canyon Monitoring and Research Center (GCMRC) which provides the science support needed by the AMWG, and Independent Review Panels who provide peer review of protocols, proposals, and science products for the AMWG and GCMRC.

The GCMRC and AMP were reviewed by the National Research Council (NRC) in 1999[1]. The NRC calls the Glen Canyon Dam AMP "…a science-policy experiment of local, regional, national, and international importance." They also call for "…probing comparisons of adaptive management experiments underway in different regions of North America…."

Dr. Dennis B. Fenn, Director of the Southwest Biological Science Center, and supervisor of the Chief of the Grand Canyon Monitoring and Research Center, USGS will discuss lessons learned from eight years of implementation of adaptive management in the AMP. These include: the importance of developing protocols for the implementation of adaptive management, the concepts of experimentation and uncertainty and potential conflicts with existing law and management culture, the need to establish a vision for the program, a process for developing management objectives and information needs, a discussion of organizational issues, the role of a single science center that will be used by all stakeholders, approaches to maintaining the objectivity and credibility of the science being performed, and how does one bring this scientific information back to the management/decision-making process.

[1]*Downstream: Adaptive Management of Glen Canyon Dam and the Colorado River Ecosystem*, National Academy Press, Washington DC

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Linking Restoration and Success at the Water's Edge

Laurence S. Fernberg, *Anthony Russo* and *Scott Thompson*
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The Marathon site hazardous waste problem was created by a battery plant located in Cold Spring, New York, across the Hudson River from the U.S. Military Academy at West Point. For years, heavy metals were discharged via air vents and wastewater effluent, contaminating residential yards, a town beach, and a sensitive wetland ecosystem. The adjacent marshlands once teemed with of beaver, muskrat, turtles, and a variety of fish such as trout, perch, and striped bass. The area also is recognized as an important stopover for thousands of migratory birds, especially black ducks and mallards. The project was complicated by an adjacent 280-ac Audubon Society wildlife sanctuary and the fact that much of the contaminated area lies within a National Historic Register site.

The plan for the Marathon Battery site was to restore the wetland ecosystem by selecting marsh plants and designing a grading plan to simulate and improve pre-excavation conditions. Once environmental conditions improved, the wildlife populations and aquatic organisms were expected to rebound and thrive once again. The 30-year monitoring plan was designed to evaluate the effectiveness of the restoration design, and included sampling of sediments, vegetation, fisheries, and benthic organisms, as well as observation of wildlife utilization of the marsh. Corps of Engineer and EPA approval was received for both the mitigation and long-term monitoring plans designed for Foundry Cove Marsh. Malcolm Pirnie is currently performing long-term monitoring under this plan.

Remediation and restoration of the Marathon Battery site began in the early 1990s and was completed by 1994. After 10 years of long term monitoring, there are many lessons that can be learned from the Marathon Battery design and implementation. Lessons learned regarding planning for diversity and coverage as well as variations in grade and elevations will be covered. The importance of adaptive management will be presented in the context of problems encountered and resolved during the course of the project, include: undesirable planting substrate, ice damage, waterfowl herbivory, and invasive species. Finally, we will show how the lessons learned from the Marathon Battery project have been successfully applied on another Hudson-Raritan Estuary project, Paerdegat Basin, Brooklyn, New York.

The design for an open water/intertidal marsh on Paerdegat Basin shoreline was developed to mitigate for habitat loss due to fill placement and new bulkhead construction on shoreline of Whale and Newtown Creeks. Prior to design, Malcolm Pirnie completed field reconnaissance and evaluations of sites previously identified as candidates and components of the Jamaica Bay Ecosystem Restoration Project (JBERP). JBERP is program co-sponsored by the USACE and NYCDEP with support and planning advice from local, state and federal agencies.

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Submergence and Salinity Effects on Decomposition of Wetland Plants; Exotic: Purple Loosestrife - *Lythrum salicaria* versus Native: Cattail - *Typha* sp.

Laurence S. Fernberg
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Exponential increase of Lythrum salicaria (purple loosestrife), an exotic wetland plant has had devastating effects on many native wetland species, such as the cattails (Typha spp.). Pilot studies have demonstrated factors which affect the growth and decay of these species. A decomposition experiment compared mass loss from leaves of these species over 330 days in pond microcosms; decay coefficients were calculated.

Field experiments in Hudson River wetlands examined decomposition rates and chemical leaching of plants in pure and mixed habitats over 256 days. Laboratory experiments included 1) manipulating salinity and water depth (suggesting tidal effects) compare effects on seed germination and seedling growth in mono and mixed culture, and 2) effects in pond microcosm of salinity on decomposition and nutrient cycling of these species. The poster highlights only the decomposition research conducted in the laboratory and at the Hudson River National Estuarine Research Reserves. This work will aid in determining causes and effects of invasive species on wetland communities and their effects on nutrient cycling, and may help develop effective management methods.

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Enhancing Restoration through Conservation - Using the Chesapeake Bay Watershed Resource Lands Assessment to Prioritize Land Protection

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The restoration of any river, estuary, or watershed cannot be successful if the underlying conditions that made restoration necessary in the first place continue to deteriorate. Population and development pressures continue to threaten and claim significant portions of the remaining forests and wetlands in the Chesapeake Bay Watershed, making the formidable task of restoring the Bay increasingly difficult. The conservation of ecologically valuable lands is essential to the success of any such large-scale restoration effort.

The *Chesapeake 2000 Agreement*, a memorandum signed by the Governors of the states of Maryland, Pennsylvania, Virginia, the mayor of Washington, D.C., the EPA Administrator, and the chair of the Chesapeake Bay Commission, offers a blueprint for restoration with unprecedented focus on conservation of valuable lands to meet long-term water quality and living resource goals. This agreement charged the Chesapeake Bay Program (CBP), a multi-jurisdictional restoration effort, with identifying resource lands (defined here as forests, wetlands, and farms) in the watershed that provide wildlife habitat, have the highest water quality, cultural, and economic value, and are the most vulnerable to loss. The CBP fulfilled this task in early 2004 with the completion of the Resource Lands Assessment (RLA).

The RLA is organized into six components: Water Quality Protection, Ecological Network, Vulnerability, Forest Economics, Prime Farmland, and Cultural Assets. Water Quality Protection is a key component from a watershed restoration perspective, while other components provide other important perspectives of the value of resource lands. However, the use of any of these components individually is an underutilization of the RLA - it is the use of components in combination that allows the realization of the full potential of the RLA.

The Water Quality Protection component is currently comprised of thirteen input parameters in the form of raster datasets. Cell values for each parameter were divided into classes, and each class was given a score from zero to four based on relative influence on water quality. Parameter scores were multiplied by a weight ranging from one to five to emphasize those parameters with a greater influence on water quality. Finally, all parameters were summed to score forests and wetlands in terms of their importance to water quality, and thus their priority to conserve.

RLA input data may be added, removed, or replaced with more recent or higher quality data, and useful information may be extracted at a variety of scales, ranging from the entire Chesapeake Bay Watershed to the smallest sub-watershed. Therefore, there is no single, final, output derived from the RLA -- it is envisioned as a continually updated collection of input datasets which can be analyzed and represented in any number of ways, including the potential for use in targeting areas for restoration, rather than only for conservation.

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Science Communication and Outreach in the Chesapeake Bay Watershed

Frances H. Flanigan
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One of the great challenges of the Chesapeake Bay restoration effort has been the communication of an increasingly complex set of scientific issues to a large and diverse public audience. Beginning in the late 1970's a sustained campaign has been underway to meet this challenge. That campaign combines the skills, dollars, manpower and perspectives of federal agencies, the states, local governments, research institutions and a host of non-profit groups.

Early in the federally sponsored Chesapeake Bay Program, a grant was awarded to a non-profit called the Alliance for the Chesapeake Bay. Organized as a coalition of groups and set up as a neutral forum, the Alliance was an appropriate partner for EPA and the states as they initiated attempts to define the scientific explanation for the Bay's ills and develop consensus on a set of solutions. The Alliance has worked for 25 years as the NGO partner to the Bay Program and has developed a wide array of programs and communications pieces which educate people and make it possible for them to get involved in decision making and implementation of restoration activities. The Alliance's most well known publication, The Bay Journal, has won national awards for its excellence in science communication and has become a "must-read" newsletter for managers, researchers, legislators and over 50,000 interested citizens.

The Alliance also pioneered the development of volunteer monitoring programs and hands-on restoration techniques for citizens. River and stream watch programs now exist throughout the Chesapeake watershed, modeled on the methodologies perfected by the Alliance. The most recent program, Restore Corps, aims to train leaders who can motivate community groups to take responsibility for habitat restoration at a very small scale. The Alliance also runs a program called Builders for the Bay which brings communities together with developers and local officials to discuss how zoning regulations and local ordinances might be modified to accomplish wiser development.

One of the significant aspects of the Chesapeake Bay outreach effort has been the emphasis on consensus building. Advisory committees and task forces have been established over the years to address many difficult issues. Examples include riparian forest buffers, toxics mixing zones, goals for land preservation, funding options, management of dredged material, and fishing regulations. Some of these efforts have been more successful than others, but all have demonstrated the importance of bringing stakeholders together with policy makers and scientists to understand complex issues and then to develop courses of action that have a high probability of implementation success.

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Wetland Enhancement Decision-Making Tools/Training for Landowners and Technical Service Providers in the Lake Okeechobee Watershed

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Despite pending state regulations, few landowners in the Lake Okeechobee watershed have taken advantage of wetland enhancement cost-share programs, even at the risk of violating regulations relating to phosphorus reduction in the future. A local Wetlands Enhancement Sub-Committee representing governmental, non-governmental entities and private landowners addressed the issue of why landowners are not participating in the programs.

The sub-committee reported that landowners were confused with cost-share options presented to them. It recommended an "unbiased team" develop and implement educational programs for landowners and technical service providers about wetland enhancement cost-share programs. Four members of the University of Florida Extension and the Okeechobee Soil and Water Conservation District, NRCS volunteered for the task. They were funded by USDA-CSREES-CRIS at $275,000 for three years.

More than 25 national, state and local programs were initially identified as possible sources of cost-share income that landowners in the Lake Okeechobee watershed could use for wetland enhancement on their properties. After the initial screening, 16 programs were selected for detailed study. The programs were studied according to 21 attributes in order to give landowners a thorough summary of each. These attributes included: (1) Sponsoring Agency, (2) Name, Phone number and e-mail address of Contact Person for Landowners in the Lake Okeechobee Watershed, (3) WEB Address of Program, (4) Major Objectives of Program, (5) Methods Employed to Meet Major Objectives, (6) Incentives to Landowner, (7) Geographic Area Covered by Program, (8) Ownership Eligibility, (9) Economic Eligibility, (10) Site Eligibility, (11) Landowner Obligations, (12) Funding Cap in Dollars, (13) Cost-Share Ratio, (14) Enrollment Schedule, (15) Months from Application to Approval, (16) Options of Program Length, (17) Land Use Provisions, (18) Landowner Rights, (19) Public Access Requirements, (20) Does Payment from Program Constitute Income of Landowner? (21) What Happens if Ownership Changes during Contract Period?

The information was used to develop an interactive, computerized dichotomous, decision making key, a printed key pamphlet, and a Best Management Practices Guide and Pocket Record Book. Through educational presentations, newsletters and journal articles, landowners and technical service providers have responded favorably to these forms of learning about wetland enhancement cost-share programs. These efforts are expected to foster the creation, restoration and enhancement of wetlands to reduce phosphorus loading to Lake Okeechobee.

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Restoration of Western River Ecosystems: Reality or Rigormortis?

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The Klamath River, originating in southern Oregon, and its main tributary the Trinity River, both flow in northern California and west to the Pacific Ocean. These rivers were placed under the California and National Wild and Scenic Rivers Systems to protect their outstanding anadromous fishery values. Additional recognition by the United States Congress, as stated in the Klamath River Basin Fishery Resources Restoration Act of 1986, finds that these rivers provide fishery resources necessary for Indian subsistence and ceremonial purposes, ocean commercial harvest, recreational fishing, and the economic health of many local communities. This Act, Public Law 99-552, authorized a twenty-year long Federal-State cooperative Klamath River Basin Conservation Area Restoration Program to rebuild the river's fish resources.

When creating this Act, Congress also realized that floods, the construction and operation of dams, diversions, hydroelectric projects, past mining, timber harvest, and road building all contributed to sedimentation, altered flows, and degraded water quality that impact fish habitat. Estimates of the impact upon fishery resources include an eighty percent decline in the fall chinook salmon populations from historic levels, and significant reductions in steelhead trout and coho salmon. Fall chinook salmon are impacted by Klamath River mainstem developments (dams) which limit upstream migration and provide obstacles to spawning reaches. In addition, both the Lost River and shortnose suckers found in Upper Klamath Lake were listed as endangered and granted protection in 1988 under the Endangered Species Act. Fishery biologists speculate that impoundments and altered flow release patterns create water temperatures that limit fish survival. The Trinity River was separately addressed by the US Congress through passage of the Trinity River Basin Fish and Wildlife Management Program Act of 1984.

So how did the 1986 congressional action go about trying to restore anadromous fisheries to optimum levels by the year 2006 in the Klamath River Basin? This action created the Klamath River Fisheries Task Force which represents over sixteen water user interests within the basin. The US Geological Survey (USGS) interacts with this Task Force and others, including four Native American tribes, to develop a better scientific understanding of how water quantity and quality affect or limit anadromous fisheries restoration. This poster provides a brief overview of some of the twenty years of government involvement in restoration efforts for the Klamath River. In addition, this poster sets the stage for several companion posters describing simulation of water management operations using an integrated group of models for resource management developed at the Fort Collins Science Center, USGS to improve anadromous fish restoration.

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Side Channel Restoration on the Lower Missouri River and Examples in Adaptive Management

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Since 1991, the U.S. Army Corps of Engineer’s Missouri River Fish and Wildlife Mitigation Project has been restoring fish and wildlife habitat lost to bank stabilization and navigation projects on the Lower Missouri River. One of the objectives of the project is to restore side channel aquatic habitat that was once prevalent on this historically braided and diverse river channel. An overview of the Lower Hamburg Bend engineered side channel project site and its potential biological benefits will be discussed. Lessons in adaptive management from other side channel developments will also be presented.

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Periphyton Stormwater Treatment Areas: Results of Increased Velocity and Increased Water Depths on Phosphorus Removal Efficiency

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The 1994 Everglades Forever Act (Section 373.4592, Florida Statutes) requires the South Florida Water Management District (District) to build and operate the Stormwater Treatment Areas (STAs) to reduce total phosphorus (TP) nutrient levels to an interim target of 50 ug-P/L as part of the Everglades restoration. In 2003 the final P standard was set at 10 ug/L, and therefore, the District and Florida Department of Environmental Protection (Department) have continued research and monitoring efforts initiated in 1996, which were designed to generate sufficient water quality data to evaluate the effectiveness of eight Advanced Treatment Technologies (ATT) to meet the final TP standard. Periphyton-based STAs (PSTAs) was one of the original ATTs targeted for additional research.

In this ATT, post-STA water flows over a substrate colonized primarily with calcareous periphyton (attached algae) and sparse macrophytes, the latter primarily functioning as additional substrate and a stabilizing mechanism for the algal mats. Phosphorus is removed from the water column through biological uptake, chemical adsorption, and algal mediated co-precipitation with calcium carbonate within the water column.

Two different scale demonstration and research PSTA projects have been studied, two smaller 0.2 ha size wetlands located in cell 3 of STA-1W and three larger 2.0 ha wetlands located adjacent to STA-2. This poster will focus on the most recent TP removal results generated from these systems. The 0.2 ha wetlands are shallow, lined wetland, known as a test cells. The PSTA test cells have a 30 cm sand surcharge directly on top of the liner, followed 30 cm of peat overlain with 30 cm of shellrock. During the past year, the test cells were operated with a mean hydraulic loading rate (HLR) of 6 cm/d and a mean depth of 0.6 m that resulted in a nominal hydraulic residence time (HRT) of 12 days. The three larger systems are collectively referred to as the PSTA field scale. Two of the wetlands were constructed with 30 cm of shellrock overlying the native peat, while in one thee peat was scraped down to expose the caprock. Of the two shellrock systems, one has internal sinusoidal levees that effectively increase the water velocity while not affecting the TP mass load into the system. This past year the systems were operated with a mean HLR of 6 cm/d, water depth of 30 cm and nominal HRT of 5 days.

The main objective of this poster will be to evaluate the TP removal efficiencies of a PSTA system under the two operating regimes. Preliminary analysis indicates that mean inflow TP concentration into the PSTA field-scale systems was about 25.0 ug/L, which is less than the mean test cell inflow of 40.0 ug/L. Although test cell mean inflow TP concentrations were higher, the test cell systems had lower mean outflow TP concentrations of 0.013 from both wetland systems, while PSTA field-scale systems had mean outflow TP concentrations of 0.021, 0.016, and 0.015 ug/L for non-sinusoidal shellrock, caprock, and sinusoidal shellrock systems, respectively.

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Monitoring Landscape Response to Ecological Process Restoration at The Disney Wilderness Preserve in Central Florida

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The Nature Conservancy's Disney Wilderness Preserve, Kissimmee, FL

The 12,000-acre Disney Wilderness Preserve was established as offsite mitigation for wetland and listed species impacts in central Florida. The Preserve, located at the headwaters of the Kissimmee River watershed in the Osceola Plain, contains a mosaic of wetland and upland communities. Within the past century, this historically broad floodplain region has been extensively converted to a variety of land uses, primarily cattle grazing and pastures, citrus and agriculture, timber harvest areas, and residential and commercial development. This project represents a pioneering approach to wetland mitigation: restoration at an ecosystem level through the reintroduction of natural processes (fire and hydrology).

Restoration is demonstrated through assessment of interwoven influences of these ecological processes on the landscape. Specific success criteria for the wetland mitigation include: increased wet season water levels, hydroperiod and water level fluctuations within target ranges, an upslope increase in wetland versus upland plant species, control of exotic and invasive species and reduction of woody encroachment on wetland edges. Results of restoration are evaluated through an innovative approach using multiple monitoring programs and spatial analysis to integrate them and interpret restoration results at the landscape scale. With information from 250 wells and 104 vegetation sampling transects, we show the extent of hydrologic improvement and vegetative response in 31 wetlands covering 1,700 acres. In most cases, we achieved predicted restoration results, using historical conditions as a target.

Natural fire regime restoration is almost as important to ecosystem integrity as re-establishment of natural hydrology, but is more difficult to document and measure effects. We conducted a fire study, as a result of a Joint Fire Science Research Program grant, to evaluate effects of fire over a 10-year period on the 12,000-acre Preserve, in differing climatic and landscape condition, focusing on wetlands. Fire intensity and site conditions were assessed as factors of fire effects, including organic soil loss, conversion of community types, woody species encroachment, invasive plant occurrences, species composition, shrub and canopy structure, and wetland plant dominance. Wetland condition and status were also considered as factors affecting fire behavior and intensity.

After more than 10 years of active efforts to restore ecological processes to the Preserve landscape, we have many examples of success stories, as well as several instances of lessons learned from less effective actions. We hope other large-scale restoration projects, especially wetland system restoration projects, can benefit from information synthesized and developed in the beautiful landscape of the Disney Wilderness Preserve.

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Measuring Progress in Aquatic Restoration

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The Clean Water Act requires the states to report on the condition of our Nation's waters (Section 305b), to list those waters that are impaired (Section 303d) and to restore those waters that are impaired (Section 319). EPA's Environmental Monitoring and Assessment Program (EMAP) is designed to provide the tools that will allow the states to meet the 305b section of the Act in a statistically sound, scientifically defensible manner. These tools are a survey design, indicators of condition – particularly those with biological meaning and quantitative benchmarks (reference condition) – that support assessments.

As the investment of federal resources in restoration continues to climb, reasonable questions are being raised about the return on this investment. While some restoration activities have appropriate monitoring both before and after treatment, most do not and there is no nationally consistent methodology for measuring progress and reporting it on a scale that allows regional or national statements about efficacy of federally funded 319 driven programs (EPA's as well as those of other federal, state, and tribal agencies). EMAP's efforts, while originally designed to respond to 305b condition reporting requirements, may provide an important framework with which impairment can be judged and restoration evaluated. By nesting finer scaled probabilistic monitoring within a larger scale state/regional survey design, and then combining the data collected with additional landscape-level information on factors that can cause impairment, a new tool is emerging that can identify spatially varying stressors of most importance. This information can then be used to suggest targeted restoration actions that would provide the greatest return on investment. The success of restoration actions can then be assessed using the broader scaled monitoring framework.

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Spatial and Temporal Changes in the Vegetation Community Structure Along the Harney River, Florida

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We hypothesize that changes in vegetation communities in the Harney River Basin are pulsed events, potentially initiated by large and local scale disturbances such as fire, hurricanes, changes in hydrologic regimes and/or sea level rise. To test this hypothesis, we explored the influence of anthropogenic and natural forces on the structure of the mangrove communities. Changes in the position of the ecotone were determined and potential causal factors identified.

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If We Build It, Will They Come? Sources of Uncertainty in Predicting Wading Bird Responses to Everglades Restoration

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Long-legged wading birds (herons, egrets, ibises, storks, spoonbills) historically occurred in large to very large breeding aggregations (50k - 200k breeding pairs annually) in the south Florida ecosystem, and were an extremely important part of the wetland trophic web. Numbers of breeding pairs have declined by over 90% between 1940 and the 1980's, the period of most intensive human hydrological alterations in the Everglades. Restoration of wading bird populations is currently both an explicit goal and an indicator of Everglades ecological restoration.

Numerous lines of research have confirmed that wading bird foraging, reproduction, distribution and abundance is highly dependent upon hydrological conditions that make prey animals both abundant and available. Hydrological restoration has therefore been seen as central to restoring wading bird populations, and the restoration plan for the Everglades is largely built upon restoring natural water depths, flow and timing of flooding.

However, there is considerable uncertainty in predicting responses of wading birds to hydrological restoration. In this talk I will present evidence that the wide variation in annual numbers of nesting birds in the Everglades is only weakly explained by annual hydrological characteristics, and that an understanding of multiyear sequences of drying and wetting may be necessary to explain food availability for these birds. I will also present examples of movements of individually tagged birds and of colony fluctuations that show wading birds often move among a variety of breeding sites within the southeastern U.S. This means that novel food production situations (eg, production aquaculture, wetland restoration) hundreds of km away may compete effectively for wading birds that might otherwise nest in the Everglades. Finally, the Everglades aquatic food web has been heavily contaminated with mercury, and I summarize recent information suggesting that ambient levels of Hg contamination may have strong effects on both the thresholds for breeding and success of breeding for the birds. Availability of methylated mercury to the aquatic food web in the Everglades is highly dependent upon sulfur availability, which may be strongly affected in turn by source of water and hydrological manipulations. Thus there is the possibility that efforts to restore a natural hydropattern may result in increased Hg availability. Separating avian responses to the effects of restored hydropattern from those of Hg contamination and attraction to distant sites is the main focus of future research.

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Guiding Fire and Grazing Restoration in Grasslands National Park of Canada with a Landscape Level Simulation Model

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Grazing and fire play important roles in determining the structure and composition of vegetation on the mixed grass prairie. With settlement, spatio-temporal patterns of fire and grazing have been dramatically altered, changing the natural patterns and processes (ecological integrity) of this grassland ecosystem. Grazing has changed from being widely spaced, punctuated events of intense defoliation to annual, seasonal grazing of moderate intensity. Fires, too, have changed from what were likely many small ignitions and frequent, large scale, intense burns to rare disturbances at the landscape scale. Hence, biotic processes governing landscape pattern in the northern Great Plains have become more homogeneous.

To restore the ecological integrity of the park, Parks Canada will reintroduce bison grazing and fire to Grasslands National Park in southern Saskatchewan. To reduce uncertainty in the long-term response of the landscape to these management prescriptions, Parks Canada has adopted an adaptive management approach, whereby hypotheses about the response of vegetation to management prescriptions are developed through simulation models parameterized in “expert workshops”. Management is applied based on these hypotheses that are tested with targeted monitoring of vegetation and faunal community responses. In an iterative fashion the models are then refined, new hypotheses are developed, management regimes are altered and monitored.

Our first iteration of models will guide management actions over the next few years. First we developed state transition models to simulate vegetation changes using the Vegetation Dynamics Development Tool (VDDT). These models consist of generalized vegetation states in five different vegetation community types - valley grasslands, upland grasslands, sloped grasslands, eroded communities and shrub communities. In addition, the models include transitions between vegetation types - either deterministic (time dependent) or probabilistic.

We used the VDDT State transition models and maps of the current landscape state as inputs to the Tool for Exploratory Landscape Scenario Analyses (TELSA). TELSA is a spatially explicit landscape simulation model that takes into account the interaction between vegetation succession, natural disturbances, and management action to project the state of the landscape into the future.

Our simulations with TELSA indicate that reintroduction of bison and prescribed fire at feasible levels can restore heterogeneity in vegetation structure to the mixed grass prairie. However this is not enough, as aggressive restoration treatments will be required to curb the ongoing invasion of crested wheat-grass, smooth brome and annual weeds from old fields.

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Vic Fazio Yolo Wildlife Area: A Lessons Learned Overview of the Largest Wetland Ecosystem Restoration Project in the Western United States

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The Vic Fazio Yolo Wildlife Area, which is located in Yolo County a few miles west of Sacramento, California, is the largest multi-purpose wetland ecosystem restoration project in the western U.S. The wildlife area is entirely within the Yolo Bypass, which is a primary component of the comprehensive Sacramento River Flood Control Project. The wildlife area successfully integrates and balances the multi-purpose needs of flood management, wildlife habitat, agriculture, recreation, and education, and represents a model cooperative approach to restoration and long-term management.

The U.S. Army Corps of Engineers, under the authority of Section 1135(b) of the Water Resources Development Act of 1986, began the planning of the ecosystem restoration project in 1989, with construction starting 1994 and cumulating with the dedication of the project by President Clinton in November 1997. The principal working partners were the Corps, California Department of Fish and Game, and Yolo Basin Foundation, a non-profit organization. The project was a leader in developing collaborative partnerships and using multi-functional ecosystem restoration processes to make the area a reality.

Over 7 years have passed since the dedication of the 3,700-acre ecosystem restoration project, which has now expanded to over 16,000 acres and is now home to over 200 species of birds. The establishment of the wildlife area and its partnerships of Federal, State, regional, local agencies, and non-profit organizations and local landowners have been widely recognized and regarded as a model for planning and completion of other wetland projects in the region. This paper presents an overview of the lessons learned and personal reflections in the planning, design, construction, and subsequent adaptive management and maintenance of this unique multi-purpose wetland ecosystem restoration project.

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Cascading Ecological Effects of Low-Level Phosphorus Enrichment and Abatement in the Florida Everglades

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We report results of a 5-year manipulation of phosphorus (P) delivery to experimental flow-through channels in Shark River Slough, Everglades National Park (ENP) to determine the levels of P addition that cause ecological change in this system. Three 100-m long flow-through flumes were established in a previously unenriched slough habitat. Each flume contained four channels which received 0, 5, 15 and 30 ppb of P above ambient concentrations. Concentration was kept constant at the head of the channel by continuous calibration with water depth, and downstream delivery was dependent on natural water flow. Multiple abiotic and biotic parameters were assessed at regular spatial and temporal intervals. The project provided the basis for establishing the Class III Nutrient Water Criterion for ENP.

Significant responses were detected in all measured ecosystem parameters at all dose concentrations. The marsh responded dynamically to dose, with effects being visible first in the microbial community, followed by the sediments, macrophytes and consumers. By the end of the 5th year, the most conspicuous differences between treated and control channels were the decreased biomass of floating calcareous periphyton mat and increased densities of the dominant emergent macrophytes in all dose channels. All biotic changes occurred without detectable increase in water column P until year 5, indicating rapid biotic uptake and downstream spiraling, first in the periphyton, followed by the floc, sediments and plants (Gaiser et al., 2004).

The results clearly indicate an assimilative capacity near zero for Everglades wetlands. In other words, although the marsh quickly removes added P from the water column, this uptake does not occur without eliciting a cascade of biotic imbalances. The system cannot be considered static: even if inputs are raised only slightly above ambient (ie., by 5 ppb P), continuous delivery will result in changes that progress downstream with time. Recovery trajectories to abated P delivery are now being documented and it appears that enriched tissue is very quickly transported and dispersed within the system.

Reference:

Gaiser E.E., Scinto L.J., Richards J.H., Jayachandran K., Childers D.L., Trexler J.D., and Jones R.D. 2004. Phosphorus in periphyton mats provides the best metric for detecting low-level P enrichment in an oligotrophic wetland. *Water Research* 38: 507-516.

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Oak Scrub Restoration at Hilochee Wildlife Management Area-A Preliminary Assessment

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Hilochee Wildlife Management Area (WMA) is situated in south Lake County, Florida. Prior to state ownership and establishment of the WMA, several hundred acres of mesic and xeric plant communities were converted to improved pasture for cattle grazing. This included approximately 125 acres of native oak scrub/scrubby flatwoods. Remnant patches of scrub occur on Pomello soils and have succeeded to xeric oak hammocks.

Efforts to restore an oak scrub community were initiated by the Florida Fish and Wildlife Conservation Commission (FWC) in 2002. Three separate areas occupying small acreages of former scrub were prepared for subsequent plantings of native tree, shrub, and herbaceous species. These areas were first mowed or burned then herbicided with glyphosate in an effort to eradicate bahiagrass. Repeated herbicide applications were needed on all three areas. In spite of herbicide treatments, a number of species present in the seed bank, including *Eupatorium*, *Polypremum procumbens* (a pioneering species), and *Richardia* persisted.

Remnant oak scrub/xeric hammocks were assessed to provide a reference list of plants. This list was supplemented with several additional species that would be expected to occur in oak scrub/scrubby flatwoods communities. The Natives, Inc., under contract with the FWC, planted over 4,000 individual trees and shrubs in January 2004. Species included sand live oak, myrtle oak, saw palmetto, staggerbush, and silver buckthorn. Plants were planted on 5- to 7-foot-centers over approximately 3 acres (all three areas combined). Plants were watered in at planting and subsequently on an as-needed basis to enhance survival. As a condition of the contract, The Natives had to meet a minimum 90% survival rate for at least 8 weeks after planting. After 8 weeks, more than 95% of the trees and shrubs had survived. The Natives was later awarded a contract to install herbaceous and semi-woody plants within two of the three restoration areas, bringing the average density to 4-foot-centers (trees and herbs combined). Due to FWC fiscal year constraints, plants had to be installed prior to mid-June 2004. In late May of 2004, 5,500 herbaceous plants, including *Pityopsis graminifolia*, *Licania michauxii*, *Solidago odora* var. *chapmanii*, *Lechea deckertii*, and *Balduina angustifolia*, were planted in hopes of taking advantage of June rains. As a condition of the contract, The Natives had to meet a minimum 90% survival rate for at least 3 weeks after planting. Although most plants were watered in immediately and at subsequent times during the initial establishment period, normal spring drought conditions resulted in a mortality rate of approximately 16%. Several trees, shrubs, and herbaceous plants succumbed to continuing drought conditions after contract requirements had been met. Myrtle oak, saw palmetto, and gopher apple (*L. michauxii*) were among the hardest hit. Survival data will be discussed in the presentation.

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On the Edge: Restoration Planning in the Southwestern Desert

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The Sonoran Desert, extending more than 200 miles into southwestern Arizona, presents the classic Old-West. It is a landscape of long views, dominated by towering mountains, boulders, saguaro cactus, flaming ocotillo, yucca and agave. It is a boundless wilderness inhabited by the peccary, the puma, the coati-mundi, perhaps a prowling jaguar; and the venomous rattlesnake. This starkly beautiful, alien, yet seductive milieu continues to attract both visitors and migrants. Yet, every Sonoran resident knows that the real life of the Sonoran Desert is sustained in only a fraction of the breath-taking landscape; in the narrow and now critically imperiled riparian ribbons that cross this vast and inhospitable desert. The average visitor is often unaware of the simple and brutal algorithm in the desert: water equals life; the lack of water equals the absence of life. Only the riparian zones along the lower Colorado drainage, importantly, the Gila, the Salt and the Santa Cruz Rivers, render the desert habitable. These streams carry waters from mountain snows that sustain life at the surface and replenish the groundwater supplies. These critical resources have been drastically diminished over the last 100 years due primarily to the unbridled appropriation and use of available water resources to support an ever-growing human population. Many reaches of riparian zones that were hundreds or thousands of feet wide, scores of miles long and dominated by dense hardwood forest, have been reduced to desiccated erosional features that now support only scattered alien weeds.

There are a number of efforts underway by public and private entities to reverse this trend. One such effort is a seven-mile reach of the Santa Cruz River in Tucson, Arizona, known as the *Paseo de las Iglesias* (the walk of the churches). Over the last three years, the Army Corps of Engineers and Pima County Flood Control District, supported by planners and ecologists from DMA and scientists from the Army Environmental Laboratory in Vicksburg, MS have conducted a feasibility study to address ecosystem restoration opportunities in this 5000-acre, urbanizing study area. Before urban development and intensive water appropriation, this riverine reach was characterized as a several thousand-foot wide gallery mesquite *bosque* (forest), cottonwood and willow lined riverbanks and *cienigas* (place of a hundred waters; “wetland”). The removal of much of the water was easily identified during plan formulation as the primary reason for its conversion to a sandy scar through the City of Tucson. The replacement of the water was also easily identified as the key to its restoration as a functioning ecosystem. The difficulty with the solution and the challenge of this restoration effort was finding, collecting, holding, distributing and applying the water to obtain a viable, effective and sustainable riparian ecosystem in a political environment for which water is the *sine qua non* for all competing activities. It was necessary to consider and balance the relationship between the absolute volume of water that could be obtained and applied, the periodicity and method of its application and the quality of the riparian habitat that could be created on lands that could be made available for a public project.

Planning efforts led to the selection of a cost-effective 1,200-acre project area based on a sustainable water budget and a maximized ecosystem value. The conduct of this multi-disciplinary planning project required the use of ecosystem functional assessment modeling attuned to the desert riparian systems, geomorphology, economic modeling, hydrological modeling and a great volume of spatial data, linked and made accessible for planning decisions through interactive GIS applications. The manner in which GIS was utilized for this project departed from the traditional usages for the preparation of summary graphics. The GIS was instead used in live planning sessions, wherein all spatial features of the study area and components of the ecological model were digitally projected on a screen, modified and rapidly re-evaluated at multiple scales. The availability of spatial data not only facilitated planning sessions but also increased the data types and the accuracy of the data available thereby enabling novel approaches to plan formulation.

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A Synthesis of the Role of Wildlife Science in Wetland Ecosystem Restoration

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Wetland restoration projects have increased in size and scope in recent years so as to be legitimately termed “wetland ecosystem restoration”. For these types of projects, there is a need for guiding principles on how and when to integrate wildlife science. This presentation proposes three roles for wildlife science to increase the chances of a project’s success: (1) contribute to conceptual ecosystem models, (2) develop quantitative performance measures and restoration targets that track the progress of restoration, and (3) achieve social feasibility by sustaining long-term public support for a project.

Wildlife data are useful for the development of conceptual models because they frequently come from long-term data sets, which are uniquely suited for detecting slow ecosystem or landscape responses to restoration. Long-term wildlife data sets arise because wildlife species often have commercial value, they are listed as federally Endangered or Threatened, or their aesthetic qualities have historically attracted the attention of scientists and funding agencies. This increased research attention also increases the likelihood that there will be a mechanistic understanding of how wildlife species respond to changes in ecosystems.

Wildlife performance measures span a large range of spatial scales as well as the structural and functional dichotomy. They are particularly good performance measures for large-scale restoration projects because they integrate information over large spatial scales and reflect the status of lower tropic levels. I discuss several characteristics common to wildlife species that require special consideration when developing performance measures.

Finally, one of the unusual characteristic of wetland ecosystem restoration projects is a requirement of sustained funding for decades, a period beyond the professional life of individual scientists, and one that will likely encompass lean economic periods when funding priorities may shift. The ability of such long-term projects to achieve “social feasibility” must be a precursor to the evaluation of technical feasibility, on which scientists tend to focus. If the benefits of a restoration project are framed in the context of “valued resources” by the public, then wildlife can help achieve social feasibility by providing a way to communicate complex science in terms the public understands and values.

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The Use of Otolith Microchemistry to Monitor and Evaluate the Movement of Coral Reef Fish in South Florida Waters

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Stable isotopic ratios of carbon and oxygen, embedded in the otolith of teleosts fish, have been well documented as useful tools for providing a wealth of information on environmental variations and stock structure of fish throughout their life history. Some of the valuable data include information about habitat temperature and salinity, migratory patterns and habitat use, diet and metabolic rates, and determination of the degree of stock mixing.

In this study, we are investigating the size-age structure of *Lutjanus griseus* juveniles in Florida Bay, examining their growth rates and migration patterns, and exploring how these relate to habitat characteristics and environmental variables such as salinity, temperature, and ontogenetic shifts in habitat. Measurements of $^{18}O/^{16}O$ and $^{13}C/^{12}C$ ratios in the sagittal otolith carbonate are obtained from juvenile gray snapper (*Lutjanus griseus)* collected in 2001-2004 from various locations within Florida Bay. Using a high-resolution Micromill drill, portions of the otolith formed during juvenile periods are collected and analyzed, in order to assess ontogenetic and environmental transitions.

Additionally, age data will make available the age at which ontogenetic and environmental transitions occur. We will discuss this data in light of natural variability in population parameters such as recruitment and growth and how these parameters are influenced by natural environmental variability. Ultimately, we are optimistic that we will afford fisheries managers with possible impacts of ecosystem change as a result of the Comprehensive Everglades Restoration Plan.

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Evaluation of Regional Models for Evapotranspiration in the Everglades

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Evapotranspiration (ET) is a major component of the water budget in the Everglades, and quantification of ET is critical to understanding the hydrologic flow system. Regional models for ET in the Everglades based on simple Priestley-Taylor models relating ET rates to water depth and solar intensity were developed using data collected during 1996-97 (German, 2000). More recent data offers the opportunity for evaluating the accuracy of these regional ET models at locations that were used in developing the original models, as well as at new locations.

Comparisons of annual total measured ET and model-predicted ET were made for four sites in the Everglades using data collected during 2001-02. This comparison indicates that the difference between model-predicted and actual ET is within 2.5 to 3 inches for two sites, P33 and ING. Both of these sites were operated during 1996-97 as well as during 2001-02; data from 1996-97 were used in developing the regional models. For the other two sites (X2 and L1), differences between model-predicted ET and actual ET are greater, that is, about 6 inches per year. Some of these differences may be because of differences in vegetative density and occurrence of periphyton. Sites L1 and X2 have abundant periphyton and are relatively sparse in vegetative cover, compared with P33 and ING.

On-going studies by other investigators, using data from the sites discussed here and at other sites, are considering the use of additional types of models, such as the Penman-Monteith model, that may provide more accurate regional models of ET. Also, data from satellite imagery are being used to study the relation between ET rates and vegetative density as a possible tool for developing more robust regional ET models.

Reference:

German, E.R., 2000, Regional evaluation of evapotranspiration in the Everglades: U.S. Geological Water-Resources Investigations Report 00-4217, 48 p.

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Linking Ecosystem Restoration with Watershed Management

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Societal recognition of the importance of effective watershed planning and management implies that the connection between watersheds and ecosystems requires more careful examination. The US Commission on Ocean Policy recently released its preliminary report in which the Commission addressed the watershed-ecosystem connectivity from the perspective of national policy needs in the coastal areas. Such conclusions would broadly apply to the interior river basins and watersheds as well.

U.S. water policy has evolved in response to changing legislative authorities, water use demands, environmental health, and economic climates over decades. With heightened public awareness of the interrelationships among all uses of water, a wider range of community partners and governmental entities at all levels are interested in active involvement in decisions on water resource planning. As a result, watershed approaches that take into account a multitude of water uses, often in direct competition, on a regional basis, have been gaining popularity over the past decade. However, ecosystem needs within the river basins or watersheds often are given scant attention absent a crisis situation. Thus, scientists and policy makers at all levels must address how to match programs and decisions for watersheds with appropriate attention to the various ecosystem components.

At present, clear policies do not exist that would focus programs on seeking balance between ecosystem restoration and the watersheds or river basins connected to these ecosystems. The Everglades restoration effort along with other similarly complex situations nationwide provide good examples of the complexity of balancing decisions for ecosystem health with the consequences of managing watersheds for other purposes. Some particular issues associated with these basinwide efforts will be presented as examples of the difficulties in satisfying watershed management opportunities with ecosystem protection and restoration needs.

At the national level, the federal agencies and Congress have not addressed the comprehensive policies that may be required to accomplish truly integrated, holistic water resources management, nor has attention been given to the ecosystem components that are a necessary part of national water policy. Efforts to collaborate among federal, Tribal, state and local or regional entities are only beginning, yet already yielding benefits. This paper will present some suggestions for further consideration to bring scientists and policy makers together to focus on creating or modifying policies and program delivery to accomplish both improved watershed management and ecosystem health.

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Coral Reef Ecosystem Restoration off Southeast Florida

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Significant coral reef community development along the eastern shelf of the United States continues northward of the Florida Keys through Miami-Dade, Broward, Palm Beach, and Martin Counties, Florida (to Latitude 27° N). These Southeast Florida high-latitude coral communities have approximately 30 species of stony corals, stony coral coverage of 2-3%, and a diverse assemblage of reef gorgonians, sponges, and fishes.

This system lays within 3 km of the coast offshore a highly urbanized area comprising a population of over 5 million people (the population of Broward County alone exceeds 1.7 million). These reefs are important economic assets: a 2001 economic assessment estimated the annual reef input for Miami-Dade, Broward, and Palm Beach Counties at 5.8 billion dollars. Potential impacts to the system include those from commercial and recreational fishing and diving, sewer outfalls, marine construction activities (fiber optic cables, channel dredging, gas pipe lines), and major shipping ports and ship groundings. Southeast Florida has three major shipping ports; Port of West Palm Beach, Port Everglades (Broward County), and the Port of Miami. At Port Everglades alone, over 5,300 ships call on an annual basis. This heavy ship traffic very near and within a coral reef system has resulted in nearly one ship grounding per year offshore Broward County since the early 1990's.

Nearly all reef damage events involve some level of injury assessment, triage and restoration, and monitoring. Triage generally involves the uprighting and caching of dislodged and fragmented stony coral colonies. At a minimum, restoration activities include the reattachment of these stony coral colonies. Restoration may also include the reattachment of dislodged octocorals and sponges and the removal of rubble generated by the damage event.

This work summarizes restoration activities and monitoring results from several representative reef damage events that have occurred offshore Broward County, Florida. Discussion will include the effectiveness of past and current restoration and monitoring activities. Recommendations for improved restoration activities and more effective recovery monitoring will also be discussed.

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Use of a Modified Macrohabitat Guild Structure for Assessing Fish Dependence on Off-Channel Habitats in the Kissimmee River

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Changes in habitat-based guilds are often used to understand the impact of habitat alteration on biotic communities. A decline in the presence or abundance of a particular macrohabitat guild is expected when the preferred habitat is lost, substantially altered, or degraded.

A current macrohabitat guild classification for river fish assemblages is based on relative dependence of associated taxa on streamflow to classify fish taxa as fluvial specialist, fluvial dependent, or macrohabitat generalist. However, in low gradient river-floodplain systems such as the Kissimmee River, dependence on floodplain and other off-channel habitats may be more critical in structuring fish assemblages. To illustrate the importance of off-channel habitat availability in structuring low gradient river fish assemblages, the existing macrohabitat guild structure is augmented to include two new categories related to off-channel use. New categories classify taxa as *off-channel dependent*, species that are found in a variety of habitats, but require access or use of off-channel habitats or limited to non-flowing, vegetated waters at some point in their life cycle, and *off-channel specialist*, taxa that are almost always found only in off-channel habitats or are described to use limited to non-flowing, vegetated habitats throughout life.

When applied to the current fish fauna of the channelized Kissimmee River, the new guild structure reclassifies 41 taxa from macrohabitat generalist to off-channel dependent (26 taxa) and off-channel specialist (15 taxa). Application to fish survey data collected in floodplain habitats prior and subsequent to channelization indicates a shift in numerical dominance from off-channel dependent taxa (88%) before channelization to that of off-channel specialist taxa (98%) under channelized conditions. Elimination of a seasonal flood pulse and degradation of remaining floodplain habitats, both resulting from channelization and a reduction of river channel-floodplain connectivity, are believed to be the principal causal agents. Off-channel dependent taxa are once again expected to numerically dominate floodplain fish assemblages following restoration of the Kissimmee River and floodplain ecosystem. This shift in guild dominance will indicate reestablishment of at least a minimum level of off-channel macrohabitat quality necessary to sustain guild taxa.

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Coming Together for Conservation: The National Fish Habitat Initiative

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Loss and alteration of aquatic habitat are the primary reason for the alarming decline in many of America's fish and other aquatic resources. Aquatic habitat is not only critical to the survival of fish and aquatic species, it also provides many significant benefits to human society. In its January, 2002 report, "A Partnership Agenda for Fisheries Conservation," the Sport Fishing and Boating Partnership Council recommended that the U.S. Fish and Wildlife Service (Service) initiate a partnership effort directed at fish habitat conservation modeled after the highly effective North American Waterfowl Management Plan. In response, the Service's Fisheries Program recognized aquatic habitat as one of its seven focus areas in its December 2002 Fisheries Program Vision for the Future. In doing so, it made a commitment to "work with Federal, State, Tribal and other partners to explore the benefits of a National Aquatic Habitat Plan and determine the appropriate FWS role in its development and implementation." The ultimate goal of the Initiative is to work closely with partners and stakeholders to build a future that ensures Healthy Fish, Healthy Habitats, Healthy Economies, and Healthy People.

As the lead federal partner, the Service has begun bringing partners and stakeholders together to develop a National Fish Habitat Plan. The Plan will foster geographically-focused, locally driven, and scientifically based partnerships that will work together to protect, restore, and enhance aquatic habitats and reverse the decline of fish and aquatic species. Other key economic and social benefits will also be achieved as a result of better coordination and direction of resources to this significant conservation challenge. Another key partner in this effort, the International Association of Fish and Wildlife Agencies, will help take the lead in developing a comprehensive plan and action strategy. This plan will establish a national framework to prioritize, coordinate and support existing and new fish habitat actions at local, regional and national scales.

The American Fisheries Society is sponsoring a forum in August 2004 to consider benchmarks for evaluating success in aquatic habitat conservation, which will be used to develop the Plan. Other partners who have expressed a strong interest in participating include the Native American Fish and Wildlife Society, NOAA Fisheries and the National Fish and Wildlife Foundation. The Service is currently conducting stakeholder meetings across the country to identify mechanisms that will be the most effective in implementing the Initiative and identifying opportunities to overcome conceptual and administrative hurdles and engage more partners in seeking solutions to the problems of aquatic habitat conservation.

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Physiological Effects of Crude Oil and Brine on Loblolly Pine (*Pinus taeda*)

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Spills from oil production and exploration are a common occurrence in Louisiana. Sensitive environments, such as wetlands and forests, are at risk to petroleum and brine contamination due to accidental spills, leaks, or discharges. These releases may result in the contamination of water, soils, and/or vegetation. Louisiana's Kisatchie National Forest, which is dominated by loblolly and longleaf pines, is subject to oil and/or brine contamination during exploration and production operations. There is little knowledge of the phytotoxic effects of crude oil and brine on pine trees and the long-term impacts on forest communities. The goal of this project is to determine the cause of death and stress of loblolly and longleaf pines that were impacted by an oil well blowout in Cravens, LA.

Greenhouse studies were initiated to investigate the effects of foliar and soil applications of crude oil and brine on 2-year old loblolly pine. In April 2000, a foliar oil pre-study attempted to determine the lethal dose to kill 50 percent of the population for oil applied directly to the needles of the trees. This pre-study proved inconclusive, as none of the trees showed any signs of stress or died 10 weeks after application. A second foliar oil study began in May 2000 and within 2 weeks of application resulted in stress and death of trees treated to cover 75 percent or greater of the needle surface area. Signs of stress included needle wilting, needle chlorosis, pre-mature needle loss, and eventual death. Using nutrient concentration analyses, it was determined that the oil was interfering with the photosynthetic pathway causing stress and death of the trees. Time of year of application seemed to affect the response of the trees to the oil. As temperatures and photosynthetic rates increased, signs of stress became more pronounced.

Soil applied oil studies indicate that oil applied at rates greater than 862 liters per hectare will kill the tree within 1 month. Ammoniated bagasse applied to the oil-contaminated soils reduced total petroleum hydrocarbon concentrations by 32 times the original concentration. The ammoniated bagasse was applied 14 days after the oil applications, but did not increase the chances of survival of trees contaminated with high concentrations of oil.

Trees treated with foliar applications of brine showed few signs of stress throughout the entire six month study period. The only sign of stress observed was needle burn at the tips on trees treated to cover 100 percent of the needle surface area. Brine applied to the soil at concentrations greater than 4 milliSiemens per centimeter (mS/cm) resulted in severe signs of stress and death of the trees, as would be expected. Treatments equal to or less than 4 mS/cm showed few signs of stress (i.e. needle chlorosis).

As a result of these greenhouse studies, it was concluded that foliar oil contamination of the pine trees surrounding the oil well was the cause of stress and death. Concentrations of oil and brine in the soil were not great enough to negatively affect the trees.

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Coupling 3-D Computational Fluid Dynamics, Water Quality, and Individual-based Models to Decode and Forecast 3-D Use of Aquatic Habitat by Highly Mobile Species

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We describe a theoretically robust mathematical method for decoding movement patterns of aquatic species (e.g., fish) responding to biotic and abiotic stimuli in 3-D space-time. The method is intuitive, mechanistic, and based on well-established principles in psychology, neuroscience, game and foraging theories, computer science, fluid and water quality dynamics, and computational fluid dynamics (CFD) modeling. We demonstrate the utility of the method by decoding observed 3-D movement and passage patterns of downstream migrating juvenile salmon (migrants) at Lower Granite Dam on the Snake River, Washington, USA. The hypothesis developed, the Strain-Velocity-Pressure (SVP) hypothesis, explains observed migrant movement as a hierarchical set of rule-based responses to hydrodynamic cues. The hypothesis is tested and refined by programming it into a 3-D spatially-explicit, time-varying "plug-and-play" fish individual-based model (the Numerical Fish Surrogate). Output from the Numerical Fish Surrogate explains 82% of the variation in migrant passage (r^2 = 0.82) at Lower Granite and other hydropower dams in the Pacific Northwest where the method has been applied. The methodology is generic and provides a new, innovative means to (1) quantitatively interpret the multi-dimensional movement of individual aquatic species responding to pattern in hydrodynamics, temperature, dissolved oxygen, salinity, and other physicochemical constituents and (2) objectively implement (forecast) hypotheses of movement behavior to support engineering and management decisions.

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Conceptual Restoration Designs of Riparian Habitat in the Lower Cuyahoga River, Ohio, for Larval Fish

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This investigation identified several types of habitat restoration options in the lower Cuyahoga River to improve the survival and migration of warm water larval fish in riparian zones. The study results include conceptual and generic restoration designs, preliminary cost estimates for construction, and recommendations for implementation. Observations made during this investigation suggest that many opportunities exist within the lower Cuyahoga River for habitat restoration that is compatible with navigation and commercial needs.

The lower Cuyahoga River is located in Cuyahoga County in northeast Ohio, and is the outlet of the 813 square mile Cuyahoga River watershed and includes the Federal Navigation Channel. The navigable portion of the river has a mean dredged depth of approximately 29 feet, and length of 5.6 miles. Surrounding the Federal Navigation Channel is the City of Cleveland. The area is a heavily industrialized urban center and provides facilities for a wide range of commerce. Degradation of the Cuyahoga River began in the mid-to-late 1800's with the advent of the iron and steel, paint, and petrochemical industries. Industrial uses of the river and extensive riverbank stabilization have resulted in a lack of sufficient suitable riparian habitat for many forms of aquatic life. Field observations in May 2003 revealed that there are four basic classes of riverbank: steel sheet pile, concrete bulkheads, wood bulkheads, and vacant land. Current land use adjacent to the river is highly diverse and ranges from industrial and commercial to vacant land. The recent shift in land use adjacent to the lower Cuyahoga River has created a unique opportunity to restore riparian and shallow water habitat.

The alternatives that were developed include riverbank contouring, the placement of LUNKERS (a technique that has been effective in small streams for salmonids), and two variations of steel sheet pile modification. These alternatives present ideas that may be developed for site-specific application and may be further enhanced with debris deflectors, solar air bubblers, etc. The conceptual plans were developed with the intent that they could be integrated into new construction, during repair of existing protection measures, or added to existing structures. The plans developed utilize a variety of engineering features, represent a range of costs to implement, and are compatible with different land use types. The conceptual plans presented in this report can be further developed for construction after site-specific engineering and analysis has been completed. We concluded that a demonstration project is necessary to quantify the benefits of the proposed restoration on larval fish populations and assist resource managers design and locate future projects. Pre- and post-post construction monitoring and data analysis will help quantify the important role these projects can play in the recovery of the Cuyahoga River.

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Seed Germination in Wild Celery, *Vallisneria americana* Michx. from Lake Okeechobee, Florida U.S.A.

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

In the first approximately 10 wk experiment, out of 122 total germinations, 121 or 99.2 % occurred in the light, while only one or 0.8 % occurred in the dark. Upon subsequent exposure to light, seeds previously held in the dark began germinating after approximately 60 days, indicating secondary dormancy.

During the 26 wk follow-up experiment the germination rate was only 1.0 per day, compared to 1.7 germinations per day in the original experiment. These observations suggest involvement of the phytochrome system in seed germination of *V. americana*, and have implications concerning the seed bank in turbid portions of Lake Okeechobee.

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

These results have implications concerning the timing of drawdown in a lake or surface water reservoir; in particular, those with the objective of encouraging the re-establishment of submersed aquatic plants, such as *V. americana*, in turbid waterbodies.

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Real Estate Considerations Associated with Large-Scale Ecosystem Restoration Programs

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Anthropogenic alteration of the environment jeopardizes the ability of natural systems to provide important ecological services like clean air and water. Ecosystem-scale restoration programs designed to replace lost ecological functions require large, undeveloped, contiguous tracts of land. Encroachment of urban and suburban development is the single greatest threat to ecological restoration. Securing the lands necessary for restoration is often a race with development. Due to extreme development pressure in many important restoration areas, restoration options are being foreclosed and potential benefits lost. The pressures of price escalation and development increase every day causing restoration footprints to shrink and result in the loss of ecosystem function.

Shrinking restoration footprints are already compromising programs like Everglades restoration. Criteria other than science are clouding land-buying decisions. Rising property values can out-pace restoration land funding. Land use decisions resulting from inadequate coordination between restoration partners, including federal, state, tribal, and local governments, and other stakeholders can result in incompatible development that further hinders restoration.

Timing is crucial, and early acquisition will help safeguard the integrity of project footprints. Collaboration among federal, state, tribal, and local governments, and private partners is essential to securing the early funding needed to acquire real estate interests required for restoration. The burden of both funding and decision-making must be fairly distributed, and should not fall on the shoulders of just one agency or stakeholder. Education and outreach programs can help the public understand environmental restoration as another form of infrastructure, such as roads and airports. Environmental infrastructure provides essential services including water supply, clean air, and improved economic opportunities for resource-dependent industries.

Ecosystem restoration requires aggressive land acquisition early on. Until all lands needed for restoration have been acquired development will continue to threaten success. In the interim, the various stakeholders, including federal, state, tribal, and local governments, and private partners must work together to protect project footprints and protect adjacent lands from incompatible land uses.

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Spatially-Explicit Modeling of Soil Phosphorus Across the Greater Everglades

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Resilience and ecological threshold theory has formed the basis to address restoration projects around the world. Resilience is the amount of disturbance that an ecosystem could withstand without changing self-organized processes and structures. Since aquatic ecosystems and its component attributes result from many physical, chemical, and biological processes the response is often non-linear a/o chaotic operating at a variety of different spatial scales. The outcome is so complex that the variation appears to be random and a fully deterministic (mechanistic) solution to our problems seems out of reach at present. Therefore, we propose a mixed deterministic-stochastic model rooted in regionalized variable theory and landscape metrics to characterize resilience and environmental status of the Everglades.

We mapped soils across the Greater Everglades including Water Conservation Areas 1, 2, and 3, Holeyland and Rotenberger, Shark River Slough, Taylor Slough, Everglades National Park, Model Land, and Big Cypress to characterize the environmental status. In total ~1,700 site observations at 3 different soil depths (floc, 0-10 cm, and 10-20 cm) were mapped using a random-stratified sampling design. Samples were analyzed by the Wetland Biogeochemistry Laboratory (WBL), University of Florida to characterize a suite of physico-chemical properties including total phosphorus (TP). This was the first massive synoptic comprehensive spatial soil mapping event throughout the Everglades ecosystem. We used geostatistical methods to characterize the spatial variability, distribution, and uncertainty of TP predictions. Distinct gradients and spatial patterns of TP were quantified in different hydrologic units caused by external and internal factors and naturally occurring and human-induced processes. Our spatially-explicit modeling approach integrates TP data collected across the entire Everglades. To characterize the environmental status across the Everglades we propose an approach that synergizes observed and predicted TP values in conjunction with metrics that quantify the spatial and attribute variability. We exemplify our approach using TP observations and predictions and their variability in attribute and spatial space contrasting natural and nutrient enriched areas.

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Wetland and Wildlife Habitat Creation at Opportunity Ponds

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Approximately 908 acres of habitat (730 acres of wetland habitat and 178 acres of wildlife habitat) will be created from soil borrow pits at the Opportunity Ponds Remedial Design Unit within the Upper Clark Fork River (UCFR) Superfund site in Anaconda, MT. The excavation of borrow materials has been designed to include sequential reclamation of borrow areas (i.e., cells) as habitat over a period of approximately 10 to 12 years. The excavation and grading plans capitalize on the opportunities presented by the borrow soil excavation, with final invert elevations within each cell ranging from 4 feet above to 6.6 feet below the design water surface elevation. This optimized design provides for complete development of a cell for borrow material in one field season, and reclamation of that cell as habitat in the following seasons.

The sustaining hydrology for wetland creation will primarily be ground water, with supplemental surface water supplies. Water level control structures have been incorporated into the design to allow the regulation of water levels, and to provide the flexibility of flooding or draining each cell for maintenance and/or management purposes. The design guidelines incorporate flexibility to update and adjust the design (e.g., zonation of planting communities) in relation to updated hydrologic data. Wetland creation will follow an iterative process that interprets historic groundwater data and responds to current and updated empirical data (e.g., piezometers, staff gages, precipitation data).

The primary goal of the planting plans is to create natural vegetation communities that reflect the composition, diversity and zonation of natural habitat in the UCFR Basin. They have been correlated to the topographic gradient and hydrologic regime to provide a full range of communities from transitional grasslands to a mosaic of wetland habitat types that include scrub-shrub, emergent, submerged and shallow open water habitat.

The relative success of the habitat creation project will be assessed in coordination with the federal regulatory agencies via a methodology that has been specifically adapted to this Superfund site. The methodology includes a weighted rating system that assigns functionally effective wetland area (FEWA) to each assessment area. Once the habitat has fully developed and has been accepted by the agencies, it will be maintained in perpetuity as a wildlife management area.

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The Impact and Recovery of Ice Roads and Ice Pads on Tundra Ecosystems, National Petroleum Reserve, Alaska (NPR-A)

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Since the mid 1970's, oil companies have been using ice roads and ice pads to support exploratory drilling in Alaska's National Petroleum Reserve (NPR-A). The ice roads are used to haul exploratory equipment and supplies to the drill site during winter months and the equipment is taken off the site before spring thaw. Ice roads are constructed by harvesting available ice and snow to form a road base, and then use water from local lakes to build up the ice surface. The construction and use of ice roads by the petroleum industry has provided access into environmentally sensitive areas without the permanent impact from gravel road construction.

The case study was a 37.5 mile long ice road, built in 1978 from the Kikiakrorak River to the Inigok drill site. The road required 35 million gallons of water for construction and maintenance and was utilized for trucking 132,000 tons of gravel to the Inigok drill site from the Kikiakrorak gravel pit. The ice road averaged thirty feet wide and varied from six to fourteen inches in thickness. Field analysis was conducted during the summer of 2001-2003 on the disturbance caused by the construction of ice roads and ice pads in NPR-A. Color infrared (CIR) photography taken in 1979 and 2002 was used to identify and locate ice road traces. The impact of a one-year 2001 ice roads and a one-year 2002 ice road was compared to the one-year 1978 Kik-Inigok ice road. Data was gathered from each transect on the profiles of the surface terrain, depth to permafrost, vegetation and vegetation damage. The impacts to vegetation on the '02 and '01 ice roads and Puviaq ice pad showed damage to the shrubs, forbs and tussocks. More significant damage occurred on the drier upland sites with little or no evidence of damage to the moist wetland sites. Comparison transects across the '78 Kik-Inigok ice road showed a full recovery and restoration of damage to shrubs, forbs and tussocks, which were vigorous and in good condition.

In March of 2003 a tour of Puviaq exploratory drill site was conducted. The ice air field, ice road, maintenance of the ice road and the ice pad at Puviaq were all observed and photographed. The site was revisited in July of 2003 to assess impacts from the use of ice road and pad technology. Ice construction during the winter of 200l had limited impacts to the tundra environment, similar to those found on the more historical ice roads.

The ice road data supports the conclusion that a single year ice road and pad can completely be restored and returned to its natural state over time. Ice roads and pads that support drilling operations, if built with care, can have no long term effects to the fragile tundra environment.

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Uncertainty Analysis of Selected Hydrodynamic and Ecological Models in the Louisiana Coastal Area Ecosystem Restoration Plan

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In the context of a coastal restoration effort, model uncertainty is defined as the deviation of model predictions from the actual response of the ecosystem to a certain restoration project. Uncertainty is usually caused by natural variability, lack of data with sufficiently high quality and resolution, gaps in theoretical knowledge, and uncertainty of model algorithms and parameters. Model uncertainty is particularly relevant for the Louisiana Coastal Area (LCA) Comprehensive Ecosystem Restoration plan that depends on the results of a complex suite of hydrologic and ecological simulation modules. The present work reports on efforts to identify the dominant sources of uncertainty in the LCA models and to quantify their impact on the performance measures that are used to assess specific ecosystem restoration alternatives. The study recognizes the difficulties and challenges in quantifying uncertainties associated with predicting the response of complex ecosystems. These difficulties arise from the fact that uncertainties propagate in a nonlinear manner through the sequentially used hydrologic and ecological models. Another challenge is caused by the inter-dependence among many of the variables and parameters used in the different modules. This requires defining marginal as well as joint probability distributions which are not typically available.

Recognizing such difficulties, the current study focuses on analyses of dominant sources of uncertainty in the LCA modules. The study applied Monte-Carlo simulations to quantify the impact of factors such as long-term climatic changes, uncertainties in the parameters of habitat switching and habitat use algorithms, uncertainties in salinity predictions that are provided by the hydrodynamic modules, and effects of hydro-climatic variability. The performed analyses examined both the systematic (bias) and random (variance) components of uncertainty. The results of these simulations emphasize the critical need for rigorous calibration and validation of the used hydrodynamic and ecological modules. The results can also be used to formulate focal future research needs both in model development and in acquisition of high-resolution reference hydrologic and ecological data sets.

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Illinois River Basin Ecosystem Restoration

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The combined effects of habitat losses, through changes in land use; human exploitation; habitat degradation and fragmentation; water quality degradation; and competition from aggressive invasive species have significantly reduced the abundance and distribution of many native plant and animal species in the Illinois River Basin. In addition, human alterations of the Illinois River Basin landscapes have altered the time, magnitude, duration, and frequency of habitat forming and seasonal disturbance regimes. The cumulative results of these complex, systemic changes are now severely limiting both the habitats, and species composition and abundance in the Illinois River Basin.

The Rock Island District, in partnership with the Illinois Department of Natural Resources, has developed an overarching goal of restoring ecological integrity, including habitats, communities, and populations of native species, and the processes that sustain them, for an ecosystem that has been severely disturbed. This overarching goal guides six goals specifically formulated to address the limiting factors in the basin. These goals are:

1. Reduce sediment delivery to the Illinois River from upland areas and tributary channels;
2. Restore aquatic habitat diversity of side channels and backwaters;
3. Improve floodplain, riparian, and aquatic habitats and functions;
4. Restore longitudinal connectivity on the Illinois River and its tributaries;
5. Restore Illinois River and tributary hydrologic regimes; and
6. Improve water and sediment quality in the Illinois River and its watershed.

Each of these goals contains specific, measurable objectives, which have been developed to optimize ecological integrity in the basin. These objectives were developed by the interagency study team, resource managers, and stakeholders, and represent a desired future condition or virtual reference of ecological condition for the Illinois River Basin. Various alternative restoration plans were evaluated based on percent attainment of the desired future condition and their cost effectiveness.

The Corps, IL DNR, numerous federal and state agencies, and NGOs worked together to develop an implementation framework to restore the Illinois River Basin, which includes 34,400 square miles in three states. Projects will be developed by local stakeholders and reviewed at the Regional Team level. Those projects that meet the study objectives will be forwarded to the System Team, which will conduct a system-level evaluation and sequencing of the projects, leading to recommendations of projects that best meet system ecological needs and goals. This restoration program also includes systemic and site-specific monitoring, special studies to address data gaps, and adaptive management.

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Optimization of Water Quality Monitoring to Achieve Least-cost, Resource-based Objectives

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The cost of operating water quality monitoring programs to document permit compliance for six major initiatives of the South Florida Water Management District (SFWMD) approaches $3 million per year. As the SFWMD moves forward on an $8 billion environmental restoration program, additional monitoring programs will be required that can easily double or triple the annual costs to the agency. This study was charged with identifying ways for reducing annual cost of monitoring for permit compliance measurement. The SFWMD is required to obtain both state and federal permits for the construction and operation of projects that it builds. Even though the District has its own regulatory programs for new construction, it cannot regulate itself, hence the mandates for permit compliance monitoring.

During the first phase of this study, a multi-disciplinary team researched the history and details of the varied permit programs under which the District is regulated. A complete database of permit, and monitoring, information was compiled which became the foundation upon which the subsequent work was performed. There were several dozen permits, within more than a dozen categories, that required some form of monitoring and/or reporting by the District. Also, during this initial work, some way of calculating the costs was required in order to determine the relative value of reduction options. The finished product of this phase was the production of a Situation Assessment Report (SAR) that documented all of the information gathered and detailed a scope of work and action plan for the subsequent phases.

This study was successfully completed within a year and identified multiple reduction options and opportunities for the District. The methodologies developed during this study included statistical, numerical, and graphical techniques for assessing data value. The long-term value will be obtained as these techniques and processes are institutionalized within the District. The immediate benefit to the agency was the identification of savings in excess of $1 million per year in monitoring program costs.

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A Spatial and Temporal Comparison of Suitability Indices for Use in Evaluating Hydrologic Restoration Alternatives for the Comprehensive Everglades Restoration Plan

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Suitability indices provide a summary of how conditions at a location affect certain aspects of habitat quality for a given species or functional group. They have been used to evaluate the potential to support specific wildlife species when habitat is modified according to some restoration plan. Multiple indices may be available for the same species, either based on different assumptions about the components that affect suitability, or different weightings applied to the components. This can cause confusion among project planners regarding the appropriate index to choose, and has the potential to produce contradictory results. The Comprehensive Everglades Restoration Project is considering the application of two distinct suitability indices for American alligators and wading birds to predict environmental effects of restoration alternatives. We compared the relative ranking of restoration project alternatives at different temporal and spatial scales using the Across Trophic Level System Simulation (ATLSS) American alligator and wading bird Spatially Explicit Species Indices (SESIs) and the South Florida Water Management District's American alligator and wading bird Habitat Suitability Indices (HSIs). We summarize the results of these comparisons with emphasis on how different spatial and temporal averages impact the relative rankings of restoration alternatives and provide recommendations for choosing and using suitability indices when evaluating restoration project alternatives.

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The White River Ecosystem Conservation and Restoration Project: A NGO/Federal Partnership

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The White River Ecosystem Conservation and Restoration Project is a partnership project that consists of NGO's Federal Agencies, and State Agencies. The partnership's focus is working with the other watershed stakeholders to develop science based integrated natural resource management plans that will serve as a wise-use-decision-model to better guide ecological restoration efforts and the sustainable human use of the White River Basin's ecosystems. .

In 2001 the Nature Conservancy conducted conservation planning activities to assess the existing fluvial geomorphic stability of the White River Basin, AR. The Nature Conservancy and conservation partners determined that the most severe threats to the Conservancy's conservation targets and the White River ecosystem's overall stability was fluvial geomorphic instability, alteration of the natural hydrologic regime, altered sedimentologic regimes and associated agri-chemical loading, and landscape fragmentation of the remaining bottomland hardwood forest.

To address the threat of geomorphic instability, staff from TNC and the USACE Engineering Research and Development Center Coastal Hydraulics Laboratory, and the Little Rock District developed an interagency geomorphology expert team within the partnership. The geomorphic experts led a training program to teach the fundamentals of fluvial geomorphology and geomorphic assessment techniques. The partnership hosted field trips focused on problem definition, partner consensus regarding existing conditions, and collaborative restoration designs.

To address the altered hydrologic regime, staff from TNC, USACE, and USGS, led an interagency water-resource expert team within the partnership to assess the existing conditions of the surface and ground water resources within the White River Basin. The hydrologic expert team is now developing recommendations for sustainable flow regimes that will better support the ecosystem's biodiversity as well as the overall ecosystem functions. The hydrologic expert team is working with agricultural stakeholders to address the unsustainable ground water and conjunctive withdrawals within the White River Basin.

To address the altered sedimentologic regime and agri-chemical load threat, staff from TNC, AR. Soil and Water Conservation Commission, USEPA Region 6, are working together to conduct a Section 319 non point source sediment reduction study. The team is also working with landowners to install on farm conservation measures.

To address the landscape fragmentation threat, staff from TNC, USFWS, USACE, AR. Game and Fish Commission, AR. Soil and Water Conservation Commission, AR. Natural Heritage Commission and DU are working to purchase or sign conservation easements on prioritized tracts of land to reforest the cleared lands within the remaining forested blocks.

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Ecosystem Restoration in the Upper Chariton River/Rathbun Lake Watershed

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The Upper Chariton River/Rathbun Watershed (UCR/RL) is located in south central Iowa encompassing portions of 6 counties. The watershed comprises over two-thirds of the Upper Chariton River Corridor and includes over 354,000 acres.

Pre-settlement land cover in the UCR/RL area was comprised of 82.6 percent prairie and 16.9 percent timber. The native prairie plant communities, particularly the prairie grasses had extensive root systems and surface biomass, which helped to control surface runoff, reduced erosion and allowed water to infiltrate into subsurface groundwater zones and wetlands. Most of these prairie and woodland communities have been converted to row crops, hay and pasture land. This has collectively reduced the percent of surface vegetation cover on the watershed, allowing for higher surface runoff and erosion. Increased runoff and erosion carries higher concentrations of fertilizer, agricultural chemicals, and sediment into the streams and lakes and provides little storm retention. The consequences of the current conditions in the watershed include significant degradation of in-stream and lake habitat for fish and aquatic organisms, increased water treatment costs, and reduced sediment storage in Rathbun Lake, a Corps of Engineers constructed and operated flood control project.

Rathbun Lake was developed in the 1960’s and supplies water to the Rathbun Regional Water Association (RRWA). RRWA provides six million gallons of water daily to over 70,000 customers for residential, agricultural, and business use in 18 counties and 40 communities in Iowa and Missouri. The 11,000-acre lake provides recreation opportunities to over one million visitors annually; flood protection for 150,000 acres of land; fish and wildlife habitat in the lake and on 21,000 acres of adjacent public lands; downstream water quality improvement; storage for supplementing navigational flows; and water for the Iowa Department of Natural Resources Rathbun Fish Hatchery. Rathbun Lake is on the US Environmental Protection Agency’s Section 303(d) list of impaired water in Iowa.

The Southern Iowa Development and Conservation Authority, the cost-share sponsor on a Section 206 Project (a COE program), and several partner organizations has initiated a wide range of efforts to protect and improve Rathbun Lake and other water resources in the watershed. Field surveys and habitat quantifications support the planning and assessment of the proposed project alternatives. These included water quality monitoring, soil and sediment studies, fish and aquatic community studies, engineering surveys, and public opinion surveys. This is a true watershed-focused project with involvement from all levels including local landowners, local agencies and organizations, state agencies, as well as several federal agencies.

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Historic Freshwater Flow to Biscayne Bay, Florida and the Role of Transverse Glades

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Historically, Biscayne Bay received freshwater from rain, groundwater, overland spring flow and from the Everglades by discharge through transverse glades into coastal sloughs, streams and tidal creeks. Except for precipitation, sources depend on the geology of the Miami Limestone, an oolitic formation that underlies the Everglades and forms the Miami coastal ridge which marks the eastern edge of the Everglades. It is highly porous which aids lateral groundwater flow, and overlain by impermeable crusts and marl soil that block flow between the rock and the surface. Groundwater flow (measured at 200m offshore at mid-bay as $0.105m^3/m^2/d$, Meeder, et al. 1997) can be pervasive or channelized in subterranean channels. Both types produced springs along the shoreline and in the bay (Parker and Cooke, 1944). Elevation of the ridge is highest where it is close to the Bay (near Miami -max 25ft) to only 5ft near Florida City where the ridge is farther from the coastline. Numerous breaks through the ridge act as drains permitting Everglades's water to exit to the east. These breaks are called rivers in the north and transverse glades to the south of Miami.

Streams discharging into north bay include Miami River, Little River, Arch Creek, and Oleta River, and these drained sloughs, had relatively steep slopes (31.6cm/km for the Miami River. Gaby, 1993) and were sufficiently powerful to erode channels. Transverse glades in comparison are typically broad (1-2km) and shallow (1-2m) in their center. Slopes (~14.2cm/km) are less than the local rivers but much greater than the Everglades. They are partially filled with carbonate and peaty marl soils that indicate long hydroperiods and means they functioned as water conduits to Biscayne Bay most of the year (Egler, 1950). This is confirmed by historical land use patterns. Water discharge volumes were directly related to Everglades's water stage therefore discharge decreased southward. We calculated historical dry season/wet season discharge rates for the glades 210/6330 acft/day. This flow fed into the largest coastal creeks that were themselves the locus of historic oyster communities at the bay shore (Meeder et al., 1997). Glade driven creeks also delivered quartz sand to the coastline where mangroves stabilized it into headlands making these creeks morphologically different from tide driven creeks.

The function of the transverse glades has been destroyed by the construction of drainage canals in each one, and now they only function in extreme rains. The canals have caused over-drainage and changed the timing, duration, and location of water discharge to Biscayne Bay. Restoration of coastline habitats, a desirable outcome, is dependent on fully understanding the role played by transverse glades and the creeks tied to them.

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Ecosystem Restoration, Coastal Erosion Protection, and Recreational Amenities using Artificial Reef Submerged Breakwaters and Coral Propagation Techniques

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This paper presents ecosystem restoration projects that incorporate coral rescue and propagation techniques using artificial reef submerged breakwaters designed for shoreline stabilization. These projects include those that have been designed and constructed in Florida and the Caribbean that also offer recreational and ecotourism amenities. Although beach nourishment is generally regarded as the most effective method for beach erosion control and shoreline stabilization, it is not economically or environmentally suitable for some sites. Even successful beach nourishment projects such as Miami Beach, Florida have required coastal structures to assist in stabilizing the beach at “hot spots” that erode at higher rates than adjacent areas.

Unlike traditional breakwaters, the use of wide crested submerged breakwaters can proivide shoreline stabilization by mimicking the functionality of natural reefs. Recent submerged breakwater projects constructed using artificial reefs in shallow water reduce wave energy reaching the shore, while also providing the environmental and recreational benefits associated with artificial reefs. These benefits include marine habitat, mitigation of damages, and recreational benefits such as swimming, snorkeling, diving, fishing and surfing.

Custom designed artificial reef units such as the Reef Ball™ have been designed to attract and provide habitat for fish, lobster, and other marine life. Each Reef Ball artificial reef module on average produces about 180 kilograms (400 lbs) of biomass annually. A special concrete mix was developed that allows the Reef Ball modules to be deployed within 24 hours of being fabricated, and with special formulations that reduce the concrete pH to match that of natural seawater. The pH balancing and unique textured surface of the Reef Ball modules ensures that coral larvae and other marine life can easily attach to the modules to develop into a natural biological reef.

Coral reefs and their ecosystems are some of the most productive and biologically rich on earth. Natural events such as storms and climate change in addition to human activities can damage and cause stresses on these fragile systems. Preservation and conservation efforts need to remain a top priority, as well as restoration of damaged reefs and the creation of new ecosystems to replace those that have been lost.

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Predicting Wildlife Population Responses by Making Comparisons across a Species' Range: A Case Study between Mangrove and Salt Marsh Diamondback terrapins (*Malaclemys terrapin*)

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We are often forced to set restoration goals based upon our most basic knowledge of a species perceived distribution and abundance, habitat requirements, or presence of anthropogenic threats. While it may be possible to predict wildlife population responses by making comparisons across different populations within a species' range, we need to recognize important differences between the populations under comparison.

Diamondback terrapins (*Malaclemys terrapin*) are long-lived turtles that exist as continuously distributed geographic populations along North America's Atlantic and Gulf coasts. Living and breeding in salt marshes, mangroves, and tidal tributaries, the terrapin is the only North American turtle that lives exclusively in brackish water. One of the top predators in the estuarine food chain, terrapins may play an important ecological role, and may thus be particularly suitable for monitoring as an indicator species.

In order to use the terrapin as a species indicative of ecosystem health, we sampled terrapins found in the Big Sable Creek mangrove system of southwest Florida (FL), Everglades National Park and in salt marsh habitat in eastern North Carolina (NC). During regular mark-recapture, habitat surveys, and genetic sampling in both FL and NC sites from 2000-2004, we marked 300 individuals at each site. However, our recapture rates, population sex ratios, and population structure varied substantially. We compare and contrast terrapin habitat requirements, population structure, sex ratio, and gene flow in each of these 2 different populations to make inferences about how the NC population that is influenced by an intense blue crab fishery might benefit from what we know about the unexploited terrapin population found in the Everglades. We also highlight some concerns for the FL terrapin population found in the Everglades, especially in light of proposed large-scale ecosystem change and restoration.

Results indicate that the FL Everglades population consists of many more adult animals with a distinct lack of young juveniles whereas the NC population consists largely of juvenile turtles with very few adults, and the population sex ratio is 1:1 in the FL Everglades but 3:1 female-skewed in NC. Additionally, microsatellite genetic analysis indicates that males are the mechanism of gene flow within populations yet terrapin capture and mortality data collected in conjunction with the NC blue crab fishery indicates that males are particularly vulnerable to capture in crab pots at every stage of their lives. Habitat surveys revealed that there is a distinct lack of nesting habitat in proximity to what we perceive as the Big Sable Creek population center in FL, but substantial upland habitat available to female nesters in NC. Moreover, capture and recapture data indicate that site fidelity is extremely strong in each population, so fine-scale habitat requirements should be given weight when restoration decisions are made that impact even tertiary stream flows.

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ATLSS Data Viewer: A Tool to Analyze and Display ATLSS Model Outputs

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The Across Trophic Level System Simulation (ATLSS) Data Viewer System (DVS) is an application developed to allow resource managers and scientists to analyze and display the outputs of ATLSS models. ATLSS is a set of models developed by the U.S. Geological Survey and other agencies to predict the response of higher trophic level species to different alterations in the Everglades and Big Cypress (South Florida) hydrology regime. The goal is to help resource managers evaluate restoration plans in comparison with no restoration efforts. The development of restoration plans and associated activities aid the creation of monitoring and adaptive management schemes. The DVS allows the display of data from the following models: Hydrology, White-tailed Deer Breeding Potential Index, Cape Sable Seaside Sparrow Breeding Potential Index, Wading Birds Foraging Condition Index, American Alligator Production Index, Snail Kite Index, and the ALFISH model.

ATLSS models generate large amounts of data, that are often difficult to manage in PC-based applications. The USGS National Wetlands Research Center has developed a customized ArcView 3.2-based project in which the standard graphical interface and functions have been enhanced to perform analysis and visualization tasks specifically designed for ATLSS data.

An ATLSS DVS Web site has also been developed to:

1) Provide details about the project, application, contacts, and technical resources related to the ATLSS DVS;
2) Provide an on-line discussion forum where information, ideas, and suggestions for using the DVS can be posted;
3) Provide a support center for DVS users for technical information, current issues, and downloads of data and applications.

One component of the Web site includes an on-line mapping system which allows visitors to navigate base maps and model outputs and retrieve and display tabular information associated with spatial locations.

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How Do You Resolve Technical Disagreements in Ecosystem Restoration? Examples of Strategies from South Florida

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In general, far more attention and resources are given to the development and conducting of monitoring programs to track ecosystem restoration efforts relative to resources for assessing those data. If fact, a significant component of this First National Conference on Ecosystem Restoration focuses on strategies and mechanisms for developing meaningful data analysis from an adaptive science and adaptive management perspective. One aspect of restoration programs, however, that often warrants more attention than initially given is the development of approaches for resolving technical disagreements among individuals, agencies, etc. In this presentation, I give examples of several approaches that have been used in South Florida.

Many established mechanisms for resolving technical disagreements stem from legal mandates. The 1991 Federal Consent Decree [Case No. 88-1886-Civ-Hoeveler] settling the Federal lawsuit over the pollution of the Everglades established a Technical Oversight Committee, composed of senior technical representatives of the five settling parties. This mechanism involved a defined structure that provides a mechanism whereby scientists address technical disagreements before raising issues to the management/policy level.

A second, less rigid approach, was used recently by the Science Coordination Team, a sub-group of the South Florida Ecosystem Restoration Task Force. In the development of a white paper on the role and potential importance of flow in the Everglades ecosystem, many different technical perspectives were brought to the table in developing alternative hypotheses about mechanisms for the formation of ridge and slough habitat. This successful approach adopted by the Science Coordination Team led to the incorporation of alternative hypotheses in addition to the leading hypotheses in their report, without the need to develop dissenting opinion reports.

Finally, the REstoration COordination and VERification (RECOVER) branch of the Comprehensive Everglades Restoration Plan recently developed general guidance on resolving technical disagreements when assessing ecosystem response to restoration efforts. This guidance pursues an intermediate approach to resolving technical disagreements, with mechanisms established at a hierarchy of different scales (local, regional, system-wide) to try to resolve technical disagreements among scientists.

The details of the examples given in this presentation are for illustrative purposes only, and do not necessarily reflect the opinion of the Department of Interior.

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A Synthesis of Ecosystem Assessment in the Everglades

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Ecosystem assessment for Everglades restoration encompasses the primary science-related themes of this First National Conference on Ecosystem Restoration (NCER), including: (1) a comprehensive assessment strategy; (2) efforts to detect change across scales; (3) the ability to synthesize across a number of spatial and temporal scales; and (4) providing sound science for adaptive management. Scientists from the REstoration COordination and VERification (RECOVER) branch of the Comprehensive Everglades Restoration Plan recently developed guidance on assessing ecosystem response to restoration efforts.

Assessments of Everglades restoration involve the use of more than 10 conceptual ecological models covering the South Florida landscape. These conceptual models identify the key hypotheses and premises currently envisioned to govern the system. A comprehensive Monitoring and Assessment Plan (MAP) has been developed to provide multi-year data that will be used to assess the magnitude and direction of change in a suite of performance measures that have been derived directly from the conceptual models. Detecting change in a performance measure is predicated on the establishment of a "reference condition" which will be developed from both historical data as well as data developed from the MAP. These two elements provide the foundation for a comprehensive ecosystem assessment strategy.

The assessment strategy involves a hierarchical approach of synthesis and scaling from individual performance measures to the integration and scaling of multiple performance measures across regional scale to provide a system-wide perspective. This synthesis and scaling is accomplished through the use of decision support and a suite of modeling tools that permit the assess ecosystem hypotheses.

The hierarchical framework of the assessment strategy for Everglades restoration includes components of: minimum reporting requirements for tracking individual performance measures; contributions of individual principal investigators working at a performance measure level to contribute for larger-scale assessment; and mechanisms for technical dispute resolution and peer review. As a whole, the framework also provides multiple points for interfacing the scientific results from the assessment and the adaptive management process in South Florida.

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Using Conceptual Models to Develop an Integrated Regional Restoration Plan: The Sacramento-San Joaquin Delta

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The Ecosystem Restoration Program (ERP) element of the CALFED Bay-Delta Program is designed to restore the ecological health of the Bay-Delta ecosystem by restoring processes, increasing and improving habitats, and minimizing stressors to support stable, self-sustaining populations of species of concern. Long-term (30-year) ERP implementation is guided by several program plans associated with various regulatory documents. The ERP is currently in the process of developing the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP), the first of several regional plans intended to refine the program's planning foundation. An important part of the process is that previously planned actions will be scientifically evaluated ("vetted"), resulting in a new plan of actions based on the current state of knowledge and restoration projects implemented to date.

Fundamental to the vetting process is the development of science-based conceptual models that outline the latest scientific understanding of both Delta species and ecosystem drivers. Conceptual models are being developed for more than 70 key Delta species and more than 30 ecosystem elements, which are grouped as processes, habitats and stressors. All models include a graphical component, corresponding narrative component, and references. Species life history models encompass life cycle stages, and identify any habitats, processes or stressors that are critical for species sustainability, along with an evaluation of certainty of all model components. Ecosystem element models include key drivers and outcomes along with the mechanisms linking them; evaluations of certainty, scale and nature of effects; and key points where these ecosystem elements are most important to species recovery and sustainability.

Based on these conceptual models, "action teams" of technical experts vet the existing lists of Delta restoration actions, developed in the late 1990's, to determine whether they clearly identify and document the cause and effect relationship between each action and the intended outcome, as well as the underlying hypotheses, revising the actions as necessary to reflect current knowledge. The action teams then consider the vetted (and in some cases revised) actions in an adaptive management context as described in the ERP Strategic Plan-again using the conceptual models to identify linkages amongst actions. The teams will evaluate actions using to determine whether they are ready for full-scale implementation, a pilot project, or whether targeted research should be conducted.

The vetting process uses the suite of new conceptual models as a "storehouse" for current understanding about all aspects of the Delta. The expectation is that they will be revised regularly and the DRERIP adapted over the next 30 years as necessary.

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Influence of the Form of Dissolved Nitrogen Inputs on Phytoplankton Community Composition in Florida Bay and the Southwestern Florida Shelf

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Restoration of the Florida Everglades is expected to significantly alter the form, amount, and delivery of nitrogen to downstream receiving waters such as Florida Bay and the southwest Florida shelf region. In particular, an increase in delivery of dissolved organic and inorganic nitrogen is expected. Knowledge of bioavailability and effects of nitrogen form on nutrient cycling and phytoplankton community composition is thus vital to predicting downstream effects of restoration. Here we show that the form of nitrogen delivered selects for different phytoplankton groups within Florida Bay and nitrogen form contributes to specific algal bloom outbreaks as well.

Florida Bay currently receives significant concentrations of dissolved organic nitrogen (DON) from Everglades sources, with DON concentrations in eastern and central Bay roughly an order of magnitude (up to 65 μM) greater than dissolved inorganic nitrogen (DIN) concentrations (up to 4 μM). During surveys in fall of 2002 and early spring of 2003, HPLC and nitrogen uptake data (based on ^{15}N uptake kinetics) showed that organic N sources in the form of urea supported picocyanobacterial blooms in the central region of Florida Bay, while DIN supported diatom populations in the western Bay. Other forms of organic nitrogen were related to dinoflagellate-dominated assemblages that were frequent in the eastern region. During a survey of the inner southwest Florida shelf region immediately adjacent to the western Everglades in May 2003, bacterial biomass as well as peridinin and zeaxanthin (indicators of dinoflagellate and cyanobacteria respectively) concentrations were significantly ($P<0.001$) correlated with DON levels. Fucoxanthin (indicative of diatoms) concentrations during this survey significantly ($P<0.05$) correlated with NH_4 concentrations. These data suggest: 1) some fraction of the dissolved organic nitrogen pool is bioavailable to microbial communities downstream of the Everglades, 2) different populations selectively utilize different N forms and 3) both amount and form of N must be considered when predicting future restoration impacts on downstream phytoplankton populations.

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A Decade of Change: Implementation of an Aquatic Restoration Strategy for Federal Lands of the Pacific Northwest

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What should be done when it is discovered that 30 years of management direction has not been sufficient to protect riparian and aquatic habitat conditions on federal forest lands in the Pacific Northwest? At about the same time, numerous salmon species were being listed as Threatened or Endangered under the Endangered Species Act. This was the situation facing land managers in the early 1990's. What emerged was a bold plan to protect and restore aquatic resources on more than 24 million acres of federal forest land in Washington, Oregon and northern California. Implementation of the Aquatic Conservation Strategy (ACS), as part of the NW Plan, introduced "ecosystem management at the landscape scale" and forced major changes in planning and management of riparian and aquatic resources. The ACS has four primary components: Riparian Reserves, special management areas adjacent to streams, lakes and wetlands; Key Watersheds, a network of refuge areas for fish stocks at risk; Watershed Analysis, whole watershed diagnosis to set a context for protection and management and a Restoration Strategy, a whole watershed approach for the restoration of riparian and aquatic resources. The ACS provides strong direction for broad-scale, protection and passive restoration coupled with a strategic approach for the use of active restoration (the Restoration Strategy).

The Restoration Strategy introduced a major shift in philosophy and approach for aquatic restoration activities/programs. First, it directed to focus activities on a limited number of priority watersheds and to first "secure" them by removing risk factors (unstable roads, areas of severe erosion, etc). Second, prior to implementation of any restoration activity, a watershed scale analysis was required. It was to diagnose watershed health and identify management and resroration needs. Watershed Analysis brought an important shift in the scale of thinking and analysis forcing interdisciplinary teams to identify key processes controlling conditions and to design treatments for root causes of altered conditions. . Finally, the Strategy provided the framework to treat whole watersheds with an integrated set of watershed-scale, restoration treatments (Roads-stabilization, decommissioning, fish passage, etc.; Up slope-surface erosion and slope stabilization; Riparian areas-fencing, silvicultural treatment and In-stream- habitat improvement, bank stabilization, nutrient supplementation, etc.). These and other changes forced lively debate and caused a dramatic shift in restoration program organization and delivery.

In the past decade, much has been accomplished. Partnerships are now an essential program element and allow significant leveraging of funds. More than 200 watershed analyses have been completed. The scale and complexity of restoration treatments has steadily increased. Annual funding has averaged about 15 million dollars per year. To date, high priority work for more than 20 watersheds, of 25,000-50,000 acres each, has been "completed".

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Jackson Hole Ecosystem Restoration Project

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The project is located in and along a 22-mile stretch of the Upper Snake River near Jackson, Wyoming in Teton County. The project area is partially in and adjacent to Grand Teton National Park, the National Elk Refuge, and is in close proximity to Yellowstone National Park. The project is a joint cost shared venture between the U.S Army Corps of Engineers, Teton County, Wyoming and the Teton Conservation District.

The project will restore fish and wildlife habitat that was lost as a result of construction, operation, and maintenance of Federal and non-Federal levees. Restoration measures include eco-fences, channel capacity excavation, spur dikes, anchored root wads, rock grade control, and secondary channels, off-channel and channel stabilization pools. The project has a 14 year phased construction schedule for 12 river segments and includes continuing construction, adaptive management and monitoring to provide implementation flexibility.

The project proposes to protect mature stands of cottonwood that remain between the levees. These isolated “islands” have been subjected to unnaturally high flow conditions from a constrained high energy river system due to levees that concentrate the flow, and prevent natural overbank flooding. The islands need additional “resistance” to withstand scouring and erosion. In the reconnaissance phase, the project considered restoration effort within the 500-year floodplain including levee removal and setback levees. However, it was determined not feasible as most landowners would be opposed, and the acquisition cost would not be affordable.

The presentation would present an overview of the project, describe work that has been performed and planned for near-term, and use AVI movie files to illustrate project features and show their usefulness in communicating the project to the public and to decision makers. Presentation topics would include:

- the process used to develop the project scope and identify objectives based on the local constraints, such as the project’s high real estate value location and willing seller basis for real estate acquisition of easements.
- the continuing construction and adaptive management methodology developed to minimize design cost, project risk and uncertainty.
- the demonstration project, constructed by the sponsors, which exposed eco-fences and constructed off-channel pools to in-river conditions. The fences were damaged during a high flow event (20,000 cfs; 9 year flood event or 11% chance) in June of 1999.
- the use of 3D modeling, using actual land topography to simulate land and water surface elevations, and locate project features, to describe and communicate project features.
- the robustness of eco-fences to withstand flood flows and provide a 50-year life. Cost of metal eco-fences verses rock fences will need to be considered and examined at future sites.

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New Monitoring Technology to Quantify Herbicide Efficacy on *Egeria densa*: Results from California Sacramento-San Joaquin Delta Sites

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Quantifying the effects of efforts to control *Egeria densa* in the California Sacramento-San Joaquin Delta (SSJ Delta) has historically been a challenge due to scale, environment, and sampling logistics. A recently developed technology, applied for the first time in SSJ Delta waters in 2003 and 2004, has helped provide a breakthrough in solving this problem.

Digitally recording acoustic measurements of submerged vegetation yields a very rapid, verifiable characterization of the entire water column beneath the transducer. Coupling DGPS-linked acoustic transects with physical point sampling provides the most complete picture to date of submerged vegetation conditions in the SSJ Delta.

Eighteen sites in the central SSJ Delta were monitored during 2003 for submerged vegetation species, health, coverage, and biovolume. Fifteen sites were monitored again in 2004. The goal of the monitoring approach was to better measure the efficacy and changes due to aquatic herbicide use on *Egeria*. Each treatment and control site was visited two-to-four times throughout each treatment season depending on factors such as active ingredient used (fluridone, copper, diquat), site location, treatment approach, and treatment schedule. Sampling consisted of recording *thousands* of acoustic measurements along multiple transects during each visit. Acoustic analysis revealed the bottom coverage and biovolume of submerged plants. Sampling also consisted of concurrent physical point sampling at each site to inventory plant species and health.

Efficacy was determined by comparing the suite of acoustic and physical data at each treated site with control sites. Changes were determined by comparing the data between each seasonal sampling event and each sampling year.

Evaluation of herbicide efficacy is critical to managing invasive, non-native *Egeria* in the complex aquatic environment of the SSJ Delta. Maximizing results while reducing risks, impacts, and expenditures requires increasingly refined and robust analytic tools. The success of this new acoustic technology for quantifying herbicide efficacy in the SSJ Delta marks a significant leap forward in achieving this goal.

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Revolutionizing Interactive Access to Current Geospatial Data for Large-Scale Ecosystem Managers: An Example Using A Web Atlas

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Rapid, organized access to current field and laboratory data is a significant hurdle for many large-scale ecosystem managers. The most-recent data available from various field teams, university scientists, subcontractors, and other project personnel are often spread out among different agency offices, local hard drives, internal networks, email in-boxes, laptops, and the like. Many a manager has entered a key decision-making meeting armed with what they *hoped* to be the most up-to-date and complete data set of data about their ecosystem.

Historical data with significant relevance to the interpretation of current situations are sometimes buried in reports stored on dusty shelves. The very existence of some data can be completely forgotten when a key person leaves an organization. Obviously these situations greatly hamper optimal decision making and data analyses. Even if the data are up-to-date, it is likely that they are spread among several stand-alone reports. The enhanced value of integrating data from such reports is often never realized, causing managers to potentially miss key data relationships.

Current geographic data (for example, results at specific sample point locations) are a particular challenge because they often require an extra step to update maps.

A solution to this potential information management challenge is the use of an interactive web-based atlas. Advancing technology is revolutionizing the ability to *interact* with map and other data rather than simply viewing pictures of maps. One can also better track and compare the most up-to-date information. Where the web was once an excellent data repository, it is increasingly becoming an excellent total "information management system."

A real-time demonstration of this approach currently in use will be provided for a large-scale ecosystem management project.

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Ecosystem Restoration and Conceptual Models–Making Sense of Complexity and Figuring Out What to Do First

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Ecosystem restoration planning requires a taking a broader system and decision-making approach than is needed for most agency projects. Responding to multiple interests, larger geographic scope, and the nature of ecosystem objectives, conceptual models are proving an effective tool in dealing with ecosystem complexities. Conceptual models assist in comprehensively defining a system, providing a forum for improved communication, and forming a common framework for project decision-making and actions.

The Corps of Engineers and its partners have found that being able to represent the system in a comprehensive manner-all significant components and interactions-critical to development of system objectives and plans (e.g., Lubinski and Barko 2003, U.S. Army Engineers 2004). Defining ecosystem components (e.g., hydrologic, geomorphic, biotic, and human forces) is a first step in identifying problems and opportunities which lead to ecosystem objectives. Priorities for actions can be established. Those with a stake in restoration outcomes-public interests, agencies, commercial groups-can see the structures and processes represented in the conceptual model and participate in visualizing future conditions.

This presentation will show how conceptual models can help address some of the most difficult aspects of planning restoration. Those include determining the appropriate spatial scale for restoration, determining the most feasible and acceptable time periods and future conditions, and communicating among people with different disciplines and perspectives.

Reasons to develop a conceptual model are many although the need may not be evident at project initiation. Lack of understanding about the system, its components and processes, and possible restoration outcomes can prevent successful restoration. Ecosystem complexity calls for broad, understandable, and logical categories so we can determine necessary actions and effects. Implementing multifaceted restoration projects requires this organization so that actions are efficient, effective, and not duplicating actions by others. These issues often develop as the restoration project is implemented and changes begin to occur on the ground.

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Restoring the Resacas of the Rio Grande River: Water Quality, Hydrology and Biodiversity

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The goal of restoration is often the recovery of limiting community characteristics-often water quality, hydrology, and biodiversity or habitat structure. In 2004, the City of Brownsville, Texas and the Galveston District, U.S. Army Corps of Engineers initiated a study for rehabilitation of three resacas communities-linear lakes that are old channels of the Rio Grande River in the Lower Rio Grande Valley of South Texas. Resacas (from Spanish *rio seco* "dry river") support high biodiversity, provide the major source of freshwater outside the Rio Grande, contain most of the remaining riparian vegetation, provide habitat for migrating birds, and serve as corridors for endangered species in rural parts of the valley.

The City of Brownsville developed around three resaca systems, comprising approximately 3,500 acres of freshwater in this urban setting. The Brownsville resacas are artificially regulated by a series of pumps, pipelines, and culverts. The resaca channels are divided into a series of ponds or basin units, from one to several acres, separated by roads, dams, and dikes.

Over the years, the Brownsville resacas have experienced reduced or diverted inflow and siltation attributed to urban and agricultural land use practices. As a direct result, the Brownsville resacas have unusually high water temperatures, decreased dissolved oxygen levels, and have lost significant volume severely reducing the quality of these ecosystems.

Alternatives are being developed for restoration of water quality, water storage, and habitat. Appropriate strategies to improve dissolved oxygen and water temperature will be determined based on the existing system of pumps, pipelines, and culverts. Dredging of the resaca systems will increase storage capacity for water, and will provide dredged material for in-water habitat creation and island formation. Native aquatic vegetation may be established for aquatic habitat and to prevent invasive establishment. The banks of the resacas will be stabilized and vegetation established or additional vegetative forms (shrubs or woody) planted to increase diversity.

To evaluate the existing Brownsville resaca community and alternatives, a Resaca Community Model has been developed by a multidisciplinary, multi-agency Ecosystem Evaluation Team, with assistance of the U.S. Army Engineer Research and Development Center. The model addresses the restoration of three key resaca community components: Biota, Water, and Human Disturbance. The model will be used in a Habitat Evaluation Procedures framework to measure the value of the ecosystem currently and with the alternatives. In this presentation we will introduce the project area and the District's proposed restoration approach. A discussion of interagency planning and the methods used to provide qualitative and quantitative information on project benefits will be included.

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The South Florida Information Access (SOFIA) System

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The South Florida Information Access (SOFIA) system was created by the U.S. Geological Survey (USGS) in 1995. Its mission is to provide easy access to information about research projects and products generated as part of the USGS South Florida Priority Ecosystem Studies (PES) Program and other federal, state, and local science providers. SOFIA provides this service by integrating information systems and tools enabling efficient storage, organization, and search and retrieval of scientific information about the south Florida ecosystem. SOFIA was designed to benefit three major user groups: USGS program managers and scientists working with the South Florida PES Program, managers and scientists working for other organizations involved with Everglades restoration, and members of the public interested in USGS research and/or the science behind the Everglades restoration effort.

SOFIA is an evolving and dynamic system that builds on the ever-increasing sophistication of new information technology. The current architecture consists of three integrated components: website, data, and metadata. The SOFIA website (http://sofia.usgs.gov) contains links to project descriptions, proposals, publications (including a new searchable publications interface), data (through links to our data exchange site), metadata, presentations, and contact information, as well as general interest items, such as photographs and posters. The SOFIA site also is a portal through which one can access an extensive database and internet map server (IMS).

Data are served by three mechanisms on the SOFIA website. The first, the Data Exchange site (http://sofia.usgs.gov/exchange), provides access to files organized by project. The projects are further organized using six primary themes: biology, chemistry, ecology, geology, hydrology, and mapping. The second mechanism of serving data is through a web interface (http://www.envirobase.usgs.gov) to an SQL-based database. The third mechanism of serving data is through a web-based map server. The map server, which is being developed using ArcIMS software, will provide a means of accessing information stored in the SOFIA database and the SOFIA data exchange website through a geospatial query. The map server will provide access to related information stored on the SOFIA website and in the SOFIA database.

Large amounts of data have been collected by USGS personnel in south Florida. With good, FGDC-compliant metadata, the data are available to a much wider set of customers through web-based queries. The SOFIA website has all the available metadata accessible by several methods. There is a navigation button for metadata and each project home page has a listing for its associated metadata for the project and for the data. All of the projects funded in FY 2003 and FY 2004 have current metadata. Work is continuing on updating the metadata for completed projects and for remaining data sets that do not yet have metadata.

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Restoring Urban Ecosystems: The Overview Hudson-Raritan Estuary, New York, New Jersey

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Ecosystem restoration is a relatively new science that is being stretched to meet one of our oldest environmental challenges. Cities have altered the natural setting to the point were restoration to historical conditions is virtually impossible. This is compounded by political and physical constraints that can severely limit practical applications of restoration principles and techniques that themselves are still in the mostly embryonic stage, resulting in a new set of rules and a different way of looking at opportunities. These conditions are especially evident in a highly developed, long industrialized, and heavily populated center like the metropolitan New York region. These constraints and limitations have been observed and slowly addressed across a series of studies ecosystem and mixed purpose studies conducted by the NYD since the early 1990s. During this time a variety of revised or new approaches to ecosystem restoration have evolved to address the urban conditions and needs that often employ less traditional, innovative, and "out-of-the-box" solutions. These solutions and the problems they address are not unique to NYC or the NYD, and will be presented in this paper as an overview to urban restoration, to be followed by series of papers that provide case studies ranging from small-scale targeted restoration actions to estuary-wide investigations. In all cases they exhibit features unique to the urban setting, providing concrete examples of these constraints and solutions in the hopes that others can both learn from and build on them.

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Alternative Approaches to Managing Everglades National Park: Working Cooperatively on New Ways to Protect Its Natural and Cultural Resources and Provide Quality Park Experiences

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This presentation focuses on the public involvement process for Everglades National Park's General Management Plan (GMP) and how it has shaped alternatives for resource protection and visitor use. Highlighted will be the principles, techniques, results and lessons learned to date.

In 2003, the park began the long-overdue effort to update its GMP in a way that addressed the complex conditions affecting the park from within and outside its boundary. The plan now features draft management alternatives, developed with broad public involvement, to set a new 20-year direction. Everglades National Park now operates under a 1979 Master Plan that is outdated for many reasons; chief among them: large-scale ecosystem restoration projects underway or planned; rapid demographic changes in South Florida such as unprecedented population increases and a metropolitan area as culturally diverse as any in the United States; a region geared toward ever-increasing outdoor recreation pursuits that has seen a 40% increase in boat ownership in the past decade; significant loss of wetlands, open space and agricultural areas to development; and greater emphasis on the relationship on quality of life issues and the valuable role parks play in people re-connecting with nature, history and a sense of community.

Today, the park gets more than 1 million visitors a year to its fragile, world-renowned freshwater and marine environments. Its proximity to the coastal areas of southeast and southwest Florida, and the growing interest about the Everglades internationally all play an important role in understanding influences on the park and requirements for effective management.

In many ways the most important goal of the new General Management Plan (GMP) is a commitment - by the National Park Service and by the public - to the reasons for which Everglades National Park was established in 1947 and expanded in 1989: to be a public park for the benefit and enjoyment of the people, that is set aside as a wilderness preserving the essential primitive conditions, including the natural abundance, diversity, behavior, and ecological integrity of the unique plants and animals.

The ultimate success of the plan - a blueprint for decisions and investment in the park over the next 20 years - hinges on public understanding and support as much as anything. To date, active public participation has played a key role in defining the issues and concerns, and identifying creative solutions. As the GMP is finalized in 2006 and implementation begins in 2007, working cooperatively with others will continue to be a cornerstone for success. A set of partnerships pursuing the best ways to enhance natural and cultural resource protection, and offering quality experiences to all that visit Everglades National Park, provides the best chance to achieve the vision of Ernest Coe, Daniel Beard, Marjory Stoneman Douglas and so many others.

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Comparing the Flooded-Area Frequency Distributions of Isolated Freshwater Wetlands: A Tool to Assess Wetland Health and Restoration Goals

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The patterns and frequency of inundation are recognized as important controls on the distribution of wetland vegetation. Isolated, freshwater wetlands are a characteristic feature of the Northern Tampa Bay area and are the subject of extensive regulatory attention and environmental monitoring. Wetlands located on and near municipal well-fields have been monitored regularly since the mid 1980's. Using bathymetric data, daily stage observations for three wetlands were translated into spatial data representing weekly average flooded area for a two year period. The weekly flooded areas from each wetland were also used to describe the annual flooded-area frequency distributions.

Flooded-area frequency distributions were compared and contrasted for three isolated marsh wetlands with similar climatic and geologic conditions. One of the wetlands is a natural marsh that has not been impacted by human activities. The second is an augmented marsh located on a municipal well-field. The water levels of this marsh are augmented with groundwater from the municipal well-field. Water levels and ecology of the third marsh are impaired by well-field pumpage, and it is not augmented. Flooded-area frequency distributions of natural, impaired and augmented marshes from a wet and an average rainfall year were compared to relate the impacts of climate, augmentation and well-field pumpage to wetland hydrology. For the average rainfall year, when well-field pumpage was higher than during the wet year, there was a pronounced contrast between the three marshes. The natural marsh was inundated over 40% of the total wetland area for 75% of the year. The impaired marsh was drier, with 40% of the total area wet for only 10% of the year. In contrast, the augmented marsh was inundated longer than the natural marsh, with over 40% of the wetland inundated 100% of the year. The flooded-area frequency distributions revealed differences in the hydrology of these three marshes that is supported by differences in the vegetation present at each marsh.

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Effective and Ineffective Science Communication in the Chesapeake Bay Program

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The Chesapeake Bay Program has utilized a wide variety of methods for communicating science to policy makers and managers over the course of its history. Not all have been equally effective, and no single method has proven to be consistently appropriate. Despite this mixed record, the program has consistently recognized the need for scientific input. It has evolved to an institutional structure that engages scientists through four basic mechanisms. These include: membership in stakeholder committees; research contractors to stakeholder committees; membership in a science advisory panel; and ad hoc advisors to Program policymakers. Advantages and disadvantages of these mechanisms can be highlighted by selective review of the Program's history.

After conducting this review, I have concluded that the effectiveness of science communication in addressing Bay Program's issues can be traced to the degree of match between characteristics of the issue and the communication. Temporal characteristics are particularly important. The maturity of the science available to address an issue can determine its sway, although there is not always a positive linear relationship between sophistication and influence. The maturity of the problem can also affect the influence of science, regardless of the latter's sophistication. The Bay Program's experience would argue that the age of a problem and the influence science may have are often negatively correlated.

The form of the communication and the form of the issue also seem to be critical in determining potential effectiveness of science. The Bay Program's mechanisms for engaging scientists have inherently different levels of formality in the communication of technical information and advice. The membership in stakeholder committees, with the resulting opportunities for interactive discourse have proven to be uniquely effective means to guide development of stakeholder policy proposals. On the other hand, the Bay Program's science advisory panel has found its greatest influence through production of formal technical reports and reviews in response to well defined issues.

I conclude, upon review, that the Bay Program has been well served by an institutional structure that creates standing opportunities for multiple types of science communication. It has not solved the problem of ensured effectiveness. Rather it has minimized that problem by encouraging diversity.

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The Ecosystem Functions Model: A Tool For Restoration Planning

John Hickey and *Chris Dunn*
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The Ecosystem Functions Model (HEC-EFM) is a planning tool that analyzes ecosystem response to changes in flow regime. The Hydrologic Engineering Center (HEC) is developing the EFM and envisions environmental planners, biologists, and engineers using the model to help determine whether proposed alternatives (e.g., reservoir operations or levee alignments) would maintain, enhance, or diminish ecosystem health. Project teams can use the EFM to visualize existing ecologic conditions, highlight promising restoration sites, and assess and rank alternatives according to the relative enhancement (or decline) of ecosystem aspects.

The EFM has been or is currently being used in studies of the Sacramento, San Joaquin, Truckee, and Savannah Rivers.

Presentation: 1) demonstrates use of the EFM process - statistical analyses, hydraulic modeling, and GIS, 2) introduces new model features, including low flow frequency analyses, selection of a water year range, analysis of individual water years, and enhanced output, 3) discusses a case study for the Savannah River Comprehensive Study, and 4) concludes with ideas for future development.

This software is a general tool, applicable to a wide range of ecotypes and Corps projects. Beta version and test version 1.0 are available for use. For more information or to obtain a copy of the EFM contact John Hickey or Chris Dunn, HEC.

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Wild Goose Chase or Addressing the Prime Stressor to Tidal Wetland Restoration Efforts? Developing a Resident Goose Management Plan in a Multi-Agency Situation

Peter J. Hill
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The DC EHA, WPD has partnered with the US Army Corps of Engineers and the National Park Service in the construction of over 80 acres of freshwater tidal emergent wetlands in the Anacostia watershed in the District of Columbia. These multi-million dollar projects have seen extreme levels of grazing by large populations of resident Canada geese, despite extensive fencing efforts and targeted planting of non-palatable species. Project success, defined as a high percentage of native species coverage in the created wetlands, is primarily determined by the extent to which these resident geese can be kept out of the planted wetlands. Due to the overlapping and sometimes unclear jurisdictional roles of many agencies (city agencies, NPS, NPS concessionaires, Army Corps of Engineers), efforts made towards addressing large resident goose populations have been met with bureaucratic delays and lack of management authority. Furthermore, a ban of hunting in the District has eliminated a commonly used tool for managing this species.

DC EHA, WPD has led efforts to develop the needed data and the partner buy-in to address this unnaturally large population of resident Canada geese. These efforts have taken the form of three volunteer goose count events, a spring egg addling project, and the development of a comprehensive resident Canada goose management plan. The goose counts that have enlisted the help of volunteers are aimed to both gather important census data and educate the public about the extreme negative impact that these birds have upon wetland restoration efforts. Over 300 volunteer hours have been logged in the resident goose census project. The egg-oiling project has been developed in order to build institutional awareness of the problem, gather relevant data, and empower local stakeholders in this work. The development of a resident Canada goose management plan, with the assistance of professional wildlife management personnel, will outline the strategies required for more aggressive management efforts in the future. The success of these joint efforts will likely point to the likelihood of success of similar urban wetland restoration projects where populations of resident Canada geese exist.

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Effective Communication between Science and Project

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After the Comprehensive Everglades Restoration Plan (CERP) was authorized by the United States Congress in the Water Resources Development Act of 2000, a system-wide program called RECOVER (REstoration, COordination and VERification) was developed. The role of RECOVER is to organize, provide and apply the best scientific information in support of the objectives of the CERP (USACE, SFWMD; 2001). One of the strengths of the CERP is the interaction of individual projects to generate system-wide benefits. It is also one of its weaknesses. Once initiated, individual projects tend to focus on project specific goals and objectives, losing sight of the system-wide benefits of Everglades Restoration. In order to provide a stronger link between the project teams and RECOVER, the RECOVER liaison concept was developed. While many of the project delivery teams had members who were also members of RECOVER, some confusion existed regarding what role these members were to play. The RECOVER liaison eliminates that confusion by providing a direct communication link between the projects and the six technical teams and scientific and technical resources available through RECOVER. In addition to improving communications, the liaisons have been able to facilitate the development of RECOVER review processes to better assist with project development and implementation without impacting project implementation schedules. Coordination between the six technical teams has also been improved. RECOVER liaisons have also been instrumental in providing new and updated scientific and technical information to the project delivery teams. Effective communication between RECOVER and CERP projects is a critical factor in ensuring the success of Everglades Restoration.

References:

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Using an Integrated Hydrologic Monitoring Network as a Tool to Analyze Everglades Ecosystem Response during CERP Implementation

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Since 1995, the U.S. Geological Survey (USGS) has participated in studies to describe the hydrologic setting along the coastal areas of Everglades National Park (ENP). Through these efforts, the USGS has established an extensive network of monitoring stations at coastal creeks and rivers that discharge freshwater into northeastern Florida Bay and the southwest coastal estuaries. The network provides data for hydrodynamic model development and calibration, and yields baseline information for other physical, biological and chemical studies being conducted in the Everglades ecosystem. These studies are conducted as part of the USGS Greater Everglades Priority Ecosystem Science Program (PES) and the Comprehensive Everglades Restoration Plan (CERP) Monitoring and Assessment Plan (MAP).

The current network includes over 30 data collection platforms (DCP's) located along transects that represent major flow paths from the Everglades wetlands to the southern estuaries. Flow, salinity, temperature, water-level and water quality data are collected along these flow paths. Real time information from this network is available from the USGS National Water Information Systems (NWIS) web page at URL: <http://waterdata.usgs.gov/fl/nwis/rt>.

Use of the historical and real-time data will benefit CERP in several ways:

- Pre-CERP (baseline) hydrologic and water quality parameters can be compared to data collected during and after CERP modifications.
- Scientific investigations can be conducted with physical data rather than theoretical values in order to increase ecosystem understanding.
- Real-time and historic data can be used to detect unexpected responses within the ecosystem.

Assuming that CERP modifications will attempt to emulate historical hydroperiods better than existing water management practices, it is reasonable to expect an extended hydroperiod and shortened dry season during years of average rainfall. Data have been collected from the network (since 1995) during a period when the southern estuaries have experienced a wide range of natural climatic conditions, including multiple tropical storms and hurricanes, and an El Nino event in 1998. Thus, the data can be used to help determine whether changes observed in the ecosystem are the result of natural processes, CERP-related activities or a combination of both.

In summary, having an integrated monitoring network spanning the major flow paths from the Everglades wetlands to the southern estuaries will help provide a system-wide understanding of the complex ecosystem responses seen in the Everglades.

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The Effects of Ecological Changes in South Florida: Are These Problems for Restoration?

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The goal of the landmark Everglades Restoration Act, signed by President Clinton on December 11, 2000, is to restore the nationally significant and unique natural resources of the Florida Everglades ecosystem. The gradual decline in water flow over the past 50 years has caused significant changes in ecosystem habitats. By returning at least 50 % of historic water flow through South Florida, the Comprehensive Everglades Restoration Plan (CERP) aims to reverse the course of declining health of the ecosystem and reestablish the biological diversity of the Everglades. To meet these targets, it is imperative to understand how the habitats have changed and the rate at which the changes have occurred.

Over the past few decades, short-lived isotopes (^{7}Be, ^{210}Pb, and ^{137}Cs) have been used extensively to define the rates of habitat changes. In a 10-year study, short-lived isotopes were used to establish historical records and baseline information at 102 sites in the southern Everglades and Florida Bay. The most profound discovery was the recognition of distinct habitat changes in the lakes and mud islands along the northern boundary of the bay. Prior to 1950, the bay floor was rock: a hardbottom habitat. Beginning around 1950, concurrent with decrease in freshwater flow, the environment changed from estuarine to marine. With this shift, marine carbonate sediment began to accumulate, creating a soft-bottom ecosystem. In addition, because of the subsurface geology of South Florida and the nuances of the short-lived isotope systematics, it was determined that subsurface freshwater retreat had coincided with the estuarine-to-marine change.

The increasingly marine nature of the bay due to decreased freshwater influx also affected the central part of the bay by increasing production of carbonate sediment. Sediment accreted to the mud islands, extending tidal flats. As a result, passes between islands were closed. The effect was restricted circulation.

In the southern bay, the sediment accumulation record showed that deposition was not as affected by the change in hydrology but was controlled by variations in progressive sea-level rise. The sea-level record, at Key West, shows that sea-level rise has not been constant but has varied with periods of relatively rapid rise followed by periods of no change. On the leeward side of mud banks within Florida Bay, the variations in sea level result in shifts in sediment accumulation rates from an increased rate during rising sea level to a decreased rate during stable periods.

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Assessing Urban Land Cover Change in the Chesapeake Bay Watershed (1990 - 2000)

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The Chesapeake Bay Program is a multi-jurisdictional interstate partnership dedicated to restoring the health of the Bay. The Program sponsored restoration efforts are guided in part by the results from a Hydrologic Simulation Program-Fortran (HSPF) model that is used to simulate nutrient and sediment loads to the Chesapeake Bay. Temporally consistent land cover data, particularly urban cover, is required to accurately calibrate the HSPF model. However, no temporally consistent urban cover datasets exist for the Chesapeake Bay watershed. Impervious surface and census data are the only temporally consistent datasets relating to urban cover that exist for the region and therefore these datasets were used to simulate urban cover.

Urban lands in the Chesapeake Bay watershed for the year 2000 have been mapped by the University of Maryland’s Regional Earth Science Applications Center (RESAC). The RESAC have also mapped impervious surfaces for 1990 and 2000 throughout the watershed. The urban lands were mapped as part of a decision-tree classification of Landsat 7 imagery combined with the post-processing of road density data. Over half of all urban lands in the 2000 land cover dataset were classified as forests and grasses on the basis of the spectral information alone but were subsequently re-classed as “urban” with aid of road density data. Landsat-derived land cover datasets also exist for the watershed for 1990 and 1997. Computing change between these datasets and the 2000 land cover dataset, however, was hampered by the lack of commensurate quality road density data for 1990 and 1997 and by the different classification methods employed to produce each dataset. A solution to the challenge of consistently mapping urban cover for 1990 and 2000 was developed through the use of impervious surface cover and housing data combined with the knowledge of the relationship between road density and housing data.

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Segmentation and Land Use in the Phase 5 Chesapeake Bay Watershed Model

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The Phase 5 Chesapeake Bay Watershed Model, based on the Hydrologic Simulation Program-Fortran (HSPF) code, has evolved to include separated land and river segmentation, and continually time-varying land use. River segmentation is developed according to a consistent set of criteria that took into account various modeling and political needs, including control structures, model linkage considerations and the presence of data. Land segmentation is developed with a separate set of criteria primarily responsive to the physical scale of data availability.

The 20 land use classes of the Phase 5 watershed model are driven by management scenario needs and data availability. The acres of each land use class are continually time-variable in the Phase 5 model to account for changes in the watershed over the long simulation period of 18 years. The Regional Earth Sciences Application Center (RESAC) at the University of Maryland developed the base 2000 land cover, as well as 2000 and 1990 impervious surface data sets from LandSat-derived satellite scenes. The 2000 land cover data are post-processed with impervious surface and road data to increase accuracy of urban extent and to hind-cast to the 1990 time period. Further land use refinements include substitution of USDA Agricultural Census data on a county basis for increased accuracy of agricultural acreages. The two resulting urban time periods are interpolated linearly and integrated with the four agricultural time periods to create adjusted county land use data throughout the simulation period. Satellite based county-segment tabular land cover data are then used to distribute the annual County-Adjusted land use into river simulation segments for delivery to the tidal bay.

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The Use of Multi-objective Cost Effectiveness Analyses in Planning for the Lake Okeechobee Watershed Project

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Cost effectiveness is the driving force in an iterative alternative plan screening process for the two primary project purposes of water storage and water quality improvement for the Lake Okeechobee Watershed Project. Accepted processes for addressing cost effectiveness are relatively straight forward when dealing with a single objective and can lead to factually supported decision making. It is much more challenging to develop plans for multi-objective projects that do not require fundamental subjectivity in decision making. The goal of the LOW Project planning process is to utilize an auditable process that is driven by cost effectiveness to the maximum extent practicable. Ultimately, socio-political judgments will be required for any major water resources project planning process, but such judgments will only be enhanced by a sound factually based planning process.

The LOW Project purposes are: storage of water to provide improved management of Lake Okeechobee water levels and to avoid damaging freshwater discharges to the estuaries; reduce phosphorus loads to Lake Okeechobee to reduce the frequency of algal blooms; and restoration of wetlands in the watershed to increase the spatial extent of natural habitat in the watershed. The screening of wetland restoration alternatives is being performed independently and in parallel with screening of alternatives for water storage and treatment.

Four major basins, or planning areas, were identified with generally independent water storage and water quality treatment characteristics. The Lake Okeechobee Watershed Combinatorial Analysis Program (LOWCAP) was created to evaluate all possible combinations of reservoirs and STAs that could be implemented in each planning area and sort them by cost.

The most cost effective phosphorus load reduction targets were identified for each planning area. Then, planning area alternatives were identified that provided a range of cost effective storage capacities and the phosphorus load reduction target. This resulted in 20 planning area alternatives. The next step in screening consisted of developing more detailed designs and costs, along with assessment of ecologic benefits. The final step in the screening process is to perform a cost effectiveness analysis of alternative plan components across the four planning areas. The product of the screening process will be three to five alternatives that will subsequently be subjected to detailed evaluation using a comprehensive set of evaluation criteria that address socio-economic, ecologic, and project efficiency issues. The selection of the recommended plan will be based on this evaluation process.

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(This abstract was developed while employed by the South Florida Water Management District.)

Management Issues in Long-term Large-scale Multi-response Ecosystem Monitoring: Comprehensive Everglades Restoration Program

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Developing a comprehensive approach for monitoring ecological patterns and processes is a key challenge for Everglades restoration. Many attributes must be monitored, requiring coordination in order to translate results into management recommendations. The multiple attributes monitoring also require substantial coordination among the agencies involved.

Some attributes such as water quality, landscape pattern, and trophic dynamics, are attributes of the entire system. Others, such nutrient loading below a specific structure, only apply to parts of the system. Most attributes are measured at point or plot spatial scales, and require inferences to larger spatial extents. A major decision is determining how tight to link the attributes. At one extreme, a one-size-almost-fits-all sampling design is followed. This maximizes the ability to integrate results from different attributes, inferring which management actions may affect a specific response driver, but requires sub-optimal designs for most individual attributes. At the other extreme, completely independent monitoring programs for each major attribute allows optimal designs for individual attributes, but makes cross-walking difficult, and may require substantial duplication of effort. Additional considerations include maintaining flexibility for adaptive monitoring as knowledge increases, and leveraging extant information collected for differing reasons and methods.

Large-scale multi-response ecosystem restoration also presents complex management challenges. Typically there are multiple stakeholders, consisting of various agencies, tribal communities, non-profit interest groups, and taxpayers. Agencies have their own historical ways of doing business, which are optimized for specific goals. Issues will arise on basic questions, such as determining priorities, how to implement restoration, or what responses should to monitor. Coordination of efforts incorporates understanding and defining goals, and who is responsible for which components. Implementation requires coordination and cooperation between stakeholders throughout all project phases, as all agencies have limited resources. Careful planning is necessary for optimal integration and assessment capabilities.

Successful implementation of a large-scale restoration activity requires multiple scale, integrated sampling designs and proactive project management. Tools such as multi-agency standardized work orders, procurement strategies, research prioritization matrices, reporting and assessment guidelines, while seeming simplistic, are necessary to facilitate project implementation and integrative assessment.

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Web Based Data Management: Collaborative Information Access for Environmental Projects

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Strategically sharing project data over the Internet is one of the most effective ways of realizing substantial savings in an environmental project, both in terms of budget and schedule. Without a centralized database that has secure, permission based access, project teams have no choice but to maintain duplicate data sets in order for the various diverse members of the team to get their work done. Historically this has resulted in redundant efforts to enter, maintain and synchronize data sets at multiple locations, and frequently many individuals who need information cannot get to it. Significant delays occur between the time that data is generated and the time that it is assembled, finalized and distributed to those who are waiting for information in order to make decisions.

In recent years, many large and small scale environmental projects have implemented a centralized web based data management system that provides them with unprecedented secure access to information of known and documented quality. This technology enables real-time collaboration among members of the project team: with no installed software other than an Internet browser, authorized users share and manage technical data, electronic documents and geospatial data associated with environmental activities.

Web based data management has been proven to provide a cost-effective solution to the problem of sharing information across organizational, disciplinary and geographic boundaries. Actual results will be shown that demonstrate the effectiveness of collaboration, highlighting the accomplishments of real world project teams that have implemented web based solutions to data management. In addition, straightforward processes that can be readily implemented by any project team will be presented, demonstrating how Internet technologies can be applied to new or ongoing environmental projects of varying sizes and scope.

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Integrating Environmental Decision Making into a Framework for Farm Policy

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Debates over farm policies span decades. For example, some critics of current farm policies urge the elimination all direct payments to farmers, while others support subsidies but would limit availability to those meeting specified income limitations. Many conservation groups advocate moving farm support programs (and funding) toward an incentive-based program emphasizing environmental goals while others would strengthen regulatory approaches. There continues to be mixed support for government investments in research, extension, new technology, risk management, and credit, but how much and where is hotly debated.

Public support for agricultural policy in the U.S. relies heavily on the perception that programs are designed to help smaller independent family farmers while maintaining a safe and affordable food supply. Nevertheless, there is an escalating viewpoint that U.S. farm programs have become "welfare" programs for wealthy landowners and large multinational agribusiness corporations. Coupled with this are mounting challenges to biotechnology, conventional production methods, and concerns over environmental problems. This creates an opportunity to re-examine the goals of farm policy and create a new policy framework.

Although agriculture can be a source of environmental degradation it can also serve to deliver vital environmental services. The need is to find the combination of policies and programs that will enable progress toward a sustainable form of agriculture. Implementing multifunctionality in agriculture policy would guide public investments toward the broad array of external benefits - beyond just food and fiber - produced from agriculture.

"Multifunctionality" recognizes and rewards the benefits - other than food or fiber - that can come from agriculture, yet often go uncompensated in the marketplace and that can vary tremendously depending on farming practices. Although very similar to the concept of compensating for "environmental services" as an instrument to change the means of production toward a more sustainable form, multifunctionality incorporates efforts to deal with socio-economic concerns and needs.

If potential ecological and social benefits of agriculture are to be realized, incentives must occur through public, rather than private, investment. New programs must create alternative means of investment into agriculture, rural landscapes and our rural communities. Redirecting farm policy in this direction will be an uphill battle against entrenched interests and deep-seated fears regarding change; however, it is vital to ensure both food security and ecological sustainability.

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Examining the Effects of the Environmental Water Account: A Novel Approach to Species Restoration or the Price We Pay for Peace?

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The CALFED Bay-Delta Program is working to simultaneously achieve four goals: 1) improve and increase aquatic and terrestrial habitats and improve ecological function to support sustainable plant and animal populations, 2) provide good water quality for all beneficial uses, 3) improve water supply reliability by reducing the mismatch between available supplies and current and future uses, and 4) reduce the risk of catastrophic failure of Delta levees.

A variety of projects and actions are underway or proposed to achieve CALFED's goals. Many of these projects and actions use traditional approaches (e.g., improving the quality of existing stream habitat through geomorphologic restoration or removal of migration barriers, or increasing aquatic habitat in the Sacramento-San Joaquin Delta (Delta) through farm-land acquisition and restoration, or improving water quality through up-stream source control of pollutants, or reducing water demand by increasing the efficiency of cropland irrigation methods). However, the complexity of issues CALFED faces has also required the development and implementation of novel programs to help achieve its core goals.

The Environmental Water Account (EWA) is one novel CALFED program intended to simultaneously address the goals of improving ecological function and water supply reliability. Initiated in 2001 as a four-year experiment, the EWA is a cooperative management program whose purpose is to provide protection to the fish of the Bay–Delta estuary through environmentally beneficial changes in State and Federal water project operations at no uncompensated water cost to the projects' water users. During its first four years of operation, the EWA program acquired approximately 945 million cubic meters of water (946,000 acre-feet) at a total cost of about $139 million in public funding. Three fishery management agencies (CA Dept. of Fish and Game, US Fish and Wildlife Service, and NOAA Fisheries) controlled the use of these water "assets." Most commonly, use of water assets involved curtailing State and Federal water project exports from the Delta to reduce entrainment loss of fish species of concern. Data from the four years of EWA operations suggests entrainment loss was reduced, but there is limited evidence to support the idea that EWA actions are having a positive, sustained effect on species populations or ecological functions.

This presentation will consider the conceptual basis and results of EWA actions as a means to examine the overall effects of this program relative to CALFED goals. The presentation will also consider the prognosis for the program going forward.

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Conceptual Ecological Models as Restoration Planning Tools for South Florida Restoration

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With rapid expansion of human impacts on natural environments, and resulting degradation of these environments, planners of restoration programs face new challenges. Science and policy must be integrated to establish objectives for restoration planning and to create a foundation for monitoring for adaptive management. The challenge of organizing and applying good scientific understandings is especially great given the large spatial and temporal scales at which regional ecosystems operate, and at which restoration plans must be designed and implemented to resolve these issues. Conceptual ecological models are tools that assist in achieving this goal.

Conceptual ecological models present causal hypotheses that describe ecological linkages between drivers and stressors and key attributes of the natural system that have been altered due to effects of stressors. General pathways are constructed by which driving forces, particularly anthropogenic, are manifested as physical or chemical stressors that result in physical, chemical and biological responses (ecological effects) on attributes. Attributes are biological representatives of overall ecological conditions of the system and can serve as indicators of the effectiveness of restoration programs designed to reduce or eliminate identified stressors. The response of stressors themselves can also serve as indicators of the effectiveness of restoration programs.

A total system and eleven regional conceptual ecological models have been developed to guide and focus scientific support for south Florida ecosystem restoration initiatives. The models include all major external drivers, stressors, ecological effects and attributes for the region. While each model contains a regionally-specific set of components, many are similar and provide an overview of the system as a whole. The major drivers affecting south Florida are water management, land use and development and sea level rise. These drivers result in common stressors: altered hydrology, degraded water quality, loss of spatial extent and connectivity, introduction and spread of exotic species, and boating and fishing pressure. Common attributes for inland systems include vegetation mosaic, periphyton mats, small aquatic fauna, fisheries, wading birds, and keystone species. Coastal system attributes include oysters and other benthic communities, submerged aquatic vegetation, shoreline herbaceous wetlands and mangrove habitats, fisheries, wading birds, nearshore reefs, and keystone species.

Conceptual ecological models are flexible planning tools that, at any given time, reflect the current state of scientific knowledge about the system and can be used with any ecological restoration and conservation program. These models are applied to restoration planning in several ways. Models organize existing scientific information enabling it to be used by decision makers, identify gaps in knowledge and assist in setting research priorities, and provide a framework for creating performance measures, which define the content of monitoring programs.

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Measuring the Influence of Water Management Infiltration Basins on Water Quality in Neighboring Marshes in Everglades National Park Using Midge Bioassessment Methods

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The REestoration COordination and VERification (RECOVER) program of the Comprehensive Everglades Restoration Plan (CERP) seeks informative and efficient tools to assess Everglades restoration. At the present time, no methods for measuring invertebrate community response to restoration activity have been developed for the Monitoring and Assessment Plan (MAP), despite their diversity (>600 species) and fundamental role in Everglades food webs. Our research has shown that sampling midge pupal exuviae has outstanding potential as a monitoring and assessment tool for detecting changes in water quality and measuring biotic response to hydrological conditions.

In 2003, we used an indicator species approach, developed from gradient and P-dosing studies, to determine whether 2 newly constructed detention pond systems along the eastern edge of ENP may be impairing water quality in adjacent ENP marshes. We collected midge pupal exuviae samples in June, August, and October from 5 *Cladium*-dominated solution holes at distances of 50 m, 300 m, and 3 km along westward transects from each detention pond, and from a canal near Chekika to serve as a control. We also collected 3 replicate water, soil, and *Cladium* tissue samples from these sites in June, and monthly water samples from July to December.

Proportions of nutrient-tolerant species indicated no enrichment at Chekika, moderate localized enrichment near 332B, and stronger, more widespread enrichment near 332C. Solution holes near 332C yielded several species that are strong indicators of enrichment, that otherwise, are extremely rare in marl prairie marshes in ENP. Proportions of species indicative of enrichment also increased through the wet season near both detention pond systems. With respect to nutrient-intolerant species, we observed decreases in their proportions with increasing proximity to the detention ponds in all 3 sampling periods. However, similar decreases were observed along the control transect in June and August (but not October). Proportions of nutrient-intolerant species were correlated with water depth, and water depths were lower near the canal and ponds, suggesting that differences in proportions of nutrient-intolerant species in midge communities between sites during summer may be influenced by hydroperiod and water depth.

Analyses of water and *Cladium* tissue samples corroborated our assessment of relative enrichment from midge community data, with 332C showing the most enrichment. However, increases in total-P near detention ponds were small, and for monthly water samples, total-P was quite variable and not statistically significant. Our results show: 1) Operation of detention areas in 2003 caused enrichment of neighboring marshes in ENP, with the most severe and extensive enrichment occurring near 332C. 2) Midge pupal exuviae sampling for assessing water quality should be conducted later in the wet season to avoid possible confounding hydrological effects.

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Development of Invertebrate Performance Measures for Everglades Hydrological Restoration: Chironomid - Hydroperiod Relationships in Everglades National Park

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We are developing metrics for detecting changes in hydropatterns and water quality in Everglades marshes based on midge community composition. Determining relationships between midge species and hydrological variables such as hydroperiod is fundamental for developing reliable metrics for measuring community response to restoration.

Chironomid species distributions in relation to hydroperiod (HP) length in eastern Everglades National Park marshes were evaluated by collecting pupal exuviae samples monthly for a year from 22 sites categorized as either short-HP (HP: 3-7 months, 8 sites), medium-HP (HP: 7-10 months, 8 sites), or long-HP sites (HP: >10 months, 6 sites) based upon known plant community-hydroperiod relationships. Species' distribution/HP relationships were assessed 3 ways: 1) applying a scoring criterion to the ratio of their mean percent relative abundance in long-HP versus short-HP habitats, 2) calculating a weighted average HP of all sites from which pupal exuviae were collected, and 3) calculating their indicator values (IV) in an Indicator Species Analysis (INSPAN).

INSPAN identified widely distributed species with strong fidelity to a certain site HP category as significant indicators of HP, but it assigned low indicator values to rare or locally distributed species that should be excellent indicators based upon their ecology. Comparisons of mean relative abundance between long-HP and short-HP sites were informative and did not exclude rare species. However, additional comparisons or analyses were necessary to resolve HP associations of species found only at short-HP and intermediate-HP sites, and at intermediate-HP and long-HP sites. Species' weighted mean HPs provided limited information on their distribution across HP gradients, but were useful for ranking species by HP association.

Everglades chironomid species can be grouped into 5 general categories based upon their distributions and spatial dynamics along HP gradients: 1) ubiquitous species or species associated with intermediate-HP habitats; 2) long-HP species with static populations that are strongly associated with features found exclusively in long-HP habitats (HP > 10 months), 3) long-HP species with spatially-dynamic populations that are responsive to short term, seasonal changes in hydrological conditions; 4) short-HP species that are widely distributed, but are closely associated with conditions in shallow water, and 5) short-HP species that are confined spatially to short-HP, higher elevation marshes. The distributions and biological attributes of species comprising each of these 5 groups will be discussed with respect to their usefulness in developing metrics for assessing long-term and short-term changes in Everglades marsh hydropatterns.

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Section 206: Aquatic Ecosystem Restoration of Big Escambia Creek, Alabama and Florida

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The Corps is currently constructing a restoration project at Big Escambia Creek, Alabama and Florida. The Gulf Coast Resource Conservation & Development of Alabama and Florida Three Rivers Resource Conservation and Development Council, Inc. of Florida requested the Corps investigate the degrading aquatic ecosystem under the authority of Section 206 (Aquatic Ecosystem Restoration) of the Water Resources Development Act of 1996, as amended. It was determined that this unproductive area was generally the result of a two-fold problem. First, along the northern portion of the creek, two logjams had diverted base flow conditions causing two new channel cuts and a subsequent realignment. Only a portion of the northernmost logjam lies within Alabama while the remaining obstructions are located in Florida. The other predicament encountered was found within the southern portion of the creek as a result of a high rainfall event combined with a sand and gravel operation encroachment causing the stream to jump its bank and flow west of the original channel.

In order to accomplish the restoration project, a team consisting of engineers, biologists, regulators, planners, soil scientists, and other disciplines was formed to identify engineering, biological, and administrative obstacles that would be encountered. Through the course of addressing these issues, the team remained aware that the project would restore approximately 1,000 acres of productive wetlands and would insure that the channel base flow moves freely through the channel downstream to its confluence with Escambia River. Over time, the base flow of Big Escambia Creek would revert to its natural channel conditions, which would benefit the area by improving the aquatic habitat in the area and reduce upstream flooding.

The Corps conducted an investigative study and developed designs for the engineering of the aquatic ecosystem restoration project based on Rosgen’s Stream Morphology principles. As a result of the project’s locality in two states, many resource agencies cooperatively worked together in order to make this project a success. The U.S. Fish and Wildlife Service provided technical assistance to the Corps. Permitting agencies participated in numerous meetings to ensure that all concerns were addressed while not conflicting the other’s vested interest. In addition, other local, state, and Federal agencies and private entities provided their assistance during the entire planning and engineering phase. The proposed aquatic ecosystem restoration project involves the selective clearing, snagging, and excavating of existing open water channels located west and east of the northern and southern logjams, respectively. In addition, flow in the existing open water channel would be diverted back into the original channel by a primary and two secondary diversion structures. The original channel located along the southern portion of the creek would be restored to allow flow to resume. Root wads and logs of sufficient size and quality would be strategically placed along the stream’s bank according to Rosgen’s principles to provide additional aquatic habitat and streambank protection.

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Monitoring the Extremes: How a Comprehensive Monitoring and Analysis Program Captured the Affects of Drastically Different Weather in 2002 and 2003 on Chesapeake Bay

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The Chesapeake Bay Program monitors the living resources and tidal and non-tidal water quality of the rivers and mainstem of the Chesapeake Bay, USA. This monitoring network is comprised of 155 tidal water quality stations (a subset of which are living resource stations), 9 river input stations as well as an annual aerial SAV survey. In 2002 and 2003, the 64,000 square mile watershed experienced two drastically different years in terms of weather. 2002 was an extreme drought year resulting in record low river flow into the Chesapeake Bay. 2003 was the polar opposite with record rainfall and river flow as well as a record storm surge from Hurricane Isabel in September of that year. The Chesapeake Bay Monitoring program was able to capture the affects of these two years on the water quality and living resources of Chesapeake Bay. 2002 and 2003 are compared to one another and to the previous 17 years of data collected by the monitoring program.

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Internal Loads in the Eutrophic Northern Everglades: Large-scale Modeling of Phosphorus Transport

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A two-site, nonequilibrium solute transport model was used to predict phosphorus mobility in the northern Everglades. Over the past several decades, agricultural drainage waters discharged into the northern Everglades, now called Water Conservation Area (WCA) 2A, have been enriched in phosphorus (P) relative to the historic rainfall-driven inputs. Phosphorus enrichment has occurred in WCA 2A soils, and the open water sloughs have become colonized by monospecific stands of cattails, Typha domingensis. While methods of reducing total P concentrations in the discharge water have been actively pursued, the effects of low-P water moving over the enriched soils have not been fully addressed. Model results suggest that if the proposed input concentration limit of 10 ppb total P is met, the soil-P will be released such that the impacted region will expand spatially. Although P movement through the marsh is slow due to biological sequestration, eventually all of the load over the past several decades will become mobilized through diffusion into the low-P water column. The release of soil P is expected to result in water column concentrations of greater than 10 ppb for over 100 years after inflow targets are met. These results have implications for resource managers who may consider restoration alternatives such as physically isolating the impacted region to retain the accrued P in the soil.

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Development of Strategies to Manage Biological Invasion by Exotic Plant Species in Everglades National Park

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Florida along with Gulf Lowlands is second only to Hawaii in the US in the magnitude of invasion by non-indigenous species. Particularly in South Florida, spread and effects of certain exotic plant species (Brazilian pepper, Old World Climbing Fern, Melaleuca) have reached "crisis" status, threatening the long-term integrity of every major ecosystem in the region. South Florida is the focus of the largest ecosystem restoration effort ever implemented. Protecting the Everglades from invasive species is one of the foci of restoration efforts. Significant infestation of Everglades National Park (ENP) by Brazilian pepper has occurred. Perhaps the largest and most infamous of the ENP Brazilian pepper infestation involves an area of over 3,000 hectares (7,500 acres) of abandoned agricultural lands in the midst of natural subtropical ecosystems, hence the name "Hole-in-the-Donut", (HID). Since the whole of ENP has over 100,000 acres that are affected by Brazilian pepper, the infestation within the HID is only part of a much larger issue with the difference being that the HID has reached a monospecific stand stage of succession where change occurs very slowly. Similarly, infestation by Old World Climbing Fern has reached beyond the level of imagination destroying biological niche for native communities. In this study, we attempt to develop strategies to manage Brazilian pepper and Old World Climbing Fern spread and provide information to the ENP Adaptive Management Program. Several spoil disposal mounds were constructed from scraped soil and mulched Brazilian pepper between 1996-2004 exhibit almost no Brazilian pepper regrowth. A long term monitoring program was established to study soil suppression factors that selectively inhibit Brazilian pepper establishment on the restored soil disposal mounds will be discussed. Collectively, these novel approaches towards management of invasive plant species in the park have the potential to become critical components of a successful ecological restoration plan.

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Monitoring Evaluation of North Carolina Stream Restoration Projects

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Numerous stream restoration projects have been implemented in North Carolina over the past decade to improve natural stream functions impaired by watershed land use changes. These range from simple riparian buffer enhancement projects to complete channel relocation and reconstruction. Many of these projects are intended to mitigate off-site impacts to streams from highway construction or other development. We initiated a long-term monitoring project in 2003 to evaluate the success of over 20 projects in meeting restoration goals of stream stability and habitat improvement. Monitoring components include surveys of stream morphology, structure assessment, streambed monitoring, riparian vegetation assessment, and benthic macroinvertebrate sampling on selected stream projects. Results indicate a wide range of success depending on watershed land uses, design/construction techniques, rainfall patterns, and vegetation management. This presentation focuses on lessons learned from stream restoration projects to improve the effectiveness of future efforts.

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Benefit-Cost Analysis to Develop the Lake Okeechobee Protection Plan

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Lake Okeechobee supports valuable recreational and commercial fisheries, provides flood control, and acts as a reservoir for both potable and irrigation waters for much of south Florida. Land use (agricultural) and hydrological changes (more efficient delivery of stormwater) have contributed to a serious decline in lake and downstream water quality, affecting most all flora and fauna communities. Best Management Practices (BMPs) and regulatory programs have been implemented over the past 25 years to reduce phosphorus loads to the lake. However, these programs, by themselves will not be sufficient to achieve an in-lake phosphorus concentration goal of 40 parts per billion (ppb) or the required Total Maximum Daily Load (TMDL) of 140 metric tons per year from all sources. Current programs need to be supplemented by additional programs to meet this goal, and non-regulatory measures with willing landowners are needed.

This study was funded by the South Florida Water Management District (District) to provide a benefit-cost analysis of 12 alternatives to reduce the amount of phosphorus entering Lake Okeechobee. These alternatives are called phosphorus control alternatives or PCAs and include regional and farm-level methods to reduce phosphorus loads to the Lake. A computerized Full Cost Accounting Evaluation Model was developed to measure the relative benefits and costs of the alternatives using evaluation criteria. The benefits and costs include phosphorus reduction benefits, cost-effectiveness, external benefits and costs, and risk and uncertainty measures. The model provides a ranking of alternatives based on the magnitude of itemized benefits and costs. The model allows for updating as new data and information become available.

This study was the first attempt to estimate benefits and costs of the PCAs. In the process, some assumptions were used when sufficient information was lacking. Benefits and costs of each alternative to the District, to landowners, and to the regional economy were described and quantified using the best available information, not necessarily measured phosphorus reductions. The information from this study assisted in the development of the 2004 Lake Okeechobee Protection Plan, a State mandate implemented by multiple agencies.

After the 12 PCAs were evaluated, 10 were grouped into combinations and evaluated together. Based on the comments of a multi-agency oversight committee, 18 combinations of on-farm and regional PCAs were evaluated using the Full Cost Accounting Model. The goal was to evaluate the benefits and costs of the PCA combinations for use in developing the 2004 Lake Okeechobee Protection Plan to meet the phosphorus TMDL for Lake Okeechobee.

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Riparian Forest Restoration Project

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The objective of the Ft. Benning riparian forest restoration project is to re-establish functional ephemeral headwater streams. When heathy, these areas act as environmental filters in trapping sediment and improving water quality. Due to intense military traffic on Ft. Benning Military Installation (Columbus, GA), severe erosion has deposited large amounts of sediment in many of the headwater riparian areas. Many of these riparian forests have received as much as 3.0 cm yr^{-1} of sediment deposition.

Nine study plots were established during the spring of 2002 to study the effects of this sedimentation on the overall function of these riparian forests. Study parameters include above- and belowground net primary production (NPP), vegetation successional patterns, and nutrient cycling. Pre-restoration studies have shown a significant decrease in NPP in ephemeral streams with the heaviest sediment deposition rates. Aboveground NPP rates on sampled plots ranged from 1507 g m^{-2} yr^{-1} on reference sites to 465 g m^{-2} yr^{-1} on highly disturbed sites. Highly disturbed areas had a greater abundance of early-successional and shade-intolerant species. Highly disturbed sites also showed a reduction in P, N, and C. Belowground root production had the most significant correlation with sediment deposition rates (regression coefficient of r^2=0.82 [$p<0.005$]), ranging from 1300.8 g m^{-2} yr^{-1} on reference plots to 803.1 g m^{-2} yr^{-1} on highly disturbed sited.

Restoration measures began in March of 2004 and included the installation of fabric dams, the addition of rip-rock along road edges, grading and stabilizing road beds, the seeding of native grasses, and planting trees. Post-restoration studies will evaluate the effectiveness of these treatments in their ability to reduce sedimentation rates and restore functioning riparian forests. A total of 13 study plots will be monitored over the next three years to evaluate forest health. Response variables include above- and belowground NPP, biogeochemical cycling, tree recruitment and survivability, and forest successional patterns. Of these 13 plots, 9 have been continuously monitored since April of 2002. Data collected on these plots will include fine root production, litterfall, vegetation composition, decomposition rates, and foliar and root nutrient analysis. We hypothesize that restoration measures will slow the rate of sediment deposition on the highly disturbed areas and allow these areas to stabilize. The success of these restoration measures should be reflected in the overall NPP and in the forest's ability to cycle minerals. Based on pre-restoration data, we expect the production of fine roots to be the best indicator of forest health in these areas.

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Long-Term Management of the Kissimmee Chain of Lakes, Florida

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The Kissimmee Chain of Lakes is managed to provide recreational opportunities, fish and wildlife resources, flood control, and downstream water supply. However, reduced fluctuation of water levels, proliferation of exotic and nuisance plants, artificial drainage, and increased nutrient inputs have stressed the lakes' ecologic health. These impacts have necessitated costly management solutions such as drawdowns and muck removal, diversion of wastewater treatment plant effluents, construction of wetland detention areas, and chemical control of exotic vegetation. These actions often require lengthy preparation and sometimes compete with other needs. In addition, hydrologic management to improve the lakes' health must consider any consequences to downstream waters. Restoration and remediation of downstream ecosystems, including the Kissimmee River, Lake Okeechobee, and the St. Lucie and Caloosahatchee estuaries, depend significantly on the quantity, quality, and timing of discharges released from these headwater lakes.

For this complex system, close coordination among the responsible agencies is required to achieve management objectives in the most efficient and beneficial manner. To improve the framework of cooperation, seven federal and state agencies, along with local governments and other stakeholders, have partnered to develop criteria for evaluating regulation of lake levels and outflows. This effort will create scientifically-based criteria for evaluating hydrologic management strategies designed to meet flood control, water supply, aquatic plant management, and natural resource objectives for the Kissimmee Chain of Lakes while preserving and enhancing the ecological values of aquatic resources downstream.

Resolution of multifaceted management issues requires a highly structured approach. The partner agencies started the process of developing evaluation criteria by identifying five broad goals that address hydrologic management, habitat preservation and enhancement, aquatic plant management, water quality improvement, and recreation and public use. Proceeding from these goals, a conceptual model was developed that identified ecosystem stressors and their ecological effects. Each ecological effect contained metrics that were assessed for their usefulness as indicators of ecosystem response. Priority indicators were further examined for their potential to be developed into evaluation criteria. Critical factors in this assessment included availability of data to determine reference/baseline conditions as well as stakeholder interest. The evaluation criteria and baseline data will form the scientific basis for management recommendations, assessment of current and future conditions, evaluation of management alternatives, development of adaptive protocols, and determination of management success.

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Characterizing Important Spatial Scale Lengths of Florida Everglades Vegetation for Hydrologic Model Parameterization and Restoration Monitoring

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The Comprehensive Everglades Restoration Plan includes various management and monitoring activities aimed at improving the condition of Florida Everglades and Florida Bay habitats while providing for multiple uses of limited water resources. For these purposes, surface water stage and flow will be manipulated throughout the Okeechobee-Everglades watershed. Models that simulate and forecast surface flow are proving to be valuable in planning, enacting, adapting, and monitoring Everglades restoration actions. These models require information on vegetation because South Florida topographic gradients are so small that vegetation plays an important role in the distribution and flow of Everglades surface water. The sizes of spatial resolution elements in current and developing regional hydrologic models were determined largely by operational constraints, not any analyses of the scale-lengths over which important processes may operate.

Previously created maps of Everglades vegetation lack information on the within-class distribution of functional vegetation characteristics that are important in hydrologic processes. Therefore, USGS vegetation mapping efforts have focused on the combination of in situ, airborne, and satellite-based technologies to produce digital databases of vegetation biomass and leaf area index for use in use in hydrologic modeling and ecosystem monitoring. In turn, spatial analyses of the generated vegetation fields have increased our understanding of resolution requirements for these modeling and monitoring activities. Landscape metrics applied to multi-resolution datasets of Everglades vegetation density characteristics quantify the sizes, shapes, and directions of vegetation patches. These metrics show that important spatial variations in vegetation type and density occur at scale-lengths well below the 500m cell size currently used in relatively fine resolution hydrodynamic models of the Everglades region. The current challenge then, is to find ways of adapting model parameters to account for measured sub-grid heterogeneity and the spatial arrangement of pertinent vegetation characteristics.

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Relating Water Depth, Hydroperiod, and Flows with Elevation Differences in the Everglades Ridge and Slough Community

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Hydrologic parameters influence vegetation and soil composition. Most of the freshwater Everglades has been characterized as having higher elevation ridge habitats adjacent to lower elevation slough habitats repeating over the landscape. It is important to maintain this elevation difference since topography influences hydrology and helps to maintain plant and animal diversity. The difference in elevation between a ridge and slough depends on location, yet what maintains this difference is not well understood. This study investigated whether hydroperiod, water depth, or flow could explain the elevation difference between Everglades ridges and sloughs.

Based on perceived hydrologic differences, two study sites were chosen in Water Conservation Area 3A (WCA3A), and two in Everglades National Park (ENP). Site WCA3A-1 is located 2 km south of Alligator Alley, WCA3A-2 is 16 km north of Tamiami Trial, ENP-1 is located in northeast Shark Slough, and ENP-2 is located in southern Shark Slough. Sites were visited approximately once every three months in 2003-2004. Initial site surveys measured relative elevation difference between a ridge and its adjacent slough. During each site visit, water velocity was observed using a dye tracer (fluorescein), while cross sectional area of ridges and sloughs were measured to estimate flows. Water depth measurements were correlated with a nearby stage recorder to calculate hydroperiod and average water depth (over the past few decades) at each site.

Results of this study indicate that deeper water may help to maintain the elevation difference in the ridge and slough. As the elevation difference between a ridge and slough increased, the average water depth increased, while this trend was not as strong with hydroperiod and flow. It should be noted that hydrology data from the post-drainage era was used to characterize soil elevation differences, which were most likely created in the pre-drainage era. Therefore, water depths, hydroperiod, and flows may have played more (or less) significant roles in forming and maintaining this elevation difference than current hydrology trends may indicate.

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Nekton Habitat Use and Responses to Wetland Restoration in the Mississippi River Delta

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Construction of artificial levees along the Mississippi River has greatly reduced delivery of sediments to deltaic marshes via natural crevasses, thereby increasing subsidence and loss of coastal wetlands. Resource managers cut artificial crevasses in levees to restore flow, accumulation of sediments, and colonization of marsh vegetation. For the past three years, I have been evaluating the response of fishes and aquatic macroinvertebrates to restoration of this deltaic ecosystem.

A combination of 1-m^2 throw traps and minnow traps were used to collect fishes every other month from adjacent plots of emergent marsh (primarily *Sagittaria*) and submerged aquatic vegetation (mixture of taxa such as *Myriophyllum* and *Potamogeton*) at 11 crevasse wetlands throughout the Mississippi River delta. The age and management history of these wetlands ranged from relatively young created wetlands to mature natural wetlands. In addition to sampling emergent marsh and submerged aquatic vegetation, I also collected nekton from beds of non-native *Phragmites* that dominate much of this deltaic landscape.

Topminnows, livebearers, gobies, and sleepers were numerically dominant fishes, whereas palaeomonid shrimp and zygopteran larvae were numerically dominant invertebrates. Abundance and community composition varied considerably during the study period. Nekton abundance was highest in the late summer and early fall and then declined considerably as above ground vegetation senesced (i.e., little or no above ground biomass) through the winter and spring. Salinity varied during the sampling period, which resulted in shifts in the relative abundance of freshwater and estuarine species. There were few differences in the abundance and composition of nekton communities in young and old crevasse wetlands, indicating that restoration of marsh habitat in the Mississippi River delta is succeeding from a fisheries perspective.

The relative importance of *Phragmites* habitat varied seasonally. During the summer, *Phragmites* supported lower densities of nekton than did emergent marsh or submerged aquatic vegetation. In contrast, *Phragmites* supports significantly higher densities and greater diversity of nekton than other delta habitats that are largely senescent (i.e., no above ground vegetation) during the late fall, winter, and spring. Nekton were abundant 10 m into *Phragmites* habitat, indicating little edge effect at this spatial scale. Phragmites appears to be a seasonally valuable habitat for deltaic nekton.

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Implications of Natural Variation of Fish Assemblages to Coral-Reef Management

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The ability to detect anthropogenic change in fish assemblages requires, at a minimum, knowledge of both the initial state prior to the change, and the natural variation within the assemblages. Whereas the former is often acquired as baseline data, the latter is not. A measure of understanding of natural spatial variation at a given point in time is readily obtained by examining the variation within a baseline data set. However, coral reef fishes often exhibit substantial temporal variability, in terms of both species richness and abundance. We examined variation of coral reef fish assemblages on the nearshore hardbottom of Broward County, Florida, USA twice in three years prior to an anticipated beach renourishment project. In the summer of 2001, we made 176 visual fish counts along a 13km stretch of coastline as part of a larger study. Eighty-eight 30x1x2m transects were run at 152m intervals, and DGPS coordinates of each were recorded. Each transect ran west to east across the north-south oriented hardbottom, beginning at the nearshore edge. We alternated between a 15m-diameter point-count or 20min rover-diver count, 20m north of each transect. With the rover-diver counts, only the species present were recorded. With transect and point-counts each species, its abundance, and lengths (TL) were recorded. In the summer of 2003 we returned to the sites (using the DGPS coordinates) and repeated the same census methods. There was a significant difference in fish abundance but not richness between the two years. The difference in abundance was primarily due to differences in juveniles (>5cm total length). Our results highlight the potential annual variation in fish assemblages and provide a cautionary note regarding reliance on baseline data established from a single year survey, especially if the survey incorporates recently settled juveniles.

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A Multidisciplinary Assessment of the Effect of the Restoration of a More Natural Hydrologic Regime on the Large Lakes of Voyageurs National Park, Minnesota

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In January 2000, the International Joint Commission (IJC), an organization established by treaty to help prevent and resolve disputes over the use of waters along the United States-Canada boundary issued a new supplementary order (2000 Order) for the management of Rainy Lake and Namakan Reservoir, which lie along the international boundary between Minnesota and Ontario. While these lakes existed as natural water bodies, they have been regulated by privately-owned dams since the early 1900s.

Water management of these shared border waters is the most significant natural resource issue for Voyageurs National Park (VNP), and is also a significant issue for the Minnesota Department of Natural Resources (MNDNR) and the Ontario Ministry of Natural Resources (OMNR). Together these water bodies cover 40% or 80,000 acres of Voyageurs National Park. Research supported by the National Park Service in the 1980s found that the existing water management programs (1970 Order) adversely affected the species and biological communities that were investigated. After considering these and other research results, the IJC instituted its 2000 Order which restored a more natural hydrologic regime, particularly on Namakan Reservoir. In doing so, they stated that the new Order was subject to review after 15 years and they charged the natural resource agencies with the task of implementing a monitoring and research program to determine if the new hydrological regime had provided the anticipated ecological benefits.

To meet the IJC's charge, VNP and other resource agencies are using existing long-term monitoring programs, establishing new monitoring programs, and conducting research investigations. Water quality monitoring from 2001-03 showed that as predicted by modeling results, total phosphorus and chlorophyll-a concentrations decreased under the 2000 Order. Long-term monitoring suggests that the reduced water level fluctuations associated with the 2000 Order on Namakan Reservoir may contribute to lower total mercury concentrations in young of the year yellow perch. The potential food web implications of this are significant since yellow perch are the primary prey of walleye and northern pike, which currently have high enough mercury concentrations to make consumption advisories necessary. In 2004, monitoring and studies of fish, common loons, benthos, aquatic plants, and muskrats were initiated that will provide before and after comparisons with the data collected in the 1980s. A paleolimnological study will be started in 2005 to reconstruct the timing and magnitude of environmental impacts of damming, water-level manipulation, and land use changes by using quantitative reconstruction of environmental variables from lake sediment geochemistry and microfossils.

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Characterization and Selection of *Uniola Paniculata* L. Genotypes for Enhanced Dune Restoration

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Uniola paniculata L. (sea oats) is the primary native dune grass used for beach restoration in the southeastern U.S. Sea oats are propagated in nurseries using field-collected seed. Dwindling natural populations, concerns regarding limited genetic diversity and potential use of non-locally adapted genotypes have resulted in severe restrictions on field harvesting and use of seed by native plant nurseries. Genetic analyses (RAPDs) have revealed extensive genetic variation within and between natural sea oats populations on the Atlantic and Gulf coasts. Reciprocal planting of micropropagated sea oats genotypes, from two Gulf and two Atlantic coast populations, was completed to assess the relationship between geographic source, genotype and growth response. In September 2001, sixteen micropropagated genotypes, four per geographic source, were planted at St George Island (Gulf) and Anastasia State Parks (Atlantic). The experimental design consisted of five replicate planting blocks per site with four replicates of each genotype per block. Data was collected after nine months. Five sea oats genotypes exhibited early flowering. Genotypes that flowered did so at both planting sites. Shoot and leaf production was greatest for genotypes from St George Island and Sebastian Inlet (Atlantic). Significant plot /genotype interactions suggest that survival and growth is impacted by localized conditions.

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Planning for the Restoration of Highly Degraded Habitat in an Ultra Urban Setting

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The District of Columbia, Watershed Protection Division (WPD) is working toward restoration of a number of severely degraded habitats in Anacostia River Basin. Projects include three stream restoration projects, three tidal wetland recreation projects and two island rehabilitations. Special circumstances such as land ownership, urban setting, and technical constraints has made the implementation of the projects challenging and demanded careful planning. Because of unique political history of DC, nearly all lands with potential for restoration are owned and managed by various government agencies.

The challenges found when trying restore significant habitat in a city fall into four interrelated categories. *Regulatory* issues are comprised of TMDL, MS4, and Chesapeake Bay Program compliance and are frequently the grantors measure of success. *Planning/Political issues*, which include the multiple planning processes undertaken by agencies involved in some manner of urban redevelopment or park redevelopment, set public expectations and attempt to address the public environmental justice concerns. These planning processes frequently change without warning despite long-term restoration plans. *Technical issues* are comprised of questions about how specific restoration techniques can work in urban areas to address the regulatory requirements that local government is faced with. Examples include the difficulty in quantifying sediment and nutrient reductions with stream restoration projects or the difficulty in determining how to remediate legacy contaminants. Another important technical issue is the cost associated with doing restoration when urban infrastructure is in the way or needs to be rehabilitated as a component of the restoration project. *Partnership relations* are the fourth, and perhaps most important category of general issues that impact all phases of restoration projects. Given the relative newness of these types of projects in urban areas, identifying partners with both financial resources and technical know-how can be difficult. It is essential to have one partner with the ability to implement contracting and construction oversight. Furthermore, different partners' expectations of what is involved in a particular restoration project can vary widely and set the stage for conflicts later on unless the construction process and end result are discussed in detail. It is highly advisable to have explicit buy in from all required partners prior to engaging in the design process.

Each of these general categories of issues impacts the others in complex ways. Technical issues should inform the regulations and the measurable goals that are required. Planning issues should work together to push restoration goals that are technically feasible and can satisfy regulatory requirements. The reality of project implementation in a large city is that city bureaucracies frequently work separately towards different goals and that regulatory requirements are not easily fixed with technically feasible tools.

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Cargill's Adaptive Management Approach to Restoration

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Cargill Crop Nutrition has initiated a large-scale coastal restoration effort that will provide significant environmental benefits to the Tampa Bay Estuary. Four miles of Cargill-owned coastline are part of a contiguous seven mile stretch that is being restored through adaptive management techniques by public, private, and non profit organizations. Several hundred acres of uplands and wetlands are being restored to their original disposition. When completed, there will be a combination of freshwater, oligohaline, and saltwater habitat that has been restored on Cargill's property. Ditch plugs have been installed to modify the hydrologic flow that was altered historically, presumably, for mosquito control. A man made section of Archie Creek, which reports to the bay, is being restored to improve water quality. Over 1,100 dbh of trees were removed from the creek construction area and relocated nearby to help restore a forested greenway buffer. Near the closed gypsum stack, plantings of nursery grown and salvaged smooth cordgrass, seaside paspalum, salt hay, and black mangroves have been planted along Cargill's shoreline for stabilization purposes. Exotic species have been eradicated and are being treated as part of an aggressive maintenance program to prevent reintroduction to the restoration sites. This adaptive management program benefits the water resources by meeting the goals and objectives of the Tampa Bay Estuary Program and participating agencies who have been attempting to restore the integrity of the estuary for many years. Cargill is a private partner who has been working closely with these individuals to ensure a successful, integrated restoration effort along the coastline.

One challenge has been to ensure that each participating agency's goals have been met in a manner consistent to all the team members. The challenge was compounded by that fact that the restoration work is within close proximity to a major highway and in a growing urban area. Cargill overcame the challenge by establishing a team approach that includes annual meetings with a "restoration reviewing agency" team (RRA) where progress, proposed restoration activities, and community issues are discussed. The meeting includes a visit to each restoration area where team members can evaluate whether to adapt the plans based on site specific conditions. In addition to the annual meeting, Cargill broadcasts restoration summaries over the Internet via <http://www.cargill-neb.com> throughout the year to notify the RRA and the public of ongoing activities. Reports include online time-series photos, interactive GIS maps, site alerts indicating unusual conditions, and an extensive database of project activities. Reports from previous years are electronically cataloged and accessible from <http://www.cargill-neb.com>. The team approach to restoration and the Internet-based reporting system have been successful in helping Cargill to maintain an Integrated Land Management Plan that is consistent with the "bigger picture" of restoration being done on the estuary and within the Alafia River watershed.

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Redefining the San Antonio Channel Improvement Project to Include Environmental Restoration

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The San Antonio Channel Improvement Project (SACIP) was authorized 1954 to provide flood protection on the San Antonio River. The flood protection modifications were initiated in October of 1957 and the last segment was completed in April of 1998. The lower 8 mile portion of the project consists of a grass-lined trapezoidal channel maintained free of any woody vegetation. This over-steepened and shortened reach of the river channel has required armoring of the baseflow channel with concrete rubble to reduce erosion due to flow conditions becoming out of balance with the sediment supply to the reach. In 2000, the project was authorized to include environmental restoration and recreation as project purposes with the intent of restoring riverine functions without reducing flood conveyance.

The project delivery team was challenged with maintaining existing flood protection and restoring natural river functions within the same footprint. Plan formulation included development of an aquatic HEP model, implementation of fluvial geomorphology principles, increasing backwater and slackwater habitats, and methodology development for restoring a riparian corridor without reducing existing levels of flood protection.

The principles of fluvial geomorphology were used to develop measures which would restore the river channel to a more natural sediment transport function. Identified measures include a pilot channel within the flood control channel to convey the channel forming flow. Grade control structures were designed to improve the sediment transport function and create shallow pools and riffle sequences. A baseflow channel is superimposed within the pilot channel where chute (run) habitat would occur to create favorable depths and velocities for native swiftwater fishes. Additional aquatic measures designed for environmental restoration include creation of embayments, tributary mouths, wetlands, and the restoration of historic river remnants.

A woody vegetation community with three differing densities was developed to assist in the design of the riparian corridor. Developing two vegetation communities of less density in addition to the historic community density allowed a range of hydraulic roughness values to be developed for analysis. Hydraulic modeling was used in an iterative process to develop vegetation plans which maximize the use of native woody riparian vegetation while maintaining the channel's flood protection function.

Through extensive coordination with resource agencies, planning, and modeling a National Ecosystem Restoration (NER) Plan has been identified that provides a 227% improvement to the riparian and aquatic habitats within the study area while maintaining the existing flood protection. The NER Plan is supported by the local sponsor as meeting their objectives for restoration of the river.

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Quantifying and Reducing Uncertainty in Wetland Restoration Forecasts for the Mississippi River Deltaic Plain: the CLEAR Program

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Natural deltaic land-building produces a predictable evolutionary sequence of channel and island development that has been related to the percent of river discharge introduced. On the other hand, field studies provide a limited basis for predictions of the time of first emergence, on the rate of subsequent land expansion, and on the modulating effects of differing geometries, background subsidence rates and marine influences within receiving basins. Further, artificial river diversions differ significantly from natural crevasses and deltas in terms of the amount and size-distribution of sediments introduced for a given percent of river flow. The Coastal Louisiana Ecosystem Assessment and Restoration program (CLEAR) has provided an avenue for scientific input to planning the restoration of the Mississippi River delta through the U.S. Army Corps of Engineers Louisiana Coastal Area study (LCA). CLEAR generates 50-year forecasts of ecosystem response to proposed wetland restoration measures, including river diversions of sediment, water and nutrients into wetlands, and more direct land-building using sediments conveyed by pipeline. Uncertainty in CLEAR forecasts has been programmatically addressed through use of a wide array of predictive tools, rather than any single approach. Findings are reported here of an expert committee of scientists and engineers that reviewed uncertainties about predictions of land-building and wetland nourishment. The LCA Land Change model is described, as well as a probabilistic supplement that allows quantification of the most important sources of uncertainty. A series of other modeling approaches are introduced briefly, including (1) a geological trend extrapolation approach, (2) an analytical model, (3) a small scale physical model, (3) a number of numerical approaches, and ending with (4) a hybrid numerical landscape model that directly predicts land-building and habitat change on a regional scale. A guided research plan is proposed to reduce forecast uncertainty through improvements made and integrated across three levels of tools. The first tier is a trend analysis, the second a desktop process simulation (typically a hybrid of process simulation and trend analysis), and the third a detailed process simulation with guided internal extrapolation. The trend analysis and desktop simulation tiers produce predictions early in the process, as they have, and provide a framework for development. Detailed simulations refine input-response relationships and check assumptions implicit to the trend and desktop analyses. Regular peer reviews document progress and build confidence by reducing uncertainty.

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Non-Traditional Calibration of Hydrologic Modeling at Lockport Prairie, Illinois Using Biological Indicators as a Calibration Tool

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Lockport Prairie Nature Preserve (Prairie) contains the largest high quality dolomite prairie in the state of Illinois, with an extensive diversity of native species, some of which are State and Federally listed. The Prairie is a critical ecological refuge within the mosaic of the Des Plaines River Valley ecosystem. As part of mitigation for a major nearby violation, USACE instituted hydrologic and restoration studies at the prairie. The Forest Preserve District of Will County assembled a technical advisory team, consisting of both technical and jurisdictional entities to evaluate the infrastructure and offsite influences to the prairie. The team developed an approach to simultaneously collate and organize existing data, collect empirical data, assess biological relationships and conflicting habitat requirements and offsite land use. Ultimately, the analysis resulted in a more integrated understanding of the relationships between the biological and physical elements of the system and an improved ability to plan and predict the outcome of reversible restorative or protective strategies.

Surface water and groundwater play critical roles in the sustainability of the Prairie, and associated wetland-dependent and rare species. Early in the assessment process, the hydric regime was categorized as a key element of the infrastructure. A determination was made that surface water and groundwater models would be required to develop a risk assessment, and predict the outcome of restorative or protective actions. All of the options considered left an unacceptable degree of error given the complexity of the interaction between the fractured dolomite aquifer and the mosaic of rivulets and sheet flow at the surface. The traditional numerical model calibration process required to achieve an acceptable level of accuracy was determined to be prohibitively expensive.

An alternative approach was developed to assess the hydric regime using data collected from other elements of the ecosystem. Extensive plant community mapping was included in the assessment methodology, as was rivulet flow and frequency modeling for aquatic habitat. The location and occurrence of groundwater and surface water dependent species were compared with the model output and observations of the hydric regime. A GIS database was developed compare the data and evaluate the reliability of the model. Findings of the assessment were used to guide technical and economic decisions on the need to conduct additional modeling and the sensitivity of models selected.

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Effects of Canal-Water Intrusion on C and N Biogeochemistry and Isotopes at the A.R.M. Loxahatchee National Wildlife Refuge

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The Refuge is one of the last remnants of the historic rainfall-driven Everglades. There is concern that changes in water management strategies associated with the Everglades restoration might increase the extent of canal-water intrusion into the Refuge. Hence, a synoptic survey of water, soil, and plant chemistry was conducted during February 2004 at 130 sites in the Refuge to better understand the effects of canal-water intrusion on the wetlands. Because stable isotope analyses had proved useful in previous Everglades investigations, samples were collected for the following analyses: water ($\delta^{18}O$), DIC (concentration, $\delta^{13}C$), nitrate (concentration, $\delta^{15}N$, $\delta^{18}O$), and algae/macrophytes ($\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$). We report preliminary data and interpretations for the subset of samples that have been analyzed thus far.

Earlier isotope investigations in collaboration with the USEPA-REMAP program showed that the biota in the interior of the Refuge had higher $\delta^{13}C$ but lower $\delta^{15}N$ and $\delta^{34}S$ values than sites near the canals. These high $\delta^{13}C$ and low $\delta^{34}S$ values were characteristic of large areas of the southern and western parts of the Everglades that are less impacted by canal nutrients, and may represent a useful environmental marker. More detailed synoptic sampling in the Refuge provides a unique opportunity for investigating the linkages between nutrient gradients, biogeochemical processes, and isotopic compositions of wetlands plants. An understanding of the biogeochemical controls on the spatial and temporal changes in $\delta^{13}C$ and $\delta^{15}N$ at the base of the food web is required if isotopic techniques are to be used effectively for evaluating ecosystem changes in food web dynamics or Hg bioaccumulation during restoration activities.

Conductivity data provides a reliable indicator of the extent of canal water intrusion into the wetlands. Water-$\delta^{18}O$ values ranged from 0-5‰, with the lowest values at western high-conductivity sites and highest values in the interior, but otherwise show little correlation with conductivity. DIC concentrations show a strong positive correlation with conductivity. DIC-$\delta^{13}C$ values ranged from -22 to -5‰, but are only positively correlated with conductivity at near-canal sites and show values ranging from -22 to -12‰ in the interior.

The few plants analyzed thus far have $\delta^{13}C$ values ranging from -32 to -22‰. Surprisingly, metaphyton and floc samples have $\delta^{13}C$ values that are negatively correlated with DIC-$\delta^{13}C$ and conductivity, whereas macrophytes show little correlation with either. $\delta^{15}N$ values range from -5 to +8‰, with macrophytes showing more variability and most of the extreme values. Preliminary data suggest that proximity from the canals is not the main factor affecting the isotopic compositions of algae and macrophytes in the Refuge. Future work will focus on testing hypotheses about how seasonal and spatial changes in penetration of canal waters, as well as other environmental factors, affect key ecological processes along these gradients in the Refuge.

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Tracing Sources of Organic Matter and Nitrate in the San Francisco Bay-Delta-River Ecosystem using Isotopic Techniques

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Hypoxic conditions in rivers, wetlands, and coastal ecosystems can cause significant problems for fish and bird migrations, the local fishing industry, and for the usefulness of the water body for drinking water and recreational purposes. While it is usually obvious that the problem is excess nutrients, it is usually less obvious exactly what should be done to remediate the problem. This is because there are usually many different land uses that contribute nitrate and organic matter to the ecosystem, and it is often difficult to determine the dominant source of the nutrients and organic matter causing local problems -- such as low dissolved oxygen levels or the production of disinfection byproduct during water treatment -- with standard chemical and hydrologic mass balance methods. Isotopes often provide new insights into sources, and are a useful adjunct to conventional methods.

Therefore, we have analyzed the isotopic compositions of dissolved and particulate organic matter (DOM, POM), nitrate, and water samples from selected sites in the San Francisco Bay-Delta-River ecosystem since 2000. Organic matter and/or nitrate samples were collected at various times in 2000-2003 from ~20 sites on or near the San Joaquin River (SJR) and ~10 sites in the Delta. POM samples from Delta and SJR sites had similar ranges of $\delta^{15}N$ and $\delta^{13}C$ values. Main-stem SJR sites have nitrate-$\delta^{15}N$ ranging from +9 to +14‰ (avg. +11‰) whereas samples from drains, creeks, and tributaries that drain into the SJR range from 0 to +12‰ (avg. +6‰). POM samples from main-stem SJR sites have $\delta^{15}N$ values ~ 4‰ lower than the co-existing nitrate. Depending on season, the nitrate-$\delta^{15}N$ may increase or decrease up to 3‰ downstream, due to changing mixtures of sources, while nitrate-$\delta^{18}O$ almost always decreases downstream as the proportion of water in the SJR derived from the Sierra Mountains (which has water-$\delta^{18}O$ values of ~ -15‰) increases. C:N values of POM at main-stem SJR sites were usually <8, whereas C:N values from drains and creeks were usually >15.

The main conclusions from our preliminary investigations are: (1) POM at main SJR sites is mainly algal in origin except during major storms, whereas POM from the creeks and drains contains appreciable terrestrial detritus, (2) most of the algae in the SJR appears to be produced in situ, (3) groundwater is a significant source of nitrate to the river, (4) much of the nitrate in the SJR appears to be derived from animal or human waste, and (5) algae in the Bay in October 2002 (during a whole-system transect) seems to be N-limited. Interestingly, these isotope data often contradicted the conclusions from previous studies that used simple mass balance approaches to determine and quantify sources, resulting in the re-evaluation of some of the earlier interpretations. The value of isotopic techniques is that it uses the natural isotopic “labels” of different sources of organic matter and nitrate to quantify the contributions from different sources. Hence, isotope data are an extremely useful adjunct to traditional methods for assessing and monitoring sources of organics and nutrients during ecosystem restoration programs.

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Streamlining the Environmental Permitting Process - A Case Study in Urban Stream Restoration in Anchorage, Alaska

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Chester Creek and its tributaries are highly managed and modified streams, with drainage areas fully within the limits of the Anchorage metropolitan Area. North Branch Chester Creek was channelized into a roadside ditch in the 1960's. The option to realign and restore this creek was made possible as a component of a roadway extension project. The Municipality of Anchorage fostered a relationship of mutual trust with state and federal permitting entities by establishing a proactive, collaborative approach to permitting modifications to the North Branch Chester Creek. The result was a net gain in wetland credits for the Municipality.

This presentation details the approach used by the owner, the Municipality of Anchorage, and the designer, HDR Alaska, Inc., to streamline the environmental permitting process, and highlights key design components. The presentation will also include "lessons learned" from the project permitting process and monitoring of the restored channel.

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Determining and Evaluating Costs and Benefits for an Ecosystem Restoration Project

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Every ecosystem project has the inherit problem of evaluating *tangible* construction costs with *intangible* benefits. How do you define and measure benefits to the ecosystem? What's the value of increasing macroinvertibrate populations or fish diversity? This paper will shed some insights on how to answer these questions.

It is based on a case study of Ohio's Monday Creek Watershed in the Hocking River Basin. The watershed encompasses 116 square miles and extensive portions were subjected to underground and surface coal mining from the 1820's to the 1950's prior to laws and regulations that protected the environment. Severe acid mine drainage has caused a number of stream reaches to become essentially sterile and unable to support any form of aquatic life. A survey of the watershed identified over 4,300 sites damaged from coal mining activities. Since it is not feasible to restore all of the sites, the challenge is to restore enough sites to improve the ecosystem at the lowest cost.

The U.S. Army Corps of Engineers, in partnership with the Ohio Department of Natural Resources (ODNR) is conducting a Feasibility Study to evaluate the applicability and feasibility of various restoration solutions to the overall degradation of the ecosystem. West Virginia University (WVU) was contracted to utilize its recently developed Total Acid Mine Drainage Loading (TAMDL) computer program to simulate the water quality before and after the various remedial treatments are constructed. The ODNR and WVU assisted the Corps in determining the costs for the restoration projects and the Corps developed the benefits and evaluated alternatives to determine the most cost effective plans using a computer model developed by its Institute of Water Resources.

Environmental restoration activities include stream restoration, wetland creation and wildlife habitat restoration involving active and passive treatment of acid mine drainage. The TAMDL model indicated that 141 projects would be required in 14 subwatersheds within Monday Creek. The Institute of Water Resources model determined the benefits of the projects and which projects are most cost effective.

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Green River Lake, KY - Modifying Reservoir Regulation and Operation

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A meeting of a small group of scientists and engineers from The Nature Conservancy and Louisville District Corps of Engineers led to a cooperative effort to modify regulation and operation of Green River Lake to restore the natural hydrologic conditions of Green River prior to impoundment as much as presently possible without impacting authorized project purposes.

Multiple alternatives and their potential impacts to lake and river aquatic resources were examined between 1999 and 2002. Careful examination was given to each alternative as the Green River is home to 71 mussel species and 151 fish species contributing to its rank as the fourth-most biologically diverse river in the nation. The two most critical physical factors are water volume and temperature. The jointly recommended alternative plan received final approval in June 2002. Improved passage of water through the dam to more closely mimic naturally occurring flows, as would occur without the lake, benefits the life cycles of many aquatic species.

The plan selected 1) increases non-crop season maximum and minimum release rates without adverse impacts, 2) delays the significant Fall drawdown until after lake destratification and reduces the September 15 to October 31drawdown to 0.5 foot without adverse impact, 3) raised winter pool to elevation 668 without significant adverse flood control impact and, 4) modifies the spring filling schedule without significant impacts to lake fisheries and recreation.

The new regulation and operation plan for the lake improves flood control capability for events of high magnitude. It reduces the percent of time in the ideal recreation zone during June, July, August and September by only 1.5 percent but increases the period for ideal recreation during October by over 40 percent. Use of this plan results in a reduction of May cold water releases by 8 percent and October cold water releases by over 46 percent. This plan also provides the best overall reproduction of a natural flow regime. In addition, the use of a 668 msl winter pool elevation creates allows more use of the upper opening of the multilevel release system. This creates better opportunity to release higher temperature waters during the spring when the overall temperature of the reservoir water column is less than the natural temperature regime. Additional benefit is realized by deferring the Fall draw down until lake destratification occurs. National Park Service scientists have already reported nearly complete elimination of flow reversals in underground streams in Mammoth Cave National Park that were evident during Fall drawdown under the previous guide curve for regulating and operating the lake.

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Preliminary Hydrodynamic Modeling of Capitol Lake and the Deschutes River Estuary to Support Restoration Feasibility Assessment

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Capitol Lake is a 260 acre body of fresh water impounded by a dam at the mouth, covering the former Deschutes River estuary, located in Olympia and Tumwater, Washington. In its present condition, the natural flushing action is limited resulting in poor water quality and excessive sediment accumulation. Without sediment removal the lake will become a freshwater marsh. Eurasian milfoil is present in Capitol Lake and its control has proved to be difficult. Also, the presence of the dam increases the potential for flooding. As part of the Capitol lake Adaptive Management Plan, the stakeholders are assessing the feasibility of restoring estuarine functions to the Deschutes River Estuary through modifications of existing infrastructure. The expectation is that a properly functioning estuary would improve water quality, naturally distribute the sediments, provide for natural weed management, and return 260 acres to productive estuarine habitat.

In this study, we present preliminary modeling of the Deschutes River Estuary and the Capitol Lake in its present condition using a three dimensional hydrodynamic model (FVCOM). The purpose of this modeling study is to provide a preview of anticipated results following restoration actions. Slight changes in the water surface elevation, or bathymetric features could affect circulation pattern which in turn could affect the biological communities that predominate and the type of estuary that is created. This preliminary modeling provides hydrodynamic sensitivity of the estuary to proposed changes. The model was first applied to simulate existing conditions. The results provide a three dimensional view of the current and circulation patterns inside the estuary and Budd Inlet portion of Puget Sound. The model was then applied for the full restoration alternative of complete dam removal to examine if the tidal functions would be restored, the current magnitudes during flood and ebb, extent of inundation and formation of mud flats, and salinity intrusion. These results may be used to guide collection of data for detailed model calibration for examining and in design of various restoration alternatives for sediment, and habitat management. The full feasibility analysis considers a suit of functions and values to asses the impacts of restoration in the social, physical and biological arenas found in this urban setting.

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Estimating Missing Rainfalls in South Florida Using Neural Networks-Based Classification

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Rainfall is one of the most important components in hydrology. There are over 400 active rain gages in South Florida. Each site has different period of records. Rainfall data in this region have been recorded extensively during the past 30 years, while couples of stations have data back to early 1900s. The recorded daily rainfall data have data gaps due to equipment mal-function and data processing error. For example, the missing rate (which is the ratio of missing to recorded days during a period of record at each site) in the southern Everglades area including ENP and WCA3 during the past 30 years are about 11 per cent (with a maximum of 40 per cent). The missing rates during both wet and dry seasons are equally alike.

Some statistical analyses, such as censored analyses and expectation-maximization algorithms, are designed specifically for the data with gaps. However, most rainfall estimates and hydrologic models should be done with rainfall data without gaps. Simple linear regression approaches or the Thiessen polygon method have been used in practice for rainfall analyses, but they often lead to inaccuracy and bias. Thus, the main objective here is to propose a practical method to estimate missing daily rainfalls. The proposed method consists with two steps: The first step is relied on a pattern classification to determine the wet/dry condition of each day at each site in a region. Several classifiers based on neural networks, such as Levenberg-Marquardt backpropagation, automated regulation backpropagation, linear vector quantification, and probabilistic neural networks, were applied. In the second step, a multi-regression model is used to estimate the amount of rainfalls at the rainy sites determined by the first step.

The proposed approach with different classifiers was tested for the selected 10 stations in the southern Everglades area. Gaps were generated randomly to mimic the actual data, then they were filled in and compared with measured ones. Both root mean square error and sum of square error statistics indicate that the proposed methods improve the conventional methods at varying degrees. The summary statistics as well as spatial patterns of the filled-in data using the proposed method are comparable to those of original data with gaps.

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Assessing the CALFED Bay-Delta Ecosystem Restoration Program: Racing to Catch Up

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In the mid-1990s California embarked on a series of programs to reduce conflicts over freshwater by restoring ecosystems and improving reliability of ecosystem services in California's Central Valley and the San Francisco Estuary. The CALFED Bay-Delta Program and its Ecosystem Restoration Program (ERP) rest on the assumption that declines in native species, particularly fish, can be reversed through restoration of physical habitat and moderate increases in freshwater flow in streams and into the estuary. ERP plans have emphasized ecosystem-level restoration using adaptive management, although application of an adaptive approach has proven difficult. Unfortunately, public and political demands forced CALFED to begin acting immediately, and planning, science, and assessment have been trying to catch up.

Such large-scale, multifaceted, long-term programs can be evaluated only through examination of underlying mechanisms at smaller scales, adaptive manipulations at moderate scales, and modeling to aggregate results to the system scale, considering variability and large-scale influences such as climate change. Several case studies illustrate how evaluation aggregates information at different scales. Many CALFED and other restoration efforts focus on salmon, because they are valued by the public, integrate through the entire system, and may be sensitive indicators of ecosystem condition. The endangered winter-run Chinook salmon (*Oncorhynchus tshawystscha*) declined to fewer than 200 adults in the early 1990s but has since been increasing due to changes in water project operations affecting spawning and migratory success, reductions in ocean harvest, and supplementation by hatcheries. However, lacking a formal system of assessment, these effects can be estimated only retrospectively, and with wide confidence limits.

One approach to restoration of rivers and streams focuses on manipulation of physical habitat, mainly to improve conditions for salmon spawning. However, in most tributaries available flow is insufficient to provide the dynamic conditions that create and replenish salmon habitat. It is possible that a miniaturized river can serve the function of the original stream at a lower flow. Planned flow manipulations in several tributaries will test this concept, providing our first moderate-scale example of active adaptive management. Restoration in the San Francisco Estuary has emphasized increasing the extent of shallow habitat, but recent investigations have shown limitations due to subsidence and invasive plants and animals. The greatest promise for restoration may be in intertidal marshes and floodplains. Juvenile salmon appear to feed and grow more rapidly on floodplains than in adjacent rivers. Opportunities for restoration in floodplains may therefore improve growth and survival of young salmon, and are at the moderately large scale most amenable to active adaptive management.

The greatest likelihood of success in evaluating restoration appears to be at a spatial scale of kilometers to tens of kilometers and a temporal scale of years to a decade. Success of the overall program, however, will be determined at much larger scales, where external factors are most likely influence success. Determining the contribution of restoration to the long-term trajectory of California's ecosystems may be the greatest challenge in this program.

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Hamilton City: Changing A System One Project at a Time

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Hamilton City - a microcosm of the Central Valley of California - serves as an example to the multiple agencies, non-government organizations, and local interests working together to meet the water resource needs of the future.

The community consists of less than 2,000 people situated along the Sacramento River. Locals constructed a levee early last century to protect the community. The levee enabled agricultural production to thrive and lands were converted from native habitat. Floodplain processes were severed by the levee. The levee was not constructed to engineering standards and the community lives at risk from flooding. For thirty years, Congress repeatedly directed the Corps of Engineers to evaluate potential for a Federal flood control project, but economic benefits have never been sufficient to justify project costs. Meanwhile, resource agencies and The Nature Conservancy have zeroed in on the area as being a critical link in restoration of the Sacramento River.

The opportunity to try something different came following widespread flooding in 1997. Congress and the California legislature authorized a comprehensive evaluation of the flood management system in the Sacramento and San Joaquin river basins. For five years, the Comprehensive Study evaluated the existing system and explored improvements. Technical issues, geographic characteristics, and stakeholder concerns ultimately combined to refocus the system-wide effort into smaller, regional projects. Even those projects will take decades to develop as stakeholders work through the issues that divide them. Out of the 42,000 square-mile river basins, Hamilton City was the only project ready to advance to detailed study. This was largely because (a) stakeholders recognized the problems, (b) they had worked at odds long enough to know compromise was the way progress; and (c) funding was available.

The feasibility study for Hamilton City has tackled may stumbling blocks facing water resource interests today: conversion of agricultural lands to native habitat; ecosystem restoration methodologies; setback levees; justifying multiple-purpose projects; and partnerships. Other regions, frustrated by the challenges the Comprehensive Study faced, are noticing Hamilton City and beginning to take steps to initiate studies of their own. While some of the suggestions the Comprehensive Study explored seemed unreasonable to stakeholders, idea of doing nothing to address the water resource problems that remain is just as objectionable. It seems that the way to address large-scale change is to learn via small steps, then apply more broadly.

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Enhancing the Quantification of Fish and Wildlife Habitat Gains in the Great Lakes' Areas of Concern Through the Broader Use of Habitat Evaluation Procedures

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Degradation of fish and wildlife populations and loss of fish and wildlife habitat have affected Areas of Concern (AOCs) in the Great Lakes basin. Remedial Action Plans have been underway since the 1980s to restore beneficial uses in the AOCs. Habitat restoration efforts in some of the forty one AOCs may have been hindered by a lack of well documented calculations of losses and gains in habitat quality and quantity. Additional efforts are required to more fully restore aquatic habitat conditions in the AOCs.

Habitat Evaluation Procedures (HEP) were developed from 1974 through 1980 by the U.S. Fish and Wildlife Service to document the non-monetary value of fish and wildlife resources. Habitat quality is documented with a habitat suitability index (HSI). HEP have not been widely utilized in the remedial activities within the Great Lakes basin. Without adequate documentation, the benefits derived from some habitat restoration efforts may be difficult to discern. Broader use of HEP could assist in achieving timely and more cost-effective restoration of fish and wildlife habitat in AOCs. Many AOCs are subject to considerable developmental pressure and considerable losses of habitat units could result from future development activity. Use of HEP could provide projections of habitat units under various management conditions. These projections would allow better accounting of positive or negative impacts due to any planned activities. Since over 155 HSI models have been developed, habitat suitability for a range of species could be tracked and predicted in the Great Lakes basin.

Broader use of HEP in the Great Lakes basin could assist in enhancing current habitat restoration decision-making and would provide scientific documentation for necessary future management actions.

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Fish Introductions into Everglades Wetlands: An Unforeseen Consequence of Restoration

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Introduced fishes currently impede fulfillment of management objectives in Everglades National Park (ENP). By the mid 1980s, seven species of introduced fish had become established in ENP. From then until 2000, we found no additional introduced species in the park. Since 2000, we have collected four additional species of introduced fishes during research and monitoring studies in ENP, demonstrating renewed colonization of the region. Here we report the identity and habitats of the additional species, factors aiding the range expansions, routes of colonization, and possible unanticipated effects of restoration.

Several widespread sampling programs employing electrofishing, minnow traps, and throw traps, have provided information on introduced species. Since 2000, the jewel, peacock, and jaguar guapote cichlids, and the brown hoplo catfish have been collected in ENP. These species were established in the canal system east of the Everglades before moving into the park. The timing of these introductions has coincided with structural and operational changes in the South Florida water management system, such as the Interim Operational Plan (IOP), that redirected water deliveries in an attempt to protect endangered-species habitat and re-water drained wetlands. Those actions appear to have aided the dispersal of the fishes.

When introduced fishes enter the park, some disperse and increase in numbers quickly, while others exhibit slower expansion and population growth. Of the newly recorded species in ENP, the jewel cichlid has expanded in range and numbers rapidly whereas the jaguar guapote cichlid has progressed more slowly. These differences may relate to the adaptability of each species to available habitats. Of the natural habitats sampled, tidal creeks and karst solution holes have the greatest richness and relative abundance of introduced fish species. Introduced fishes are often the predominant survivors in deep holes in the Rocky Glades at the end of the dry season.

Introduced fishes are an important issue facing Everglades restoration. The tools to control or eradicate introduced fishes are limited or non-existent. Designing water-management alternatives that limit direct connections between natural areas and canal habitats may be a way to prevent introduction of introduced fishes. Additional species (e.g., Asian swamp eel, snakehead, grass carp, various cichlids) are established in the bordering canal system from which dispersal into the Everglades is very likely. If introduced fishes are not considered in the development, construction, and operation of water-management structures, “getting the water right” may compromise restoration and management mandates for natural areas.

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Visual_HEA: Habitat Equivalency Analysis Software

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Habitat Equivalency Analysis (HEA) is a means to determine the amount of compensatory restoration required to provide services that are equivalent to the interim loss of natural resource services following injury. The lost services are calculated from the time of injury through the recovery process. Recovery could be either via natural recovery or active restoration. The compensatory restoration services are calculated from the time of commencement through process of the chosen restoration. An injury to natural resources therefore involves a time component during which the ecological services that the resources provide are lost and over which the services of any compensatory restoration are gained. HEA uses a discounting procedure to account for asset valuation in that the total asset value is equal to the present discounted value of the future stream of all services from the natural resource or the compensatory resource. This concept of discounting is explained by an individual's preference for goods and services at any given time. Discounting takes into account that the further into the future that a service is provided, the less it is valued today. Therefore, the HEA approach is particularly well suited for analysis because it can be used to quantify the loss and recovery of resources and includes this time factor.

Visual_HEA is a program that provides an efficient method of calculating the required compensation. The program accepts input of parameters necessary to determine long-term service loss from the injury (injured area size and degree; times of injury, functional shape, and equilibrium; post-injury recovery); parameters to determine long-term service gain from compensatory restoration actions (times of restoration beginning and equilibrium; maximum service level; service gain function shape); and general program parameters (relative value of lost and gained services, baseline level of lost and gained services, discount rate).

Because HEA results are highly dependent upon assumptions, it is useful to examine sensitivity of results using a range of parameter values. Visual_HEA facilitates comparisons by offering an intuitive graphical interface that allows the user to modify input parameters and quickly alter the lost and gain service level shape functions. The ability to formulate many scenarios provides an efficient method of gauging the sensitivity of the required compensatory action scale to the analysis parameterization and time variability.

Visual_HEA is being made available free of charge to interested researchers affiliated with scientific institutions, and is provided for non-commercial use only. More information can be found at: http://www.nova.edu/ocean/visual_hea/index.html.

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Mercury Contamination of the Florida Everglades: A Convergence of External Forces and Natural Ecosystem Sensitivity

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Mercury (Hg) contamination of aquatic ecosystems is a global issue that is presently at a cross roads of substantial science-policy debate. The dominant source of Hg to most aquatic ecosystems is atmospheric deposition, and as a result, there are presently proposed regulations in the US and elsewhere to reduce Hg emissions. Due to uncertainties concerning where locally deposited Hg is derived from local, regional or global sources, scientists have been unable to answer questions from regulators and resource managers as to the timing and magnitude of benefits from possible reductions to Hg loading. In addition, although aquatic ecosystems are most sensitive landscapes to mercury inputs, variability among and within aquatic ecosystems make predicting responses to possible load reductions difficult. The Aquatic Cycling of Mercury in the Everglades (ACME) project has made many significant advances in understanding of the factors controlling Hg cycling and fate in the environment. One important discovery was that land-based factors can have an important role in controlling exposure of Hg to food webs. In particular, ACME scientists have demonstrated that three factors converge in the Everglades to control the distribution of methylmercury (MeHg), the most toxic and bioaccumulative form of Hg: sulfate from agricultural runoff; perturbations to the natural hydrologic cycle; and, Hg deposition from the atmosphere. In the past few years, ACME project scientists have focused on determining the relative importance of these three factors, and whether the Everglades restoration process could be expected to affect Hg toxicity in the future.

In the past three years, the ACME project has conducted extensive in-field experiments intended to help elucidate how Everglades Restoration activities may affect Hg toxicity in the future. Our basic approach is the use of *in situ* mesocosms (or wetland enclosures) to determine the individual responses of MeHg formation to alterations in critical water quality constituents (Hg, sulfate, dissolved organic carbon (DOC), and phosphate). Several expected, as well as unexpected results were apparent from the mesocosm-dosing experiments. Not surprisingly, Hg dosing rate was positively related to MeHg levels in sediments, water, and the food web (mosquito fish and periphyton). Sulfate-only additions at low, medium and high levels yielded nonlinear results that mimicked the sulfate-MeHg distribution of the Everglades; greatest MeHg production responses were observed at the medium dosing level and corresponding lower levels at low and high sulfate additions levels. Somewhat surprisingly, the addition of DOC alone stimulated the production of additional MeHg from “old” (previously existing) and new mercury in sediments and subsequent release to the overlying water and food web. These results suggest DOC plays a direct role in facilitating the methylation process, rather than the common assumption that DOC is simply an effective ligand for mercury in aqueous solution. However, it is important to point out that although DOC amendments facilitated MeHg production, it also showed pronounced ability to retard transfer MeHg into the food web.

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Habitat Use by Wetland Fish Assemblages: Establishing Baseline Community Conditions for Wetland Restoration in Tampa Bay, Florida

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Restoration and creation of salt marsh and mangrove wetland habitats has become more widespread during the last decade. However, the creation of a functional wetland system still proves to be much more of a challenge than simply creating wetland structure. A thorough understanding of faunal ecology, including that of the fish communities which use wetland habitats, is necessary for the successful creation of a functional wetland.

In order to assess fish community response to wetland habitat restoration, fish ecologists at the U.S. Geological Survey's Center for Coastal and Watershed Studies in St. Petersburg, Florida have initiated, as part of the larger Tampa Bay Integrated Science Study, a three year sampling program at selected wetland sites within the estuary. The primary objective is to establish a quantitative baseline of fish community conditions at wetlands in Tampa Bay, specifically those wetlands scheduled for restoration. In order to accomplish this objective, we will: (1) establish a species inventory of wetland fishes, pink shrimps and blue crabs, with emphasis on two assemblages: marsh residents/transients and economically valuable species; (2) characterize wetland habitat types based on vegetation, substrate, hydrology, and water quality; (3) determine the spatial use of wetland habitats by fish assemblages.

Sixty-six fixed-sample sites were chosen randomly from wetland areas of several county preserves throughout the estuary and were sampled quarterly with a center-bag seine net. Wetland habitats were characterized by documenting the width, length and bottom profile of the ditch/creek site. Substrate type and depth, water depth, flow, and quality were measured at all sites, as were shoreline and bottom vegetation. Faunal community structure was described by identifying and enumerating fishes, pink shrimp and blue crabs collected in replicate haul seine samples. During the first six months of sampling, 54,517 individuals comprising 60 species were collected. Sixteen species comprised 90% of the total catch. Dominant species included marsh residents: mosquitofish (*G. holbrooki*) and sailfin mollies (*P. latipinna*) as well as the transient species: spot (*L. xanthurus*). Sixteen species of economic value were collected and comprised 18% of the total catch, with spot, red drum (*S. ocellatus*), blue crab (*C. sapidus*), mullet (*Mugil* spp.) and pink shrimp (*F. duorarum*) as the most abundant. Following the completion of Year 1 sampling, differences in species abundance, composition, and diversity, as well as size structure and overall biomass will be used to define community structure. Habitat characteristics influencing fish community structure will then be delineated using multivariate statistics. The results of this study will provide baseline community conditions for wetland fishes in the Tampa Bay estuary.

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Feasibility Study for the Restoration of Oxbows and Wetlands Along the North Fork St. Lucie River, Florida

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The St. Lucie River is approximately 35 miles long and is comprised of two branches - the North Fork and South Fork. The majority of the North Fork floodplain is within an aquatic preserve and flows to the St. Lucie Estuary. The watershed of the North Fork was expanded significantly by the creation of Five Mile and Ten Mile Creeks during the early 1900s and these alterations have caused dramatic changes in salinity due to the increase in surface water drainage area. The results of dredging have also led to the partial or complete isolation of a number of oxbows and floodplain wetlands along the river which has reduced habitat coverage and functions and values for fish and wildlife. Dredged material was placed along the banks of the river creating spoil berms that range between 2 to 25 ft high and 10 to 50 ft wide. As a result, a number of natural communities within the original water course including tidal swamp and forest, floodplain swamp and forest, baygall, and oxbows (black water river, sloughs, and streams) are not fully connected to the main river branch. A significant portion of the river's natural flow path has been altered, resulting in altered salinity gradients, stagnant stream reaches, and sedimentation within isolated oxbows.

This presentation will discuss the results of a recent feasibility study performed for the Florida Department of Environmental Protection (FDEP) to determine the restoration potential of reconnecting isolated oxbows and wetlands along the NFSLR. The results of field investigations, hydrologic analyses, and GIS mapping conducted to evaluate the feasibility of oxbow and wetland reconnection, along with a cost benefit analysis of various restoration alternatives will be presented. In addition, the direct and indirect benefits associated with oxbow restoration for the NFSLR will be discussed.

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Development of Monitoring and Assessment Plan (MAP) for Everglades Restoration

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The Comprehensive Everglades Restoration Plan (CERP) is a 35-year, $8-billion program comprised of approximately 60 water-management components designed to assure local water supplies and flood protection while re-establishing natural flows to the Florida Everglades. Authorized by Congressional legislation, the MAP is the primary tool by which the REstoration COordination and VERification (RECOVER) program will assess the performance of the CERP. Under this $10-million/year monitoring program, the scientific and technical information generated will be organized to provide a process for RECOVER to evaluate CERP performance and system responses and to produce assessment reports describing and interpreting these responses.

The overarching goal for implementation of the MAP is to have a single, integrated, system-wide monitoring and assessment plan that will be used and supported by all participating agencies and tribal governments. Aside from providing a means of tracking and measuring the performance of the CERP, it will also allow scientists, managers and decision-makers to make informed decisions as part of the adaptive management framework being applied in this effort. The CERP monitoring program is built upon a strong science foundation yet structured to be logistically and economically feasible, as well as sustainable over the long term, and to provide data at appropriate spatial and temporal scales to support the CERP Adaptive Management Program.

The initial draft of the MAP was focused on 150 performance measures proposed for use to assess the restoration success of CERP. Through an initial round of agency coordination it was revised to reduce the number of performance measures and to center it around the various physiographic regions of the south Florida ecosystem, specifically tailored to highlight the CERP hypotheses, ecological premises, and monitoring components applicable to each geographic region. The MAP is organized into five main sections: *Section 1*, Purpose and Scope of the CERP MAP; *Section 2*, Development of the MAP and a description of the CERP Adaptive Management Program; *Section 3*, Integrated Monitoring Requirement including the initial six monitoring modules designed to evaluate the performance of the CERP as it is implemented and to test the working hypotheses contained within the conceptual ecological models; *Section 4*, Quality Assurance/Quality Control and Data Validation, Management, Evaluation and Reporting; and *Section 5*, Implementation Strategy for the MAP. *The Appendices* contain the eleven conceptual ecological models covering the major physiographic regions of South Florida as well as a summary of the direct and indirect effects of projects as they relate to the modules.

The Final MAP version released in January 2004 is Part 1, Monitoring and Supporting Research (science needs). Part 2 is being developed, and will further develop and provide the assessment strategy and processes, including reporting.

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Hydrodynamic Modeling Efforts of the U.S. Geological Survey in Support of Everglades Restoration

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The U.S. Geological Survey (USGS) has developed two hydrodynamic models for the southern Everglades to better understand and predict hydrologic conditions, including the mixing of salt and freshwater within the coastal mangrove fringe. The Southern Inland and Coastal Systems (SICS) model, which was developed first, encompasses the Taylor Slough area and northeastern Florida Bay with 305-m grid resolution. The second model, referred to as the Tides and Inflows in the Mangroves of the Everglades (TIME) model, is coarser in resolution (500 m), but covers a much larger area than SICS, including Shark and Taylor Sloughs, the Gulf of Mexico, and northern Florida Bay (see Schaffranek and Riscassi, these proceedings). Although TIME encompasses the SICS model domain, the SICS model will continue to be used to provide detailed simulations for the Taylor Slough area. Both models use the Flow and Transport in a Linked Overland/Aquifer Density Dependent System (FTLOADDS) computer program to simulate coupled surface water/groundwater flow and solute transport. Subsequently, output from both models is similar and consists of flows, stages, and salinities in the wetlands and underlying aquifer system. SICS and TIME simulations have focused primarily on the period from 1996 through 2002 and use sub-hourly timesteps to capture hydrodynamic responses to high frequency stresses, such as tides. This 7-year period was selected because it encompasses the 5-year data set used for Florida Bay studies (1996-2000), and because it correlates with the focused data collection effort of the USGS and other agencies in the southern Everglades. Model input and output data are available from the USGS SOFIA website.

The original motivation for SICS and TIME was to synthesize highly varied Everglades hydrologic and hydrochemical data, assess optimal data collection locations to resolve uncertainties, and evaluate dominant hydrologic processes. However, because SICS and TIME are unique in their ability to represent the complex hydrodynamic conditions, new applications are continuously evolving. For example, as part of the Florida Bay/Florida Keys Feasibility Study (FBFKFS), the USGS is providing simulated estimates of freshwater flows to Florida Bay modelers (see Wang and others, these proceedings). In addition, a link was established between SICS and the South Florida Water Management Model (SFWMM), which allows for accurate prediction of freshwater flows to Florida Bay under restoration conditions. Another application is the use of SICS model-derived salinities in conjunction with the ATLSS models (Across Tropic Level System Simulation) to assess restoration effects on fish populations (see Swain and Cline, these proceedings). Future applications with SICS and TIME will include the capability to simulate water quality and the use of optimization schemes to improve management strategies.

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A New Aerial Survey Method to Monitor the Response of Manatees to Restoration of the Florida Everglades

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The endangered Florida manatee is a coastal near-shore and riverine marine mammal dependent on freshwater for drinking and seagrass and freshwater vegetation for forage. Hydrological restoration of the Everglades should result in changes to freshwater availability and seagrass quality and quantity, thus changes in manatee habitat use and distribution are anticipated. Because manatees move freely along the coast, they are ideal indicators of environmental change in the estuary and can be monitored at a relatively large scale with aerial surveys. Estimation of habitat occupancy from analysis of survey counts, however, is biased because not all animals are detected. Detection varies with viewing conditions and observer, and some unknown fraction of the population can be below the surface and unavailable for viewing. We are developing a new approach, which makes use of new capture-recapture statistical models (MacKenzie et al. 2002, MacKenzie et al. 2003) that estimate the proportion of area occupied (PAO) by a species, while adjusting for detection probabilities less than one. In addition to less biased estimates, the approach allows us to model and test for effects from habitat variables proposed to influence manatee distribution and habitat patch occupancy. We apply the new methods to data collected during fixed-transect strip surveys of manatees in the Ten Thousand Islands region of south Florida. Restoration north of the region in the area of the Southern Golden Gate Estates is planned and pre-restoration aerial survey data were collected in 2000, 2001, and 2002. We directly estimate detection probabilities with capture-recapture analysis of sighting data from two independent observers and the resighting of manatees during multiple flights over the transects. We model possible effects on occupancy rates due to habitat type, proximity to foraging beds, and proximity to freshwater sources.

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The Feasibility of Marsh Restoration and Connectivity in the New Jersey Hackensack Meadowlands

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The Meadowlands, which once contained 17,000 acres of wetlands, has lost nearly half of these wetlands as a result of hydrologic and environmental alterations. Of the remaining wetland areas, over 5,000 acres are vegetated by *Phragmites australis*. Restoration of intertidal wetlands in the Meadowlands typically involves (1) re-establishment of historic tidal flow patterns, and (2) removal of *Phragmites* and replacement with other marsh plants (e.g., *Spartina alterniflora*). Restoration of intertidal marsh that results in expansion of a shorter, sparser community with little-to-no *Phragmites* is expected to net an overall improvement in habitat quality for fisheries and wildlife species, and maintain marsh-open water trophic linkages.

In spite of the presumed benefits to marsh ecology by the removal of *Phragmites*, we question the feasibility of functional restoration in the Meadowlands due to inherent difficulties in marsh restoration, and the strongly urban context of this site. Due to their position within the watershed and historical and current landuse, the Meadowlands do not act as pristine or “textbook” marsh ecosystems (e.g. New England salt marshes or mid-Atlantic brackish and freshwater marshes). Although there has been much talk about restoring wetlands in the Meadowlands, and, in fact, there have been a number of wetland restoration projects, we argue that to date there is little or no evidence these restorations contribute to greater functioning of the Meadowlands ecosystem. Furthermore, compliance success (i.e., required rates of revegetation) does not necessarily mean that functional progress is being achieved.

This poster examines some of the difficulties in measuring marsh function in the Meadowlands, and relating compliance success with functional progress. We propose an approach designed to supplement current techniques with cumulative indices and alternative metrics (e.g. soil organic matter accumulation, enzyme analyses, stable isotope analyses) to link compliance with functional progress at the landscape level (e.g. larval fish recruitment and trophic transfer). Our approach combines knowledge from past restoration efforts, literature on physical/chemical/biological mechanisms of salt marsh functions, experimental manipulation on test sites, and a survey of biological tracers across the marsh sites to infer connectivity. In sum, we propose the use of alternative metrics by the regulatory community to aid in monitoring and achieving functional progress at the landscape scale.

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Restoration Program Assessment for the National Estuarine Research Reserve System (NERRS)

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The National Estuarine Research Reserve System (NERRS) encompasses a network of 26 protected areas in the United States. The National Oceanic and Atmospheric Administration's (NOAA) Estuarine Reserves Division (ERD), has responded to a recent Congressional mandate with a programmatic review of the reserve system, with a focus on habitat restoration and restoration science activities. A standardized sampling instrument was developed for data collection. Responses were received from 23 of 25 reserves surveyed. The results of the survey indicate that all of the responding reserves are involved, at some level, in restoration related projects. Standard protocols for prioritizing, selecting and monitoring restoration projects are currently employed or under development at the reserves. The restoration inventory, along with site visits conducted in 2003, provide significant insight into the status of restoration science and habitat restoration projects in the reserve system. Many reserves are very active in restoration science and provide examples of the use of innovative technologies for restoration projects. Some sites are developing formal restoration programs; others may lack the personnel and/or resources necessary to become active in restoration science.

The reserve system has committed time and resources to the development of a national restoration science strategy. At the same time, individual reserves have actively engaged in site-specific restoration activities. With the implementation and continued development of the NERRS Restoration Science Strategy Framework, and continued support at state and local levels, the reserve system has the potential to be one of the most significant and advanced venues for habitat restoration, science and education in the United States.

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Restoring Tidal Influences to a Historically Impounded System in Westchester County, New York

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For over 80 years, an impounded "coastal lake" system (called Manursing Lake) has existed at present-day Edith G. Read Natural Park and Wildlife Sanctuary adjacent to Playland Park in Rye, NY, which is adjacent to Long Island Sound, on habitat that was once tidal marshes, mudflats and embayments. The present-day habitat includes a large saline coastal lake (80.2 acres) and a smaller lake-like impoundment (16.5 acres) connected by a 72-inch culvert fringed with upland vegetation and some patches of saltmarsh grass (*Spartina* spp.) and common reed (*Phragmites australis*). For several decades, tidal exchange between Long Island Sound and these water bodies has been limited by a culvert blocked by large stone riprap at the northern end and a manually controlled, rarely-opened tide gate at the southern end. As a consequence, the habitat has limited fish access, poor nutrient and sediment exchange, low dissolved oxygen concentrations and some *Phragmites* encroachment. Restoration of some tidal flow to this site is a priority of the Long Island Sound Habitat Restoration Initiative as well as local, state and federal agencies. Furthermore, restoration of these tidal wetlands will result in an important sheltered salt marsh for southern Westchester County.

In 2003, we completed a feasibility study to evaluate restoration strategies at Manursing Lake. The feasibility study evaluated existing conditions and proposed a series of restoration alternatives to restore some tidal exchange in the system. Components of the study included a bathymetric survey, hydrological modeling, natural resource inventories, and restoration alternatives, but most importantly resulted in a meeting of the minds of several federal, state, and local associations. Restoration alternatives evaluated included different combinations of engineering solutions such as self-regulating tide gates, functional culverts, and optional dredging at the northern and/or southern ends of the impounded system. The team evaluated several restoration alternatives that differed by the amount of tidal fluctuations on a daily basis (e.g., 2-foot, 4-foot, and 7-foot fluctuations). The variable tidal fluctuations will all differentially influence the reduction of *Phragmites* stands, cycle nutrients, filter sediments, improve wildlife habitat and increase overall productivity. The Manursing Lake Project is an excellent example of a project with limited funding and highly pro-active stakeholders.

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Using Vegetation to Establish Minimum Flows for the Alafia River in West Central Florida

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Florida water management districts are required to establish minimum flows and levels at which further withdrawals would be "significantly harmful" to state waters. The purpose of this study was to evaluate vegetation, soils, elevation, and hydrologic conditions in wetlands as potential criteria for establishing minimum flows for the Alafia Rver. Plant species composition and dominance, soil characteristics, and elevations were measured and evaluated for 8 transects along the river. Hydrologic analyses and elevation data were used to evaluate periods of inundation.

Six distinct vegetation classes were identified along the study corridor: dry palm banks, palm/cypress swamps, cypress swamps, hardwood swamps, wet hardwood hammocks, and dry hardwood hammocks. Discriminant function analysis was used to measure the contribution of elevation, distance from river channel, and soils characteristics in separating vegetation classes. Vegetation classes were correctly classified in 38 percent (cypress swamps) to 83 percent (palm/cypress swamp) of the cases. In addition, relative elevations, distance from channel, and hydric soil index were all significant ($p < 0.01$) in separating vegetation classes from each other. Soil index had the strongest correlation with vegetation class ($r^2 = 0.73$), while correlations with relative elevation ($r^2 = 0.25$) and distance from river ($r^2 = 0.23$) were lower.

Total and consecutive days of inundation were greatest for palm/cypress swamps and least for dry hardwood hammocks in the study corridor and consecutive days of inundation of a vegetation class were generally about half of the total days. Total days of inundation during the period 1970-2000 were about half of that for 1933-1969 and there were also fewer two-week inundation periods (necessary to preclude upland plant species from wetlands) for post-1970 stream flows. Based on river stage, wetland vegetation along the Alafia River was inundated less frequently than reported for the southeastern U.S., although inundation patterns were similar.

There is evidence that low flows in the Alafia were greater from 1970-2000 when compared with 1933-1969, while high flows have decreased. These results are consistent with rainfall patterns attributed to the Atlantic Multidecadal Oscillation (AMO), a naturally occurring variation in sea surface temperature and subsequent rainfall patterns that occurs every 20 to 50 years, e.g. in the Peace River. Therefore, long term hydrologic trends should also be considered as part of any proposed MFL regime. Other sources of variation that influence the water table to the soil surface, and therefore wetland vegetation composition, include antecedent rainfall, overland and groundwater flow, adjacent topography, and groundwater discharge. In addition, vegetation composition can be strongly influenced by conditions under which initial establishment occurred, such as historically different inundation regimes, rainfall patterns, or disturbance.

Based on these results, cypress, hardwood, and palm/cypress swamps may provide a criterion on which to establish minimum flows for vegetation communities along the Alafia River.

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Restoration of a Wisconsin Seepage Lake by Hypolimnetic Withdrawal

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In 2002 a siphon pipe system was installed in Devil's Lake, Wisconsin to withdraw phosphorus (P)-rich water from the lake's bottom waters (hypolimnion) during late summer and early fall over a 15-year period. Hypolimnetic withdrawal was chosen as the technique to restore the 151-ha, 14-m deep seepage lake to its original pristine state because field and laboratory studies confirmed that internal P loading rates could be significantly reduced after multiple withdrawals, and because external P inputs from sewage and agricultural runoff had been eliminated. Other lake restoration techniques were deemed unsuitable due to cost (dredging), short-term effectiveness (chemical treatment and especially aeration), or unsuitable (chemical treatment) for a lake designated an "Outstanding Resource Water" in Wisconsin's most popular state park. Water quality objectives for the lake restoration project include a reduction in excessive growths of algae (planktonic, filamentous, and periphyton) with indirect reductions in swimmer's itch problems and fish mercury concentrations.

The project budget was US$310,000 for installing the 1,680-m long, 0.50-m diameter pipe system that includes 1,265 m of lake pipe weighted with 50 metric tons of concrete to counteract the pipe's buoyancy. To replace the withdrawn water, low P runoff water from a nearby intermittent stream is being diverted to the lake using an historic diversion system that was refurbished in October 2003 as part of the project.

In 2002 when lake levels were abnormally high, the siphon was operated for seven weeks and removed 466 kg of P from the lake - over 4 times greater than the background external loading rate estimate of 110 kg. The withdrawal system was used less extensively in 2003 due to a prolonged drought, but 171 kg of P were still removed. Although not part of its intended purpose, the siphon was used briefly in the summer of 2004 to mitigate flooding conditions - a recurring problem for other Wisconsin seepage lakes. In this presentation, research that supported the decision to use hypolimnetic withdrawal to restore the seepage lake will be summarized along with the steps required to obtain approval and funding for the pipe installation. Finally, the installation of the hypolimnetic withdrawal system will be showcased and data for the first three years of the pipe's operation will be presented.

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Restoring Species Composition with Managed Wildfire in Old-growth Ponderosa Pine Forests

Daniel C. Laughlin
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Managing lightning-set wildfires under the strategy of Wildland Fire Use is an essential component of ecosystem restoration in old-growth ponderosa pine forests. Wildland Fire Use is the management of naturally ignited wildland fires to improve forest health and resources in fire-adapted ecosystems. Since the 1980s, several wildfires have been managed by the National Park Service on the North Rim of Grand Canyon National Park. The park's forests provide valuable examples of pre-Euroamerican settlement reference conditions due to their relatively uninterrupted fire regimes, limited grazing history, and protection from logging. Data on wildfire effects from relict sites are especially valuable since these fires may produce effects akin to presettlement processes.

In 1999, a low-severity Wildland Fire Use fire burned 156 ha on Fire Point, a peninsula dominated by old-growth ponderosa pines, which had not burned for at least 76 years. We measured understory plant community and forest floor characteristics in 1998 (1 year before the fire) and 2001 (2 years after the fire) at this site and at nearby reference sites that did not burn in 1999, but have had continuing fire regimes throughout the past century.

After the wildfire, the plant community at Fire Point shifted toward higher compositional similarity with the reference sites- due primarily to an increase in native annual forbs, especially *Gayophytum diffusum*, *Polygonum douglassi*, and *Chenopodium* spp. Species richness, diversity, and plant cover were lower at Fire Point than at the reference sites in both years. Few exotics were detected. Duff depths were reduced to depths similar to the reference sites. There was a significant inverse relationship between the ratio of duff:litter and species richness. This study supports the continued application of the Wildland Fire Use strategy in old-growth montane forests to maintain and improve forest health by restoring understory species composition and reducing fuel loads.

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Lessons Learned from Assessing River Restoration Projects in California

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The California node of the National River Restoration Science Synthesis (NRRSS) effort, led by the University of California at Berkeley and with important help from staff of the California Resources Agency and support from Calfed, has compiled basic data for over 5000 projects in the state (mostly from 1990 or later), and has conducted post-project appraisals (Downs ands Kondolf 2002) of subsets of projects in categories such as channel reconstruction, levee setback, dam removal, and environmentally-sensitive flood control. The task of surveying projects statewide has been complicated by limited record keeping and reporting for many projects, and incompatibility of existing data bases, which have used different project categories and recorded different types of information. Nonetheless, we can summarize some trends. Projects completed to date have emphasized (in order of decreasing numbers of projects) fisheries/instream habitat enhancement, bank stabilization/erosion control, education/outreach, and fish passage/instream species management. Fewer than five percent of projects had explicit monitoring components, and when the monitoring data were examined closely, they commonly provided an inadequate basis for project assessment because the variables measured were inconsistent or not appropriate to answer the questions, the monitoring period was too short, etc. In the future, we recommend that data collection for projects follow the format established for the national NRRSS study, and be submitted for review and entry into a supervised statewide data base, so that experiences from project performance can be more easily shared and drawn upon by those designing future projects, and so practitioners, funders, and proposal reviewers in California can more easily access experiences on similar projects in other states.

Our post-project appraisals (PPAs) of over 20 channel reconstruction projects indicate that project objectives need to be more clearly defined and articulated for many projects, and that a number of projects have not performed as expected because physical processes in the channel and watershed were inadequately understood. Commonly, funding has been available to construct a project but not to undertake scientific studies to plan the interventions and to evaluate their physical and ecological effects; in these cases the learning potential from failed projects is limited.

Reference:

Downs, P.W., and G.M. Kondolf. 2002. Post-project appraisal in adaptive management of river channel restoration. Environmental Management 29:477-496

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The Ecological Challenge, the Human Condition, and Community Based Restoration as an Instrument for its Cure

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We have entered an unprecedented period in human history. By the vigor of our consumption and procreation, the human species has modified our global environment at wide regional and global scales. At the close of the twentieth century, global warming, biodiversity losses, ozone and freshwater depletion, to name a few, are now recognized as human induced wide scale environmental transformations. In spite of admirable efforts to arrest some of these processes and restore environmental vitality, the pace humans modify the environment continues with considerable intensity. The future health of the biosphere for sustaining all life may be drifting close to the margins as environmental crises increase within the life span of the generation now coming of age. These destructive propensities have deep cultural and psychological roots that divide us from the rest of the environment. Significant social change is needed to offset these ecopathological tendencies for altering our collective relationship with the earth. Humans, with our unique capacity for self-reflection, are beginning to understand that the underpinnings to our current ecological problems lie within our attitudes, values, ethics, perceptions, and behaviors. New ways to reconceptualize our unity with the biosphere, understand downstream impacts, and link social behavior with environmental transformations are increasing with corresponding intensity. Community based restoration is a powerful means for facilitating this trend by reconnecting communities with their environment, regionally empowering citizenry, and fostering an environmental ethic based on ecopsychological health.

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Designing for Ecology and Community: Restoring the Neglected Spaces Enmeshed in Florida's Urban Sprawl

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A trash-lined stormwater drainage canal in West Palm Beach bordering a residential neighborhood and schoolyard. An old town dump on the shores of Lake Worth Lagoon. One hundred acres of abandoned vegetable farm encircled by retirement communities. The landscape is littered with remnant parcels of land, once on the outskirts of towns, now abandoned. Urban sprawl is forcing municipalities and inspiring citizen groups to rethink the role of neglected spaces. Golf Avenue Linear Park, Lantana Nature Preserve and Green Cay Wastewater Treatment Wetlands and Interpretive Center exemplify creative restoration design by weaving habitat, land use and citizens connection to nature into the local geography. Projects highlight a multi-disciplinary, collaborative approach combining the perspectives and expertise of restoration ecology, restoration design and site interpretation. In addition to created habitat, the canal now provides efficient drainage and an outdoor learning environment adjacent to a school. The restored dump also provides a community nature trail, site for field trips and a quiet setting for residents of the nearby assisted living facility. And, the created treatment wetland will help clean valuable freshwater while providing a regional destination for birders, nature photographers and residents who will experience wetland ecology and water conservation firsthand. This vision acknowledges the absolute necessity of both restoring functioning habitats, which may also serve a purpose for human society, and designing habitat that invites all members of the local community to connect with their "place" during daily life. We work towards healing human disconnect with the environment through restoring discarded urban spaces.

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Restoration of the Tampa Bay Ecosystem

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The Tampa Bay Ecosystem covers 6739 km^2, including a 5700 km^2 watershed, 967 km^2, of primarily unvegetated estuarine waters, with an average depth of 3.5 m, and 72 km^2, of existing emergent wetlands. Using the most probable distribution of historical emergent wetlands and submerged aquatic vegetation (SAV - primarily seagrasses), the last century has seen a loss of 81% of SAV and 41% of the emergent wetlands. Water quality became severely degraded in the mid 20th century, resulting in citizen led efforts to restore the estuary.

Over the last three decades major efforts to improve domestic sewage treatment and industrial discharges have significantly reduced chlorophyll a measured in the water column and benthic algal biomass. As a result, seagrasses have naturally recolonized 1791 ha of unvegetated benthic habitat due to improvements in water quality. Human-assisted plantings of seagrass have largely failed. The rate of seagrass recovery has slowed or stalled in some areas of the bay. The cause appears to be due to factors controlling the natural establishment of seagrasses, including loss of a large, natural, offshore bar system in some areas, and water quality degradation in other areas. Efforts are now focused on restoring this bar system through beneficial use of dredged material, and defining more clearly the specific water quality degradation parameters.

Shareholder reviews of target fish and wildlife species and guilds, and analyses of the historical distribution and ratios of various emergent wetland types (mangroves, cordgrass marshes, needlerush marshes, salt barrens), resulted in an emergent wetlands target restoration plan referred to as "Restoring the Balance." This strategy targets the acquisition, protection and restoration of the habitats of the various priority fish and wildlife guilds that represent "choke-points" or apparent limiting mechanisms on successful maturation of larval fish and invertebrates and recruitment to adult populations, and management of feeding and nesting areas for coastal seabirds and wading birds. Application of this management principle to restoration has produced 428 ha of a mosaic of coastal uplands and wetlands over the last 33 years. Several thousand ha of more restoration are planned over the next several decades. Within the watershed, stormwater management projects are targeting reduction in nutrient and suspended materials discharges to the Bay. Freshwater wetland restoration within the watershed is a newer initiative needing greater emphasis, particularly within riverine systems.

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Risk Communication in Community Participation: CERCLA's Lessons for Everglades Restoration in South Florida

Alfred R. Light and *Maria Dolores Espino*
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In 1986 Congress formally mandated and elaborated CERCLA's administrative process and limited system of judicial review, detailing public-participation requirements and backing them with citizen suit-enforcement procedures and citizen rights to intervene in federal suits against potentially responsible parties. Because of the nature of the overall ecosystem in South Florida, however, during the past two decades the EPA's Superfund program has run into difficulties selecting remedies for a number of national priority list (NPL) sites. Because groundwater pollution from various sites migrated throughout one large aquifer, the EPA consolidated its remedial decisions at various times, complicating the mandated site-specific citizen-participation processes. The Army Corps of Engineers faced a similar situation in the Central and South Florida Project over the years. Numerous flood control projects served the narrow purposes for which they were designed but dramatically changed the ecology of the Everglades. In its Restudy and the subsequent Comprehensive Everglades Restoration Plan, however, the Corps and other governmental entities developed different citizen-participation frameworks that appear to have garnered much greater public participation than that which typifies its permit programs.

On the surface, CERP's situation appears very different from that of CERCLA in that for CERP special intergovernmental institutions are growing up to advocate and manage coalition and consensus building. Such institutions include the South Florida Ecosystem Restoration Task Force, the Governor's Commission for a Sustainable South Florida [now the Governor's Commission on the Everglades], and the Everglades Coalition. This cooperation has produced higher-profile campaigns for risk communication and citizen participation for CERP than appear to have existed in connection with CERCLA in South Florida. Nonetheless, there are interesting parallels between the CERCLA and CERP programs from a risk communication perspective.

This presentation focuses on two of these parallels - that is two of CERCLA's "lessons" for Everglades Restoration in South Florida: (1) the problematic use of legal standards developed for regulatory purposes (e.g., CWA, SDWA, RCRA) as restoration criteria, and (2) the role of litigation (judicial review) as a method of dispute resolution in remedy selection processes. This research is being funded by a grant from the United States Environmental Protection Agency to St. Thomas University - 2002 Minority Institutions Program: Hazardous Substance Research, STAR Grant # R830843 - "Risk Communication in Community Participation: Comparing Regional Programs in South Florida."

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National Ecosystem Restoration Conference (NCER) Best Practices Workshop

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Ecological restoration efforts are now underway in every quadrant of the nation. Some attempts at large-scale environmental mitigation and ecological restoration like the Chesapeake Bay and Columbia River date back to the 1980s. More recently, the Bay/Delta Authority and Shared Salmon Strategy for Puget Sound are making considerable contributions to the understanding and direction of ecological restoration. The Everglades Restoration, the flagship of large-scale restoration efforts as declared by Congress, is the most ambitious and comprehensive restoration underway in the world. Still more projects are underway in the Saltan Sea in Southern California, Coastal 2050 in Louisiana, and the recovery programs being initiated in the Missouri River and the Gulf of Maine.

The challenge of these restoration programs is shifting from obtaining authorization and restoration planning to implementation, monitoring and assessment, adaptive management, collaboration and dispute resolution, data synthesis techniques, and effective communication of restoration ecology. These are the issues that are being addressed at the NCER. The "Best Practices" workshop is intended to provide a process for identifying, compiling, and distilling the top science and technology being utilized as presented in the six topical tracks at the NCER. The Best Practices Workshop is proposed as a 3-hour session on December 10, 2004 in which participants at the NCER will have the opportunity to discuss which tools, techniques, ideas, and infrastructure for ecological restoration appear to set the bar for future efforts.

Listeners will be posted in various NCER sessions to prepare notes on presentations that capture new and tested principles, guidelines, "rules of the road, "ways of doing business" and ideas that are gaining traction and producing desired results. This workshop will attempt to draw together a representative sampling of these "best practices" and invite NCER participants to join in the 3-hour session to discuss various topics and nominate practices as exemplars of what the field has to offer. John Ehrmann of Meridian Institute will be leading the workshop and providing facilitation.

The Best Practices Workshop is being piloted at an estuaries conference in Seattle during mid-September 2004. The results of that effort sponsored by the Collaborative Adaptive Management Network will provide a framework for the NCER Best Practices Workshop in December 2004.

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Computational Challenges in South Florida Watershed Modeling for Ecosystem Restoration

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Computing water flow and/or contaminant transport within a given watershed is a MUST in evaluating restoration alternatives for the associated ecosystem, where water depth, salinity, and/or other constituent concentrations are key variables in desired performance measures. Although today's technology allows us to use denser observed field data and more accurate topographical and geological information on much more powerful computers than the past for watershed modeling, we are still facing many computational challenges in watershed modeling for ecosystem restoration when we try to use first-principle, physics-based distributed models to generate accurate computer results. In this paper, computational challenges concerning resolution issues, mesh aspect ratio issues, coupling issues (coupling between surface and subsurface and coupling between canal and overland), and convergence criteria issues will be addressed. All of these issues impact model run times. Some possible solutions for these issues, such as employing parallel computing, using the inset model for design-level purposes, and adopting suitable coupling algorithms, will also be discussed. The application of the first-principle, physics-based WASH123D model (a numerical model simulating flow and transport for WAaterSHhed systems composed of 1D river/stream network, 2D overland regime, and 3D subsurface media, Version 2.0) to modeling the water flow of south Florida watersheds will be taken as an example to demonstrate these computational challenges.

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Modeling the Water Flow of the Biscayne Bay Coastal Wetland Watershed System for Ecosystem Restoration

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Restoration of the South Florida ecosystem is a major undertaking for the U.S. Army Corps of Engineers and the South Florida Water Management District. The Biscayne Bay Coastal Wetlands (BBCW) Project is one of more than 60 projects included in the federally approved Comprehensive Everglades Restoration Plan (CERP, http://www.evergladesplan.org/) and has as its ultimate goal, to restore or enhance freshwater wetlands, tidal wetlands, and near shore bay habitat. This goal is to be met primarily by redistributing runoff from the watershed into the Biscayne Bay, away from the canal discharges that exist today, thus providing a more natural and historical overland flow through the existing and/or improved coastal wetlands. In an effort to restore the wetlands, several structures, management plans, and flow distribution scenarios may be considered. To help determine the best plan(s) for restoration, a valid BBCW flow model must be constructed to provide information, such as water depth and salinity, for use in the evaluation of performance measures.

This paper presents the BBCW flow model developed with the first-principle, physics-based WASH123D computer code. This model conceptualizes the BBCW watershed as a system composed of 1D canal network, 2D overland regime, and 3D subsurface media. A brief overview of the mathematical statements and numerical strategies of the model will be given along with some details regarding the development of the hydrogeologic conceptual model, the screening and processing of the field data, the selection of the model domain and boundaries, and the computation of the initial conditions. The paper will also describe the approach and results of the model calibration and validation. Any difficulties encountered during model calibration/validation will be addressed. Also, some modeling issues that may exist when future restoration alternatives are considered will be discussed, and possible solutions will be proposed.

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Urban Watershed Restoration in the Lower Bronx River, New York: Unique Challenges, Partnerships, and Technologies

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Urban watersheds are some of the most overburdened ecosystems in the world. Corridors that were important for trade and commerce in turn attracted high-density human settlement and its concomitant problems of increased nutrient loads and increased impervious surface. As there was a high demand for prime waterfront access by industries, much of the shoreline in urban areas has been altered to a degree where there is little or no trophic transfer and a loss of critical shallow water habitats. The desire to control the corridors of shipping and transit in a predictable fashion led to extreme modifications including rechannelization and armoring of shorelines. As a response to the growing concerns of the loss of the system functionality, efforts are underway to restore these urban watersheds. Challenges that arise with habitat restoration for anadromous and estuarine species within urban landscapes vary in each unique setting, although there are common problems of high land values and contaminant loads. While many of the local residents are coastal inhabitants, there is a general sense of dissociation from their nearby water bodies, usually as a result of industrial and water quality hazards. Certain habitat restoration programs operating in urban settings attempt to align the needs of the local citizenry with the needs of the ecosystem to restore functionality, which can stimulate a stewardship ethic under the banner of environmental justice.

The NOAA Restoration Center (RC) funds many fisheries habitat restoration projects in urban settings. Through partnerships with the New York City Parks Foundation and the Wildlife Conservation Society, the RC supports restoration efforts in the Bronx River. These partnerships involve many local community groups, seeking to promote a sense of connection to and stewardship for the Bronx River. This second order stream flows 32 km from its source from a reservoir north of Westchester, New York and empties into the East River. The park-like lands of the New York Botanical Gardens and the Bronx Zoo and the un-natural break in the course of the river at three dams within these park lands separate the dense suburban upper two-thirds of the river from the urban and industrial lower third. As it represents the habitat currently available for anadromous and estuarine resources, efforts have largely been targeted at the lower 10 km of the river. Although fisheries habitat restoration efforts have been made difficult by the lack of suitable restoration sites and the high costs of purchasing lands or conservation easements, they have provided opportunities for local citizens, especially inner-city youth in the lower Bronx River, to become actively engaged in the process of habitat restoration.

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Riparian and Wetland Restoration Projects in the U.S. Army Corps of Engineers Albuquerque District

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A number of restoration efforts are taking place throughout the southwest involving riparian and wetland habitat. The U.S. Army Corps of Engineers (Corps) Albuquerque District is working with a number of communities within the District (which covers New Mexico, southeastern Colorado and western Texas) in these efforts. Many projects are taking place along the Middle Rio Grande, which is the main focus of these efforts.

The Corps has a number of projects taking place under the Continuing Authorities Program. Two of these authorities are Section 1135 of the Water Resources Development Act (WRDA) of 1986 for Ecosystem Restoration and Section 206 of the WRDA of 1996 for Aquatic Ecosystem Restoration. Under Section 1135, restoration along the Rio Grande in Albuquerque is underway through the Albuquerque Biological Park Restoration Project and the Ecosystem Restoration at Route 66 Project. Under the 206 program, restoration is taking place along the Arkansas River in Colorado.

Numerous Corps restoration efforts are taking place under other initiatives. Under the Endangered Species Act (ESA) Collaborative program, Corps habitat restoration efforts are underway in Los Lunas, New Mexico. The ESA Collaborative program is a multi-agency non-profit group including federal, state, tribal and local entities working on restoration efforts along the Rio Grande from the New Mexico-Colorado state line south to the Elephant Butte Reservoir in New Mexico. ESA efforts are focused on the Rio Grande silvery minnow and the Southwestern Willow Flycatcher, both endangered species along the Rio Grande. Another project under the ESA Collaborative Program is about to begin at the Rio Grande Nature Center in Albuquerque.

The Corps is also providing assistance to local communities in and around Albuquerque for fire prevention in the riparian zone. The Corps is also embarking upon a General Investigation Feasibility Study to look at the long-term restoration of the Middle Rio Grande, beginning with the Albuquerque Reach.

Many of these efforts are intertwined and an evaluation program similar to that used on the Kissimmee River is being reviewed for applicability to the Middle Rio Grande.

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Simulation of Chesapeake Bay Water Clarity and Submerged Aquatic Vegetation

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The Chesapeake submerged aquatic vegetation (SAV) resource provides food for waterfowl and is critical habitat for shellfish and finfish. The nadir of SAV decline, which started in the 1960s, was reached in 1984, when SAV covered only 38,000 acres of the estimated 200,000 acre historical coverage. Since then, the SAV decline has been partially reversed, with a recent high in coverage of 88,000 acres reached in 2002. In 2003 the Chesapeake Bay Program set a new SAV restoration goal of 185,000 acres.

To reach this goal, further reductions in nutrients, and newly established reductions in sediment loads, are required. Reduction of Chesapeake sediment loads is necessary for improving water clarity. Suspended sediment scatters and attenuates light, and is a major impairment of Chesapeake SAV restoration. Sources of suspended sediment include watershed loads, shore erosion, and wave resuspension. To assist the Chesapeake Bay Program in estimating sufficient nutrient and sediment load reductions needed to achieve the SAV goal, the Chesapeake Bay Estuary Model Package, (CBEMP) is used.

The CBEMP is comprised of loading models of the Chesapeake watershed and airshed, and a decision model of estuarine water quality and key living resources. The key CBEMP models simulating sediment loads, water clarity, and the SAV response are a deterministic watershed model based on HSPF (Watershed Model Phase 4.3), which provides estimated daily loads of nutrients and sediment to a linked, deterministic, three dimensional, hydrodynamic and water quality model based on CH3D and CE-QUAL-ICM respectively. The CBEMP simulates the mechanisms related to SAV growth including light extinction due to water, dissolved organic material (color) , particulate organic material, suspended sediment, epiphytic algae, and planktonic algae. The water clarity criteria is discussed, and the level of nutrient and sediment load reductions required for the protection of SAV in the Chesapeake Bay are examined.

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Alternative Ecosystem States and the Likelihood of Restoration Success in Chesapeake Bay

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Rapid, non-linear ecosystem alterations have been demonstrated in lakes, oceans, coral reefs, forests, and arid lands. These drastic changes in ecosystem state are often facilitated by loss of ecosystem resilience due to environmental degradation, and may be subsequently triggered by catastrophic perturbations. We present evidence for a dramatic ecosystem alteration in an estuarine system, as evidenced by population phase shifts of floral and faunal species in Chesapeake Bay due to a catastrophic disturbance, Hurricane Agnes, in 1972 subsequent to extensive environmental degradation and loss of resilience. A similar and long-lasting ecosystem alteration occurred in the seaside lagoons of Chesapeake Bay following a 1933 hurricane, the Storm King. These findings highlight the dynamic nature of estuarine ecosystems, whose community structure is governed jointly by chronic (e.g., overfishing, pollution) and acute (e.g., catastrophe) disturbances. Such alternative states will make it extremely difficult to restore degraded ecosystems to historically "pristine" conditions.

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Success and Limits of a Marine Protected Area: the Blue Crab in Chesapeake Bay

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Restoration of the blue crab population in Chesapeake Bay, which has undergone an 80 % decline in abundance since 1992, has been approached through multiple avenues including classical fisheries management and newer techniques (i.e., Marine Protected Areas). The substantial reduction in the spawning stock that occurred in 1992 has persisted through 2004, and there is little indication that the spawning stock is recovering. On the contrary, it appears that the spawning stock is continuing to decline with a projected collapse in 2007-2008. In lower Chesapeake Bay, a 172,235 ha marine protected area and corridor (MPAC) was established to protect blue crab adult females either en route to or at the spawning grounds during the reproductive period. The MPAC was situated in waters deeper than 10 m due to the high abundances of adult females in this zone, and it was a major expansion (~300 %) of a historical spawning sanctuary near the bay mouth. Tagging data indicates that the spawning sanctuary has been effective in protecting females that have entered its borders during the spawning season, but that inadequate numbers of mature females are successfully migrating to the spawning sanctuary. The current management regime must be further altered to increase the numbers of mature females entering the spawning sanctuary, through a combination of extended spatial management zones encompassing migration corridors and nursery grounds, as well as effort reductions in fished areas. The MPAC serves as a foundation for long-term protection of the blue crab spawning stock, and should be utilized concurrently with complementary management measures to conserve the blue crab population in Chesapeake Bay. Furthermore, the MPAC for the blue crab in Chesapeake Bay may serve as a model system for investigating the value of marine protected areas for exploited marine populations with distinct stages that utilize diverse habitats.

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Kissimmee River Restoration–Overcoming Barriers and Seizing Opportunities

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The Kissimmee River Restoration Project employed several principles of adaptive management during the era of its field demonstration projects and the alternative plan evaluation and preliminary design processes that followed. During the last half of the 1980s, a number of practical field experiments were coupled with physical and numerical modeling analyses to address agencies' and stakeholders' questions that were shaping the future of this restoration project. Techniques used broke through barriers that had previously thwarted restoration progress. While conducting these studies, opportunities for and limitations to breaking through restoration barriers were experienced.

The Kissimmee River is located in central Florida and was channelized for flood control in the 1960s. The flood control project constructed a canal with a cross-sectional area approximately ten-times that of the natural stream channel. The canal shortened the original meandering path of 103 miles to 56 miles and left the remnants of the original river channel short-circuited and dying a slow death from no flow, sedimentation, and choking levels of aquatic plant growth. Additionally, to control the water surface along the canal, six spillways were constructed, terracing the waterway into level pools with six-foot steps between pools. The resulting floodplain drainage promoted conversion of more than 50,000 acres from floodplain wetlands to dryer agricultural lands. The headwaters of the river underwent significant water control regulation for the purposes of water conservation and flood control. Restoration challenges included undoing the effects of headwaters regulation, reestablishing proper floodplain dynamics, and revitalizing and "recreating" original river channels.

Winning support for Kissimmee River Restoration early in the restoration movement was aided by adaptive management. Lessons learned in the 1980s provide insights for today's restoration projects.

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Between the Rock and a Wet Place: Restoration of the Rocky Glades

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The Rocky Glades is a remnant of a large, short-hydroperiod habitat that separates Shark River and Taylor sloughs. It remains structurally intact only within Everglades National Park (ENP). Pre-drainage accounts indicate that this region was wetter and likely provided a better habitat for aquatic species. Drainage has reduced wet- and dry-season water levels. Today, hydroperiods rarely exceed six months, and aquatic animals must disperse, find refuge, or perish. Little data were available that described aquatic-animal community composition and successional patterns on the wetland surface until our study began in 2000. We developed a new trapping method to document relative abundance and catch per unit effort of animals during the wet season to address several questions: how rapidly do different species appear in the traps?; how does composition, size-structure, and recruitment of aquatic animals change during the flooding period?; and what is the source of colonizing fishes in the wet season? We found a rich community of 38 fish species, characterized by small-bodied livebearers, killfishes, and sunfish. Each year, adults appeared in the traps first, followed by juveniles within one month. Juveniles of larger-bodied species were collected later in the wet seasons. Peak catches occurred within one to two weeks of re-flooding, and again as the sites dried. We collected three newly introduced cichlid and catfish species, and two native species with expanding ranges.

The numerous karst solution holes in this region once may have been effective dry-season refuges. However, our data demonstrated that, today, nearly all fishes that entered the holes died when the waters receded because most holes dried. Most fishes that survived to the end of the dry season were introduced species, and were not the species that first colonized surface habitats. This observation suggests that colonists disperse into the Rocky Glades from elsewhere. The region is a “sink” habitat for aquatic fauna under today’s hydrological management, and depends on connections to other landscape units to replenish its fauna each wet season. We are investigating methods to determine the sources of those colonists.

Restoration of higher water levels in both the wet and dry seasons should enhance the biotic characteristics of the Rocky Glades by providing more persistent connections to other landscape regions, longer flooding of the wetlands to allow animals to build populations, and better animal survival in the dry season as a result of solution holes remaining flooded.

This study was funded by the Critical Ecosystem Studies Initiative by agreement between the U.S. Geological Survey and the National Park Service.

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Can Restoration Change the Role of Everglades Karst Holes as Sinks for Aquatic Animals?

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The karstic wetlands between Shark River and Taylor sloughs in Everglades National Park contain thousands of solution holes of varying areas and depths. In these short-hydroperiod wetlands, access to groundwater in those holes offers a chance for survival to aquatic animals during the dry season. Historically, groundwater levels apparently were higher than under current management. A proposed water-management plan for these wetlands suggests that water levels fall no more than 46 cm (1.5 ft) below ground level for greater than 90 days per year at an average periodicity of no more than once in three years. Today, water levels routinely fall more than 1.0-1.5 m below ground. The average depth of holes we studied was about 50 cm. Therefore, we studied whether the holes were sinks rather than refuges for aquatic animals, and whether an Interim Operations Plan (IOP) for water delivery begun in 2002 had had any effect on refuge quality.

Beginning in 2002, we sampled 30 holes for physico-chemical and biological data; in 2003 and 2004, we increased the number of holes to 40. We compared our IOP-period data to pre-IOP data from 1999-2000 (Kobza et al. 2004. Biological Conservation 116:153-165). Shallow to medium-depth holes had the highest fish species richness and most resembled the surface-water community. Those holes were the first to dry and lose their animals. The karst-hole environment became more adverse for fishes as water levels receded. Dissolved-oxygen levels were extremely low in the deep holes remaining wet late in the dry season.

At the beginning of the dry seasons, numbers and species richness of fishes were highest in the traps, but both declined as dry season progressed. Fishes were able to survive in solution holes until conditions became critical, although mortality continued through the dry season. Native cyprinodontoid fishes were abundant in shallow solution holes, while predatory native and introduced species dominated deeper holes. Apart from several newly introduced species taken during the study, patterns in our data differed little from the pre-IOP study.

Solution holes can serve as dry-season refuges if groundwater levels are maintained higher than under present conditions. An immense loss of fish biomass occurs when water levels fall below the level of the average solution-hole depth. To date, there is no evidence that management changes associated with IOP have improved the situation present during the pre-IOP period. The effects of groundwater management on dry-season habitats and refuges are critical to the survival of aquatic species and their re-colonization of surface-water habitats.

This research was funded through the Critical Ecosystem Studies Initiative by agreement between the U.S. Geological Survey (USGS) and the U.S. National Park Service.

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Current Loxahatchee Watershed Restoration Activities - Martin County, Florida

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Martin County's Office of Water Quality, headed by its Chief, Gary N. Roderick, was created to ensure the County's goals and objectives of protecting, restoring and enhancing the County's rivers and overall water resources. The Office of Water Quality is responsible for the development, design, and implementation of capital stormwater projects that improve and enhance local waters. The Office is further charged with working closely with the South Florida Water Management District (the District), the Florida Department of Environmental Protection (DEP), the U.S. Army Corps of Engineers (the Corps), as well as other State and Federal agencies in the development and implementation of the Comprehensive Everglades Restoration Plan (CERP) and other related water quality and resource projects that affect Martin County.

Tropic Vista and Little Club are two stormwater projects that will enhance and improve water quality, timing and volume of delivery of stormwater to the Loxahatchee River. As part of its efforts to assist in the restoration of the Loxahatchee River, Martin County, teamed with the District, the Florida Fish and Wildlife Conservation Commission (FFWCC) and DEP, has begun phase two of a study to address water resource related issues in the Pal-Mar/Cypress Creek Basin.

The Kitching Creek Restoration Project has been divided into two major components and will include headwater revitalization, rehydration of disturbed wetlands, redistribution of stormwater and restoration of historic wetlands bisected by the construction of Bridge Road (C.R. 708) and Flora Avenue. Martin County is working with the Florida Department of Environmental Protection to complete a water quality project for the North Fork of the Loxahatchee and with the U.S. Army Corps of Engineers to complete a restoration project for the upper basin area of Kitching Creek.

The major current land acquisition effort is the Pal-Mar East Project. This project is comprised of approximately 3000 acres of historic wetlands that has been converted, in large part, to rangeland. This parcel is key to the restoration of the Loxahatchee River and is the final link in establishing the greenway and trail from the Atlantic Ocean to Lake Okeechobee.

Martin County takes seriously its obligation to protect its natural resources. The projects outlined above illustrate a concerted effort on the part of the Board of County Commissioners to enhance water quality, expand wildlife habitat and provide extraordinary recreational opportunities. Implementation of these projects will secure and sustain the world-class quality of life for which Martin County is so well known.

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Linking the Science Needs of Restoration with Policy: Examples from the CALFED Bay-Delta Program

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Communication between scientists and policy makers is crucial to adaptively managing ecosystem restoration, but is not easy to accomplish. There were several indications of effectiveness in science/policy communication in the CALFED Bay-Delta program. Policy makers were engaged in technical aspects of issues. Science was accepted as credible. Scientific breakthroughs and long-term learning were not only evident but resulted in adjustments in the original plans. And, some felt the scientific discourse "helped smooth contentious waters". The linkage of science and policy was affected by the receptiveness of policy makers to scientific input, and the approach that was used to develop or describe science needs and present scientific findings or advice.

Communication between scientists and policy makers can take several forms. In advocacy debates, parties with differing views attempt to convince policy makers that one or the other is "right". CALFED explicitly tried to minimize advocacy debate in scientific forums. It is ineffective in defining uncertainties and science needs, or in inspiring collaboration. Advocacy science can cause policy deadlock and reduce the credibility of the scientists involved. "Science-based management" is another model that was avoided by CALFED. It assumes that scientists can and should tell policy makers what directions or decisions are the best choices. This approach assures that scientists are represented in policy debates, but it undervalues the non-science aspects of policy judgments, and can impede incremental resolution of difficult policy choices. It is not the most effective means of credibly clarifying uncertainties or defining future science needs. The "trickle down" approach is most traditional. Specialists report on their findings in conferences, workshops or the literature and assume decision makers will read, understand and interpret policy significance. Policy is affected by information that trickles down from science when individual scientists are effective at promoting or explaining their findings. Trickle down is effective at identifying uncertainties. But it is slow. Credibility is an issue if a few individuals dominate the discussion. And it does not generate joint ownership of new knowledge or collaboration of traditionally incommunicative parties. CALFED explicitly tried to avoid some of the difficulties of the above models. Competition and peer review fostered the credibility of grant selection. Studies with long-term and short-term horizons were of equal priority; so a body of interdisciplinary knowledge relevant to multiple crucial issues is progressively being built. Frequent, repeated, transparent reviews of progress were conducted by independent, "outside" experts. These helped communication, collaboration and justifying modifications of direction. The scientific dialogue was frequent and open to all parties. Technical forums fostered joint ownership of ideas by routinely including policy makers, stakeholders, multiple agencies and academics. Forums were framed to build toward common understanding about a specific issue, clarify uncertainties and identify what concepts were outliers. Advocacy was discouraged as were explicit recommendations of policy choices. None of these mechanics are new in themselves, but in combination they seemed to help break down some of the barriers that can inhibit managing adaptively.

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The Federal Symposium on Coastal Habitat Restoration (FSCHR)-Initial Reactions and Next Steps

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On December 3, 2002 the interagency Estuary Habitat Restoration Council published the final "Estuary Habitat Restoration Strategy," in accordance with the requirements of the Estuary Restoration Act of 2000 (ERA). The overall goal of the Strategy is to restore one million acres of estuarine habitat by 2010. Reaching the million-acre goal will require close coordination among public and private partners as habitat priorities, project efficiencies, and funding sources are identified. The Strategy encourages coordinating, integrating, and capitalizing upon the broad spectrum of ongoing estuary restoration efforts throughout the country. Its objective is to bring together the collective expertise, technical, and financial resources of the federal community, the practical experience of tribal, state, local and non-governmental organizations, and the vision of private industry to restore the integrity of our nation's estuarine systems.

To move forward on the goals of the Strategy, the Federal Symposium for Coastal Habitat Restoration (FSCHR) was held in July 2004 as a formal step toward increased coordination within the federal community for strategic planning and prioritization of on-the-ground restoration projects. Specific objectives of the symposium were to:

- Understand the specific role of each program in habitat restoration
- Identify common program objectives, goals, and priorities
- Identify common program tracking and reporting mechanisms
- Identify common performance measures
- Facilitate discussion on steps for coordination among federal agencies and between the public and private sectors

Preliminary results of the symposium will be presented at the 2004 National Conference on Ecosystem Restoration in Orlando, FL. The presentation will: (1) Identify the federal programs involved in coastal habitat restoration, (2) Describe how the various federal programs facilitate restoration, (3) Provide an overview of the topics/themes discussed at the symposium, (4) Discuss outcomes of the symposium (common goals/objectives, common priorities, common performance measures, etc.), and (5) Lay out appropriate next steps for coordination of restoration activities. It is hoped that this initial Federal Symposium on Coastal Habitat Restoration will create a mechanism for ongoing communication and coordination among federal habitat restoration programs.

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The NOAA Community-based Habitat Restoration Program: Partnerships for Success

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Habitat restoration replaces, revitalizes and repairs environments and natural resources that have been compromised by human activities. However, resource agencies are unable to restore coastal and marine habitats by themselves. It is vital that stakeholders be encouraged to get involved in local conservation, protection and restoration activities. The NOAA Community-based Restoration Program (CRP) began in 1996 to catalyze local efforts to conduct meaningful, on-the-ground restoration of marine, estuarine and riparian habitat. The role of the NOAA Restoration Center (RC) is to help identify sound projects, strengthen their development and implementation with help from communities and local interest groups, and generate long-term national and regional partnerships to provide funds and other support for community-based restoration efforts around the country. Partnerships allow communities to reach significant milestones faster, and the cooperative nature of the community-based restoration process fosters a sense of collective stewardship and respect for the environment as a result of grass-roots habitat restoration activities. Project proposals are requested several times each year, either directly by the RC or through its numerous partners. NOAA Fisheries field staff conduct site visits and meet with potential grantees to answer questions and guide them through the restoration process. Proposals undergo a competitive review, and projects are selected based on their technical merit, ecological benefits to marine and anadromous fish habitat, cost-effectiveness, the level of community involvement and partnership opportunities. Past projects have leveraged up to $10 for every NOAA dollar invested. In 2003, $10 million was available to support community-based habitat restoration projects and partnerships.

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Hydrologic Restoration on Florida's Gulf Coast: An Examination of the Process

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The NOAA Fisheries' Community-based Habitat Restoration Program has funded three large scale hydrologic restoration projects along the Gulf Coast of Florida. The geographic proximity of these restoration efforts provides an opportunity to examine and monitor the projects as they develop from their initial design plans to their completion. This also presents the chance to conduct comparisons and gain valuable 'lessons learned' from these projects. The three projects highlighted here are the Ft. DeSoto Tidal Exchange project, the Tarpon Bay Hydrologic Restoration Project and the Clam Bayou Restoration Project. Each has a unique design and set of objectives, but all three are working to restore historic hydrologic tidal circulation to larger embayments.

The Ft. DeSoto Park Tidal Exchange Project was initiated by the Pinellas County Department of Environmental Management. This project will restore tidal circulation to over 600 acres of back bays and lagoons by replacing a portion of the dredge and fill causeway with a 40' span bridge. The Tarpon Bay Hydrologic Restoration Project will restore tidal exchange between Tarpon and Johnson Bays in the Isles of Capri in Collier County. The Florida Department of Environmental Protection/Rookery Bay National Estuarine Research Reserve will install two culverts and one bridge along the road that bisects the two bays. The City of Sanibel will conduct the Clam Bayou Restoration Project to restore a 470 acre estuary that has become severely impounded from the construction of Sanibel-Captiva Road. Tidal flow will be restored with the installation of a culvert beneath the road, reconnecting Clam Bayou to Pine Island Sound.

Examination of these projects provides the opportunity to catalog the strategies, successes and challenges of implementing large scale restoration projects. All three projects have similar elements, for example acquiring permits, design, costs and community support, but each individual project has taken a unique approach to these project components. This study provides the opportunity to explore and compare a variety of these individual parameters along with topics such as monitoring techniques, measurements of success, ways to characterize acreage, and roles of the project partners. These topics will continue to be followed as the projects progress so that best practices and lessons learned can be gained to benefit future large scale hydrologic restoration efforts.

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The Human Ecosystem as an Organizing Concept in Ecosystem Restoration

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The restoration of severely disturbed ecosystems represents one of the grand challenges of applied ecology in the 21st century. Restoration ecology requires theory, method, and evidence from a wide range of relevant scientific disciplines; ecosystem restoration is most likely to be effective when it applies these insights within a framework that encompasses biophysical and sociocultural systems. The challenges of achieving restoration are particularly complex when ecosystems have been significantly degraded, damaged, or destroyed *and* the related social, political, and economic systems have likewise been substantively (and negatively) transformed. Examples in the United States include landscapes impacted by industrial plunder (such as selected mining/timbering landscapes), military control (such as large-scale bombing ranges), rampant land speculation (leading to sprawl), urban decline, and more. In such cases, restoration extends to restoring sustainable social, political, and economic structures and processes, and interdisciplinary models for restoration practice become critically important.

The *human ecosystem* is proposed as an organizing concept in ecosystem restoration, and a specific human ecosystem model is presented that describes the critical linkages between biophysical and sociocultural variables. The model (in its conceptual form) includes a set of essential variables, including *base conditions*, *critical resources*, *social institutions*, *social cycles, social order, and key flows*. The model is primarily useful for predicting and evaluating cascading and non-linear first-, second-, and third-order effects, and is capable of synthesizing a large range of theory, method and evidence. It has had significant application, from US parks and an urban LTER site (Baltimore), to Asian mega-cities planning (Kuala Lumpur) and the monitoring of sustainable development.

Application of the model to complex restoration challenges (“wicked problems”) is both new and potentially useful. An example is the restoration of Vieques, Puerto Rico-an island used by the US Navy since WWII for extensive military training, and recently returned to civilian use and restoration. Similar US examples of “swords to plowshares” restoration include Kaho’olawe in Hawaii and the Rocky Flats facility in Colorado; worldwide, the challenge includes abandoned nuclear testing sites in the Pacific, post-war restoration in Kosovo, and the reconstruction of Iraqi marshlands after the second Gulf War. The model also has potential application in other kinds of restoration efforts underway in South Florida, Chesapeake Bay, and elsewhere.

The application of the human ecosystem as an organizing concept in ecosystem restoration provides an interdisciplinary framework for restoration research, strategy, implementation, and evaluation. It may contribute to a restoration science that is at once rigorous, interdisciplinary, adaptive, and capable of providing usable knowledge to practitioners of ecosystem restoration.

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Effective Communication of Scientific Information: A Case Study in Adaptive Management

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CALFED Bay-Delta Program is a cooperative effort of more than 20 state and federal agencies working with local communities to improve the quality and reliability of California's water supplies and revive the San Francisco Bay-Delta ecosystem. The collaborative process that characterizes this program requires transparency, recognition of scientific uncertainties, and open discussion and publication of scientific findings. In this process the CALFED Science Program is tasked with providing an on-going assessment and analysis of critical science needs, and with communicating and integrating science throughout the various CALFED Program elements.

The Science Program has faced challenges in disseminating science knowledge among the effected audiences involved in CALFED despite the establishment of new communication tools, such as a program website, monthly e-newsletter, online journal, workshops, white papers, and reports. Because these communication tools alone have not been sufficient in communicating science to these audiences, other components are needed to effectively convey information and engage audiences in a meaningful, forward-moving, dialogue.

To address these gaps and challenges, the Science Program has designed a communication implementation plan that builds on existing structures to nurture audience understanding and participation within the CALFED Science Program. The plan identifies strategies that link existing tools with new approaches to address various levels of scientific knowledge among target audiences, establishes new processes for participation outreach, and defines performance measures to gauge progress and effectiveness. The strategies involve identifying all audiences engaged in the CALFED program, identifying specific needs of differing audiences, and recognizing what is currently working in our communication process. Performance metrics will be used to track the effectiveness of our current communication tools when applied to the proposed strategies to assist us in identifying why they have not worked in the past and how we can improve implementation for the future. By applying an adaptive management approach to scientific communication strategies we hope to create a set of tools that others can apply to future restoration efforts. When science is communicated effectively it improves the chances for successful policy and decision-making, ultimately leading to better management of limited resources.

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Creation of an Atlantic Ocean Shore Bird Nesting Island

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The Savannah District Corps of Engineers is using Savannah Harbor, Georgia dredged sediments to construct a shore bird nesting island in the Atlantic Ocean between Tybee Island, Georgia and Daufuskie Island, South Carolina. The island is sized at four-acres and located about a half-mile offshore to limit predation by hogs and raccoons. Gulls and pelicans were observed resting on the island as it rose above water and at mid-construction about 2,000 birds of various types, included migrating birds banded in South America and the Arctic, were observed feeding and loafing. Likely future nesters include: Wilson's plover, American oystercatcher, black skimmer and gull-billed terns.

The island is constructed of previously dredged sediments from Savannah Harbor pumped to the site. Geotextile bags bedded on rock and protected by large stone surround the horseshoe-shaped four-acre pumped sand island. The horseshoe shape is aimed into the prevailing waves and the wide area on the landward side is open to allow free access to the ocean.

Island construction is a beneficial use of dredged material providing rare habitat. Bird island construction was required to continue dredging of Savannah Harbor as part of the 1996 Long Term Management Strategy (LTMS) for Savannah Harbor. The LTMS was an agreement between local, state and federal transportation and resource agencies considering private, industry, local, state, and federal needs. The LTMS requires construction of the offshore island and creation of two one-acre islands in harbor dredged material containment areas as mitigation for diking of an inactive inshore dredged material containment area.

Controversy surrounding the construction includes the general public's questioning: whether the island should be built, the project cost of the $8 million, limited access to the general area during construction, and construction in South Carolina using Georgia tax dollars.

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Adaptive Management Applied to Treatment Wetlands Constructed to Remove Phosphorus from Agricultural Runoff in South Florida

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Adaptive management has been defined as a systematic process applied to improve management policies by learning from operational scenarios. It has been portrayed as a six-step cycle proceeding as follows: Problem assessment – Design – Implementation – Monitoring – Evaluation – Adjustment - Problem assessment. Generally adaptive management has been applied to the formulation of public policy at landscape and ecosystem scale. We are applying this process to the operation and optimization of 14,000 ha of constructed wetlands, known as Stormwater Treatment Area (STAs).

The STAs were constructed to aid in the restoration of the Everglades ecosystem through the removal of excess total phosphorus (TP) concentration in stormwater runoff, and were designed to achieve outflow TP concentrations of 50 µg/L. Subsequent research has shown that long-term exposure to runoff with TP concentrations greater than 10 µg/L will be detrimental to the Everglades. Therefore, the South Florida Water Management District has begun to implement several engineering enhancements to the existing STAs in an effort to increase the TP removal performance. These enhancements include structural changes, such as additional levees and changes in the dominant plant community. A long-term monitoring program was implemented to provide ongoing evaluation of the effectiveness of these enhancements in providing increased P removal. This information will be routinely evaluated and, if appropriate, further adjustments and enhancements will be implemented. Documenting the TP removal performance of these systems before and after these engineering changes is critical for developing successful management strategies for the STAs.

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Remediation and Restoration of Embayment, Rivers and Coastal Regions of New York's South Shore of Lake Ontario - the North Coast Initiative

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New York's Lake Ontario coastal waters are a valuable resource for drinking water, recreational boating, fishing and swimming, tourism, and waste water processing, and a key asset in the economic revitalization of upstate New York. Despite significant water quality improvement in the open waters of the Lake over the last three decades, the 300 miles of New York's Lake Ontario shoreline and embayments-bays, river and creek mouths and their associated wetlands-are suffering from many impairments that severely limit their recreational use and ultimately affect the economic development of the region. Remediation efforts are fragmented, with projects, communities, and counties competing for attention of state and federal agencies and limited funds. The mission of the Lake Ontario Coastal Initiative (LOCI), encompassing all New York State North Coast stakeholders from the Niagara River to the St. Lawrence River, is to enlist and retain broad public commitment for remediation, restoration, protection, and sustainable use of the coastal region. This mission will be accomplished by securing funds and resources to achieve scientific understanding, educate citizens, and to implement locally supported priorities, programs and projects.

CEI, SUNY Brockport, FL-LOWPA and our other partners, are working with the three Coastal Action Teams (West, Central, East) and the North Coast Coordinating Committee Board to: (1) Convene, facilitate, and manage the work of the Initiative throughout the coastal region; (2) Implement strategies to resolve identified problems where current funding and resources clearly cannot meet needs; (3) Expand the Initiative into an ongoing community-based Partnership among the seven coastal counties; (4) Build the capacity of coastal communities, agencies and citizens to work cost-effectively with state and federal agencies and each other; (5) Foster public participation, information dissemination, communication, education, and consensus-building and (6) Undertake and organize research and monitoring to evaluate effectiveness of implemented actions and to inform community decision makers about sources and appropriate resolutions to water quality problems.

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Community Partnering and Educational Outreach Have Made Ten Mile Creek More Than Just A Restoration

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The Ten Mile Creek project, now under construction has already done more than help restore the St. Lucie Estuary, it has been a focal point for community involvement and education. The project involved our youth in relocating precious plants and trees, and has reached from the distant past into the hands and minds of our current generation. Over a decade ago, the community, intent on preventing continued damage in the Indian River Lagoon, began the process that has lead to the Ten Mile Creek project construction. Federal, state and local governments partnered, as they found a plan that served many needs, even some unexpected ones, like the educational opportunities during the archaeological data recovery required by the State of Florida. Ten Mile Creek continues to find many supporters, and will soon be drawing visitors to the adjacent recreation area.

The purpose of the Ten Mile Creek Project is to provide temporary storage of storm water from the Ten Mile Creek Basin. Ten Mile Creek is the largest sub-basin delivering water to the North Fork of the St. Lucie River Estuary (SLE), which has been established as an Outstanding Florida Water (OFW). The project is ideally situated at the headwaters of the North Fork of the St. Lucie River Aquatic Preserve. The Preserve is one of the last remaining freshwater/estuarine wilderness areas in this region of Florida and supports a wide variety of fish and wildlife. The SLE discharges into the Indian River Lagoon (IRL), which is also an OFW. The IRL is the most biologically diverse estuary in North America. The entire lagoon is endangered from increased runoff from watershed drainage enhancements. Excess storm water due to drainage improvements is causing radical fluctuations of the salinity concentration in the SLE. Adverse salinity concentrations are eliminating viable habitat in the SLE suitable for oysters, seagrasses, and marine fish spawning. Also, state biologists are documenting an alarmingly high incidence of fish abnormalities, expected to be a result of the low-salinity induced stress to the fish populations inhabiting the SLE.

Storage of excess storm water in the 550 acre, above-ground reservoir, will allow its measured release, and hence, a more natural salinity regime. Sediment and nutrient uptake processes that will occur in the reservoir and storm water treatment area, and will reduce pollution loads delivered to the estuary. Stabilizing the salinity concentration will greatly enhance the SLE's ability to support seagrasses, oysters, and nursery grounds for marine fish. Commercial and recreational fishing are very important activities in this region and will be benefited by an improved estuary. The West Indian Manatee, an endangered species, is dependent on seagrasses as a primary food source. This project, coupled with ongoing Water Quality improvement projects, will help to reduce future decline of seagrasses in the area.

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Effect of Time Scale on Patterns and Processes of Salinity Variation in Florida Bay

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Understanding patterns in terms of the processes that produce them is the essence of science, and is the key to the development of principles for management.
(Levin 1992)

The salinity regime in an estuary can exhibit various modes of behavior across time scales. This occurs because different driving processes operate on different time scales. For example, daily wind patterns and seasonal variation in fresh water flows are both recognized to be factors in the variation of salinity in Florida Bay, but they operate with different characteristic temporal cycles. Efforts to forecast the effects of restoration activities in an estuary must take into account how the estuary behaves on the time scales relevant to the restoration activities.

In this study, the pattern of salinity variation in Florida Bay is examined over the range of time scales from hours to a few years using spectral analysis. Salinity is a key characteristic of habitat for biotic components of the ecosystem. As a conservative tracer, variations in salinity reflect the influence of physical processes that also affect other aspects of water quality. This investigation makes use of a unique data set compiled from continuous salinity measurements made at a number of fixed stations in Florida Bay over several years.

The spectral density functions for data collected at seven locations indicate that a change in behavior occurs in the range of time scales from two weeks to two months. An independent analysis reveals changes over the same range of time scales in magnitudes of components of the total derivative of salinity. The contribution of advective processes to variation in salinity declines relative to the contribution of non-advective processes at longer time scales. Non-advective processes that appear to govern the long-term behavior salinity behavior include changes in fresh water flows into the bay.

Recognizing how the physical characteristics of Florida Bay are organized by time contributes directly to understanding the link between organisms and their physical environment. This knowledge also benefits efforts to implement predictive models as tools for resource managers.

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Status of Statistical Modeling of Salinity in Florida Bay, Southern Biscayne Bay, and the Southwest Gulf Coast

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A Critical Ecosystem Studies Initiative (CESI) project for Everglades National Park (ENP) developed multivariate linear regression (MLR) models for salinity at 12 locations in Florida Bay and the mangrove areas of the south Florida coast where long-term data exist. The locations for MLR salinity models are Joe Bay, Little Madeira Bay, Terrapin Bay, North River, Long Sound, Little Blackwater Sound, Highway Creek, Taylor River, Whipray Basin, Duck Key, Butternut Key, and Bob Allen Key. The salinity data were collected as part of the ENP Marine Monitoring Network. The MLR salinity models were developed from water level elevations (stage) in wells located in the Everglades within ENP, wind speed and direction measured at Miami and Key West, and sea level measured at Key West. The period of record used for model development was March 24, 1995 through October 31, 2002, and the period for verification was March 24, 1994-March 23, 1995.

Daily average values were used in an innovative step-wise regression process for model development. R^2 values for the developed models ranged from 0.56 to 0.86. Parameters were retained in the models when they were significant at the 0.999 or higher level. A variety of error statistics were computed to describe the uncertainty that may be associated with the use of the MLR salinity models. MLR salinity models were rated as good to very good based on these statistics. The MLR salinity models were used with stage values simulated by the South Florida Water Management District's SFWMM watershed model and historic wind and sea level data to produce daily simulations of salinity at each of the stations for the period 1965-2000, for four water management scenarios.

In a separate study for the Army Corps of Engineers (ACOE), similar model are have been developed for Middle Key, Thursday Point, Manatee Bay, and Card Sound in southern Biscayne Bay; and for Garfield Bight in Florida Bay; and Whitewater Bay, Clearwater Pass, Shark River on the southwest Gulf coast. These models were developed to extend the spatial domain of statistical salinity models. The primary purpose of both the ENP and ACOE projects is to use the statistical salinity models to evaluate salinity performance measures for the analysis of the Initial CERP Update water management alternatives. The statistical salinity models are also being used for a separate but similar evaluation of the CSOP program. The performance measures were developed from the ecological requirements for salinity variation.

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Population Decline of the Federally Endangered Snail Kite in Florida

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The snail kite (*Rostrhamus sociabilis plumbeus*) is an endangered raptor that inhabits flooded freshwater areas and shallow lakes in peninsular Florida and Cuba (Sykes 1984, Sykes et al. 1995). The historical range of the snail kite covered over 4000 km^2 (2480 mi^2) in Florida, including the panhandle region (Sykes et al. 1995), but is now restricted mainly to the watersheds of the Everglades, Lake Okeechobee, Loxahatchee Slough, the Kissimmee River, and the Upper St. Johns River. Recent demographic results show alarming trends concerning the snail kite population in Florida. First we found that kite abundance, has drastically and steadily declined since 1999. The reasons for this severe decline are still unclear. However, we should note that the number of nests and consequently the number of young fledged also exhibit a negative trends. Again we are not exactly sure about what factors are actually limiting the reproductive ability of the kites, although one can confidently assert that Lake Okeechobee which from 1985 to 1995 was one of the productive breeding sites of the system has been severely altered since then, to the point that almost no fledging has been produced out of this site since 1996. In addition, there has been a major drought in the study area (Water Year 00/01), lake enhancement (draw downs) and extensive aquatic weed contol activities in the Kissimmee Chain of Lakes; and the implementation of IOP-Alt. 7A in Water Conservation Area 3A. While the drought did temporarily affect adult survival (decreased by 20 percentage points), it is the decreased nesting activity and reproductive success that gives us special concern regarding the stemming of this decline to achieve a more sustainable population growth rate.

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Construction, Operation, and Monitoring of a Delta Building Diversion Located in the Lower Mississippi River Active Delta Region at West Bay

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The West Bay sediment diversion project, located in southeastern Louisiana, can be briefly described as a sediment rich freshwater diversion. The goal of the project is to create or restore wetlands in the shallow open waters of West Bay historically composed of emergent coastal marsh. This diversion will provide a unique opportunity of the capability and viability of a manmade large-scale uncontrolled delta building diversion that utilizes the resources of the Mississippi River.

The diversion is just one part of a larger ecosystem restoration effort, the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), to develop and implement long-term and sustainable projects in coastal Louisiana. The construction of an uncontrolled sediment rich freshwater diversion into West Bay, through the west bank (right descending bank) of the active Mississippi River delta at river mile 4.7, Above Head of Passes (AHP), will be an attempt to take advantage of natural river cycles to re-invigorate deltaic land building processes in an area severely impacted by subsidence and erosion. West Bay is a vast shallow open water area and will serve as the primary receiving area for the diversion as the target area for wetland restoration.

Construction of the diversion is being done in two phases. The first phase, completed in December of 2004, features an interim diversion channel designed to accommodate a discharge of 20,000 cubic feet per second (cfs) at the 50 percent duration stage of the Mississippi River. Phase 2 involves the modification of the interim diversion channel design to accommodate the full-scale diversion of 50,000 cfs at the 50 percent duration stage of the Mississippi River. The construction of phase 2 will be initiated upon completion of a period of intensive monitoring of diversion operations.

Monitoring will be done to ensure that the diversion is functioning as anticipated, does not capture the thalweg of the river, and whether or not excessive shoaling impacts waterborne commerce in the Mississippi River. Monitoring plans also include an assessment of wetland development over the duration of the project life as a gauge of project performance and success. Furthermore, as the diversion matures, adaptive management measures will be implemented as needed to improve performance of project. It is anticipated that the diversion will create approximately 10,000 acres of vegetated wetlands over a 20-year project life period.

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Restoration of Sod Pastures to Native Vegetation at the Disney Wilderness Preserve

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The 12,000-acre Disney Wilderness Preserve is located in the Kissimmee River watershed, a landscape mosaic of wetland and upland communities that within the past century has been extensively converted to a variety of land uses, including cattle grazing and pastures. A primary goal of the Preserve is landscape restoration through reintroduction of natural processes (fire and hydrology) and re-establishment of native plants and animals, as well as structure.

As part of this restoration approach, 8 sites totaling 365 acres of improved pasture are being restored to native upland habitat, over a 9-year period. Success criteria include restoration of continuity with surrounding native areas to restore ecological processes on a landscape scale; reduction of non-native invasive species cover to <20%; establishment of native plant species to a self-perpetuating population (measure 3-5 new native plant seedlings/m^2); and the demonstrated ability of the area to carry a growing season fire. Site preparation includes burning to remove biomass, multiple broadcast herbicide application and seeding of native plants.

Onsite seed-harvesting areas are identified and burned in the growing season to promote a vigorous seeding effort by wiregrass (*Aristida stricta*), the primary seed mix component. Other characteristic pine flatwood species are hand-collected by staff and volunteers. Seed from approximately 70 species was collected in 2004 and preliminary phenology schedules and seed-counts-by mass estimates were generated. Wiregrass seed is harvested with a tractor-mounted Flail-Vac in late October or early November. The seed mix is applied to restoration areas with a Grasslander seeding machine in December. Seed viability and dispersal measurements are collected at seeding time. Fall vegetation monitoring prior to treatment and each year following restoration consists of visually estimating cover in randomly located 1-x 0.5 m plots; number of plots is determined as a function of site variability. Monitoring is conducted until success criteria are met. Vegetation is identified to species and Daubenmire cover classes are used to categorize estimated cover, and a comprehensive species list is also compiled for each site.

Pre-restoration vegetation monitoring and site preparation is underway or completed in all 8 sites. Pre-restoration sampling indicates dominance by non-native pasture grasses, primarily bahiagrass (*Paspalum notatum*) and pangolagrass (*Digitaria pentzii*). Three sites have been seeded to date. One growing season post-restoration, sites are dominated by early successional plants (e.g., *Cyperus spp*. and *Fimbristylis spp*.), however bluestem species cover increases substantially during the second growing season. Approximately 3 wiregrass seedlings/m^2 are observed in the sites post-restoration. Non-native invasive species cover varies among sites, but all sites are dominated by native species. Germination by bahiagrass seedlings and sprouting from rhizomes were issues in inadequately prepared sites. Preliminary results of selective herbicides are promising. Wiregrass seed viability for seed harvested in fall 2002 is 31-34%.

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The Role of Science in Ecosystem Restoration and Management: Foundation or Failure

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That ecosystem restoration should be based on sound science is an oxymoron. If science was the foundation of policy-making we would be managing ecosystems not restoring them. There is a concern that if science was not applied in managing an ecosystem what is the reality of science being applied to restoring an ecosystem. Certainly ecosystem restoration is based on the hope and expectation that science not only will be applied, but will be the foundation for policy making. This presents two questions. How do we apply science? How can we tell if we are being successful? We owe Buzz Hollings, Carl Walters and others a debt of gratitude for giving us "Adaptive Management" as an integrated approach for doing science for ecosystem management. Decision support systems are being developed to communicate this information to the policy-making process. To be applied, scientific information must be considered in a policy-making process, that integrates environmental, social, economic, and political data in a transparent process. Whether science will prove to be a foundation or a failure in restoration of South Florida Ecosystems has yet to be determined, however, formidable obstacles have appeared. These obstacles include institutional limitations, lack of integration of social, economic and political factors, inconsistent use of science, and lack of environmentally literate adults. The prescription for successful inclusion of science in policy-making includes better, deliberate, educational programs for policy-makers through a hierarchical decision support system and more effective communication between policy-makers and scientists on scientific, needs, expectations, and capabilities.

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Adaptive Management: A Three Process Model Framework for Learning

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Adaptive management is a deeply ingrained concept in the field of natural resource management. It is generally recognized that adaptive management provides the necessary nexus between science and management in dynamic natural systems over time. Adaptive management theory provides guidance for managers dealing with scientific uncertainty. However, the linkage between the political dynamic involving human values overarching and permeating the management process is more implied rather than theoretically explicit. This is a barrier to the essential element of adaptive management - learning. A more objective and theoretical approach to the integration of science, management, and politics, would facilitate this essential learning process. Putting all three functions on a common "process model" basis provides a cogent, theoretically integrated framework of analysis for learning and management.

Presenting the science, management, and politics of a given project in terms of interrelated process models allows an objective view of the integrated whole in terms of relatively distinct functional components. The three larger components of adaptive management can be posited as processes each involving a list of smaller functional component steps. These process models are cyclical in nature. Science is a process that typically starts with a hypothesis, involves a treatment, yields findings, and then conclusions based on findings; while management is based on some form of operational hypothesis, which is foundational to a plan of action, which is then applied, and then is monitored for results (Kendall 2002). Politics too can be seen as a process involving issue identification, agenda setting, policy formulation/design, legitimization through political processes, implementation, and evaluation. In politics there are larger cycles that overarch a given project as well as the smaller cycles directly associated with any specific local endeavor. Each iteration of each cycle yields new information that is fed into the larger process and the cycles continue. Together these three processes determine the policy environment for any given restoration or conservation project.

Public administrators in charge of natural resource programs find themselves managing much of the ground-level political competition surrounding the natural assets they manage. Supporters and detractors are both present in the public policy environment. Ultimately the public interest must be interfaced with scientific knowledge in the management process. As scientific knowledge expands, goals must be refined and objectives revisited in light of new knowledge and current social values. Conflicts, old and new must be addressed. The integrated process-model framework links science, management, and politics providing managers a valuable conceptual tool to analyze, learn, and educate in a harsh and demanding managerial environment.

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Monitoring and Evaluation of Ecosystem Restoration on Longleaf Pine Flatwoods of the Gulf Coastal Plain

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The Pt. Washington longleaf pine restoration study conducted through the University of Florida is focusing on determining the effects of post-site preparation, low level herbicide applications on longleaf pine seedling growth & survival, soil nutrient cycling, water quality, and plant species richness. First and second year data on the effects of the herbicides have been collected and are being analyzed. At this point it is necessary to find out if the site is headed for restoration on a path similar to natural patterns (few anthropogenic influences) or if it has been drastically altered. In simple terms, how are we doing at restoring this site to a healthy longleaf pine ecosystem?

This study will try to answer these questions by using plant species richness, a set of soil quality factors, and soil microbial biomass as environmental indicators, which will give a significant level of confidence in assessing the restoration trajectory. Secondly, by utilizing Chassahowitzka Wildlife Management Area, St. Marks National Wildlife Refuge, and Topsail Hill State Preserve as reference communities at clearly defined successional stages, the data can be ordered within very specific temporal and spatial scales. This scaling of the data will allow for differences in ecological conditions to be observed within effective chronosequencial and biogeographical gradients. Finally, ecological restoration will be tracked along these temporal and spatial scales by the use of a monitoring plan and modeling. Modeling will provide a tool for integrating the different ecological indicators and predicting the restoration trajectory of the longleaf pine site based upon the collection and analysis of reference community data through monitoring.

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Understanding Patterns of Canal-Water Intrusion to Predict the Effects of Everglades Restoration on the A.R.M. Loxahatchee National Wildlife Refuge

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The Arthur R. Marshall Loxahatchee National Wildlife Refuge represents one of the last vestiges of the historic rainfall-driven Everglades. Whereas surface-water chemistry across much of the remnant Everglades is influenced by inflows of high conductivity (i.e., mineral-rich) canal water, the Refuge appears to have largely retained the low conductivity condition indicative of a rainfall-driven hydrology. However, there is concern that changing water management strategies associated with Everglades restoration may be increasing the extent of canal-water intrusion into the Refuge, with consequent effects on water chemistry, ecosystem processes, and native communities.

A synoptic survey of water, soil, and plant chemistry was conducted during February 2004 to better understand patterns of canal-water intrusion into the Refuge and associated environmental effects. Multiple indicators of intrusion were measured at 130 sites throughout the Refuge. Measurements of surface-water conductivity provided a reliable instantaneous measure of the intrusion of canal water (specific conductance > 1000 $\mu S\ cm^{-1}$) across this rainfall-driven wetland (specific conductance < 100 $\mu S\ cm^{-1}$). Conductivity values within the Refuge varied widely (60-1017 $\mu S\ cm^{-1}$) and showed that most intrusion was occurring along the western and northern boundaries. Soil concentrations of uranium, a fertilizer-derived contaminant in canal water, were positively correlated with conductivity, indicating that longer term intrusion patterns were reflected in the conductivity readings. The nutrient content (nitrogen, phosphorus, and sulfur) of plant tissue and soils was also elevated at sites with high conductivity, suggesting that intrusion may affect nutrient biogeochemistry and wetland productivity. Survey findings show that large areas across the western portion of the Refuge are exposed to canal-water intrusion and support the need for routine monitoring to document temporal trends and identify potential hydrologic drivers of this process.

Detailed information on spatiotemporal fluctuations in canal-water intrusion into the Refuge and their relationship to water management activities will be provided from a recently established conductivity monitoring network. Changes in key ecological processes across canal-water gradients within the Refuge will be used to assess the nature and extent of environmental effects.

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The Influence of Habitat Structure on the Vertebrates of Reclaimed Phosphate Mines in Central Florida

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In central Florida, reclaiming phosphate-mined lands to resemble unmined uplands could replenish some of the intrinsic value of these lands, and, thereby, supplement more traditional forms of conservation. Reclaiming damaged lands to function as wildlife habitat requires that we understand the requirements of vertebrate species, including habitat structure, extremely well, however. Previously (McCoy and Mushinsky 2002), we determined how closely the vertebrate compositions of 30 mined sites resembled those of 30 unmined sites - fragments of xeric uplands - in central Florida, to derive a reclamation target. For amphibians, reptiles, and mammals, preference for kinds of water bodies, or kinds of substrate, or complex vegetation structure, and for birds, preference for complex vegetation structure alone, could explain the absence of nearly all of the taxa that were under-represented at mined sites ("focal taxa"). Simplified vegetation structure of the mined sites contributes, at least in part, to the failure of these sites to attract and retain many vertebrates, especially birds.

The structural components of the vegetation that are most important for attracting and retaining vertebrates at our 60 sites are those that provide cover at heights relevant to the largely ground-dwelling quadrupeds and to the largely foliage-dwelling birds. At unmined sites, the most important structural components are woody ground cover and middle-canopy. Cover can become too dense at unmined sites, however, adversely affecting many focal taxa, such as by shading out ground cover. At mined sites, the most important structural components are woody ground cover and extensive canopy at all levels. Woody ground cover often is absent at mined sites, and focal taxa respond positively instead to grass (quadrupeds) and saw palmetto and tall non-runner oaks (birds). Cover never becomes too dense at mined sites. We integrated these patterns of structural relationships using a general ecological model of habitat structure (McCoy and Bell 1991). By using the model, we were able to understand better how changes in vegetation structure are likely to affect vertebrate composition over time, and thereby, to predict changes in vegetation structure and vertebrate composition through time, at both mined and unmined sites.

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The National Estuaries Restoration Inventory (NERI): A Tool for Sharing Information and Tracking Our Progress

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The Estuary Restoration Act (ERA), signed into law in November 2000, makes restoring our estuaries a national priority. The ERA promotes the restoration of estuarine habitat and encourages partnerships among public agencies and between the public and private sectors. As part of the ERA, NOAA is required to develop an inventory of estuary restoration projects.

The National Estuaries Restoration Inventory (NERI) was launched on February 16, 2004. The purpose of NERI is to provide information to improve restoration methods and to track acres of habitat restored toward the million-acre goal of the Estuary Restoration Act. Eligible projects may be submitted through a user-friendly, publicly accessible web site <http://neri.noaa.gov>. General project information includes location, partners, and funding, as well as specific restoration information on habitat types, acres restored, restoration techniques, project benefits, monitoring parameters, and success criteria. The project information is searchable and project descriptions are available on individual project profile pages. An interactive, web-based mapping application is also available, making the inventory useful for restoration planning efforts.

Project managers are encouraged to visit the NERI site to submit project information, track and manage their projects, find new partnership opportunities, and locate other regional restoration efforts to assist in future restoration planning and design. In addition, NERI reports, maps, and other on-line features are excellent tools for outreach, increasing public awareness and promoting local participation in and support for restoration projects.

The inventory continues to grow through the efforts of various partners, and by building upon existing federal and state tracking efforts. Currently, NERI primarily contains NOAA-funded estuary habitat restoration projects. Other ERA Council agencies also have plans to contribute. NOAA is actively working with these other federal agencies, as well as states and nonprofit organizations, to populate NERI with project information from throughout the country.

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Establishing Baseline Data for Mangrove Forest Fishes in the Everglades: How Important is Hydrology?

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Understanding the factors that affect the composition of fish assemblages associated with intertidal mangrove forests along the complex environmental gradient present in Shark River is a significant challenge. Nonetheless, such understanding is required to detect change from two opposing sources: restoration of historic freshwater flows under CERP (Comprehensive Everglades Restoration Plan), and rising sea level from global climate change. This project seeks to establish quantitative baseline data from representative stations along the river that can be used to track change from the interaction of these two factors.

This project has successive goals: methods development and calibration, detection of ecological patterns, and analyses to detect the correlative and possible causative factors. Preliminary analysis of the data suggests that hydrological factors are of major importance. We report here on two aspects of our research: methods development and analyses of the hydrological and physicochemical factors that appear to shape fish use of closed-canopy mangrove forests in southwest Florida.

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Phosphorus Estimation in Isolated Wetlands of Lake Okeechobee Sub-basins Using GIS, Remote Sensing and Classification Trees

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Four basins north of Lake Okeechobee in South Florida contain active dairy farms and cattle ranches known to be significant sources of phosphorus (P) to the lake. Wetlands cover 18% of the basins and historically isolated wetlands account for 59% of the total wetland area. Understanding their role in P storage is important for future efforts of reducing P inputs to the lake. A first step to achieve this goal is to estimate total phosphorus (TP) storage in surface wetland soils. This study employs an upscaling method to determine TP storage in wetland soils at the watershed-scale using site-specific TP to build a TP storage estimation model.

In the wet season of 2003, soil samples from the centers and edges of 118 wetlands were sampled and analyzed for TP and soil bulk density. Using a Landsat7 ETM+ satellite image from the same year, reflectance data were processed for sampled and unsampled wetlands derived from the National Wetland Inventory (NWI). Landscape-scale spatial data including land use, hydrology, wetland characteristics, soils and distances to features such as ditches, roads and high intensity dairy areas, were assembled within a geographic information system (GIS).

These spectral and GIS parameters were imported into a classification and regression tree software to build trees that classify each wetland as having high or low soil TP. Because of significant differences in mean edge (320 mg kg^{-1}) and mean center TP (669 mg kg^{-1}), classification trees were developed for each. Overall accuracies of the trees based on cross-validation data were about 75%. The most important variables for wetland edge classification trees were Tasseled Cap spectral index parameters, whereas for wetland center classification trees, spectral reflectance values were the most important.

Unsampled wetlands were then classed as high or low TP using the classification trees for both edges and centers. Storage of TP in the unsampled wetlands was calculated based on mean TP values and bulk densities from high and low classes of sampled wetlands. The proportion of edge and center for each unsampled wetland was determined based on a regression model. The classification trees will be used to estimate the TP stored in historically isolated wetlands throughout the four basins. The model can provide information for land managers to identify and target high impact areas with best management practices. This landscape-scale model is a powerful approach to characterize the spatial distribution of TP across the basins, and will provide useful input to restoration projects.

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U.S. Army Corps of Engineers Ecosystem Restoration Title I Project Authorizations, 1990 - 2000, Costs and Benefits

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Since 1990, the U.S. Army Corps of Engineers has completed about 21 traditional planning studies that recommended construction projects to provide ecosystem restoration benefits to the nation. These projects have been authorized in Title I of the Water Resources Development Acts of 1996, 1999, and 2000. The construction cost estimates for restoration ranged from about $4 million to over $120 million (Oct 02 price levels).

Restored habitats varied from tidal wetlands in Washington, DC and San Francisco Bay; to the deserts of the southwest; to salmon streams feeding the Puget Sound; to isolated beaches along the Delaware Bay; and cypress swamps along the Georgia Coast. The total estimated first cost of these projects was about $620 million with predicted restoration benefits to about 28,000 acres of fish and wildlife habitat. On a first-cost-per-acre basis, the cost to restore an acre of habitat ranged from less than $1,000 per acre to more than $250,000 per acre.

This wide range in project costs in part reflects the difficulty in expressing restoration benefits solely on two-dimensional basis. Overestimates and underestimates of project benefits likely occurred. While all of these projects used some type of non-monetary benefit analysis process in to evaluate alternatives, more clearly articulated metrics are needed to provide decision makers with the opportunity to support wise restoration investments.

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The Initial CERP Update: A Collaborative Planning Initiative in Applying Adaptive Management Principles to the Comprehensive Everglades Restoration Plan

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The implementation of the Comprehensive Everglades Restoration Plan (CERP) is expected to take place over a 30-plus year timeframe. Numerous references in federal and state law and regulation instruct that the CERP be implemented adaptively, that is, innovation in the forms of science and technologies employed in the implementation of the CERP is expected and desired.

The federal Programmatic Regulations (DOD 2003) governing CERP implementation require that the CERP be “updated” periodically, using “new or updated modeling that includes the latest scientific, technical and planning information” (§385.31(c)). The Initial CERP Update is the first of such efforts.

The Initial CERP Update has been a 2-1/2 year, interagency and interdisciplinary work-in-progress led by the South Florida Water Management District and the US Army Corps of Engineers as the sponsoring agencies for the CERP. As part of the update process the primary regional models that were used to formulate the 68 projects that comprise the CERP have undergone several version changes to better simulate our current understanding of how the extensive water management system in south Florida functions both with and without the CERP. As model versions and input data change, so do the results of the simulations, such that the benefits calculated for the original CERP modeling (1998) have changed with the Initial CERP Update modeling (2004).

A collaborative interagency and interdisciplinary technical team was formed to perform the update. At numerous team and sub-team meetings, members worked through defining conditions and assumptions to depict, through model simulations, an existing condition circa the year 2000, a future without CERP projects circa the year 2050 and finally the future with CERP projects for the year 2050. Extensive use was made of the world wide web to disseminate information and display model results. In this manner team meetings could be made more efficient as members from Jacksonville to Homestead had access to the same data for evaluation. Use of this medium also made this information available to the many stakeholders interested in Everglades restoration.

The team faced many challenges in the conduct of the Initial CERP Update, none the least of which were how to be adaptable in the planning process, without crossing either policy or legal bounds, how to ensure a level of comfort with uncertainty and change and how to keep “bringing everyone along” towards a common goal.

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Building Adaptive Capacity in the River Murray, Murray-Darling Basin, Australia

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The River Murray is Australia's largest and most economically important river system (length 2530 km, Catchment Area 1.06 million square kilometers). Since 1914 it has been managed under a series of agreements between the Federal and relevant State Governments. In recognition of ongoing deterioration of the riverine environment, an investment of approximately US $500 million was committed in 2003 to the achievement of specific ecological objectives at six significant ecological assets through recovering water from consumptive uses and a program of environmental works and measures. Adaptive management is a central feature of the implementation of this initiative. Arrangements being developed and implemented will be described during the presentation at the First National Conference on Ecosystem Restoration.

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Water Quality in South Florida's Arthur R. Marshall Loxahatchee National Wildlife Refuge ---Trends and Spatial Characteristics of Selected Constituents

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Water has historically entered the Arthur R. Marshall Loxahatchee National Wildlife Refuge from rainfall and from perimeter canals receiving water from two large pumping stations (S-5A and S-6). Water quality of the interior marshes is affected primarily by natural seasonal processes such as evapotranspiration, rainfall, and biological activity. Water quality in perimeter marshes is significantly affected by water from the nearby canals. Water from S-5A and S-6 drains agricultural lands and often contains relatively high concentrations of dissolved solids, nutrients, and pesticides. The influences of canal waters extend up to 5 km or more into the marshes, depending on location in the Refuge and on water levels in the canals. Nutrient concentrations are an order of magnitude higher in canal waters than in interior marsh waters, but high concentrations of nutrients seem to be more restricted to marshes adjacent to the canals than are conservative ions.

Concentrations of pesticides and other organic compounds in water and sediment have been measured at inflow pumping stations more frequently and over a longer period of time than at Refuge marsh sites. Most pesticides have been found at concentrations near or less than the minimum reporting level for the analytical methods used. At S-5A, the most commonly detected pesticides in water were atrazine, ametryn (total), metachlor, and simazine. Atrazine (unfiltered) was detected in 57 out of 75 samples (1987-2002), with a maximum concentration of 12.3 μg/L (micrograms per liter). At S-6, the most commonly detected pesticides were atrazine, ametryn (total), and dieldrin. Atrazine (filtered) was detected in 83 out of 84 samples between 1996 and 2004, with a maximum concentration or 7.8 μg/L. Only a few water samples from the Refuge marshes have been analyzed for pesticides, and none contained detectable concentrations. Although a number of pesticides have been detected in bed sediments, including p,p'-DDD, p,p'-DDE, p.p'-DDT, and ametryn, most have been found at concentrations near or less than the minimum reporting level for the analytical methods used. The highest concentrations of DDT compounds occurred in sediment collected at the pumping stations; the maximum concentration was 300 μg/kg for p,p'-DDE at S-5A.

Proposed increases in canal inflow to the Refuge associated with Everglades Restoration could adversely affect water quality over greater expanses of marsh. Even inflow of water with relatively low nutrient concentrations could adversely affect water quality of interior marshes if this additional water has high concentrations of pesticides and common ions such as chloride or sulfate that are not easily removed in Stormwater Treatment Areas.

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FIU-Singeltary Restoration Project

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The FIU-Singletary Restoration project is a 1200 acre area located in Southeastern Miami-Dade County that is the site of active limestone mining. Singletary (operating as Florida Rock and Sand), the mine operator, has deeded the land to FIU as part of mitigation imposed by the state and county. FIU's tasks in this mitigation include: production of a long-term restoration plan, aiding Singletary with mitigation problems, monitoring the removal of exotics, natural resource inventory and analysis, and long-term ecosystem monitoring (hydrology, climate, vegetation, soil parameters). The restoration site provides easy research and teaching access with many interesting problems typical of many Florida lands.

The area is important to the Greater Everglades Restoration Project, because it straddles the watershed divide between Florida Bay and Biscayne Bay-Barnes Sound. The property is a mix of sawgrass marsh, muhly grass prairie, tree islands, native scrub vegetation, and dense exotic stands. The area was severely impacted early in the 20th century when the Flagler Railroad was built, and is cut off from historic freshwater flow today by US 1 and Card Sound Road. In addition much of the area was under cultivation until the mid 1960's and fires have been suppressed.

At present, detailed vegetation (natives and exotics) and topographic maps have been made. Several long-term studies have been established: recovery from bulldozer impacts made during a prior land elevation and boundary survey; most efficient exotic plant [Australian Pine (*Casuarina equisetifolia*), Brazilian Pepper (*Schinus terebinthifolius*), and Shoebutton Ardisia (*Ardisia elliptica*)] treatment and native plant patterns of recovery; sawgrass reproduction and the effects of changing hydroperiod; the origin and development of tree islands; the influence of soil nutrients on tree island and scrub development; and understanding the spread of natives and exotics into adjacent marsh habitat. This latter issue is very complex and not simply related to disturbance; we find exotics in undisturbed sites as well as natives in disturbed sites.

Problems encountered include difficulty in obtaining management burn permits, public access (dumping, property destruction, off road vehicle damage), and small private inholdings that limit management solutions.

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Freshwater Discharge Required to Re-Establish Biscayne Bay Coastal Wetlands and Nearshore Estuarine Zone

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Calculated freshwater volume required to re-establish coastal wetlands and the estuarine zone of western Biscayne Bay is 467,507acft/ year. This calculation is the summation of average dry season daily discharge 686.77acft (212 days) and a wet season discharge of 2,104 acft (153 days). The freshwater discharge is to maintain coastal freshwater marshes (23,618.5acres) and a salinity gradient with bottom salinity of 20ppt 500m offshore during the wet season and 250m offshore during the dry season.

Methodologies were developed during two studies: historic creek site (Meeder et al, 2001) and Black Point site (Meeder et al, 2003). Daily flow requirements were calculated as follows:

Dry season: [(Aw + Asta) x (ET-P)] + [(SL x Z x (E-P) + SL x Z x Dm) x 0.5 x R]

Wet season: [(Aw + Asta) x (ET-P) + (Aw x Dw + Asta x Dsta)/WSD] + [(SL x Z x (E-P) + SL x Z x Dm) x 0.5 x R]

where AW=wetland area, Asta=STA area, ET=daily evapotranspiration, Dw=wetland depth, Dsta=STA depth, WSD=number of days in wet season (5 months=153days), P=daily precipitation, SL=shoreline length, Z=nearshore mesohaline zone width, E= daily evaporation, Dm=outer depth of mesohaline zone, R=estimated daily exchange rate.

The volume of freshwater required to rehydrate the coastal wetlands was calculated for six coastal reaches and then combined. The reaches were: Burger King to Black Point, Black Point to C-1, C-1 to Princeton Canal, Princeton Canal to Military Canal, Military Canal to Convoy Point and Convoy Point to Turkey Point. Three scenarios of marsh area were used in calculation of required water volume (Marsh area from L-31E to the Bay, from the proposed new N-S canal west of the L-311E, and from the development boundary to the Bay). The second scenario was the preferred scenario by the Performance Committee and was used to produce the volumes presented. The major parameters in marsh water needs are: area, desired water depth, rainfall and evapotranspiration.

The volume of water required to restore the estuarine zone is much more complex than required for the coastal marshes and includes: estuarine volume, tidal volume, tidal volume exchanged with each tidal cycle, target salinity, Bay salinity, estuarine area, rainfall, and evaporation rate. These parameters were calculated in detail for two sites: historic creek site (Meeder et al, 2001) and Black Point site (Meeder et al, 2003). The results from these two studies were then applied to the entire coastline addressed to calculate total annual freshwater requirements.

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Hydro-Ecological Modeling of the Lower Mississippi River

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The Mississippi River is one of the largest rivers in the world and has major economic, environmental, ecological, and industrial values not only to Louisiana but also to the entire United States. At present, the Mississippi River Delta area of coastal Louisiana is being deprived of practically all the sediment (about 220 million tons annually) that the river is transporting to the Gulf of Mexico. Therefore, to benefit the restoration of Louisiana coastal lands, alternative solutions to recover or re-direct portion of this massive amount of valuable sediment should be carefully investigated.

In order for such investigation to be successful, the impact of management and restoration projects on the conditions of the River (supply side) and on the surrounding wetland and water bodies (demand side) should be considered.

The focus of this study is the supply side with the objective of developing a three-dimensional (3D) model for a portion of the Lower Mississippi River (from Tarbet Landing to Venice). The model should provide detailed information on the spatial and temporal patterns of the river's hydrodynamics, salinity, sediment, and water quality parameters.

Such model is crucial to provide accurate and detailed information on the availability of fresh water and sediment for diversion to surrounding wetlands; and to quantify the impact of exiting and planned diversion projects on the dynamics of the river itself from hydrologic, ecologic, and navigation points of view. The model will serve as an efficient overall management and analysis tool for the Lower Mississippi River.

An extensive model selection process is underway to identify the most appropriate modeling tool for this large-scale project. Several widely used three-dimensional models are considered. The selection process is based on careful evaluation of the capabilities and computational efficiency of each model. A river reach (approximately 18 miles long) for which detailed bathymetric, and three-dimensional velocity measurements are available, was selected to perform the model selection step. The selected model(s) will be calibrated for broad range of field conditions; i.e. high/low tidal conditions, high/low fresh water discharge, high/low salinity regimes, and variety of wind forcing. The modules calibrated will include hydrodynamics, sediment, and water quality.

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Use of Hydrologic Numerical Modeling for Ecological Restoration and Management: the Chenier Plain, Louisiana

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The Chenier Plain is located in the western portion of Louisiana's coast. This region is bound on the east by Vermilion Bay, and extends into the state of Texas. It includes two major basins; namely the Mermentau River Basin, and the Calcasieu-Sabine Rivers basin. Hydrologic changes to the Chenier Plain have contributed to the loss in acreage and deterioration of ecological value of these wetlands. Due to their significant ecological and economical value, concerned agencies devoted considerable amount of resources to develop and implement restoration and protection strategies and management plans. However, designing and ensuring the success of restoration strategies is a complex process. It is believed that the success of such strategies relies on three components: 1) full coordination between all concerned agencies; 2) well-designed monitoring plan; and 3) thorough analysis of the design and impact of any given restoration project. This paper discusses the role of numerical modeling in support of the later two components.

Numerical models can be used as an efficient tool to assess the impact of restoration projects and refine their design and operation rules. When fully calibrated and validated, these models can provide valuable information of water levels, salinities, and sediment and nutrient distributions. With recent advances in the field of numerical modeling and with the drastic improvements in the computing power, large-scale multi-dimensional models are now feasible. These large-scale (spatially) models allow scientists and engineers to develop regional understanding of the dynamics of complex eco-systems. Numerical models can simulate hydraulic structures (including their detailed operation strategies and rules) and their impact on the system. However, without a comprehensive monitoring program, these numerical models are of limited value. Therefore, careful planning and full coordination between the monitoring and modeling efforts is crucial to the success of the ongoing restoration efforts of the Chenier Plain.

This paper presents case studies to illustrate the use of numerical models to evaluate the feasibility of proposed restoration projects. Ongoing comprehensive field measurements campaigns will be also discussed. Plans for integrating the monitoring and modeling effort for the Chenier plain will be presented.

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Coastal Habitat Restoration and Science-Based Monitoring Efforts in Southeast Florida

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Regional modifications of freshwater inflow, and past dredging and filling practices associated with the rapid urbanization of southeast Florida, have resulted in serious environmental degradation to the south Florida ecosystem. The ecological, cultural, and economic value of coastal habitats to the south Florida ecosystem is well documented. South Florida historical natural communities are being restored on publicly owned lands through the cooperative efforts of federal, state, and local agencies.

Miami-Dade Department of Environmental Resources Management (DERM) has completed 40 habitat restoration projects (22 coastal sites and on 18 island sites) along and in Biscayne Bay. Since 1987, DERM has successfully restored and enhanced the following south Florida ecosystem components: 70-acres of tropical hardwood hammock, 30-acres of dune/coastal strand, 400 acres of coastal wetlands (mangrove forest, salt marsh, fresh/ brackish water wetlands), and 3-acres of seagrass. Approximately 100 native species are presently being used to restore dune, coastal strand, tropical hardwood hammock, isolated freshwater wetlands, marine wetlands, and submerged aquatic vegetation communities throughout the coastal areas of southeast Florida. The restoration processes for dune, coastal strand, and tropical hardwood hammock typically utilize selective clearing of exotic and/or invasive species, placement of suitable community soil amendments (if needed), groundcover, and planting of native species. Restoration processes for isolated freshwater wetlands and marine wetlands typically consists of the clearing of exotic and/or invasive species, modification of elevations (usually excavations) to levels appropriate for restored species, creation of tidal channels and tidal pools in marine wetlands, and planting of native wetland species. Submerged aquatic vegetation (SAV) is being restored in regions of altered (e.g., dredged) bottoms by modification of the depth of an area, addition of appropriate sediments and some transplanting.

Cost-effective restoration techniques and strategies, and innovative habitat designs have been developed and tested during the restoration effort. Monitoring efforts at selected restoration sites has, and is documenting the value of habitat heterogeneity in maintaining taxonomic diversity as well as resulting in features such as nursery fish habitat, bird habitat, crocodile habitat, and rookery areas. Various methodologies have been employed during the monitoring to detail efficacy of the restoration efforts. Long-term wetlands vegetative monitoring for percent survival, growth rates, and natural recruitment is documenting the influences of site-specific interacting variables (e.g. site design, substrates, elevation, slope, etc.). High survival, community stabilization and supplemental natural recruitment have been positive indicators of the projects' and program's overall success.

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Fish Assemblage and Vegetative Monitoring of Restored Mangrove Habitat in Southeast Florida

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Rapid urbanization and associated coastal development in south Florida over the last 100 years, along with the growing body of scientific evidence documenting the importance of coastal wetlands as habitat and a vital link in the marine food web, has resulted in government regulatory protection and wetlands habitat restoration. By the mid 1900s, an extensive network of drainage and flood control canals had been completed, which significantly altered how freshwater was delivered to southeastern Florida coastal areas. These regional modifications of freshwater inflow, plus past dredging and filling practices associated with rapid urbanization, caused serious environmental degradation to south Florida coastal wetlands and estuaries. Biscayne Bay is a shallow, subtropical estuary on Florida's southeastern coast. Overall, the bay has lost approximately 45% of the linear shoreline of mangrove wetlands habitat that once bordered it. Fringing mangroves were virtually eliminated and replaced with bulkheads and unconsolidated fill in the northern portions of Biscayne Bay. In contrast, southern Biscayne Bay has experienced much less drastic watershed and shoreline modification such that most of its perimeter is still lined with a narrow coastal band of red mangroves (*Rhizophora mangle*). Since 1987, Miami-Dade Department of Environmental Resources Management (DERM) has restored and enhanced approximately 160 hectares of coastal wetlands. This presentation reviews the long-term science-based monitoring efforts conducted at four large-scale wetlands restoration sites in southeast Florida, inclusive of vegetation success and aquatic habitat utilization.

Vegetative monitoring (2000-2004) for percent survival, growth rates, and natural recruitment is being conducted at four large-scale wetlands restoration sites. Various monitoring methodologies have been employed to detail efficacy of the restoration efforts. The monitoring is documenting the influences of site-specific interacting variables. Planting survival of *R. mangle* at the restored sites ranged from 64% to 100%, and natural recruitment to the sites ranged from 0-4/m^2 for black mangrove (*Avicennia germinans*) and 2-17/m^2 for white mangrove (*Laguncularia racemosa*).

Ichthyofauna monitoring of a 30-hectare mangrove wetlands restoration site at the Bill Baggs Cape Florida State Park (Key Biscayne, FL.) was conducted during consecutive wet and dry seasons (9/00 and 2/ 01), and the spring of 2002 and 2004. Twenty-eight shallow tidal pools (30 meters in diameter) were sampled using a seine net. A total of 29 fish taxa have been identified in the restored tidal pools, and the diversity of fish species has increased from 5 species per tidal pool to 10 species per tidal pool over the five year monitoring effort. In addition, the inventory reveals that the restored areas are functioning to support sub-adult species of fisheries value.

These monitoring programs are providing valuable information on survival, rates of growth, natural recruitment, inter-species competition, and succession while documenting the value of habitat heterogeneity in enhancing taxonomic diversity in wetlands restoration projects.

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Sediment Microbial Communities to Assess Restoration Success in Mangrove and Seagrass Habitats: A Novel Approach Using DNA

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Primary production is, in part, regulated by below-ground interactions such as the accumulation of pathogens, parasites, and herbivores. Since the links among microbial decomposers, pathogen and parasite diversity, and above-ground plant productivity are poorly understood, we developed a novel approach using a sediment condition metric that more directly assesses these linkages as they relate to restoration success in two aquatic habitats. Specifically, the metric was based on the genetic composition of the below-ground microbial community. This technique circumvents time-consuming sample sorting. Also, it avoids the taxonomic problems inherent in benthic invertebrate data sets by using genetically-based microbial communities determined by targeting conserved regions of a universal gene, a small subunit of the ribosome. The collection of sequences in a DNA extraction from a sediment sample forms a fingerprint that can be compared among other samples with Applied Maths' GelCompar™ software. This multivariate statistical approach (PCA) quantifies the factors associated with significant shifts in microbial communities through time and allows a community-based approach to evaluate plant performance and, ultimately, restoration success. Results of two experiments that manipulated soil conditions during planting and relocating mangrove seedlings and seagrasses, respectively, are presented. Mangrove seedlings were planted at a hydrologically restored site using leaf litter and nutrient treatments as well as a control plants receiving neither litter nor nutrients. Seagrasses were relocated from a dredge site as mitigation for lost habitat under two treatments: with and without native sediments. The success of the plantings and relocations was evaluated according to mangrove and seagrass performance measures and their associated below-ground microbial communities.

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Integrating Environmental Water Management and Flood Control in Florida's Upper St. Johns River Basin

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The Upper St. Johns River Basin Project (USJRBP) is a $180 million flood control project currently near completion in the headwater region of the St. Johns River. The project is a joint effort between the U. S. Army Corps of Engineers and the St. Johns River Water Management District that uses the historical floodplain to capture and hold storm water as the means for providing flood protection. When completed, the USJRBP will encompass an area greater than 160,000 acres. Although the primary purpose of the project is flood control, a secondary goal is to restore, protect and enhance basin wetlands.

To achieve environmental objectives we are focusing on restoring the spatial and temporal attributes of the natural hydrologic regime. By creating a hydrologic regime that mimics natural conditions we believe that optimum soil and vegetation characteristics will be maintained. This in turn will provide other environmental benefits such as enhanced fish and wildlife habitat and improved water quality. Unfortunately flood control regulation schedules designed to maintain extensive storage capacity during the wet season and store water during the dry season creates hydrologic conditions that are exactly opposite those which occurred naturally. As a solution, the Corps has agreed to provide the District the flexibility to manage water levels for environmental benefits when water levels area below regulation schedules. This has become known as Zone B management and to our knowledge constitutes a unique approach to water management in a major Federal flood control project. By incorporating Zone B management strategies we have been able to re-create natural attributes of the hydrologic regime with regard to mean depth, inundation frequency, maximum depths, magnitude of water level fluctuation, timing of water level fluctuation, and water level recession rates. Eventually these management strategies will be incorporated into an Environmental Water Management Plan that will be included in the Final Federal Water Control Manual for the project. By incorporating a more flexible approach to the water control process a framework for implementing adaptive management with regards hydrologic restoration has also been established.

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Application of Conceptual Ecological Models to Everglades Restoration

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Teams planning and implementing restoration programs in south Florida developed an applied science strategy as a process for linking science and management. The principle organizing component in the applied science strategy is a set of non-quantitative, conceptual ecological models of the major physiographic regions in south Florida. Conceptual ecological models are planning tools developed to guide and focus scientific support for the south Florida ecosystem restoration initiatives. Models are used to build understanding and consensus among scientists and managers regarding a set of working hypotheses that explain sources and effects of major anthropogenically-induced changes in the natural systems of south Florida.

Conceptual ecological models are applied to restoration planning in several ways. The process of developing working hypotheses and laying out linkages in conceptual models serves as a basis for identifying gaps in knowledge and setting research priorities. For the Comprehensive Everglades Restoration Program (CERP), these identified gaps are serving two purposes to date: 1) once prioritized, the system-wide monitoring program recommended a subset as research topics, and 2) recommendations will be made for federal and state agency research dollars.

Conceptual models provide a framework for creating system-wide performance measures used both to plan the design of restoration programs and assess responses in the natural systems during implementation of each program. Specific hydrological, water quality, biological and ecological performance measures derived from stressors and attributes in the models focus restoration planning on agreed upon quantitative objectives. Project members can focus on how the stressors and attributes can be simulated by existing predictive models or drive development of new simulation models. Lastly, during planning of restoration projects, performance measures indicate what to quantify for non-monetary benefits or ecosystem outputs to incrementally justify a selected alternative relative to its costs.

Performance measures also define the content of a system-wide monitoring program designed to measure system responses to restoration efforts. Simplified conceptual ecological models were developed to reflect those components that are expected to be affected by CERP implementation. These simplified models guided the development of a monitoring and assessment program that will lead to technical reports assessing CERP's progress towards achieving its broad restoration goals. CERP's Restoration Coordination and Verification Team (RECOVER) will produce technical reports that evaluate system-wide hypotheses, goals and performance measures and address progress towards achieving Interim Goals and Interim Targets. The ensuing discussion may lead to suggested decision alternatives for CERP managers to take corrective actions, and thus complete one more step in towards adaptive management of the system.

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Large Lake Rehabilitation: Lessons from the Lake Ontario Ecosystem

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The Lake Ontario ecosystem has undergone considerable ecological change during the past three decades. Most notable changes have been reductions in phosphorus loading, facilitative interactions among nonindigenous species (NIS), regime shifts in ecosystem processes, and marked declines of key native species. Significant reductions in phosphorus with a concomitant shift toward oligotrophy and a dramatic increase in water clarity resulting from both nutrient reduction and proliferation of filter-feeding *Dreissena* spp. have favored benthic over pelagic energy pathways (especially in the nearshore and embayment habitats), a process termed benthification. Water level stabilization in Lake Ontario and the upper St. Lawrence River has had a significant negative effect on recruitment of fish species such as northern pike. Large-scale stocking of Pacific salmonids into Lake Ontario to control nuisance levels of non-native alewife was successful but has led to overwhelming stakeholder demand for maintaining a non-native predator-prey system at the expense of focusing resources on restoring the native fish community. Several lessons emerge from Lake Ontario's ecological history. Rehabilitation efforts aimed at reversing eutrophication and reducing chemical pollution have been largely successful whereas the effects of NIS remain largely irreversible. Rehabilitation efforts must reach into the surrounding watersheds since degraded tributaries contribute excess sediments and nutrients, resulting in unfavorable conditions for fishes in embayments and nearshore habitats. The challenges for scientists, managers, and stakeholders to meet future goals linked to large lake rehabilitation are monumental and complex as humans continue to perturb these ecosystems and new stressors like global climate change and invasion by NIS impede future progress.

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Formulation of a Multiple-Purpose Project for Hamilton City, California

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Multiple-purpose projects that include ecosystem restoration can meet economic needs in an environmentally sustainable manner, while attracting support and funding from a broad range of stakeholders. The consideration of restoration benefits from project features that serve both environmental and economic purposes increases the potential that a project will be found to be economically-justified.

The Hamilton City feasibility study is one of the first to be completed under recent Corps guidance on the formulation of multiple-purpose plans that include ecosystem restoration. The selected plan for Hamilton City, California combines non-monetary ecosystem restoration benefits with monetary flood damage reduction benefits. The plan formulation process for Hamilton City will be presented as an example of quantitative multiple-purpose plan formulation. This presentation will focus on the evaluation and comparison of alternative plans, trade-off analysis, incremental cost analysis of both monetary and non-monetary benefits, and the allocation of costs between project purposes. Understanding these plan formulation processes is important in developing successful multiple-purpose projects.

Hamilton City is a small agricultural town on the Sacramento River, 85 miles north of the city of Sacramento, in California's Central Valley. The town has a low level of flood protection provided by a private levee maintained by individual landowners. Most of the floodplain upstream and downstream from the town is used for agriculture. Previous efforts to develop a single-purpose flood protection project were unsuccessful because the economic benefits were not sufficient to justify the project costs, and because of the lack of sufficient non-federal funding. The Corps' latest study considered ecosystem restoration as a major project purpose, along with flood damage reduction. The alternatives considered in detail consisted of new setback levees along various alignments, with restoration of riparian forest and associated habitats on agricultural lands in the floodplain between the new levee and the river.

Four cost-effective alternatives were identified from an initial array of six multiple-purpose alternatives. A trade-off analysis was performed using habitat units, flood damage reduction benefits, and total project costs as factors, along with a set of preferences selected by the study team. A single-purpose National Ecosystem Restoration plan was also identified.

The selected plan for Hamilton City includes construction of 6.8 miles of setback levee, removal of the existing private levee, and restoration of about 1,500 acres of riparian habitat at an estimated cost of $45 million. About 90% of the total project costs were allocated to the ecosystem restoration project purpose using the separable costs - remaining benefits method. The selected plan is supported by a diverse group of environmental and economic stakeholders.

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Setting Interim Goals and Targets for the Comprehensive Everglades Restoration Plan

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Many public, political, and scientific challenges exist when attempting to predict and measure the interim success of large-scale, multi-project restoration plans. We discuss these challenges and describe a framework used for establishing interim goals and targets for The Comprehensive Everglades Restoration Plan (CERP). The CERP was authorized through the federal Water Resources Development Act of 2000, which required the establishment of restoration expectations. The process for the development of these expectations was provided in the 2003 Programmatic Regulations which required 'interim goals' to provide a means of tracking success in restoring south Florida's natural areas and 'interim targets' to provide a means of tracking success in providing for water supply and flood protection. Demands for setting interim goals and targets for CERP were unique because other large-scale restoration projects have not set goals and targets based on predicted ecosystem response to plan implementation. Rather, other restoration plans have set goals and targets based upon desired restoration endpoints. An interagency team selected a set of hydrologic, chemical, and biological indicators from regional conceptual ecological models. When possible, interim goals and interim targets were predicted using a deterministic hydrologic model that currently incorporates an historic 36-year period of climatic data. Predictions were made for five year increments starting at 2010 and ending in 2035, the planned completion of the restoration plan. Although predicting interim targets was relatively straightforward, predicting quantitative goals for chemical and biological indicators proved challenging because few ecological models can predict numerical responses relative to large-scale improvements in wetland function. Therefore, interim goals for many biological indicators were predicted using related hydrologic modeling output, resulting potential habitat suitability, and best professional judgement. Indicators for Interim goals and targets were also tied to previously developed monitoring and assessment plans to determine how well predicted interim goals and targets are met throughout the implementation of the CERP.

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Understanding the Role of Natural Processes in Guiding Human Restoration Efforts

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Glacier Bay National Park, Alaska (GLBA) is most remote and least human-impacted areas in the United States. It is also one of the most dynamic landscapes on Earth. During the past 250 years, large-scale glacier fluctuations and earthquake-induced landslides have greatly altered GLBA's landscape. Specifically, since the mid-18th century, glacier retreat has exposed more than a million acres of land surface. Similarly, in Lituya Bay, part of GLBA located along the Gulf of Alaska coast, four post-1840, earthquakes have produced giant waves that have removed all vegetation from more than a thousand acres of shoreline. Consequently, GLBA is one of the best locations on Earth to study natural landscape evolution and ecosystem development.

In spite of its remote location, the GLBA area has an extensive photographic history. Ground-based photography began in the mid-1880s and much of the GLBA area was photographed from the air in 1929. Many of these historical photographs are being used to document ongoing landscape and glacier change. More than 350 pre-1980 photographs that show the GLBA landscape and glacier termini positions have been acquired by the authors. Beginning in 2003, approximately 150 of the sites from which historical photographs had been made were revisited. At each site, elevation and latitude and longitude were recorded using WAAS-enabled GPS. Compass bearings to photographic targets were also determined. Finally, using the historical photographs as a composition guide, new photographs were made using digital imaging and film cameras.

In the laboratory, 21st century images and photographs were compared with corresponding historical photographs to determine, and to better understand rates, timing, and mechanics of GLBA landscape evolution. These comparisons also help to clarify the response of specific glaciers to changing climate and environment. Throughout the GLBA area, the comparisons clearly document rapid vegetative succession throughout the bay; continued retreat of larger glaciers in the East Arm of the bay; a complex pattern of readvance and retreat of the larger glaciers in the West Arm of the bay, coupled with short-term fluctuations of its smaller glaciers; transitions from tidewater termini to stagnant, debris-covered termini; fiord sedimentation and erosion; development of outwash and talus features; and many other dramatic changes.

As might be expected, 100-year-plus photo comparisons show significant changes throughout the GLBA landscape. Surprisingly, recent changes, occurring during the second half of the 20th century are equally dramatic, especially documenting the rapid thinning and retreat of glaciers in East Arm, followed by the rapid development of forests and wetlands. Examination of the variety and complexity of the natural processes that operate in remote locations such as GLBA should be a fundamental and critical factor in guiding human restoration efforts.

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Economic Impact Survey of Eurasian Watermilfoil Removal From Houghton Lake

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It is common knowledge throughout the aquatic field that an exotic plant infestation on a lake can have serious detrimental consequences to the ecology of the water body. We often discuss the logical significant economic impact that degraded water quality from excessive exotic plant growth, can have on the local businesses and commerce connected with a given lake. It is, however, not very easy to quantify many of the economic values associated with the lake community, making even an extensive economic study, still incomplete.

The purpose of this report will be to explain the documented economic impacts of the 2002 Sonar treatment of Houghton Lake. Through personal interviews, local economic data research and the analysis of an extensively distributed survey, the outcome of the Sonar treatment of Houghton Lake will be critically looked at both in terms of personal/communal satisfaction and overall satisfaction of project results for the property owners who paid for the treatment. A measurement will be made to estimate its impact on the local economy. Qualitative as well as quantitative analysis of this data will be reviewed to better understand the economic impact of the 2002 Sonar Eurasian Watermilfoil treatment.

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Projecting Future Population Dynamics of the Florida Snail Kite in Relation to Hydrology

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The Florida snail kite is an endangered raptor that occurs as a closed population of about 2000 birds in the wetlands of Southern and Central Florida. Its demography is severely affected by the hydrology of these wetlands. An individual-based model has been developed to project population change under future hydrologic scenarios. As basic information for any predictive model, good empirical studies are required. A large number of empirical studies have been done on the Florida snail kite. These studies provide the correlative relationships between specific aspects of the snail kite life-history and behavior with the hydrology of the system. These relationships form the building blocks of any hydrologically driven population-dynamics model.

Two alternatives are available for modeling the life history of a population and involve either (1) a system-wide deterministic matrix model, or (2) a spatially-explicit stochastic individual-based model. Rather than choosing between these two approaches, we have combined them by implementing a spatially matrix model that can be run both in a deterministic and in a stochastic mode. With this tool in hand, we approached the challenge of making reliable projections of future population development of the snail kite under various hydrological scenarios.

The reliability of the model can be judged by comparing its predictions for the historical hydrologic patterns with observed demographic patterns during the past decades. The annual count of snail kites that was performed during 1969-1995 provides the type of data needed for such a comparison. This dataset has been criticized, however, for being biased in several ways. Without an unbiased dataset on kite numbers, it is hardly possible to check the reliability of the kite model against the historical situation; this potentially limits the utility of the model in discriminating among hydrological scenarios.

To circumvent these problems we adopted the following research strategy. Rather than implementing a single version of the model, we implemented a suite of model versions representing the structural uncertainty in our understanding of the dynamics of the kite population. For each model version, we then developed a number of parameterizations, representing the uncertainty in the model parameters. We will evaluate each hydrological scenario for each model version for each parameterization, focusing on the long term population growth rate (λ) as the main response parameter. This analysis will enable us to evaluate whether structural uncertainty and parameter uncertainty interact with differences due to hydrological scenarios. If these interactions are absent, they will prove to be a reliable tool for scenario evaluation, despite considerable structural and parameter uncertainty.

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Wildlife Utilization of Phosphate Mined Lands

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The U.S.A. is the world's largest producer of phosphate rock and Florida provides about 75% of the nation's supply of this mineral resource. The mining of phosphate in Florida has a well-documented history and is typically conducted using strip mining techniques. The strip mining procedure involves clearing the site of all vegetation and soil and mining the phosphate rock with draglines. Following the extraction process, the site is back-filled with overburden and "waste" sand tailings. In some instances, surface soils which have been set aside are distributed over the surface prior to revegetation. While strip mining is limited to two regions of Florida, where it occurs it can result in a dramatic alteration of landscapes and habitats, "Bone Valley" in South-Central Florida is the larger and more southerly of the two phosphate mining regions in the state.

Since 1975, phosphate mine operators in Florida have been required by law not only to fill in the strip mines, but also to "reclaim" the mined lands as well. Reclamation is the process of recontouring and revegetating land and water bodies disturbed or affected by mining activities. Land reclamation has involved a variety of technologies and regulations which reflect the complexity of economic and ecological forces involved in the process. The nature of reclamation therefore varies greatly among sites, from simply planting pasture grasses to support cattle to spreading native topsoil and planting native vegetation to attract wildlife. The evolution of technologies associated with Phosphate mining may be used to advance the development of various aspects of restoration science.

Biological Research Associates and the University of South Florida have teamed to conduct a three-year wildlife habitat and wildlife utilization study of lands mined for phosphate in the Bone Valley Region of Florida, funded by the Florida Institute of Phosphate Research (FIPR). The study commenced in May 2004. Seventy three locations representing mined and reclaimed lands and encompassing a range of reclamation procedures and successional stages were selected for the study. The presence and relative abundance of vertebrates (including freshwater fishes) at each site is being documented by conducting surveys across all seasons and using a variety of techniques. From the findings of the surveys, vertebrate distributional patterns and habitat requirements on reclaimed and mined lands will be established using GIS. Patterns of wildlife utilization will then be related to habitat attribute data to identify specific reclamation practices that would enhance habitat for targeted wildlife species. Results will be used to generate recommendations for improving the habitat quality of reclaimed lands for fish and wildlife.

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Assessment of Soil Salinity and Moisture Fluctuations in the Bald Cypress Floodplains of the Loxahatchee River Watershed

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The Northwest Fork of the Loxahatchee River is home to one of the last remnants of native cypress river-swamp within southeast Florida. Vegetation studies conducted along the Loxahatchee River show that the highly valued bald cypress have been retreating upstream since the turn of the century. It is believed that the increasing salinity in the Loxahatchee River and the altered hydroperiod that makes it impossible for the bald cypress to thrive are caused in part by the following: 1) the construction of canals drain water away from the historic river basin of the Loxahatchee; 2) between the period of 1958 and 1974 the majority of the freshwater flow from the headwaters of the Loxahatchee River was re-diverted from the North west Fork to the Southwest Fork for flood control; 3) the Jupiter Inlet, historically an intermittent barrier to saltwater intrusion, was permanently opened by the US Army Corps of Engineers, and 4) lowering of the groundwater table. Field observation suggests that vegetation change in the transition zone between freshwater vegetation to saltwater tolerant mangroves is dynamically related to seasonal change in groundwater levels and soil water salinity in the floodplain. However, no formal study has been conducted in the area to confirm this hypothesis.

The goal of this study is to characterize soil moisture and salinity changes in the floodplain during wet and dry seasons, and calibrate and test the numerical model Hydrus-2D to simulate soil moisture salinity movement. Two river transects perpendicular to the river will be monitored for one year. Twelve dielectric probes measuring soil moisture and salinity with internal data loggers were installed on each transect at 3 depths for one wet and one dry season. Monitoring wells were used in each plot to record local groundwater salinity and elevation and develop water table depth soil moisture profile relationships. Additional hydrological data was obtained from the SFWMD on flows and stages over Lainhart Dam and local rainfall.

The model, once calibrated and field tested will be used to assess performance measures for floodplain hydroperiods within the watershed as well as to make recommendations on the potential for freshwater reforestation and the management measures necessary for future successful restoration efforts.

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Large-Scale Ecosystem Restoration Initiatives and the U.S. Federal Policy Process

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Many regions of the country have launched, or are considering launching, large-scale ecosystem restoration efforts. Invariably, proponents of these complex and expensive efforts will interface with Congress and/or the executive branch to gain the essential statutory and budgetary authorizations and appropriations. Proponents are frequently surprised by the constraints that the architecture of congressional committees and other features of the federal system impose on such initiatives. Yet, the results of these federal processes are critically important to the outcomes of the restoration effort itself, defining fundamental features of the restoration initiative such as its lead agency, intergovernmental/stakeholder coordination, the planning process, and the funding mechanism.

This paper identifies and discusses the realities of the process of federal involvement in ecosystem restoration, and analyzes the resulting types of federal involvement currently in place or proposed for the Upper Mississippi River, Chesapeake Bay, and Great Lakes. Particular attention is given to the likely implications of each approach for realizing federal funding (including indirect effects on line programs), involving states and stakeholders, and achieving concrete restoration outcomes.

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Cost Risk Assessment for Ecosystem Restoration Projects

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Ecosystem restoration is a relatively new endeavor for public works projects. The complexity of the ecosystems and the relative lack of experience with them presents analysts with a considerable challenge in dealing with the variability and uncertainty that can plague the formulation of these projects.

Cost risk assessment provides a logical, defensible and systematic way to address the variability and uncertainty in an ecosystem restoration project cost estimate. The information generated in cost risk assessment can improve the quality of all the decisions made based on the cost estimates. Instead of a single estimate of project cost, this analysis produces a distribution of feasible cost estimates. The information produced by this analysis enables the user to better characterize the cost estimate and to estimate the likelihood that specific costs will be equaled or exceeded. Cost risk assessment provides an alternative way to handle the uncertainties in a project that contingencies have been used to address in the past.

We can be virtually assured that a point estimate of project costs will not be right. In best practice the point estimate will be close enough to the true costs so as not to cause anyone who uses the point estimate to suffer any extreme consequences. A good risk assessment, however, never fails to encompass the actual costs of a project.

The techniques used to identify and describe the uncertainty inherent in a risk assessment of ecosystem restoration costs are the same techniques that would be used for any cost estimation purpose. They are simply adapted as necessary for the unique aspects of ecosystem restoration. The preferred method of assessing the risks in estimating the costs of an ecosystem restoration project is to calculate the costs for hundreds or thousands of possible scenarios and then to study the results of those many calculations. From the thousands of possible cost estimates, we can learn what can go wrong, how it can happen, how likely it is and the consequences as well. What is needed, however, is a reliable and cost effective method for calculating these thousands of estimates. The Monte Carlo process is one such method.

An application of this method has been made to an ecosystem restoration project on Monday Creek, Ohio. The results provide considerable insights to planners for improving their cost estimates as well as information decision makers can use to judge their exposure to cost overruns.

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Age and Growth of Florida Gar, a Top Predatory Fish in Southern Florida

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In southern Florida, a huge effort is underway to change current hydrological management in an attempt to restore historical functions of the ecosystem. This restoration effort is using simulation tools, such as the Across Trophic Level System Simulation (ATLSS) ecological model, to model restoration alternatives and performance measures. Inputs into these models include data on identified indicator groups, such as fishes. Life-history traits, specifically age and growth, are essential to understanding the response of fish populations and communities to altered abiotic and biotic conditions. As part of this restoration effort, we are studying age and growth and population dynamics of selected common or abundant large-bodied fishes inhabiting south Florida. A primary target species is the native Florida Gar (*Lepisosteus platyrhincus*), a top predator in the system. Secondary target species include introduced Spotted Tilapia (*Tilapia mariae*), and three other native fishes, Yellow Bullhead (*Ameiurus natalis*), Warmouth (*Lepomis gulosus*), and Spotted Sunfish (*Lepomis punctatus*).

Sampling of fishes has focused on three major south Florida waterways: Tamiami Canal (C-4) (W of water control structure S-12D, S of Water Conservation Area 3A), Canal L-31W (E boundary of Everglades National Park, S of Florida Hwy 9336), and Snake Creek Canal (C-9). The reaches of C-4 and L-31W are directly connected to adjacent marsh habitats. Conversely, the portion of C-9 sampled is in a heavily disturbed urban area not associated with natural wetlands. Fishes were sampled during January 2000 to January 2001, with preliminary samples taken in 1999. Fish were collected using electroshocking boats covering 4 km of each canal. Each fish was measured and sampled for ageing structures, gonads, and stomach contents.

In total, 516 Florida Gar were aged using branchiostegal rays. This method was validated using monthly growth at the margin of the rays, which demonstrated that one annulus is formed each year in gar in southern Florida. Female gar in southern Florida ranged in age from 0 to 19 years of age, and males ranged from 0 to 10 years of age. Females were slightly larger on average than males at any given age after 3 years.

In addition, 737 Warmouth, 871 Spotted Sunfish, and 942 Spotted Tilapia were aged using sagittal otoliths. Yellow Bullhead were preliminarily aged using pectoral spines, and this work is continuing. Warmouth and Spotted Sunfish were relatively short-lived, ranging from 0 to 6 years of age, whereas Spotted Tilapia ranged from 0 to 11 years of age.

Species-specific growth curves, and age-length keys used to reconstruct the age structure of the populations, will benefit the restoration effort by providing quantitative inputs to ecological models used to evaluate alternative restoration scenarios.

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Hydrology, Ecology, and Simulation of the Six Mile Cypress/Ten Mile Canal Watershed System

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Understanding the hydrology and ecology of the Six Mile Cypress/Ten Mile Canal Watershed System in Fort Myers, Florida, a subset of the Tidal Caloosahatchee River Basin, is critical to establishing a dynamic equilibrium between natural and human systems in the region. The heart of the Six Mile Cypress Watershed, the Six Mile Cypress Slough Preserve, is a 9-mile long, 1500-foot wide cypress slough encircled by residential and commercial development and crossed by 5 highways.

A study is underway to answer the question, “Has the Six Mile Cypress Slough Preserve been impacted by regional hydrological changes?” If this is true, a second question arises, “What can be done to restore the system to its predevelopment state?” Observed data from Lee County Natural Resources and the South Florida Water Management District suggests that the hydropattern in the slough may be suboptimal for ecosystem maintenance. As development progresses and climate change occurs, the hydropattern will be altered in unknown ways. Water quality changes in the slough also merit further consideration. These factors may impact ecosystem health, fire and flood regimes, and soils.

An integrated, regional hydrological simulation model based on field investigations has been developed that encompasses the watersheds in question. Surfacewater, groundwater, and atmospheric interactions are included. This model is being modified and refined to allow a detailed examination of the Six Mile Slough Preserve and the surrounding area. DHI Water and Environment’s MIKE SHE/MIKE 11 simulation software is being employed. Simulation results are being coupled to ecosystem and human system understanding to optimize overall system integrity and functionality. Hydropattern, water quality, fire regimes, soils, and human factors such as control structures and drainage systems are among the variables under consideration.

Simulation scenarios currently include:

1. Model calibration, prediction, and refinement within the time frame of available input data, e.g. precipitation and evapotranspiration rates, input/output flows, control structure operation, etc.
2. Investigating the possibility of transferring water into the slough from Ten Mile Canal or reservoirs to optimize the hydropattern in the slough
3. Predicting the impact of land use changes through 2050

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Habitat Requirements of Three Species and Their Responses to Translocation to Reclaimed Phosphate Mined Land

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Upland habitats in Florida are subjected to disturbances created by urban development, agriculture and phosphate mining. Approximately 5180 square kilometers of Florida harbors accessible phosphate resources. The majority of the central portion of Florida, called Bone Valley, has been mined or is slated for strip-mining for phosphate. A state severance-tax law, enacted in 1975, required reclamation of newly and future mined lands. Current mining and reclamation practices make it exceedingly difficult, if not impossible, to restore the original habitat characteristics to a site following phosphate strip mining. Rather than restoration, rehabilitation is a more reasonable, attainable goal for reclamation. A rehabilitated ecosystem is one in which some of the key habitat features are reinstated but not duplicated. Given time for natural ecological processes, rehabilitated lands perhaps can heal themselves and eventually support the normal range of species for that habitat type.

Two studies (Mushinsky and McCoy 1996, 2001) indicated that some vertebrate species were underrepresented on reclaimed lands relative to unmined lands. Relative to unmined habitats, reclaimed lands had course and compacted soils, were dominated by few plant species, had less complelx vegetation structure and lacked temporary ponds. A species could be absent from reclaimed lands either because its habitat requirements are not satisfied or because the reclaimed land is too isolated for natural recolonization.

We studied the autecologies of two toads ***(****Bufo terrestris* and *B. quercicus*) and the southeastern five-lined skink (*Eumeces inexpectatus*) to understand their microhabitat requirements at unmined sites, and used those findings to evaluate microhabitat characteristics at reclaimed sites. Also, we translocated fifty toads and ten lizards to reclaimed and unmined sites. Efforts to translocated the three species were influenced by untimely drought conditions, but our findings strongly indicate that many of the reclaimed sites did not provide habitat to satisfy the needs of these three wide-ranging, generalist species.

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Cat Island Chain Restoration, Green Bay

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The Cat Island chain of islands, located within Green Bay, was severely eroded during high water levels and extreme wave attack in the early 1970s. It is believed that the loss of the above water part of the islands was responsible in whole or part for the loss of almost 700 acres of emergent and submerged aquatic vegetation in the lee of the islands. In addition to these indirect impacts, the terrestrial habitat of the islands themselves was also directly lost. The US Fish & Wildlife, Brown County and the US Army Corps of Engineers plan to restore the islands through beneficial use of clean dredged sediment from the Green Bay Federal Navigation Channel.

There are three key objectives of restoring the Cat Island Chain:

1. Creating the conditions for re-establishment of emergent and submerged aquatic vegetation southwest of the Cat Island Chain;
2. Providing capacity for placement of clean dredge spoils of Green Bay Federal Navigation Channel dredging activities;
3. Restoring terrestrial habitat associated with the islands.

The study tasks included: (1) field investigations; (2) geomorphic analysis; (3) physical modeling; (4) numerical modeling of waves hydrodynamics and sediment dynamics; (5) evaluation of aquatic vegetation survivorship; and, (6) development of plans and specifications.

Both from this study, and from previous investigations, it was determined that the large areas of aquatic vegetation that once existed in the lee of the Cat Island chain have been prevented from recovering due to two primary processes that impair water clarity: the advection and dispersion of sediment plumes discharged from rivers; and re-suspension of lake bed sediment by wave action. Only one of the two sources could be directly influenced by the construction of the islands to reduce turbidity levels. The investigations showed that sediment re-suspended from the lakebed by waves could be reduced to levels conducive to the recovery and survival of aquatic vegetation with the construction of the islands. The water clarity impairment associated with the plumes from the two rivers will not be significantly influenced by construction of the islands. Therefore, in order to promote the recovery of the aquatic vegetation in the lee of the islands it will also be necessary to ensure that the sediment load (TSS) from the two watersheds (and that created biologically within the bay itself) is equivalent to or less that the levels experienced prior to 1970.

The islands will have a storage capacity of approximately 2,300,000 cubic yards and have been estimated to cost $20 million (without the cost placing the dredged sediment).

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Lessons Learned in The Use of Community Based Stakeholders to Determine Strategies for Reducing Nutrient Loads to the Choptank River and Chesapeake Bay

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As a signatory of the 1987 Chesapeake Bay Agreement, Maryland was committed to achieving a 40% reduction of 1985 nutrient levels (nitrogen and phosphorous) in the Chesapeake Bay by the year 2000 and capping nutrient levels thereafter. While the State nearly achieved its 2000 goal, it was further determined that further nutrient load reductions were required to remove the Chesapeake Bay from the Federal list of impaired waters by the year 2010. Back in 1995 Maryland's Chesapeake Bay Cabinet divided the state into ten geographic areas, each with its own Tributary Strategy Team, to determine the most plausible local methods of reducing nutrients, irrespective of the State's priorities.

Each Tributary Strategy Team consists of volunteer stakeholders who may or may not have a technical background but who could presumably influence nutrient reductions from point and non-point sources. The Choptank Teams has been briefed on physical and ecological processes as well as best management practices, their usage, and their effectiveness throughout their existence. Nutrient loads entering the Chesapeake Bay are predominantly from waste water treatment plants, agriculture, and atmospheric sources, while the Choptank receives nutrients primarily from agricultural sources. A coordinated effort between the State's environmental agencies recently developed new strategies that will achieve further nutrient reductions equivalent to 60% of the original 1985 load. The final strategy relies on the use of winter cover crops on agricultural fields, forested and grassed waterway buffers, and enhanced nutrient removal at wastewater treatment plants, among other practices.

Since the Choptank Team's first formation it has been difficult to assess their true role in affecting nutrient reduction policies on a local or State-wide basis, while notable examples of their success do exist. Moreover, they have served more as the "first reactors" when the State shifted its policies or communication strategies.

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Cottonwood Management and Regeneration along the Missouri River

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In their 2000 and 2003 Biological Opinions the U.S. Fish and Wildlife Service (USFWS) advised the U.S. Army Corps of Engineers (Corps) that current river operations on the Missouri River as well as the continued maintenance of the Bank Stabilization and Navigation Project are likely to jeopardize the continued existence of the bald eagle, piping plover, least tern, and pallid sturgeon. The USFWS recommended the following reasonable and prudent measures (RPM's) to minimize the take of bald eagles: (1) map and evaluate the current health of cottonwood forests that could provide habitat for bald eagles, (2) develop a management plan so that cottonwood regeneration is maintaining pace with or exceeding mortality, and (3) ensure that no more than 10 percent of cottonwood forest habitat that is suitable bald eagle habitat is lost during the project life.

For the first RPM, the current health of cottonwood forests that could provide habitat for bald eagles is being evaluated along a 5-mile test reach on the Missouri National Recreational River between Yankton, South Dakota and Ponca State Park, Nebraska. The cottonwood forests are being mapped and outlined into different land uses and age classes. From those maps, areas with bald eagle use and high erosion rates will be overlaid using GIS techniques to see if there are trends in bald eagle use for both nesting and roosting sites. The knowledge of these trends can then be applied in a model to use along the entire stretch of the Missouri River.

The Corps has created a draft cottonwood regeneration report to address the second RPM. The report is based on both the scientific literature and discussions with land managers who have experience with cottonwood restoration on the Missouri River and other rivers. It discusses the basic biological criteria for selecting restoration sites, methods for restoring cottonwoods, lessons learned from previous cottonwood restoration efforts, and management techniques for cottonwood seedlings. In the fall of 2004 the cottonwood team, consisting of members from various federal and state agencies, universities, tribes, and non-profit organizations, met to discuss potential restoration sites and seeding or planting methods and in the spring of 2005 initial cottonwood restoration efforts will begin.

RPM 3 will be addressed when the first two RPM's have been further developed.

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Particulate Phosphorus Transport in the Everglades Wetland Landscape

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The transport of suspended particles is an important process that regulates ecosystem structure and the restoration of Everglades wetlands. Particle transport is likely a key process for maintaining topographic heterogeneity and influencing the movement of nutrients through the landscape. Particle generation, transport, and retention are also important for understanding phosphorus (P) cycling in the ecosystem. At present, the composition, concentration, and transport of suspended particles are all poorly understood in the Everglades and other wetlands. Information concerning these processes would benefit restoration planning.

Ecosystem P budgets for Everglades marshes suggest the potential importance of downstream particulate P (PP) transport. For example, uptake of sedimentary P by macrophytes drives a flux of P into the water column. Following P enrichment and colonization by *Typha,* this flux rate increases from 0.04 in oligotrophic wet prairies to 1.59 g P m^{-2} yr^{-1} in P-enriched *Typha* marshes. This large amount of organic P moved into the water column has the potential to drive significant downstream movement of P by advection of P-rich particles, and this process could become even more important if greater sheetflow velocities are restored. Similarly, particle transport in oligotrophic regions could affect the delivery of nutrients to coastal systems, and also could influence future shifts in ecosystem structure. Transport of flocculent detrital -matter (floc) would be particularly important in the Everglades, because it stores a large proportion of P in oligotrophic Everglades wetlands (13-21% of total). Related studies also support the need for more information on suspended particle transport. For example, dosing of $^{32}PO_4$ showed that particles in the water column dominate short-term P cycling in oligotrophic Everglades wetlands. Also, solute and fine particle tracer injections demonstrated the importance of fine-particle filtration by vegetation.

Given the potential importance of suspended particles, we have initiated studies of particle characterization and transport. Preliminary sampling of surface water from WCA-2A during the dry season has shown the importance of PP (>0.45 µm), especially in P-enriched areas. Measured indirectly as the difference between total P (TP) and total dissolved P, PP comprised 14% of TP, or 1 µg L^{-1}, at the unenriched site U3 (TP= 7 µg L^{-1}). At the enriched site F1, PP constituted 41% of TP, or 8 µg L^{-1} (TP=18 µg L^{-1}). Direct measurements of PP concentrations, through the filtration of large water volumes and analysis of filtered particles, were 3.6 µg L^{-1} at U3 and 7.0 µg L^{-1} at F1. In contrast to P, particulate nitrogen (N) comprised just 2% and 6% of total N in the surface water of U3 and F1, respectively. These results show that 1) particulate P can be a large proportion of total P in the water column, especially in P-enriched marshes, 2) direct measurement of particulate P is necessary in unenriched areas, and 3) particles carry a small proportion of the N load in surface water. Future work will further characterize the composition and investigate the transport of suspended particles.

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Integrating Conservation Biology and Restoration Ecology for the Long-term Integrity of Southwestern Ponderosa Pine Landscapes

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Since 1976 research at Northern Arizona University has addressed the restoration of ecosystem health in southwestern ponderosa pine and related dry forest types. Most research has focused on relatively small study areas with plot sizes ranging from one to one hundred hectares. Interest in this work has increased substantially as a result of the increasing size and severity of wildfires over the past ten years. Because fires are now on the scale of mid-sized landscapes (about 10,000 to 200,000 hectares recently), agencies and the public are now pushing for large, landscape-scale treatments. Nevertheless, several key questions must be answered: (1) What types of treatments (e.g., thinning, prescribed burning) are most appropriate for restoring ecosystem health and conserving biodiversity while allowing fire to play a constructive, rather than a destructive, role in the landscapes? (2) How large should these treatments be and how should they be located to protect critical landscape elements, especially for conserving biological diversity? (3) How can we best prioritize forest restoration treatments? (4) Should treatments occur within reserved lands (e.g., wilderness areas, natural areas, National Park lands)? (5) How does salvage logging of burned landscapes contrast with ecological restoration focused on the recovery of native ecosystem composition, structure, and function?, and (6) How do reserve size, connectivity, and other design concepts apply to landscapes dominated by a managed wildland matrix?

The goal of our current research is to integrate the principles of conservation biology with ecological restoration to develop guidelines for landscape-scale ecological restoration and management of southwestern pine forests. In addition to developing broad recommendations, we illustrate and test draft recommendations on the Mogollon Plateau of central Arizona, the location of the largest continuous ponderosa pine forest in existence. An intended product of this ongoing research is a regional-scale conservation plan that encompasses restoration areas, managed areas, and protected areas with varying intensities of treatments, human uses, and protection.

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Historic Changes in the Everglades Ridge and Slough Patterned Landscape

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The Ridge and Slough landscape once dominated most of the central and southern Everglades in south Florida. It consisted of long, linear sawgrass ridges and tree islands interspersed with sloughs, all trending parallel to the dominant flow direction of water. Some areas of the remaining Everglades have retained this patterning, while others exhibit degraded or no patterning. While the exact mechanisms creating and maintaining the landscape patterns are unknown, water flow appears to play a major role in these processes. In many parts of the Everglades, pattern degradation appears to be related to altered water management practices over the last century.

The Ridge and Slough landscape is a patterned peatland. The ridges consist of elevated peat with emergent plant communities and are interspersed with sloughs. Peat is produced by decomposition of plant materials, so changes in habitat conditions may alter vegetation growth and decay processes. Hydrologic changes and altered flow may impact the landscape through their effects on wetland processes that initiate and maintain the patterning.

Aerial photos from 1940 through 2003 were utilized to analyze changes in landscape patterns over time. Using an established set of quadrants, several landscape metrics were utilized to quantify the properties of the ridge and slough landscape. These indices focused on the ridge and island sizes, shapes, and spacing within the sloughs. Patterns of change seen in the ridges and sloughs included ridge fragmentation, expansion of sawgrass, and loss of slough connectivity. Historic information on water management practices for these areas were then used to explain qualitatively the changes that occurred to the Ridge and Slough patterning. Results suggest that shifts in local patterning in the Ridge and Slough may be the result of flow alterations within the ecosystem.

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Defining Success and Setting Objectives: the Everglades Case Study

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The ecological characteristics of the pre-drainage Everglades basin are largely unknown by most quantitative measures, a fact that raises challenging questions as restoration objectives are decided. Opportunities for achieving restoration also vary considerably within the basin even where pre-drainage conditions are comparatively well known, due to large differences among sub-regions in the degree of ecosystem alterations that have occurred. For these reasons the goals of the Comprehensive Everglades Restoration Plan (CERP) reflect a spatial dichotomy in public opinion about objectives, which generally can be described as "restoration" for some natural system sub-regions and "enhancement" for other natural system sub-regions.

"Restoration" objectives for the core Everglades basin, which includes the "true Everglades", Everglades National Park, Florida Bay, and the Big Cypress Swamp, are aimed at recovering an Everglades that is as true to the original system as possible, as described by a set of "defining physical and ecological characteristics" of the pre-drainage ecosystem. Among these defining features are over-land sheet flows, large extent of contiguous wetlands, highly variable surface water hydrology, oligotrophic freshwater marshes, and immense numbers of large aquatic vertebrates (e.g., water birds and alligators).

"Enhancement" objectives for the remaining natural areas in the basin, which includes Lake Okeechobee, the linked Caloosahatchee and St. Lucie estuaries, and Biscayne Bay in extreme southeastern Florida, are based on a broad public preference to recover degraded recreational and commercial fisheries and supporting wetland habitats in these sub-regions. These objectives are influenced in large part by modern public values for wetlands that are closely proximate to large urban areas, and which have assumed important recreational and water supply roles.

Measures of success for both CERP objectives have been developed from conceptual ecological models, including nine sub-regional models and one total system model. The models are planning tools which provide a framework for deciding the most appropriate system-wide restoration and enhancement performance measures (e.g., sheet flow and wading bird nesting colony patterns for the core Everglades, and Lake Okeechobee water levels and SAV community structure for enhancement areas).

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Rouge Oxbow Restoration Project: Reestablishing Habitat and Recreation on the River

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The Rouge Oxbow Restoration Project is located at The Henry Ford (THE), a premier historical museum, adjacent to the Rouge River in Dearborn, Michigan. Until recently, the water quality of the Rouge River had degraded significantly as a result of pollutant loadings from various sources. In addition, development within the watershed had resulted in a significant reduction in the percentage of pervious area tributary to the River. A flood control project, whose main feature was the concrete realignment of the river, was constructed in the 1970s to prevent flooding. Consequently, a number of river meanders were cut off.

The main objective of the Oxbow Restoration Project was to enhance the ecological viability of this Oxbow by creating fish and wildlife habitat, restore riverine wetlands that have been lost due to channelization and improve water quality. Secondary objectives include flood storage, providing educational opportunities and improved aesthetics of the channel and upland island.

Phase I, completed Summer of 2002, provides restoration of the original channel to Oxbow Wetlands similar to riverine wetlands common in Michigan rivers. The restoration provides a 2,200-ft channel that varies in width from 15 to 105 feet and depths of 3 to 6 feet. The channel is surrounded by 3 acres of wetland systems that provide habitat for wildlife species. The wetland transitions to 10 acres of upland woodlands and meadow. Uplands are planted with native tree, shrub, grass and wildflower species. Bioengineering also provided shrub area. In Spring 2003, native fish were introduced to the oxbow and wildlife has been observed reestablishing. The island created in the middle of the oxbow will be an interpretive area for educational and public programs. It is anticipated that project will also be utilized by the adjacent Henry Ford Academy for biological/ecological studies. Phase I restoration was accomplished using primarily earth-moving equipment. One of the issues with removal of the former sediment in the oxbow channel was that over half of it was contaminated with low levels of metals and was filled with all types of urban material, including the proverbial kitchen sink. Because this area of the Rouge River was historically industrialized, soil testing was conducted throughout the excavation period to ensure that the remaining soils are clean. The river is now hydraulically connected to the oxbow by means of a 60-inch storm sewer (future open cuts through the concrete channel as envisioned). This storm sewer originally carried storm water from The Henry Ford directly to the river. About 350 feet of the sewer was removed allowing for flow of the storm water into the Oxbow in addition to the river. Following completion of the main restoration, additional recreation and ecological control activities were requested to be completed. These include removal of invasive species in the existing woodlands, creation of trails, installation of interpretive signage throughout the Oxbow.

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Urban Lake Restoration - The Return of Newburgh Lake

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Newburgh Lake is a 105-acre impoundment located on the Rouge River in Wayne County, Michigan. It is potentially one of the valuable recreational areas in the urban metropolitan Detroit area. The history encompasses over 65 years of sediment accumulation, which have degraded the lake water quality. Shallow depths resulting from the accumulation and nutrient-rich water led to excessive plant growth. Initial monitoring of the sediment indicated the presence of PCBs that tend to bioaccumulate. This was consistent with previous fish studies that had resulted in fish consumption advisories because of PCBs. The Project set out as its objective to reduce the risk at the lake associated with the sediment by removing and disposing of it and restoring the lake to beneficial use.

Construction on the project took 18 months to complete. Restoration was completed through the use of cutterhead dredges, draglines, and conventional earth moving equipment. The removal operation was complicated by the varying nature of the sediments in the lake bottom, the urban setting, storm events, the highly used park area, and a major sanitary sewer that ran under the lake. The contaminated material and some of the non-contaminated material was hauled to a solid waste landfill in the area. Additional clean sediment was used to help create shallow water shoals and increase surface area of an island for habitat. Though out the construction phase monitoring was continued to define classification levels of PCBs in the sediment, to insure that impacts on the rive were kept to a minimum, and to make sure that the sediments left in place and used to build habitat were free of PCB contamination.

The project accomplished: repair of dam level controls; removal and disposal of 558,000 tons of sediment (350,000 tons contained PCBs); deepening the lake to a minimum of 8 feet; establishment 10 acres of aquatic vegetation; eradication and disposal of 30,000 pounds of contaminated fish; creation of structural and spawning bed habitat; restocking with fish; and resurfacing roads, providing a new boat ramp and docks, cleared areas for more recreational use and establishment of a healthy fishery.

For the following two years water quality and sediment monitoring took place on a periodic basis to help establish a new baseline for the lake. Sediments continued to be clean and the water quality had improved. However, there remained elevated phosphorus levels in the lake. Additionally, visual monitoring of the fish population took place for four years and bio-assays were done in 2002 for PCB. Both the visual and the assays indicated that the fish population was doing very well and the data was been submitted to the Michigan Department of Health (MDH) for revision/removal of the fish consumption advisory. In fall 2003 the MDH revised the fish advisory to that of one similar to all Great Lake lakes and the fish were able to be eaten again. As a result the lake has once again become a valuable resource to the community.

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Restoration of Freshwater Tidal Wetlands in the Anacostia River, Washington, DC

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During the first half of the 20th century, several thousands of acres of wetlands along the tidal Anacostia River were destroyed in an attempt to reduce disease and flooding while developing the waterfront for recreational and commercial uses. Over time, some of the constructed backwater areas filled in and shallow mudflats were established. Additional mudflats formed along the fringe of the river as a result of over-widening of the channel. Over the last decade, the Corps of Engineers, in partnership with the District of Columbia and the National Park Service, has utilized some of these mudflat areas for the restoration of approximately 100 acres of freshwater tidal wetlands.

To construct these wetlands, the Corps dredged material out of nearby navigation channels. This material was needed to raise the elevation of the mudflats to a level that would support wetland vegetation. The higher areas were then planted with hundreds of thousands of native wetland plants. After construction, the wetlands were turned over to the National Park Service to manage. In addition, a multi-agency monitoring and adaptive management approach was employed to address problems caused by non-native plants, such as *Phragmites australis*, and animals such as resident Canada geese. Despite some adversity caused by these nuisance species, the wetlands have flourished as a result of on-going efforts by the Corps and its partners.

Currently, these restored wetlands represent approximately 75% of all the tidal wetlands on the Anacostia River and add significantly to the ecosystem diversity within the urban environment of Washington, D.C.

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Sulfur Contamination in the Florida Everglades: Where Does It Come From, What Is Its Extent, What Are Its Impacts, and What Can We Do About It?

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Sulfur (S) contamination represents a significant water quality issue for Everglades' restoration. Sulfur enters the Everglades as sulfate, primarily in runoff of canal water from the Everglades Agricultural Area (EAA). Sulfate is reduced to sulfide by sulfate reducing bacteria (SRB) in the anoxic sediments of the Everglades. Thus, S contamination of the ecosystem includes sulfate in surface water, sulfide in sediment pore water, and reduced S in sediments, produced by reaction of sulfide with metals (metal sulfides) and organic matter (organic S). Areas of the Everglades near canal water discharge have average surface water sulfate and porewater sulfide concentrations of 60 mg/l and 1,500 ppb, respectively, greatly exceeding surface water sulfate concentrations ($\leq$ 1 mg/l), and porewater sulfide concentrations (< 0.1 ppb) in pristine areas. Most of Water Conservation Area (WCA) 2A and large portions of WCA 2B and WCA 3 are impacted by sulfur contamination, and small portions of Everglades National Park and Arthur R. Marshall Loxahatchee National Wildlife Refuge are also affected.

The major known impact of S contamination in the Everglades is its link to methylmercury (MeHg) production. MeHg is produced from Hg (II) by SRB. Sulfate stimulates SRB activity and MeHg production, but buildup of sulfide in sediment porewater inhibits MeHg production. This dual effect of S on MeHg production produces maximum MeHg concentrationa in areas of the Everglades with intermediate S contamination. This conceptual model has been verified for the Everglades by field, laboratory, and mesocosm experiments, and likely applies in most freshwater wetlands, but does not appear to be the case for the marine environment. Another important feature of the S-MeHg connection in the ecosystem is the stimulation of MeHg production by fire/drought and subsequent rewet of wetland areas. Fire/drought results in: (1) oxidation of organic soils, transforming reduced S in sediments to sulfate, (2) remobilization of this sulfate following rewetting, and (3) stimulation of MeHg production by the remobilized sulfate. The fire/drought model linking S and MeHg production has important implications for management of the Everglades and Stormwater Treatment Areas (STA's).

Sulfur contamination may have other unknown impacts on the Everglades. A mesocosm experiment is currently underway to test the hypothesis that buildup of sulfide in sediment porewater may influence macrophyte distribution due to sulfide toxicity. Mitigating S impacts on the Everglades is a restoration challenge. Unlike phosphorus, S is not removed in significant amounts by aquatic plants, and STA's appear to have little effect in reducing concentrations of sulfate in surface water. Best management practices on agricultural use of S in the EAA could be an important first step in reducing the levels of S contamination entering the ecosystem. Other strategies for reducing S inputs to the ecosystem (e.g. electrolytic reduction, ion exchange) may be expensive, and will require further study and cost/benefit analysis.

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Water Quality in Big Cypress National Preserve: Present Conditions and Potential Impacts of Restoration Plans

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The Big Cypress National Preserve (BCNP) is the western extension of the south Florida wetlands ecosystem. This environment differs from that of the Everglades to the east, but water quality issues impacting the Everglades also affect BCNP. Less is known, however, about water quality in BCNP (see Miller and others, 2004, USGS Water Resources Investigations Report 03-4249 for synopsis), and the impact restoration efforts will have on water quality in BCNP. The aims of this study were to: (1) examine present conditions of water quality in BCNP, focusing on phosphorus (P), sulfur (S), and mercury (Hg); (2) determine source(s) of P and S using isotopic methods; (3) investigate potential impacts of restoration on water quality in BCNP.

Previous work showed that surface water in BCNP has concentrations of P higher than those in pristine areas of the Everglades, but the source(s) of higher P in BCNP is unknown. We previously used uranium (U) concentrations and isotopic abundance (activity ratio (AR) of $^{234}U/^{238}U$) to determine the presence of fertilizer-derived U (and by inference, P) in the northern Everglades. Concentrations of U within BCNP are low (0.016 to 0.16 ppb) compared to P-impacted parts of the Everglades (0.1 to 1.0 ppb), suggesting that fertilizer-derived U or P is at most very minor. Dissolved U concentrations in canals near BCNP are higher (0.1 to 0.7 ppb), and typical of canals in the northern Everglades. A graph of AR values versus 1/U can be used to evaluate possible future mixing of low U-low AR water from BCNP with higher U-higher AR canal water. Further sampling of runoff from agricultural fields will be needed to confirm a fertilizer source to the canals surrounding BCNP.

Sulfur and Hg are important water quality issues in the Everglades, but little work on these contaminants has been conducted to date in BCNP. The S and Hg contaminant issues are linked in that S (as sulfate) stimulates microbial production of methylmercury (MeHg) in wetland soils. MeHg (a neurotoxin) is bioaccumulated and found in high concentrations in Everglades biota. Sulfate concentrations in surface water from within BCNP are generally <1 mg/l, similar to pristine areas of the Everglades. Some canals external to BCNP (notably L28), however, have sulfate concentrations approaching 10 mg/l. Total Hg and MeHg in surface water of BCNP range generally from <1 to 5 ng/l (mostly as filterable Hg), and 0.06 to 0.2 ng/l, respectively. Soils in BCNP contain 20-50 ng/g total Hg and 0.1 to 8 ng/g MeHg. The soil MeHg levels at some sites are rather high, but the reasons for this are presently unknown. A concern is that movement of sulfate-contaminated canal water from L28 or other canals into BCNP to enhance water levels may have the unwanted effect of stimulating MeHg production. Proposed mesocosm experiments in BCNP will examine the effects of sulfate-contaminated water on production in soils and lower trophic level bioaccumulation of MeHg.

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The State of River Restoration in the United States: Data to Inform Prioritization?

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In the fall of 2002, a team of scientists and engineers from multiple institutions around the country began building a new database under the auspices of the National River Restoration Science Synthesis (NRRSS) project (www.nrrss.umd.edu). The goal was to establish a truly comprehensive, national-level database on river and stream restoration to be freely available to researchers, policy-makers and citizens. The database is now populated with > 40,000 projects from over 400 sources including electronic databases, paper files, agency summary reports, individual project websites and 208 personal contacts with consulting firms and agency staff. Less than 6% of all projects in the database come from the 17 federal databases that exist, underscoring the inadequacy of previously existing databases. Databases such as NRRSS provide information helpful in prioritizing restoration efforts and prioritizing research that can enhance the effectiveness of restoration.

We found that significant differences exist in the motivation (*intent)* for the dominant restoration projects around the country and in the types of methods (*activities*) that were used to implement the projects. The majority of the projects across the U.S. are being done to improve water quality, manage the riparian zone, improve in-stream habitat and stabilize stream banks. However, the vast majority of these (ca. 85% of NRRSS database) have no pre and post monitoring. This means that the effectiveness of project types and of implementation methods within a given project type are typically unknown. In this talk, I suggest three strategies that will contribute to a stronger national prioritization protocol. First, based on the frequency with which certain restoration methods are used and on the differences in implementation strategies that exist, I recommend five high priority research efforts that can be implemented at the local, state, or federal level. Second, based on what we know to date from past studies and from interviews with project managers, I recommend several high priority restoration efforts that should be implemented immediately - we do not need additional data to move forward in these areas. Third, I propose 5 criteria be accepted as the standard for evaluating ecological success in river restoration.

It is critical that the U.S. simultaneously boost both the implementation of aquatic ecosystem restoration <u>and</u> implement research to identify the most effective restoration practices. Only through an *adaptive restoration strategy*, whereby watershed-scale efforts are informed by and adapted based on new findings will we realize healthier inland and coastal waters.

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Using "Surplus" Water to Meet Downstream Environmental Needs in Systems Constructed for Water and Power Benefits

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The Colorado River Storage Project consists of large Federal dams and reservoirs on the Upper Colorado River Basin. The largest of these are the Glen Canyon Dam in Arizona, Flaming Gorge Dam in Utah and Blue Mesa Dam in Colorado. The authorizing legislation requires that these dams be operated for purposes related to water development and power production. In recent years the operation of these facilities has been the subject of intense environmental review. Downstream of these dams are endangered fish species, sport fisheries, white water recreation and national parks or monuments.

One way of reconciling the conflicts that have surfaced is to use "surplus water" or "water at risk of spill". Based on forecasts, water is identified beyond what is needed to fill reservoirs, meet water delivery obligations and generate electrical power. This amount of water is then patterned in terms of timing, magnitude and duration to meet downstream environmental needs. Hydrological/operational studies have shown that "water at risk of spill" can meet the biological flow recommendations for endangered fish species for the Gunnison River below Blue Mesa Dam. Moreover, "water at risk of spill" forms the underpinnings of beach and habitat building opportunities below Glen Canyon Dam. These examples provide evidence that important environmental needs may be accomplished in water delivery systems without changes to the legal authorities of dams constructed for water development purposes.

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Determining the Condition of Northern Everglades Tree Islands Impacted by Hydrology and Invasive Exotic Species

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Arthur R. Marshall Loxahatchee National Wildlife Refuge (the Refuge) is the northern remnant of the Everglades ridge and slough. The majority of the Refuge is Water Conservation Area 1 (WCA 1), a 143,238-acre impounded marsh. Currently managed by the U.S. Fish and Wildlife Service for the protection of native flora and fauna, WCA 1 is also used as water retention area. Water levels in WCA 1 are managed by the U.S. Army Corps of Engineers and the South Florida Water Management District according to a schedule that attempts to balance water storage and flood control with wildlife habitat needs.

Tree islands are one of the signature habitats of the Refuge. Slightly raised areas within the marsh colonized by woody vegetation, tree islands are sites of high species diversity. They provide the only terrestrial habitat for nesting and foraging for many species of wildlife including deer, wading and migratory birds, turtles, snakes, and small mammals. Over the past 50 years, anthropogenic changes in hydrology and invasive exotic species have adversely impacted tree islands throughout the Refuge. Tree islands in areas where conditions are too wet have disappeared and tree islands in areas that are too dry have been susceptible to fires and have lost their distinctive shape because of shrub encroachment. Tree island vegetation community composition has also changed due to exotic plants.

Managers seek to minimize any further deterioration of tree islands at the Refuge. However, it is unclear how current water management practices are affecting tree islands, in particular, whether tree islands are experiencing chronic stress due to extended hydroperiod and depth in some areas. To protect tree islands, managers first need to determine the current condition of tree islands, and then need a method that will enable the on-going assessment of tree island condition in a rapid and economic manner.

This study will first determine the condition of tree islands throughout the Refuge. Condition will be determined by community structure analysis through examination of the composition, abundance, vitality and vigor, and associations of plants along the Refuge hydrologic gradient. A Rapid Assessment Protocol will then be developed which will set forth indicators of tree island condition based on community structure, methods for using those indicators in the field, and a scored index in which indicators can be utilized to assess tree island condition. A spatial database will be developed to enable managers to protect tree islands in good condition, and improve conditions for impacted tree islands.

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Hydrologic Changes Following Removal of Invasive Plants At Prairie Creek, Midewin National Tallgrass Prairie

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Within the Prairie Creek 1 area of Midewin National Tallgrass Prairie (the former Joliet Arsenal), invasive shrub and tree species were identified as a significant problem limiting grass and forb species indigenous to the savanna community. Savannas in Illinois developed when the area was subject to fires that were ignited annually by Native Americans. With the cessation of burning in the 19th and 20th centuries, the eastern tallgrass prairies, savannas, woods, and forests experienced a rapid invasion of woody vegetation.

Many questions have been raised about the effect of invasive woody species on ground water elevations. Vegetation in glaciated areas is adapted to the presence of ground water in the rhizosphere, and disruptions to it may have a negative influence on vegetation diversity and quality, which in turn may influence the ability of an area to support a diversity of native fauna.

Removal of the undesirable woody vegetation was planned to rehabilitate the degraded savanna. The project area was divided into an eastern experimental area and western reference area. During June through July 2002, twelve groundwater well points, twelve soil moisture monitoring stations and two meteorological stations were installed along two north-south transect lines. Monitoring stations were also established for soil organic carbon and plant communities. Woody vegetation was removed from the eastern experimental area during February 2003.

After two years of monitoring, a statistical evaluation was performed on the average water table depths using the Student's t-Test. Before woody vegetation removal and during the early part of the growing season, the water depths in the eastern experimental area were not statistically different from the western reference area. However, from July 2003 through early November 2003, the water depths were statistically different at greater than the 95 percent confidence level.

Statistical comparison of the 2002 volumetric soil moisture content between the experimental and reference areas using the Student's t-Test implied similar conditions. However, by the end of the growing season in 2003 there were statistically significant differences between the two sides, with increased soil moisture content within the experimental area.

It was concluded that the observed change in depth to groundwater and soil moisture content was directly related to removal of the woody vegetation from the experimental area.

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Restoration of Longleaf Pine Sandhill and Flatwoods in a City Park in North-Central Florida: A Progress Report

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Although Longleaf Pine ecosystems once covered vast acreages in the southeastern coastal plain, these fire-dependent communities have largely disappeared from their former range. Morningside Nature Center in Gainesville, FL is a 278-acre nature preserve consisting mostly of longleaf pine sandhill and flatwoods. Although prescribed fire is an important part of the management of the park, past disturbance and lack of fire in some areas have allowed oaks and loblolly pine to dominate some areas, fragmenting and reducing the remaining longleaf pine habitat.

In 2001, loblolly pine and water and laurel oak were removed from a 12-acre area, with the goal of restoring historic vegetation and improving connectivity. Prior to planting, herbicide treatment and prescribed fire were used to reduce density of non-fire dependent plants; fire burned discontinuously on the site due to a lack of fine fuels. In November 2002, wiregrass was planted at one plant per square meter, and longleaf pine seedlings were planted at 350 plants per acre.

Vegetation was monitored on six 50-m belt transects. Mean survival of wiregrass was 88.6% after 6 months. Wiregrass survival between 6-12 months improved to 94.7%; after one year 85% of wiregrass plants were still alive. Survival of wiregrass plants did not differ between areas that were burned and areas not burned by the pre-planting fire. By November 2003, 52.4% of wiregrass plants had flowered; flowering rate was significantly higher in areas that had been burned prior to planting than in unburned areas. Wiregrass cover increased from 0% on all transects in 2002 to a mean of 17.2% after one year of growth, which compares favorably to some stands with intact groundcover. Total foliar cover of graminoids increased from 16.3% to 58.2% one year post-planting.

Mean survival of longleaf pine seedlings after 1 year was 90.55%. There was a consistent but non-significant trend towards increased survival of longleaf pine seedlings in areas that were burned in the 2002 fire, prior to planting. After one year an average of 16.4% of longleaf seedlings had initiated height growth, and pine seedlings planted in burned areas were marginally more likely to have begun to elongate than seedlings in areas not burned by the 2002 fire.

Overall the project has been successful so far, with high survival rates of both wiregrass and pine. This high survival coupled with the rapid growth of wiregrass plants should allow successful use of prescribed fire in the short term, further accelerating the restoration of fire-adapted vegetation on the site.

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Oyster Restoration in the Maryland Portion of Chesapeake Bay

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The Chesapeake Bay was once the largest producer of oysters in the world. The 2003/2004 harvest in Maryland fell to a record low of 22,000 bushels- less than half of the record low of 53,000 bushels set the previous year. The Chesapeake is also among the most well known degraded estuaries in the world. Over the last 200 years damage to the watershed from societal development, nutrient overloading, and historically poor natural resource management led to large-scale degradation of water quality, the loss of benthic habitat and the near extinction of local oyster populations in many areas. The mean density of oysters on Maryland oyster bars is less than 2 oysters/m^2, and many historic oyster bars are completely bereft of oysters. Oyster restoration - the process of restoring dense oyster populations on historic oyster bars - has been undertaken over the last eight years to help boost the fishery and to reestablish the important ecological functions oyster reefs performed in the pre-colonial Bay.

Oyster restoration in Maryland has been undertaken on a relatively small, experimental scale to date, in an attempt to learn how large-scale restoration might best be accomplished and what benefits might result from such an effort. Restoration efforts in low salinities (5 - 14 psu) have been largely successful. Oysters grow quickly in these areas and, when protected from harvest, create substantial complex reef habitat that is quickly colonized by many benthic species. Many restored reef plots are 5 years old or older and contain dense assemblages (>50/m^2) of large oysters (mean size >100 mm). Paired comparisons of restored and un-restored natural oyster bars show dramatic differences in faunal abundances (4000 organisms/m^2 vs. 1,500 organisms/m^2). Xanthid crabs are present on the restored plots at approximately 500/m^2 but less than 100/m^2 on the un-restored plots. Energy available for forage by larger pelagic predators estimated from literature values of energetic content for each species observed was 5 times higher on restored reefs.

Unfortunately, two parasitic diseases limit the geographic range of oyster restoration at present; oysters planted in higher salinities typically die within 2 or 3 years - limiting their ecological contributions. Selective breeding for disease resistance has provided some disease tolerance but may not be enough to be useful for restoration purposes; at least in the short term. In summary, oyster restoration appears to offer substantial ecological benefits but oyster diseases may severely limit the areas in which restoration can be successfully accomplished.

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Decision Models and Directions for the South West Florida Feasibility Study

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The Southwest Florida Feasibility Study (SWFFS) is a component of the Comprehensive Everglades Restoration Plan (CERP). The SWFFS will result in an independent but integrated implementation plan for CERP projects. The SWFFS will provide a framework to address the health and sustainability of natural systems, including water quantity and quality, flood protection, and ecological integrity. The SWFFS was initiated because there were additional water resource issues (needs, problems, and opportunities) within southwest Florida that were not being addressed directly by CERP. A purpose of the SWFFS is to identify alternatives that address those issues in the study area. The purpose of this project is to develop regional habitat evaluations of stressors to coastal and inland ecological systems and decision aid tools for the evaluation of alternative water management scenarios being proposed within the Caloosahatchee watershed.

Large, complex, regional, ecosystem restoration projects should have a means to evaluate how well the actions of these projects achieve the desired goals. Learning from experience, this project builds on procedures being applied as part of CERP. Conceptual models are being used to identify the critical linkages between ecosystem stressors, indicators, and performance measures. Regional hydrological and ecological models have been used to evaluate alternative scenarios and the results have been applied to modify alternatives. An adaptive assessment strategy is being developed apply the performance measures in developing a system-wide monitoring program to measure and interpret ecosystem responses. These steps will be integrated into a spatially explicit Decision support systems (DSS) to inform the process of developing and evaluating restoration alternatives. DSS are broadly defined as computer-based systems that integrate data and models to aid decision-makers where goals are conflicting and issues are complex. Support methodologies that help authorities involved in ecological restoration sort out all the decision variables and parameters, categorize problem solving heuristics, and appreciate the impacts of potential policy actions are critical to successful planning and management.

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Integrating Urban Growth Models and Habitat Models for Ecological Evaluation of Landscape Impacts

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An urban growth model is integrated with models of wildlife habitat to evaluate the impacts of projected growth on spatial patterns of habitat and on habitat use. Regional projects such as the Everglades and South Florida restoration that attempt to restore ecological processes in natural areas can be impacted by urban and residential growth that is largely out of the domain of restoration scientists. It may be critical to the restoration decision process to understand the potential landscape impacts of urban growth on the success of proposed restoration scenarios. The probability of urban conversion is modeled in a cellular automata model that simulates the spread of residential and urban development from urban edges, growth centers, road corridors, and stocastic new growth centers. Landscape habitat changes are evaluated using potential habitat models for the terrestrial vertebrates in the region. Spatially-explicit measures of species diversity and functional connectivity are used to compare alternative development scenarios for two case studies: conversion of a natural areas in southwest Florida for a new university and associated residential and urban areas, and conversion of agriculture to residential development in the Everglades Agricultural Area.

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Great Basin Restoration Initiative: Integrating Science and Restoration at the Landscape Level

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The Great Basin is the largest desert in North America, occupying nearly 130 million acres in the western United States. This desert is characterized by low rainfall, diverse biota, and local economies that depend on the products or resources from these lands. Nearly sixty percent of this area, roughly 75 million acres, is managed by the U.S. Department of Interior's Bureau of Land Management (BLM) whose mission is to "sustain the health, diversity, and productivity" of public lands in the West. This mission is threatened by the expansion of existing and introduction of new invasive plants and altered disturbance regimes.

Cheatgrass (*Bromus tectorum*) is the most ubiquitous invasive species in the Great Basin and is responsible for more ecological and economic impacts than any other species. It was introduced to the Great Basin in the late 1800's from Eurasia and is now estimated to occupy around 25 million acres of public causing them to be much more susceptible to wildfires. Because of the early maturity and ease of ignition of these alien grasses, historical wildfire return intervals have been reduced from 35-100 years to less than five years now in some areas. Recently, invasive, alien forbs have increased on Great Basin rangelands causing further degradation of ecological integrity and economic impacts to land users. This new wave of invasive forbs is generally unpalatable or poisonous to wildlife and livestock, may alter soil properties, and is more difficult to control than cheatgrass. An accelerating downward ecological spiral is occurring as this new generation of weeds is invading native plant communities and even replacing cheatgrass at some locations.

A proactive approach to reduce the impacts of invasive species and wildfires was started by BLM in 1999 after 1.7 million acres of rangeland burned in the Great Basin. The concerns about wildfires and invasive species prompted the formation of the Great Basin Restoration Initiative. The objectives of this Initiative are to: 1) Maintain landscapes where plants and ecological processes are functioning properly; 2) Restore desired perennial plant communities to degraded landscapes; and 3) Provide long-term sustainability of the natural resources in support of the people that use and enjoy the Great Basin.

A fundamental need to successfully restore these arid rangelands is science-based strategies and technical information. To meet this need, three collaborative, multi-state research projects have been initiated to: 1) Develop cost effective techniques to restore native plants on cheatgrass-dominated rangelands, 2) Increase the availability of native plant seed for restoration, and 3) Utilize fire and fire surrogates to restore natural disturbance regimes on rangelands. Scientists and land managers are working together in the design and implementation of these research projects thereby increasing the application of results to public land restoration projects.

Current restoration efforts in the Great Basin include rehabilitation of burned areas, fuels reduction projects, and limited wildlife habitat restoration. Efforts to identify priority areas for restoration are being assisted by several Geographic Information System projects that assist managers in selecting treatment areas. The focus of this priority setting is on watersheds instead of a patchwork of restoration projects across the landscape. Integrating science with management is seen as the key to cost-effective and successful restoration of degraded landscapes in the Great Basin.

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Ecological Functions of Restored Stream using Benthic Maroinvertebrates as Indicators

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Geomorphic monitoring of streams following restoration is a widely used form of monitoring to determine project success. However, little is know about the ecological functions of restored stream reaches since monitoring protocols infrequently use biological indicators. A national inventory of stream restoration projects noted that in many parts of the US post-construction monitoring isn't conducted at all.

Benthic maroinvertebrate larvae (aquatic insects) were collected as part of an EPA funded project with the North Carolina Division of Water Quality and continued as part of a grant at North Carolina State University. Data were collected prior to and post-construction at 15 stream restoration projects and these data were used to prepare preliminary success criteria for biological communities. Success criteria are proposed and include an analysis of Dominant-In-Common (DIC) taxa between upstream reference reaches (if available) and the restored reach, and the presence of indicator taxa or habitat specialists. At this point all of these restoration projects have less than 5 years of post-construction information; however, based on these data restored stream reaches have not met the proposed success criteria (DIC of 75%). These data suggest that a minimum of five years of post-construction information need to be collected, but also that the use of success criteria using biological communities will need to be further tested. Ideas for improving the biological responses to stream restoration practices will be discussed.

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The Upper Mississippi River System Environmental Management Program

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The Upper Mississippi River System Environmental Management Program (EMP) is recognized as the most important effort to restore the vitality of the Mississippi River's diverse and significant fish and wildlife resources. Agriculture, river navigation, and human population pressures over the past 200 years have divided a once contiguous, floodplain ecology into a series of isolated natural communities. This fragmentation has resulted in the loss of habitat diversity and the reduced abundance of native freshwater mussels, fish and birds. To reverse this fragmentation, Congress authorized the EMP by Section 1103 of the Water Resources Development Act (WRDA) of 1986. The EMP provides a well-balanced combination of monitoring, research, and habitat restoration activities. To date the program has restored 71,000 acres of aquatic and floodplain habitat. There are currently 28 additional projects under design or construction, which will result in an additional 55,000 acres of restored habitat. This represents approximately 11 percent of the Upper Mississippi River floodplain and aquatic area.

In addition to restoration projects, the EMP has established a rigorous long-term monitoring program, where water quality, fish, vegetation and invertebrates data are collected and analyzed. The monitoring program provides a quantification of existing conditions as well as an understanding of the processes likely to affect future habitat conditions. The program addresses habitat needs at the system-wide, river reach, and pool levels of spatial scale. The monitoring program provides the scientific data that helps guide the selection, design, and evaluation of habitat restoration and protection projects.

The EMP has created a strong partnership of Federal and State agencies, non-governmental organizations, and the general public. Personnel from three U.S. Army Corps of Engineers Districts (St. Paul, Rock Island, and St. Louis) and one Division (Mississippi Valley) administer the program with assistance from the U.S. Fish and Wildlife Service, the U.S. Geological Survey, USDA Natural Resources Conservation Service, U.S. Environmental Protection Agency and the five Upper Mississippi River states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.

The presentation will provide an overview of the program, including the results of past projects, status of current ones, and a look at future plans. Features of several EMP projects, including wetland and moist soil unit creation, fish passage design, mast hardwood reforestation, sedimentation control, and dredging to improve habitats for waterfowl, wildlife and fisheries will also be presented.

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The Effects of Hydrologic Stressors on Wading Bird Foraging Distributions in the Everglades: Modeling for Adaptive Management in Restoration

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The restoration and conservation of Everglades' wading bird populations requires the development of effective management strategies. Developing these strategies is complicated by uncertainty in ecological processes, in implementation of multiple and often conflicting management objectives, and in the sheer size and diversity of the Everglades. To aid in the decision-making process, we advocate an adaptive approach to resource management in which information is used to reduce uncertainty and improve management decisions. The main challenge of our project is to assess how wading birds use a dynamic landscape with key variables that vary at different time scales and relate this bird production and distribution. Because we believe it unlikely that a single factor or explanation is operating at a particular scale, we have developed hierarchical models representing alternative ecological hypotheses for variation in bird abundance and distribution. To evaluate the relative plausibility of these hypotheses, we are using long-term data bases to assess relative contribution of short- and long-term effects of hydrologic stressors and landscape variables on the variation and trends in wading bird feeding patterns and population sizes. These models, coupled with ongoing bird monitoring efforts, then can form the basis of adaptive stochastic dynamic decision models for evaluating management strategies.

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Building Consensus around Contention - Florida Natural Resource Leadership Institute (FNRLI)

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While ecological degradation is typically the result of human activities, an attempt to restore a degraded ecosystem is often met with divergent expectations, varying degrees of support, and sometimes even bold opposition. Issues such as endangered species, private property rights, industry interests, and specific restoration strategies can lead to heated disputes and policy gridlock.

The Florida Everglades is a complex merger of politics, ecology and economics. Contention blends seamlessly among this mix. Under terms of the Everglades Restoration/Mitigation Project, biologists, developers and county and state officials eventually negotiated a new strategy and formula for mitigating wetland loss, but only after an extended impasse. The agreement laid out a plan for "off-site mitigation," where mitigation banks sell environmental credits to developers that are then used to offset loss of biologic function within a specific basin (The Special Area Management Plan - Bird Drive Everglades Basin). The Hole in the Doughnut (HITD) is the result. Developers contribute a specific sum of money for each acre of wetland destroyed in the basin to be used for eradicating exotics in the HITD among other uses.

The differing perspectives offered on the HITD process led to a lively debate that brings to light many of the issues facing the environmental managers when diverse groups come together and represent conflicting goals. In January, 2004, The Florida Natural Resource Leadership Institute (FNRLI) used the HITD as a case study in order to empower emerging leaders in environmental management with the skills and ability to move beyond conflict and achieve resolution. FNRLI seeks to impart an understanding of conflict and the fundamental principles underlying conflict resolution. Participants in the FNRLI program become aware of various theories of conflict resolution and the principles of cooperation and competition, problem solving and decision making. In the HITD case study, the skills and dynamics of the negotiation process were examined. Fundamental skills such as preparation, management of the negotiation process, and identification of optimal agreements were explored.

The Hole in the Doughnut shows that various government agencies, environmental advocates and engineers can work together to build consensus. Each of the stakeholders provided their perspective and voiced their concerns before coming to a resolution to which everyone agreed. It is cases such as HITD that provide the environmental community with an opportunity to utilize the crucial skills and important principles needed to effectively manage ecosystem restoration projects in the future. This poster presentation will highlight the key principles of conflict resolution and case studies used by FNRLI to help restoration projects succeed.

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Multistage Sampling for Long-term Large-scale Multi-response Ecosystem Monitoring: CERP Trophic Monitoring as a Case Study

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Three major systemwide components of Comprehensive Everglades Restoration Plan (CERP) monitoring, water quality, landscape change, and trophic dynamics, all require measurement at scales of meters to 10s of meters. However, they require scaling up to scales of 10s or 100s of km^2, the size of predicted responses to restoration actions, and the scale foraging wading birds integrate over.

The trophic monitoring subplan is based on sampling fish, invertebrates, and periphyton in $1m^2$ throwtraps. Pure or simply-stratified sampling locations would be inefficient, and cost-prohibitive for useful confidence limits at the scales of interest. Further, some local habitats such as dense sawgrass cannot be sampled, or cost 100 times more per sample than sloughs.

Our solution is a two-stage sampling approach. Within landscape subunits (10-200km^2), random .5km*.5km cells will be selected as primary sample units that will be sampled every year. Aerial photography will be used to distinguish sampleable (slough) habitat from unsampleable habitat. Each year, random throwtrap locations (secondary sample units) will be drawn from the sampleable areas within each cell. This design allows estimation of temporal trends in fish densities in landscape subunits, and decomposition of those trends into change in fish densities within sloughs and change in areal extent of sloughs.

This design also finesses the issue of repeated sampling at fixed locations. Re-drawing sample locations each sampling period reduces the power to detect temporal trends by adding spatial variation to the temporal variation. However, repeatedly sampling the same slough locations cannot support inferences about densities in sloughs in out-years, as locations that become sloughs during restoration would not be sampled. Analyses of 23 years of Joel Trexler and Bill Loftus' Everglades fish throwtrap data show that spatial variation and space * year interaction variation are very small at spatial scales less than 1km. Therefore, fixed, repeatedly sampled .5km cells minimize the power loss, yet redrawing throwtrap locations based on updated habitat classification captures changes in the location, type (e.g., depth or hydroperiod), and amount of slough within cells.

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Factors Affecting Nutrient Delivery to Chesapeake Bay: Implications for Restoring Water-Quality Conditions in the Nation's Largest Estuary

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The Chesapeake Bay and many estuaries in the Nation have been adversely affected by excessive inputs of nutrients resulting in low dissolved oxygen, loss of submerged aquatic vegetation, and toxic algal blooms. In the mid-1980's, the Chesapeake Bay Program (CBP), a partnership between the Federal Government and states within the Bay watershed, began an effort to reduce nutrient loads to improve dissolved oxygen levels to support living resources in the Bay. In spite of these management actions, the Chesapeake Bay was listed as an impaired water body under the Clean Water Act in 2000; as a result, the CBP must meet standards for dissolved oxygen, chlorophyll, and water clarity by 2010. The CBP has revised strategies to reduce nutrients and sediment and in an attempt to meet water-quality standards by 2010. However, there is growing concern that water-quality in the Chesapeake Bay will not be restored by 2010 because of the multiple factors that affect the sources, transport and delivery of nutrients to the Chesapeake Bay and the subsequent ecosystem response.

The U.S. Geological Survey (USGS), in cooperation with several agencies, has been monitoring major rivers entering the Chesapeake Bay since the late 1980's to estimate nutrient loads and trends. The USGS utilizes these monitoring results with additional analysis of nutrient sources and watershed properties to assess the primary factors affecting nutrient delivery. While the nutrient loads show a high degree of variability and no significant trend, the nitrogen concentrations in some rivers have shown a slow decline from the late 1980's to 2003. The concentrations of phosphorus show less of a decline. The primary factors affecting the nutrient loads and concentrations are streamflow, nutrient sources, and influence of watershed characteristics (including in-stream biogeochemical transformations and the influence of ground water). The monthly and annual variability of streamflow has a large impact on nutrient loads. Nutrient sources in the Bay watershed have the primary impact on concentration in rivers. Nutrients from point sources have been reduced by about 25% since 1985, but non-point source reductions have been less. In-stream loss reduces nutrient loads by up to 90 percent in some streams in the Chesapeake Bay watershed. Ground water supplies a significant amount (about half) of water and nitrogen to streams in the watershed and is therefore an important pathway for nitrogen to reach Chesapeake Bay. The age of ground water in shallow aquifers in the Chesapeake Bay watershed ranges from modern (less than 1 year) to more than 50 years, with a median age of 10 years.

All of these factors contribute to the "lag time" between implementation of practices to reduce nutrients and the response in Chesapeake Bay ecosystem. While these factors affecting nutrient delivery will make meeting the 2010 water-quality criteria in Chesapeake Bay very difficult, the information is being used to better plan and target the types of management actions that may provide the most rapid water-quality improvement in the Bay.

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The Biscayne Bay Coastal Wetlands Project: Planning the Restoration of a South Florida Estuary

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This poster describes the Biscayne Bay Coastal Wetlands (BBCW) Project and provides an overview of the planning status for this project. The BBCW is one of the 68 components of the Comprehensive Everglades Restoration Plan. The goal of the project is to restore and enhance approximately 60,000 acres of estuarine and freshwater wetlands along the southwestern shore of the bay, as well as nearshore areas of the bay itself. These areas have suffered negative ecological impacts as a result of anthropogenic changes to the natural hydrology of the area over the past century. Presently, freshwater runoff from the watershed is discharged to the bay through a system of conveyance canals, which severely reduces the amount of freshwater made available to the wetlands and has resulted in their gradual degradation. The point source discharges of freshwater to the bay result in large but ephemeral salinity fluctuations near the mouths of canals. These unnatural salinity fluctuations are physiologically stressful to fish and invertebrates inhabiting these areas. The BBCW Project is being designed to redistribute water from conveyance canals through a spreader system across a relatively broad front, which should restore a more natural salinity regime to wetlands, tidal creeks and nearshore bay habitat. Specific project objectives include enhancing estuarine nursery habitat for fish and shellfish, re-establishing the nearshore oyster reef community, enhancing existing mangrove wetlands, restoring natural coastal glades habitat, and re-establishing connectivity between these wetlands and adjacent wetland basins. Over the past year an interagency team known as the Project Delivery Team has attained several milestones in the planning and development of the project. This poster will identify these milestones and further describe the planning status of the project with regards to performance measures development, alternative formulation, model refinement, and other aspects of the planning process.

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Modeling Hydrologic Events in a Post-Wildfire Watershed Restoration Environment Using the MIKE-SHE Model

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The western United States has experienced unprecedented catastrophic wildfires in the past decade. Next to the combustion of forest vegetation during a wildfire, the most destructive impact of a wildfire comes from post-fire flood peak flows. These flows can severely affect stream physical conditions, aquatic habitat, aquatic biota, cultural resources and human health and safety. The Burned Area Emergency Rehabilitation (BAER) Program has been responsible for the past three decades for implementing projects to affect some level of watershed restoration to mitigate adverse hydrologic responses after wildfires. An important step in the BAER process is to determine and prioritize restoration efforts to protect human health and safety, cultural resources, infrastructure, and ecosystems resources. Being able to accurately model hydrologic events in a post-wildfire watershed restoration environment is important for protecting resources, values, and populations at risk to the impacts of post-fire floods. Distributed hydrologic models, such as the Danish Hydraulic Institute's MIKE-SHE models, can be used within a single GIS platform to model potential flood effects and guide restoration efforts. We have taken data from recent wildfires in Arizona (Coon Creek Fire, 2000; Rodeio-Chediski Fire, 2002; and Aspen Fire, 2003) to analyze post-wildfire flooding and watershed restoration potential in southwestern ponderosa pine and mixed conifer forests.

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Restoration of Incised Streams in the Semi-Arid Regions of the Columbia River Basin, USA

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Incised streams and the concomitant loss of extensive riparian forests and meadows are now common features of watersheds in semi-arid regions of the American west. We examined the feasibility of restoring incised (downcut) streams throughout the semi-arid regions of the interior Columbia River basin, where channel incision has dramatically reduced the quantity and quality of aquatic habitats, especially for threatened or endangered salmon populations. Initial results suggest that under proper land use management, it is possible for streams to aggrade (fill back up) such that they become hydrologically reconnected to their former floodplains within relatively short time frames, thus greatly expanding the extent and quality of riparian vegetation and improving off-channel stream habitat. Over decadal time scales, changes to land management that excludes grazing and allows riparian vegetation and beaver (*Castor canadensis*) dams to reoccupy incised stream valleys can cause significant and rapid filling. This in turn helps to create wide, shallow floodplain aquifers that can be accessed by the roots of riparian floodplain vegetation.

While many natural resource managers are aware of widespread channel incision in the Columbia River basin, the extent of incision within the range of the Pacific salmon is largely undocumented. Incision dramatically reduces salmon habitat availability by lowering stream-adjacent water tables and, subsequently, killing riparian vegetation. The loss of above-ground vegetation reduces shading and organic inputs to the stream, while the loss of roots increases the erosivity of stream banks. The lowered water tables also reduce cool groundwater inputs to the stream, resulting in reduced summer low flows (often no flow) and increased summer stream temperatures. Because incised streams rarely access their floodplains, high flows are concentrated within the incised channel and fish have no access to slow-water refugia during floods (e.g. see Harvey and Watson 1986, Elmore and Beschta 1987, Shields et al. 1995).

The historical record shows that numerous salmon-bearing streams in the semi-arid region of the interior Columbia River basin once contained narrow and deep, slowly meandering channels lined with cottonwoods, willows and/or sedges, numerous beaver dams, abundant and easily accessible off-channel habitat on the floodplain, and good flow and cool temperatures throughout most of the year (Wissmar et al. 1994). Today most of these streams are incised and contain little or no riparian vegetation or beaver dams. Stream temperatures are high and flow is ephemeral. Many of these streams no longer support fish populations. Preliminary model results suggest that if incised streams were restored by creating conditions such that they could aggrade and reconnect to their former floodplains, that habitat conditions would be sufficient to again support salmon populations.

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Restoration of Floodplain Marsh Along the St. Johns River in Brevard County, Florida

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The Moccasin Island Marsh Restoration Project (MIMRP) is a 9,242-acre property located in Brevard County, Florida. The St. Johns River Water Management District and the Natural Resources Conservation Service (Wetland Reserve Program) jointly funded the 1.3 million restoration project. The project lies in the transition area between undisturbed floodplain wetlands of the St. Johns River and improved uplands. Approximately 70% of the project area was severely impacted by diking and draining and was converted to cattle pastures in the late 1960's. The remaining area consisted of relatively unimpacted wetland communities.

The objectives of the MIMRP were to restore and maintain herbaceous wetland plant communities with their unique ecological functions and values. Restoration objectives for this project were re-establishment of the natural hydrologic regime; establishment of native wetland vegetation; enhancement of habitat for wading birds and other wetland dependent wildlife; and improvement of water quality. The project area was restored to a mosaic of wetland habitats along a topographic gradient and included deep marsh, shallow marsh and wet prairie.

A three-phased approach to restoration was employed to reach these objectives. Phase I involved the removal of the agricultural infrastructure (e.g. fences, culverts, and artesian wells). Hydrologic modifications were made by backfilling internal canals and installing a pump to allow for water level manipulations needed for the next phase. Phase II involved the maintenance of shallow water levels through pumping which provided conditions appropriate for the establishment of wetland vegetation from the remnant seed bank. In addition, native floral biodiversity was enhanced by limited plantings of native species and the control of exotics. During Phase II, water chemistry is being monitored to assess the feasibility of reconnecting the restoration area to the adjacent St. Johns Marsh during the final phase. The implementation of Phase III will depend upon several factors including water quality improvement, establishment of wetland plant communities and issues regarding flood control and drainage of adjacent uplands.

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Natural Recruitment in a Mangrove Forest Following Spoil Mound Removal by Hydroblasting

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The Gateway Tract Habitat Restoration Project began in 1999 as a cooperative effort sponsored by the Southwest Florida Water Management District Surface Water Improvement and Management Program, the Florida Department of Transportation, and Pinellas County. The project area encompasses approximately 176 acres located on the west side of Old Tampa Bay in the city of St. Petersburg. The project involved the creation and enhancement of 110 acres of coastal habitat. An enhancement objective included the removal of exotic plant species within the site's mangrove forest.

Mangrove forest with extensive mosquito ditching represents the primary ecosystem of the Gateway Tract. Three species of mangrove, red (*Rhizophora mangle*), black (*Avicennia germinans*), and white (*Laguncularia racemosa*) exist on site in addition to significant stands of buttonwood (*Conocarpus erectus*). The site was infested with Brazilian pepper (*Schinus terebinthifolius*), which was primarily located on spoil mounds created by the mosquito ditching. These spoil mounds were the principal target for removal in the mangrove enhancement plan.

An innovative technique, referred to as hydroblasting, was employed to accomplish the Brazilian pepper removal. Hydroblasting uses high-pressure water to move spoil mound material into the surrounding ditches and to ultimately lower the elevation of the mounds. By lowering the elevation, conditions favorable to the reestablishment of Brazilian pepper is eliminated.

Beginning in February 2004 and continuing through April 2004, the hydroblasting technique was used over a 42.5-acre portion of the site to remove 123 spoil mounds. After hydroblasting, a survey of the previous mound areas was conducted. Mound removal generally resulted in the creation of conical shaped gaps in the otherwise continuous stand of mangroves. Six sites on the southern portion of the Gateway Tract and six sites on the northern portion were chosen to monitor natural recruitment in gap areas. A line-intercept method, using the north-south and east-west extent of each mound pattern as transects, was applied to determine percent cover at each site.

Baseline recruitment monitoring was performed in mid-June 2004 where it was noted that new vegetation has already established along the perimeter of one-quarter of the gap monitoring sites. White mangrove saplings and an abundance of saltwort (*Batis* spp.) and glasswort (*Salicornia* spp.) species are the predominant groundcovers. The study is ongoing and monitoring will occur monthly over the next year.

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Water-Quality and Living-Resources Monitoring to Support Ecological Restoration Efforts in the Chesapeake Bay and Its Watershed

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The Chesapeake Bay Program (CBP) is a consortium of Federal, State and regional agencies that are charged with restoring the ecological integrity of the Bay. Monitoring is an important aspect of the restoration effort and an extensive monitoring program has been in place since the inception of the CBP in 1984. The CBP monitoring program currently consists of three major components including: 1) tidal water quality; 2) tidal living resources; and 3) nontidal stream water quality. Extensive records of many parameters have been compiled over the past 20 years, and the records provide a detailed account of changes that have occurred throughout that period.

Recently the emphasis of the CBP has shifted to address the need for removing Bay waters from the U.S. Environmental Protection Agency list of impaired waters. This new emphasis has resulted in the development of new designated uses and water-quality criteria for the Bay, which will need to be attained in order to remove Bay waters from the list. Monitoring information will be used for that purpose and the tidal monitoring network was refined to provide the data and analytical methods to assess water-quality criteria attainment. Tidal living-resources monitoring was also refined to provide information to document the ecological improvements associated with attaining the designated uses and water-quality criteria.

Excessive nutrient and sediment loadings are the primary causes of impairments in the tidal waters of the Bay. Management efforts are focused on reducing loads from nontidal streams in order to achieve the tidal-water designated uses. In order to track progress toward the nutrient and sediment load-reduction goals, the CBP has begun efforts to develop a new nontidal stream-monitoring network. This network consists largely of existing State and Federal monitoring programs, but new monitoring stations have been established to fill gaps in the coverage for the entire watershed. In addition, the Bay watershed States and Federal Agencies are now cooperating to establish consistent data-collection and laboratory-analysis methods across the entire 64,000-square-mile Bay watershed so that all data are comparable. A centralized database is being developed, and all State and Federal agencies will submit nontidal stream-monitoring data to that database, which will be available for use by CBP workgroups.

Refinement of the CBP monitoring programs is ongoing and will continue as needs change and technology improves. However, funding is always the largest obstacle because of the expense of data collection over such large spatial and temporal scales. Detailed network designs have been developed and those designs clearly establish: 1) the need for monitoring; 2) an overall plan for collecting the required data; and 3) where the current gaps in monitoring exist. This information provides the justification for additional funding, and is often a necessary prerequisite in a funding search. This presentation describes the approach, current status, and lessons learned from the CBP efforts to refine monitoring programs to support Chesapeake Bay restoration.

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Using Natural Chemical Tracers to Evaluate Point-source and Non-Point Sources of Freshwater Inputs to Biscayne Bay

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Identification of point-source and non-point sources of freshwater to coastal estuaries is essential in understanding the water quality of these areas. Planned future changes in freshwater deliveries to Biscayne Bay from point-source discharges via canals to non-point source discharge from wetlands and groundwater flow requires a monitoring method that effectively detects these changes, i.e. one that can detect changes in canal discharge versus groundwater seepage. The goal of this research is to use naturally occurring geochemical constituents as tracers to differentiate between the dominant sources of freshwater, i.e. rainfall, canal flow, and groundwater discharge into Biscayne Bay. Specific objectives of the research involve 1) defining the geochemical signature of the freshwater end-members, rainfall, canal water and groundwater discharge; 2) determining the spatial and temporal variability of the dominant freshwater sources into Biscayne Bay; and 3) using a geochemical mixing model to quantify the contributions of the major freshwater end-members with seawater to form the observed water chemistry in Biscayne Bay.

Currently, surface water samples are collected from 25 stations in Biscayne Bay in conjunction with Florida International University's (FIU's) Southeast Environmental Research Center (SERC) water quality monitoring program. In this project, groundwater, canal water and rainwater are collected to determine the geochemical character of each of these freshwater sources. Water samples from groundwater wells in and near the bay, along with surface water from 10 major canals that discharge into the bay, and rainfall are being collected on a monthly basis for two years. All water samples are analyzed for the stable isotopes of oxygen and hydrogen as well as for calcium, strontium and salinity.

Oxygen isotope and salinity data of surface water samples collected from Biscayne Bay between 1997 and present day suggest isotopically enriched water indicative of canal water being contributed along the western portion of the bay. Towards the eastern portion of the bay, isotopically depleted water indicative of rainwater is the dominant freshwater contributor to salinity variations. One area in the central portion of the Bay is more isotopically enriched suggesting some contribution from groundwater in this region. Preliminary results of Sr/Ca values suggest that Biscayne Bay surface waters are a combination of canal water and seawater, although the Sr/Ca values could also be explained by a mixing between water of varying salinity composed of rainwater and groundwater.

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Monitoring and Adaptive Management of Restored Freshwater Tidal Wetlands in the Anacostia River, Washington, D.C.

Steven B. Pugh and *Claire D. O'Neill*
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Over the last decade, the Corps of Engineers, in partnership with the District of Columbia and the National Park Service, has restored approximately 100 acres of freshwater tidal wetlands in the Anacostia River. To evaluate the success of these restored wetlands, monitoring has been conducted at four different wetland sites in the Anacostia watershed. These sites consist of three restored marshes and one reference marsh. The three restored marshes include Kenilworth Marsh, Kingman Lake, and the River Fringe Wetlands. The reference site, Dueling Creek Marsh, is the only remaining naturally formed freshwater tidal wetland of substantial size in the tidal portion of the Anacostia River.

In order to structure the monitoring effort, a monitoring plan was developed. The plan focused on three general elements: 1) plant community characteristics, 2) contaminants, and 3) faunal use of the restored sites. Monitoring results have reflected both the benefits and constraints of marsh restoration in the urban environment. Wildlife use, educational value and cumulative impacts of the restoration initiative are some of the obvious benefits. Constraints include some of the common stressors that may be expected in the urban environment such as non-native invasive plant and animal species and degraded water and sediment quality.

In concert with the monitoring effort, a provision for adaptive management has been incorporated into the restoration strategy. Each year, results from the monitoring program and other pertinent research are presented to a partners committee. This committee consists of both managerial and technical representatives from the Federal and local government and proactive citizens groups. As a result of these informative meetings, several adaptive management strategies have been initiated that are critical to insure the future of the tidal wetlands in the Anacostia. These strategies have included non-native plant species control, development of exclosures to establish seed sources for targeted plant species, the development of a resident goose management plan, and engaging the local citizens in the long-term stewardship of the wetlands.

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Mitigation of a S.E. Florida USA Coral Reef Damaged by the Grounding of a Nuclear Submarine; Results of a Hypotheses-Based Restoration Study

T. Patrick Quinn, *Elizabeth G. Fahy, Judy L. Robinson, Richard E. Dodge* and *Richard E. Spieler*
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This multivariate project compared settlement, growth, and survival rate of corals amongst concrete artificial reefs with and without potential coral attractants. One hundred-sixty small (1.13 m) Reef Balls" were organized into 40, 4-module reef units (quads), each in a square configuration with 3-m sides. Each quad had Reef Balls with one of four attractant treatments: iron, limestone, coral transplants or plain concrete (control). Each Reef Ball had two standardized settlement plates incorporating one of the attractant treatments. The quads were further divided into four treatments of structural complexity by filling the central void space of the Reef Ball with differently sized fill (empty, small, mixed, large). This allowed the determination of the interactive effects of four different fish communities on coral settlement and growth.

Different fill complexities generated different fish assemblages. Empty reef balls had lower total fish abundance and richness than the three treatments with fill ($p<0.05$, ANOVA), which did not differ from each other. Interestingly, corals were also lower on the outer surface of empty reef balls than on those with fill ($p<0.03$). Corals tended to be higher on limestone treated settlement plates (12) than other substrate treatments (6 each)($p<0.08$). *Porities spp* were the predominant corals recorded (69.9%) followed by *Agaricia spp*. (18.2%) and *Diploria spp* (9.5%). A more complete understanding of the potential interaction of the differing assemblages, and specific fishes, with coral recruitment and mortality awaits a more intensive statistical analysis.

Montastrea cavernosa and *Meandrina meandrites* were selected for coral transplantation. 100% of the *M. cavernosa* and 27.5% of the *M. meandrites* transplants maintained or increased their tissue surface area. The remaining 72.5% of the *M. meandrites* transplants showed varying degrees of tissue mortality. These species-specific differences in transplant growth and mortality indicate that species selection must be considered in future coral reef restoration efforts.

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Ecological Risk Assessment of Contaminants in Sediment from South Florida Aquatic Ecosystems

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A tiered screening level ecological risk assessment (SERA) was conducted according to the U.S.EPA ERA framework to evaluate sediment contamination in South Florida. In the first tier, an initial screening benchmark assessment was used to determine which contaminants (e.g., pesticides, metals) in sediment may be of potential risk. South Florida sediment contaminant concentration data was collected from the literature and our 3-year monitoring project in Everglades and Biscayne National Parks. Measured concentrations for metal and organic anthropogenic contaminants were compared to screening benchmarks for tier 1.

In total, 39 contaminant violations occurred at different sites based on exceedence of sediment quality criteria (SQC) in the Tier 1 assessment. The organochlorine insecticides chlordane, endosulfan, DDT, and its metabolites, DDD and DDE were found to have multiple violations. SQC violations were located at S-2, near Lake Okeechobee, and S-5A, located directly to the east of S-2 in the Water Conservation Areas. Endosulfan was found to have multiple violations in sediment at S-178 on C-111e.

Arsenic was found to violate the SQC at S-18C on C-111. SQC violations for chromium were also found at S-178, S-176, and 18C on C-111. Copper SQC violations were found at S-178 and S-177. S-79 had violations for copper, chromium, and arsenic.
Nickel had SQC violations at several sites in the C-111 region (S-176, S-177, S-178, S-18c, and S-332). Zinc was also found to exceed SQC at S-178.

When a screening sediment benchmark for a site was exceeded three or more times from measured sediment concentrations after 1990, the site and the contaminant were used for a Tier 2 assessment (probabilistic ecological risk assessment). All measured concentrations of the contaminant (e.g., pesticide) at each of the sites was ranked and fit to lognormal distributions after converting the whole sediment concentration to predicted pore water concentrations using the equilibrium partitioning approach. Toxicity data (LC/EC50s, chronic NOECs) were used in lognormal species sensitivity distributions (SSDs). The highest potential risk to aquatic organisms was for DDE, DDD and endosulfan based on available measured concentrations and toxicity data. DDE appears to be contributing to the potential risk at sites where multiple compounds were detected. At sites where DDT and chlordane were assessed, potential risks to freshwater invertebrates were lower than for DDD and DDE.

Results of the Tiers 1 and 2 ERA will be discussed along with uncertainties.

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The (Continuing) Restoration of Sarasota Bay: A Comprehensive Approach

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The presentation, using Sarasota Bay as a case study, will illustrate the value of a coordinating agency (whether it be a municipality, regional group, or non-governmental organization) in the creation and implementation of a watershed-scale restoration plan. The agency can act to ensure that necessary actions are carried out, changes in the estuaries are monitored, and actions are redirected, as needed, for watershed-scale restoration.

During the late 1980's to mid-1990's, the Sarasota Bay National Estuary Program (SBNEP) and its Management Conference (relevant local, state, and federal agencies and other stakeholders) identified five major problem areas for the Sarasota Bay watershed: habitat loss, fisheries, stormwater, wastewater, and recreation. As part of the ongoing process to restore the region, the SBNEP developed the Comprehensive Conservation and Management Plan (CCMP) to aid in the integration of the several distinct problem areas. SBNEP staff promotes and oversees implementation of the CCMP, coordinates efforts among the various organizations responsible for Bay decision-making, seeks external funding and promotes public involvement.

The Framework for Action (1993) presented a variety of technical findings regarding wetlands, fisheries, bottom habitats, water and sediment quality, circulation, recreational uses, shellfish contamination, sea-level rise, and pollutant sources and loading and described potential management options for bay protection and improvement. These findings and related projects also helped focus the attention on Bay issues, improved inter-agency coordination, provided opportunities for citizen volunteerism, and served as a mechanism for public education.

Improvements to Sarasota Bay since 1989 include extensive design and construction of intertidal wetlands restoration projects, an active artificial reef program, and an increase in seagrass coverage attributed to nitrogen pollution reduction through the continuing transition to advanced wastewater standards and regional wastewater reuse systems. An emphasis on public outreach and education to involve citizens in restoring the Bay includes programs for public schools, action projects, exhibits at community events, opportunities for volunteers, workshops and publications. Recent technical activities include a juvenile fishery habitat analysis of previous restoration projects, a GIS assessment of the Sarasota Bay shoreline and intertidal habitats, the creation of a five-year plan for intertidal habitat restoration and oyster restoration feasibility studies. Upcoming endeavors include an assessment of non-point sources of nitrogen pollution within residential areas and an assessment of possible stormwater retrofit projects.

The SBNEP, acting to bring together the various regional stakeholders, has been able to provide an impetus for many inter-jurisdictional projects and has been able to promote partnerships in decision-making and developing long-term ecosystem restoration and management policies for the Sarasota Bay watershed.

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The Master Implementation Sequencing Plan and its use as a Planning Tool for Environmental Restoration

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The development and use of the Master Implementation Sequencing Plan (MISP) is a critical planning tool in the implementation of the Comprehensive Everglades Restoration Plan (CERP). The MISP will provide sequencing and scheduling of projects that will maximize the achievement of the goals and objectives of the CERP.

Large restoration projects that exist in today's world normally consist of a number of smaller projects/components that require the coordination with and sequence under one master-sequencing plan. While the details needed for this master-sequencing plan may be complex the outputs of the plan need to be presented in a format that is understandable by both decision makers and stakeholders. For the CERP the latest project information and requirements, along with the latest software, to include Primavera P3e and a complex cost sharing program developed by South Florida Water Management District, have been used to develop a recommended sequencing plan that is understandable to the public and stakeholders involved. These recommendations are being presented in "Bands", showing five (5) year increments of time throughout the duration of the CERP. The MISP, and its "Bands", is being used as the tool to present to others how projects are being implemented and how the projects/components of CERP are scheduled to maximize achievement of goals and purposes of CERP, at the earliest possible time and in most cost-efficient way. The MISP includes discussion of logic, constraints, and other parameters used in developing the sequencing and scheduling of projects.

While evaluating how projects should be sequenced, the MISP is also a tool that assists in identifying the resources (budget and manpower) required for implementation. While individual project management plans identify the resources required for that project's implementation the MISP will evaluate the effects of those requirements on the entire program resources. This may lead to recommendations/modifications of that project, or others, by decision makers based on the overall goals and objectives of the program. These may be recommendations/modifications that the decision makers may not have been aware of without the MISP.

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Seed Germination and Growth of Four Wetland Tree Species in Response to Environmental Factors in Tree Islands of Northern Shark Slough, Everglades National Park

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Seedling dynamics are the initial filter in the establishment of tree species in wetland forests. Patterns of seedling establishment of dominant species can be attributed to key environmental variables including light and hydrology. The vegetative communities within Everglades tree islands known as Bayheads and Bayhead Swamps are continuously inundated for parts of the year and are delineated by heterogeneous canopies and microtopographic features, creating correlate variable light and hydrologic environments. Hydrology is further affected by seasonal oscillations in water level in Everglades National Park (ENP), allowing for temporary drainage of soils during the spring. This may cause seedling emergence to be a function of the timing of seed germination. Likewise, microtopographic highs along the elevation gradients within these communities provide temporary refugia from rising water levels and prolonged drainage.

Life history and physiology of four dominant wetland tree species: pond apple (Annona glabra), cocoplum (Chrysobalanus icaco), sweetbay (Magnolia virginiana), and wax myrtle (Myrica cerifera) with regard to variable shade and flood conditions were explored. Field experiments quantified elevation, hydrology, and light environments, while monitoring recent germinant density and growth in three tree islands of northern Shark Slough, ENP. The physiological and morphological responses of early juveniles to variable light and flood conditions were assayed in shadehouse experiments, including three light and three flood treatments.

Seasonal trends were observed in seedling density, species diversity, and growth morphology. March through May yielded the greatest densities and species diversity, of which the earliest cohorts had the highest survival rates. A. glabra dominates the wet sites throughout the year and all (wet and dry) sites during winter months. C. icaco appears ubiquitously, but at lower densities than A. glabra. M. cerifera densities increase in the spring and summer months, with peak densities at higher elevations, although survival rates are low. M. virginiana seedling emergence was rare within the study sites, however seedlings were observed in nearly all sites. A. glabra seedlings had both the highest overall densities and survival. A. glabra and C. icaco exhibit apical dominance during the rise and initial flooding conditions in correlate plots. Synthesis of seedling and site hydrologic data allow for prediction of early juvenile species composition and density, and may further predict community response to long-term changes in hydropattern.

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The Coast at 2100: Prioritizing Ecosystem Restoration Needs

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As coastal populations continue to grow greater pressure is placed on coastal ecosystems. The challenge for the 21st century is to balance societal needs for coast-dependent services such as ports, recreational facilities, and urban development with the direct and indirect pressures these activities exert on our coastal ecosystems. It is not simply a matter of confronting past damages and ‘repairing’ what is broken - at the coast the escalating pressure of development calls for effective planning that considers ecosystem needs as fully as economic development. This is achievable at the local scale where planning can specifically address both past ecosystem losses and potential future impacts. For example, restoration planning for the Cargill salt ponds in South San Francisco Bay is considering the implications for flood protection and vector management illustrating how restoration planning in the context of local societal needs.

At the national scale, identifying our restoration priorities requires consideration of the ecosystem under stress in the context of its history, its future and the opportunities that restoration provides to the broader community. Restore America’s Estuaries have proposed that estuarine habitat restoration priorities be set on the basis of 1) severity of need (e.g., scarcity of resources or threat to species), 2) the benefits provided by the habitat, 3) the likelihood of restoration success, 4) public support, and 5) social and economic benefits of the restoration. However, such issues cannot be used to set national priorities without a clear context set by national restoration objectives. What are we trying to achieve? What kind of future do we want? One way to approach these questions is to identify different categories of ecosystems that comprise our coast and how the restoration needs of society vary across the country.

In highly developed coastal areas, existing ecosystem are likely to be under most stress. In systems such as New York-New Jersey Harbor, ecosystems are highly disturbed but even fragments may provide important services to the local community and the particular migratory species. Full ‘restoration’ is unrealistic in these circumstances and continued future disturbance often likely. Restoration in such areas should focus on the value to the local community and the maintenance of important habitat ‘corridors. At the other end of the spectrum are relatively undisturbed coastal areas, such as Apalachicola Bay, where ecosystem rehabilitation needs may be minimal but priority should be placed on minimizing future disturbances and maintaining a high level of ecosystem functions. Much of the coast falls between these endpoints and supports moderate commercial development (e.g., small ports, fishery harvest, tourism), much of it dependent on the maintenance of a healthy coastal ecosystem. In these areas restoration opportunities should be considered in terms of their ecological benefit but also their socio-economic implications. Such a categorization allows restoration actions to meet the needs of a wider sector of society rather than focusing on the largest, the most economically important, the most damaged or even the most promising opportunities.

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The Adaptive Management Forum: A Collaborative Review to Integrate Science and Policy

Rhonda J. Reed
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A founding premise of the CALFED Ecosystem Restoration Program (ERP) is that actions and management decisions will be based on scientifically-based adaptive management. The ERP has piloted several different approaches, including convening a Core Team of science experts to review planning documents in 1997, instituting scientific and technical review processes for grant requests for ecosystem restoration projects in the Central Valley Bay-Delta system in 2000, and in 2001-2003, the Adaptive Management Forum for Large-Scale Riverine Habitat Enhancement Projects. The Adaptive Management Forum was initially conceived as a mechanism to provide scientific peer review of several large-scale projects to enhance salmonid populations by restoring the natural functionality of rivers through re-constructing damaged sections of the Merced and Tuolumne Rivers, and Clear Creek, a tributary of the Sacramento River. Tens of millions of dollars from ERP and the Central Valley Project Improvement Act, Anadromous Fish Restoration Program, have been invested in these projects; both management and stakeholders wanted assurances that these funds were spent on effective projects, using state of the art science. Additionally, it was important to evaluate the potential learning that could be gained by a structured, scientific adaptive management approach to such projects.

The Adaptive Management Forum process was successful for evaluating the various projects, andit encouraged new thinking on multiple levels. The Forum, coordinated through the UC Davis, convened a panel of seven nationally, and internationally, recognized experts in a range of fields, including academics and practitioners. The Forum format allowed two days for the Panel to meet with the local project implementation team to discuss the projects, followed by a day among Panel members to formulate recommendations. The Panel developed an understanding of the projects by direct interaction with the local teams, evaluated the projects at various scales, assessed how adaptive management was used, and made recommendations to improve the the projects, individually, by river, and from comparing similar projects on different rivers. Reports are available at <http://calwater.ca.gov/Programs/EcosystemRestoration/Ecosystem.shtml>. The direct interaction with the Panel allowed for a higher level of acceptance of the recommendations by local implementers, who typically are not subjected to strict scientific review. Key relationships with program management and Panel members fostered support for Forum recommendations. Key results: 1) Valuable communication occurred among participants, different watersheds, and between the Panel and local project implementation teams. 2) The adaptive management was generally passive and lacked structured experimental design which could significantly enhance scientific learning. 3) These restoration projects offer “world class” opportunities for scientific experimentation. 4) Monitoring was generally the weakest element of projects. In response, ERP will focus over 10% of its grant funds on monitoring this year.

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Impact of Anthropogenic Disturbance on Wetland Communities: Changes in Patterns of Fish and Macroinvertebrate Density as a Function of Distance from Canals

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In aquatic systems, a major mechanism of anthropogenic impact has been the alteration of the natural hydrologic regime, including the disruption of natural flow, flood cycles, and connectivity. In temporary habitats, hydrologic alterations can result in increases in water permanence and may convert ephemeral habitats into permanent. Since aquatic organisms segregate strongly along a temporary to permanent habitat gradient, added water permanence can result in important changes in the food web structure and dynamics of aquatic communities.

In the Everglades, 1000 miles of canals and 700 miles of levees presently compartmentalize the system and have drastically changed natural hydrologic conditions. In particular, the addition of canals has provided permanent deep-water refuges that historically did not exist. These artificial habitats may increase predatory fish densities and result in important changes in the small fish and macroinvertebrate communities in nearby marsh habitats. Canals may also act as a source of nutrient enrichment to these habitats.

In this study, we examined the impact of man-made canals on the densities of aquatic organisms inhabiting Everglades marshes. Fish and macroinvertebrates were sampled in transects away from canals in the dry and wet seasons. At 5 canal sites (WCA 3A and C-111 Basin), we sampled two parallel 1-km transects, one bisecting an undisturbed, vegetated marsh, and the other following an airboat trail. Sampling was done at 5, 100, 500 and 1000 m from canals. Small fishes and macroinvertebrates were sampled with a 1-m^2 throw trap, whereas large fishes were sampled with an airboat-mounted electrofisher. For comparison, we also sampled an inner marsh site, at approximately 7500 m from canals.

We found evidence that canals had an effect on the distribution of all sampled taxa. However, the effect was only detected in the immediate proximity of canals. Densities of large predatory fishes, small fishes, and macroinvertebrates increased within 5 m of canals, whereas no effect was detected at greater distances. The magnitude of this effect was greater in the dry than in the wet season. Small fish and invertebrate densities were higher in the trail than the marsh transect, whereas no difference was detected for predatory fishes.

This increase in consumer densities close to canals despite higher densities of large predatory fish suggests that these consumer populations may not be limited by predation. Instead, increases in abundances of all organisms in the close proximity of canals may be better explained by increases in basal productivity. Analyses of total phosphorus in the flocculent detrital layer showed a sharp increase in concentrations within 5 m of canals, which parallels the observed increases in abundance.

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Are Manatee Over-Wintering Strategies and Restoration Efforts Compatible in the Northwestern Everglades Region?

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Florida manatees (*Trichechus manatus latirostris*), which occupy habitats in the northern limit of the species' range, have adapted behavioral strategies to over-winter in the subtropical environments of Florida. Identified winter use patterns include migration south along the coast to warmer ambient waters, directed movements to natural and artificial thermal refuges, and specific use of warm water sources and surrounding resources. A large proportion of the southwest Florida manatee population occurs throughout the Everglades National Park (ENP) and north into the Ten Thousand Islands (TTI). Cold-related mortality is especially high for manatees in this region due to the absence of industrial warm-water effluent, major springs, or the influence of the Gulf Stream.

Manatees are currently being tracked in the TTI as part of a study on manatee use patterns and freshwater flows, which focuses primarily on movements outside the winter season. As an extension of this work, we initiated a two-year study to understand manatee over-wintering strategies in the greater Everglades and to relate these to planned hydrologic changes. Tracking data during the winter season documented strong responses to cold fronts by tagged manatees in this region. During cold periods, tagged manatees spent much more time inshore at a few key aggregation sites that serve as passive thermal refugia, notably, Port of the Islands basin in the Faka Union canal, Wooten's basin in the canal system along US 41, and the canal system at the Big Cypress Preserve, Oasis Ranger Station. We also documented several individuals making large movements of 40-60 km south from TTI to Whitewater Bay associated with the onset of the winter season. As an additional objective of this study, we characterized spatial and temporal changes in water temperature and manatee use patterns at these known winter aggregation sites. We established a network of data-logging temperature probes to profile temperatures within the water column at these sites. Additional information was collected on numbers of manatees present during cold periods. Observations and temperature data show that manatees using these sites bottom-rest within thermally-inverted, higher salinity bottom layers that are several degrees warmer than surface waters. With the return of warm weather following extended cold fronts, significant numbers of manatees shift to deep-water sites adjacent to shallow in-shore bays, where water temperatures increase rapidly due to solar heating. Cooler Gulf water temperatures during these periods limit the duration of feeding bouts on offshore seagrass beds.

Because this is the least developed area in the state occupied by significant numbers of manatees, we suggest that understanding their winter behavior will be of great importance to the long-term management of manatees in this natural region, and in regions where power plants will be shut down or where spring outflow is greatly reduced.

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Comparing Wildlife Utilization in Natural, Restored and Disturbed Coastal Strand Vegetation

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Ecological restoration projects typically use vegetation criteria to determine success or failure. Our objective was to compare wildlife use of coastal strands that were natural, restored and disturbed by non-native plants. Our site was Blowing Rocks Preserve, a 29.5 ha barrier island preserve in Martin County that has approximately 13.8 ha of coastal strand vegetation in varying degrees of disturbance and restoration. Disturbed areas are dominated by non-native invasive plant species like *Schinus terebinthifolius* (Brazilian pepper). This study was initiated in 1992, when there were 8.3 ha of natural, 4.6 ha of disturbed, and 0.9 ha of restored strand. By 2004, 4.1 ha had been restored. From 1992-1999 two herpetological arrays and one small mammal grid were sampled annually in July in each of the natural, restored and disturbed strands. From 2002-2003 three arrays and one mammal grid were sampled annually in July in each of the natural, 1987-restored and 2001-restored strands.

Total number of identified species increased from 19 to 37 during the ten-year sampling period. Numbers of mammal, non-native reptile and non-native amphibian species remained fairly constant. Number of native reptile species varied from 2 to 6. Invertebrate species' numbers increased with greater emphasis on identification of insects. Significantly greater numbers of crabs were captured in the disturbed strand, probably due to the moist, shady and heavy leaf litter environment created by *Schinus* trees.

Mean native species richness was significantly greater for the natural and restored strands than the disturbed strand for the 1992-1999 sampling period. This pattern was significant for native reptile and invertebrate species. Three non-native species of reptiles and amphibians showed no pattern of distribution. Significantly more unique individuals of the native *Sigmodon hispidus* (hispid cotton rat) were captured in the natural strand every year. *Sigmodon* were also captured with high frequency in dense *Stenotaphrum secundatum* (St. Augustine grass) patches in the restored strand before the removal of this non-native species. *Sigmodon* captures significantly increased in the recently restored, mixed woody and herbaceous strand from 1997-1999.

In 2002-2003 total native species richness and captures were significantly higher in the 2001-restored than in the natural and 1987-restored strands. This reflects the high density of arthropods in the dense, herbaceous vegetation in the 2001-restored strand. Significantly higher richness and numbers in the Order Decapoda occurred in the 1987-restored strand. High capture rates of *Uca* spp. adjacent to mangrove wetlands contributed to this result. From 8 to 25 *Sigmodon* were sampled in both the natural and 1987-, but not the 2001-, restored strands.

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Disturbance: Tree Island Spread vs. Exotic Plant Species Invasion

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Everglades plant communities depend on fire and hydroperiod to maintain boundaries (Egler, 1952). With changes in hydroperiod and fire, community boundaries are altered and types of communities may be invaded and thereby lost. This is true of sawgrass marshes in the Southeast Saline Everglades. Without fire and shorter hydroperiod, both native and exotic scrub vegetation can invade the marsh and reduce heterogeneity in the landscape.

The FIU-Singeltary Restoration Project is a 1200 acre parcel located in southeastern Miami-Dade County. The area has been cut off from historic freshwater flow for almost a century. Today it remains isolated from freshwater flow and overdrained by several local canals. The change in hydrology has also altered the natural fire regime. Fires usually burn in late spring and are small in extent. Fires are suppressed in the area, because of it's proximity to US1 and Card Sound Road. As a result of these changes to the natural system, trees and shrubs are invading the drier sawgrass prairies and turning them into dense patches of scrub forest.

The sawgrass prairie is invaded by both native and exotic plant species. There seems to be two major sources for these invading plants. Native plant species have spread out into the marsh from tree islands. Fire and hydroperiod usually control tree island boundaries. With no fires and a short hydroperiod, trees are free to invade the marsh. There are 12 tree species commonly found in tree islands in the FIU-Singeltary restoration area. Only 4 of these trees, *Ilex cassine*, *Myrsine floridana*, *Persea palustris*, and *Salix caroliniana*, are present in large numbers in the marsh. The source of exotic plant species are seeds and fruit carried in from other locations. *Ardisia elliptica*, *Schinus terebinthifolius*, and *Casuarina equisetifolia* are the most important exotic species present in the restoration area. Their seeds were carried onto the property by wind or animals, from east of Card Sound Road or nearby road right of ways.

The distribution of native and exotic forests on the property present several interesting questions. There are large areas of native forest where exotics have been relatively unsuccessful in invading. Why are exotic plants not able to compete as successfully in these areas as they were in other locations? We have also found a lack of correlation between land disturbance and plant species distribution. A large percentage of the land in the restoration area has been used for agricultural purposes in the past. But these areas are as likely to be invaded by native plant species as exotic plant species. The question why exotic plant species not more successful in disturbed areas than in natural areas remains.

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Habitat Assessment for Hatching American Crocodile in the C-111 Wetland Basin and Florida Bay Wildlife Protection Area Based on Monthly Salinity Contouring Analysis from 1996 to 2003

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Growth and survival rates of juvenile American crocodiles have been decreased because of detrimental salinity ranges in coastal wetlands and tidal creeks of Florida Bay due to altered freshwater inflow regimes. Based on the Comprehensive Everglades Restoration Plan (CERP) performance measure (GE-A13) “The restoration of hydrology towards Natural System Model (NSM) conditions will provide freshwater inflows and salinity regimes that will increase the growth and survival of juvenile crocodiles”. The C-111 wetland basin- Florida Bay Wildlife Protection Area (WPA or “Crocodile Sanctuary”) is a principal area of crocodile activity, including nesting. Using data from a combined network of surface water gaging stations (n=10 to 27 stations) managed by the U. S. Geological Survey, National Park Service and National Audubon Society surface water salinity values were integrated and synthesized between 1996 and 2003 into a series of monthly surface water salinity contour maps. The months between July and December were of special interest because they are peak time for crocodile nest hatching and early hatchling crocodile survival. Hatchling crocodiles grow and survive best when salinities fluctuate between 0 - 20 ppt. To evaluate restoration alternatives it is essential to determine the current the status and trends of surface water salinity over the study area. We observed that in 1996, 1997, 2002 and 2003 salinity over the study area dropped below 20 ppt by June, and during the years of 1998, 1999, 2000 and 2001 salinities fell to 20 ppt by July or August.

These surface water salinity data provide a salinity profile for the WPA and spatial analysis tools such as salinity contouring can assist the CERP Monitoring and Assessment Plan goal of providing less abrupt and less extreme decreases in salinity in the northeastern bay for improved juvenile crocodile habitat.

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Use of Amphibian Communities as Indicators of Restoration Success in the Everglades

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The Comprehensive Everglades Restoration Plan (CERP) requires the use of indicator species to measure the success of restoration efforts. The Everglades amphibian community is an ideal ecosystem restoration indicator because amphibians are present in all habitats and under all hydrologic regimes in the Everglades. The hydropattern in the Everglades, the amphibian biphasic life-cycle, and individual species requirements are all responsible for the distinct pattern of amphibian communities across habitats. Most amphibians need water to reproduce and many amphibians are aquatic or semi-aquatic throughout their life. Amphibians are sensitive to changes in hydrology and, therefore, can serve as good restoration indicators. Amphibians are also cost-effective to sample. For example, vocalization surveys are an effective and inexpensive way to inventory frog communities, and crayfish traps provide an effective way to sample aquatic amphibians. This ease of sampling allows for reliable and adequate data on amphibian distribution and abundance that can be used to measure restoration success.

We have developed two major projects that use amphibian communities as ecosystem restoration indicators. The first project, completed in 2003, was an inventory of amphibian communities in Everglades National Park, Biscayne National Park, and Big Cypress National Preserve. This project established baseline data for the amphibian communities in the study areas and elucidated the habitat and hydrologic associations of the amphibian species. The second project, currently underway, is investigating amphibian communities in different hydrologic regimes of the Everglades. This project will define and measure the membership and area occupancy of amphibian communities at different hydrologic regimes, thus allowing managers to evaluate Everglades restoration efforts, establish restoration targets, and compare restoration alternatives. Further, we will investigate the relationship of occupancy, survival, movement probability, and density of amphibians with hydroperiod and other environmental factors. Finally, we will provide a method for measuring restoration success based on these communities.

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The Role of the American Alligator in Measuring Ecosystem Change in the Everglades

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During Everglades restoration, managers use indicator species to evaluate the results of their efforts. The choice of indicators relies on finding species or communities that not only indicate the health of their environment but have aspects of their life history that can lead to quantifiable measures of change due to restoration. Everglades restoration is seeking to restore natural hydropatterns and changes in indicators due to hydrology will need to be measured. We have developed relationships between many American alligator (*Alligator mississippiensis*) population characteristics and hydrologic variables establishing the alligator as a viable indicator species.

Alligators once occupied all wetland habitats in south Florida, from sinkholes and ponds in pinelands to mangrove estuaries during periods of freshwater discharge. In Everglades National Park, large alligator populations occurred in broad shallow marl prairies to the east and west of deep water habitats, in ridge and slough habitats, and in the freshwater mangrove zone. Land development and water management have reduced spatial extent and changed hydropatterns of these habitats. As a result of these habitat alterations, alligators are now less numerous in prairies and mangrove fringe areas, and in poor condition in remaining ridge and slough habitats.

In our research program on the alligator, we have established a comprehensive set of studies designed to develop tools and monitoring methods necessary for detecting change in populations in response to Everglades restoration. We have developed baseline data on health and population status for post project assessments, modeling tools to allow evaluations of proposed restoration alternatives, and monitoring programs to detect ecological changes.

Our current work concentrates on addressing uncertainties identified while developing components for ecological models. Included in those are questions related to breeding female size, juvenile dispersal, and spatial and temporal variation in alligator distribution and abundance throughout the Everglades. Further, we have established a new project to assess uncertainties associated with monitoring (distribution, abundance, condition, nesting, and alligator hole occupancy) of alligators during restoration. We will be using mark-recapture, multiple-observers, radio and GPS telemetry, and other quantitative techniques to estimate detectability and reduce variability during monitoring. The results of this study will lead to detection of trends in populations within the time periods required by managers to measure restoration success. Careful development of a monitoring and modeling program for an indicator of restoration success, such as the alligator, will insure that uncertainties and surprises about the system are incorporated during the Adaptive Assessment process of Everglades restoration.

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The Restoration Planning Process for the South San Francisco Bay Salt Ponds – Opportunities and Challenges: Year 2 of a 5-Year Effort

Steven Ritchie
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The loss of approximately 85 percent of the tidal marsh in San Francisco Bay has led to dramatic losses of fish and wildlife in tidal marsh habitat, decreased water quality and increased risk of local flooding and demand for dredging. The South Bay Salt Pond Restoration Project is a program to restore 15,100 acres of former industrial salt ponds at the southern end of the Bay to a mixture of tidal and managed pond habitats. The Project's overarching goal is "the restoration and enhancement of wetlands in the South San Francisco Bay while providing for flood management and wildlife-oriented public access and restoration."

The property was purchased from Cargill Salt in March of 2003 by the State and Federal governments, with assistance from private foundations. The acquisition of the South Bay salt ponds provides an opportunity for landscape-level wetlands restoration, improving the physical, chemical, and biological health of the Bay. The project is the largest tidal wetland restoration project on the West coast. Unlike many major land and water conservation projects, this one is in the heart of a major urban area, providing a new model for large-scale wetland restoration projects adjacent to large population centers.

This presentation will focus on: 1) the strategic, scientific and public involvement aspects of the South Bay Salt Ponds Restoration project, 2) strategies for addressing the policy and funding challenges faced by state and federal agencies as they move from small, isolated restoration projects in the Bay to a large, landscape scale project, and 3) how the lead agencies (California Coastal Conservancy, California Dept. of Fish and Game, and U.S. Fish and Wildlife Service) are cooperating on the project and working in concert with the U.S. Army Corps of Engineers, local flood control agencies, and a wide array of regulatory agencies.

The technical and public participation aspects of the project are particularly challenging. The presentation will describe how the project is attempting to engage and integrate the scientific community and the interested public, as well as the public at large. Technical challenges posed by the project include mercury contamination in the project vicinity, invasive Spartina hybrids, the mix of habitats needed to support migratory birds, endangered species, and native wildlife, and overall sediment availability for restoration. These and other issues must be faced in a scientifically sound manner to provide for the commencement of restoration within five years, yet incorporate adaptive management that will continue for decades.

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Application of Soil Mapping and Modeling Efforts in WCA-2 Integrating GIS, Geostatistics and Remote Sensing Techniques

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WCA-2 is the smallest but also the most impacted of the three Water Conservation Areas (WCA) in the Everglades, with an area of 543 km^2 . These three areas total 3,500 km^2, which represents approximately 11.6 % of the Greater Everglades Area. While WCA-1 and WCA-3 receive most of their water from rainfall, WCA-2A receives the majority of its water from surface water inflows which include drainage from the EAA (Everglades Agricultural Areas), Lake Okeechobee and outflows from WCA-1. Soil and vegetative patterns in WCA-2 are influenced by wet and dry periods, nutrient influx, and introduction of invasive species, fire and other stresses. Numerous studies documented the expansion in the spatial distribution of *Typha sp.* coverage with conversions of *Cladium sp.* communities to *Typha/Cladium* mixes which has been attributed to elevated phosphorus levels in soils and water. Previous studies have estimated a reduction of tree island area from 1,500 ha in 1950 to less than 200 ha in 1995. Our objectives were to develop a spatially-explicit model for WCA-2 that is holistic integrating soil and vegetative proxies derived from remote sensing imagery. We used hybrid geospatial modeling to characterize the spatial distribution and variability of soil properties, their uncertainties and spatial interdependencies among soil and vegetative indices.

In order to improve our understanding of soils and its relations with other environmental variables, an extensive soil sampling effort has been conducted by the Wetland Biochemistry Laboratory (WBL) at the University of Florida in WCA-2 in 2003. A total of 111 sites in WCA-2A and 57 sites in WCA-2B were sampled at floc, 0-10 cm, and 10-20 cm depths. Samples were analyzed for total phosphorus (TP) and a suite of physico-chemical properties. We used ASTER/NASA satellite imagery with 15 m spatial resolution and Landsat ETM+ with 30 m spatial resolution to derive indices as proxies to map tree islands and characterize vegetative patterns. We used regression kriging to predict total phosphorus at unsampled locations. Special attention was given to tree islands that were masked from the variogram and kriging process.

Our multivariate spatially explicit approach was beneficial to model the environmental status of WCA-2 and characterize prediction uncertainties. Spatial autocorrelation and cross-correlations were quantified providing insight into relationships between soil and vegetative factors. Such understanding provides the basis to improve the ecological function and resilience of WCA-2 as part of major restoration efforts in the Greater Everglades.

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History of Phosphorus Accumulation in Soils along a Nutrient Gradient in Water Conservation Area 2A, South Florida

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Huge increases in loading of phosphorus to south Florida wetlands during the latter part of the 20th century is an established cause of increased plant biomass production. In highly impacted areas, sustained excess nutrient loading has induced a gradual replacement of native sawgrass (Cladium) by cattails (Typha). A notable example is Water Conservation Area 2A (WCA2A) bounded on the north by Hillsboro Canal. Phosphorus-rich water from upland agricultural areas has been pumped from the canal into WCA2A since its construction in the early 1960s. Previous studies have shown that down-flow gradients in vegetation types, from cattails to sawgrass, are accompanied by decreases in mean concentrations of total phosphorus (TP) in surface water and soils. Reddy et al. (Soil. Sci. Soc. Am. J. 57:1147-1155,1993) showed that mean net rates of soil accretion since the mid-1960s also decrease along such gradients.

From soil cores collected in 1997 at six sites along an 8 km transect running roughly parallel to that of Reddy et al, we established soil core chronologies using ^{210}Pb-^{226}Ra methods as verified by ^{137}Cs. Unique to our approach is the use of a model (as opposed to a mapping) to predict the distribution of excess ^{210}Pb in cores. The central tenet of the model is that, at any specified time, net soil accretion rates are linearly related to concentrations of total phosphorus (CTP) in near-surface soils. While quite simplified, the CTP model is nonetheless able to account well for complicated structures in profiles of excess ^{210}Pb, especially at impacted sites. The analysis yields estimates of the site-dependent strength of soil TP coupling to net soil accumulation rates, shows a slow linear increase in net mass accumulation rates before construction of WCA2A followed by nearly exponential increases thereafter, and reveals post-construction doubling times of TP accumulation rates that increase 3x (9-25 years) from impacted to un-impacted sites. This suggests that TP loads are subject to an increasing degree of time integration along transects as a result of spatially distributed averaging processes.

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Habitat Relationships of Fish and Shrimp in Southern Biscayne Bay

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Ecosystem processes in southern Biscayne Bay, Florida are threatened by urban development and associated altered freshwater inflows. Productivity and diversity in this clear-water, seagrass/algae-dominated system is concentrated in its benthic community. Small forage fishes, juvenile sport and reef fishes, and invertebrates such as pink shrimp are strongly linked to benthic habitats, particularly seagrass. Because of the strength of habitat associations, understanding fauna-habitat relationships is critical for discerning the effects of salinity on this community and, thus, for evaluating the success of upstream hydrologic modifications in restoration. Here we characterize fish and shrimp/habitat relationships in the bay, and evaluate two habitat-estimation techniques: harvest-based biomass and density estimation, and Braun-Blanquet visual-cover estimation (Braun-Blanquet, J., 1932. Plant sociology: the study of plant communities. Hafner, London).

We are developing a baseline dataset that relates fish and shrimp density to salinity and habitat measures. The dataset will be used to develop performance measures for assessing restoration alternatives and success in southern Biscayne Bay. Within a random stratified sampling design, a 1-m^2 throw-trap is being used to collect fish and shrimp bi-monthly at 54 locations between Chicken Key and Turkey Point. We collect measures of seagrass/algal habitat, and other physical and environmental parameters, with each throw-trap sample. Sampling was initiated in October 2002.

Preliminary factor analysis reduced sixteen measures of habitat (including seagrass and algal parameters, water and sediment depths, and turbidity) into five composite habitat gradients: turtle grass, shoal grass, algae, a north/south gradient, and turbidity. Of sixteen dominant fish and shrimp species, only the dwarf seahorse was not correlated with at least one habitat gradient, demonstrating the importance of habitat in structuring the nearshore zone in southern Biscayne Bay. Among the remaining dominant fauna, distinct seagrass habitat associations were evident. The rainwater killifish was the only fish positively correlated with both turtle and shoal grass. The spotted dragonet was negatively correlated with both gradients, demonstrating its affinity for hardbottom habitat. Generally, the addition of salinity to the statistical model, in addition to habitat, improved correlations with fauna only slightly, possibly because of the narrow salinity range within the study area. These analyses were based on a partial (1-year) dataset and will be expanded to include a second year of data. The utility of measuring biomass/density habitat estimates will be compared with visual-cover estimates of habitat.

The Florida State Legislature, through the South Florida Water Management District (SFWMD), funded the current study by agreement with NOAA and USGS.

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The Use of Community Metrics and Health Indices to Monitor the Health of Restored Ecosystems and the use of Adaptive Management Strategies to Promote Future Success

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The authors developed a five-year monitoring program to track the fulfillment of permit requirements associated with the development of Consumer Square, a commercial development in New Hartford, NY that required the relocation and construction of a stream channel, and the construction of riparian buffer and wetlands. Several techniques were incorporated into the monitoring program to assess the overall health of the wetland and stream communities, and to promote the success of the restoration project. Health indices were developed to track the condition of the wetland vegetation community over time. These indices were based upon individual plant species' nativity, invasiveness and frequency of occurrence in wetlands. Vegetation community metrics, based upon diversity, dominance and frequency were also developed. For the stream biota, health indices were calculated using the EPA Rapid Bioassessment Protocol. Fish data from pre-construction conditions was used to track the re-establishment of the fish community. In an effort to promote future success of the restoration effort, and to help ensure compliance with strict permit requirements, adaptive management practices were implemented during the monitoring phase. Annual reports of invasive species sightings and stream bank erosions were made to the developers and immediate action was taken to correct the situation.

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Watershed and Habitat Rehabilitation for Fishes: A World Review of Effectiveness of Habitat Restoration Techniques

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The degradation of aquatic habitat from anthropogenic activities has led to large efforts to rehabilitate aquatic ecosystems throughout the world. These efforts have focused on improving habitats for fishes and associated fisheries. Despite the cultural and economic importance of these activities, it is difficult to locate information on the effectiveness of these techniques both in North America and elsewhere. In an effort to help guide future restoration efforts for fishes and other aquatic biota, we synthesized the published information on the effectiveness of common freshwater habitat rehabilitation and restoration techniques including: reconnection of isolated habitats, riparian restoration and grazing management, sediment reduction and road improvements, nutrient additions, and placement of instream structures. We located over 200 published studies the vast majority from European and North American watersheds. We examined project “effectiveness” at three levels: 1) years to achieve response, 2) physical response, and 3) biological response. Activities that focused on restoring watershed processes (reconnecting habitats, riparian restoration and sediment reduction) often took several years to achieve physical and biological responses, but are long lived. In contrast, habitat improvement techniques often produced quick results but many did not last more than a decade or two. Most studies focused on short-term physical responses with little information on biological responses. Biological responses focused on fish and macroinvertebrates and rarely examined watershed scale responses and or were long enough to detect significant biological responses for any of the common techniques. Removal of roads, replanting of riparian vegetation demonstrated improvement in fine sediment, riparian conditions and bank conditions. The reconnection of isolated habitats is one of the few methods that had a relatively quick physical and biological response (increase in number and diversity of fishes). Instream habitat improvement techniques are one of the most common techniques and the most widely evaluated. While in many cases published studies demonstrated improvements in local species diversity and abundance following placement of instream structures, there was high variability in the success of projects. The failure of many habitat improvement projects to increase fish and macroinvertebrates was typically from lack of making large changes in physical habitat (>25% change), inappropriate instream habitat improvement techniques, or failure to addressing watershed-scale processes (sediment, water quality, etc.). Preliminary results of our review of effectiveness of habitat improvement and watershed restoration techniques demonstrate common approaches and problems throughout the world. The two largest challenges are lack of watershed-scale planning, and adequate monitoring and evaluation. Improvements in restoration of watersheds and habitat for fish and other species will require an improvement in planning, prioritization, and evaluation of single and multiple actions at a watershed scale.

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Urban Stormwater Management and Ecological Restoration Is Not An Oxymoron

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A working coalition of local, state and federal agencies has completed the planning process on a novel ecological restoration project for the American Bottoms of Illinois that beneficially utilizes stormwater as a valuable ecological resource. The multiple watershed planning effort focused on opportunities to recreate and enhance the area's once rich aquatic ecosystem by beneficially utilizing stormwater events, which currently cause serious flooding for the urban residents. Challenges include a rapidly developing study area composed of multiple communities, remnant wetlands that have been severed from the historic riverine hydrologic pulse that once sustained them, tributary stream degradation, sedimentation concerns, and nationally significant agriculture and archeological resources.

When complete the recommended plan will use bluff stormwater events to mimic Mississippi River overbank flood pulses that occurred in presettlement times prior to the channelization of streams, construction of the Mississippi River levee system, and urbanization of the floodplain. Increased biodiversity will result from the restoration of about 4,900 acres of wet prairies, forested wetlands, marshes, and meandering floodplain streams, and 178 miles of tributary streams. The project will restore nationally and regionally significant environmental resources, improve water quality by reducing sediment loads throughout the system, and incidentally reduce flood damages.

In this presentation we will introduce the project area and restoration approach and rationale. A discussion of the benefits and challenges of inter-agency planning efforts and the methods and models utilized to provide qualitative and quantitative assessments of project benefits will be included. Results will be presented for selected areas as well as a discussion of the tradeoffs of social, economic and ecological considerations that necessarily take place in the planning of a project of this size.

A discussion of the importance of identifying environmental services provided to the urban community by a restoration project of this nature will be covered to explain the rationale for a sponsor to invest significant dollars on environmental restoration when budgets are strained to provide basic services to communities.

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Evaluating the Biogeochemical Effects of Everglades and Florida Bay Restoration

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Restoration of the Everglades watershed hydrology is expected to modify Florida Bay salinity and facilitate ecological restoration of the Bay. However, changes in the hydrologic linkage between the Everglades and the oligotrophic Florida Bay will affect biogeochemical linkages such as nutrient imports to the Bay and algal bloom dynamics within the Bay. Previous studies have demonstrated strong retention of phosphorus in Everglades wetlands, while nitrogen, primarily in the form of dissolved organic matter (DOM), is more readily transported through the wetlands to the coastal zone. Determining the sources, fate, and effects of this DOM, and predicting how this will change with Everglades Restoration is a major challenge for restoration science. This challenge is currently being addressed via analysis of long term water quality monitoring data, experiments on rates of DOM decomposition and algal responses to DOM additions, and the development of coupled hydrodynamic and water quality models.

Long-term monitoring data imply a connection between water quality conditions throughout the greater Everglades-Florida Bay ecosystem. During the past two decades, there has been a trend of decreasing total nitrogen concentrations in water flowing into the northern Everglades and Everglades National Park, as well as within Florida Bay waters. These trends probably reflect a system-wide change in anthropogenic inputs via surface water or large-scale changes in internal nitrogen cycling.

Experiments are underway to quantify rates of Everglades DOM decomposition and the effect of this DOM on Florida Bay microbial activity (including nutrient cycling and algal production). Initial results indicate that 15% to 30% of DOM entering eastern Florida Bay can be mineralized within two months, and decomposition rates were higher in treatments with added phosphorus and suspended sediments. Short-term bioassays have shown that primary production is not significantly affected by DOM additions, indicating that the primary mechanism by which changing DOM inputs could affect Bay productivity is via microbial decomposition.

The results of these small-scale experiments are currently being “scaled up” with the development and use of hydrodynamic and water quality models in support of the Florida Bay and Florida Keys Feasibility Study, which is part of the Comprehensive Everglades Restoration Plan. With these models, the importance of Everglades DOM as a nutrient source and how this importance changes with changing fresh water flow can be quantitatively evaluated, with consideration of various external nutrient sources, nutrient cycling rates, and water flushing (retention) rates within the Bay’s basins.

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Quantifying the Effects of Nutrient Reduction on Growth Rates of Phytoplankton in Kings Bay, Florida

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The recreational and economic viability of Kings Bay is linked to its water clarity, which is primarily determined by suspended algal abundance. The abundance, composition, and productivity of phytoplankton have been linked to anthropogenic nutrient enrichment, particularly nitrogen and phosphorus. Nutrient enrichment studies have shown that Kings Bay is primarily limited by phosphorus, but can show nitrogen limitation particularly in the fall. Managers are interested in maintaining optimum water clarity in Kings Bay. This study will provide quantitative data that may be used as a management tool to predict the effects of nutrient removal on phytoplankton growth and biomass.

The effects of removing nitrogen and phosphorus will be examined by using nutrient dilution bioassay techniques. The first bioassays will be run July and August 2004. Site water will be brought to the lab and filtered using a Millipore stirred cell concentrator. This allows a given percent of the site water and nutrients to be removed while maintaining ambient concentrations of plankton. DI water and stock solutions of nitrogen and phosphorus will then be added to bring the water level back to the original volume, and nutrient concentrations to the various treatment levels. Each nutrient (nitrogen and phosphorus) will be tested at four concentration levels: ambient, 25% increase, 25% reduction, and 50% reduction. Daily measurements of in vivo fluorescence will be taken to determine biomass and calculate growth rates of phytoplankton.

This study provide water resource managers not only with information on what nutrient is limiting, but also information on the magnitude of reduction that might be needed to receive a desired response in phytoplankton growth and biomass.

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The Lilly ARBOR Project: An Experiment in Urban Riparian Restoration

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The Lilly ARBOR Project is an experimental riparian restoration project along the White River in downtown Indianapolis, IN. The site has been undergoing ecological restoration since 1999 through the reforestation of eight acres of the riparian corridor along a one kilometer reach of a highly engineered urban stream. The experiment is designed to test the relative success of three commonly utilized reforestation strategies: a) three gallon containerized stock planted in a grid; b) bare-root stock planted along random tracks; and c) bare-root stock planted in rows with weed control strategies (3’ X 3’ geotextile mats and Canada wild rye (*Elymus canadensis*) planted as a cover crop). A total of 1332 trees were planted with two acres planted in each style. Two additional acres are unplanted control plots. The 12 tree species selected for planting were derived from historical floodplain composition studies and included those native species whose geographic range occurs within the riparian forests of the Tipton Till Plain Natural Region of central Indiana. Extremely rare or habitat restricted species were excluded from planting. Site preparation included treating mowed turf grass with glyphosate (Rodeo™). All plantings utilized the same species composition, 12’ spacing, similar numbers of each species, and between 204 and 240 trees per plot. Tree species were randomly distributed throughout plots to determine whether hydroperiod had a differential affect on either species or planting style. Tree plantings and monitoring are conducted by volunteers and students participating in service learning programs at IUPUI. Every tree is tagged and located with GPS.

Results show containerized plots had significantly higher survival compared to both types of bare-root methods. Also, there is no statistically significant difference in survival rates between the two bare-root strategies. Important differences in survivorship are apparent between different species. The cost of different restoration strategies is often an important factor in determining approach. We assessed the costs associated with initial planting and the cost per surviving tree for each strategy. Our experience with the ARBOR project suggests that the advantage of utilizing containerized stock is that it provides taller trees quickly. The increase in survivability relative to cost for containerized stock can be made up by planting higher numbers of bare-root stock for lower cost. Restoration managers may choose to use containerized stock planting methods if the appearance of the restoration is important or bare-root random planting methods if cost is the overriding factor when choosing a restoration strategy.

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Modeling the Effect of Soil Amendments (Composts) on Water Balance and Water Quality

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The agricultural area of South Miami-Dade County, Florida, is bound by urban development to the north, Biscayne Bay and Biscayne National Park to the east, Everglades National Park (ENP) to the west, and Florida Bay to the south. The climate is maritime subtropical with a yearly mean temperature of 23 °C and an annual rainfall of 165 cm. The warm climate, high humidity, and ample rainfall are appropriate for the production of tropical and subtropical fruits year round and traditional vegetable crops for eight months of the year. About 85% of precipitation occurs from June to September. The soils (krome, Perrine, and Chekika) overlay bedrock of porous limestone containing the shallow Biscayne Aquifer. The soils have low water holding capacity and high permeability. Therefore, large quantities of water, fertilizers, and pesticides applied to crops during a growing season have the potential to leach into the aquifer. Application of composts as a soil amendment promises improved water holding capacity and chemical retention.

The retention and movement of water and atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) was investigated in a calcareous soil (Krome) amended with three types of compost: 1) Clean organic waste (COW)- municipal solid waste cleaned of plastic materials and metal containers, 2) Biosolids (BSD), and 3) Bedminster (BDM)- a mixture containing 75% COW and 25% BSD. The research was conducted in two phases; a column-leaching study (dynamic) and a batch-equilibrium method (static). The column study demonstrated that while applying simulated rain, atrazine leached out at a slower rate by 41, 24, and 18% from soil amended with BDM, BSD, and COW composts, respectively, during the first simulated storm event. BDM application resulted in lowest water movement and atrazine-leaching rate compared to the other composts tested. The result of the filed study was used to model the effect of composting in soil water balance, crop yield, and leaching of agrochemicals.

The USDA- Everglades Agro-Hydrology Model (EAHM) has been developed to evaluate the impact of agricultural practices on crop production, water balance, and the fate and transport of nutrients and pesticides. During the last six years, the required model parameter has been determined for south Florida agricultural condition. A programmable rainfall simulator has been used to determine soil hydro-physical parameters such as infiltration capacity and saturated hydraulic conductivity has been collected for dominant soil in south Florida. The model was used to select the best management practices (BMPs) while considering the long-term impact of composting on soil water balance, crop yield, and the fate and transport of nitrogen and a pesticide (atrazine) on a South Florida agricultural farm. Considering the poor soil quality, the model simulation test indicated that the application of 90 to 134 $T.ha^{-1}$ of compost (Bedminister) annually will result in an increase of soil water content, crop yield, and reduced water seepage below the root zone, thus reducing the potential for N and atrazine to leach into groundwater.

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Aspects of Oyster Ecology and Their Utility in the Design of Estuarine Restoration Projects in the Greater Everglades: Example from Southern Golden Gate Estates

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Greater Everglades restoration projects concern both terrestrial and estuarine habitats and focus on entire watersheds. Under guidance from the U.S. Army Corps of Engineers and the South Florida Water Management District, restoration planning follows a strict protocol. The American oyster, *Crassostrea virginica*, is being employed in numerous steps within the protocol: as a bioindicator of estuarine health, as a tool for establishing restoration targets, and as a measure of estuarine restoration effectiveness. This presentation reviews the protocol employed, demonstrates the utility of oyster ecology to this process, and lastly illustrates its application by reviewing the Southern Golden Gate Estates (SGGE) project that presently awaits Congressional authorization.

The protocol adopted for Everglades restoration consists of 9 steps: (1) defining restoration goals, (2) characterizing current conditions, (3) establishing the pre-alteration state, (4) designing alternative restoration scenarios, (5) establishing performance measures and targets, (6) modeling to evaluate each scenario; (7) designing a restoration monitoring plan, (8) implementing a restoration scenario, and (9) initiating adaptive management. Oysters and their reef communities are being used in steps 2, 3, 5, and 7. Various aspects of oyster physiology and ecology, including growth, standing stock, recruitment, susceptibility to disease, living density, the aerial distribution reefs, and the composition of the reef community, serve as bioindicators of estuarine health (step 2). These aspects are compared using a spatial homologue approach, whereby geomorphologically similar positions along the estuarine axis are compared among estuaries. Step 3 is achieved by comparing the present distribution of reefs with pre-alteration surveys or by inferring paleosalinities using stable isotope and trace metal geochemistry of subfossil oyster shells. The same aspects of ecology are used to define targets and performance measures for restoration (step 5). Targets are defined for specific homologues using conditions in the neighboring, pristine estuary. Finally, restoration success can be gauged (step 7) by how close the system approaches a given target.

SGGE is a failed housing development project that disrupted freshwater sheetflow through the building of extensive canal and road systems. Current water management practices have reduced freshwater input due to beheading in most of the receiving estuaries and freshwater inundation due to canal-fed drainage in Faka Union Bay. Comparisons of oyster reef distribution, living density, and the prevalence of the disease DERMO among homologues within the effected estuaries and Fakahatchee Bay, a pristine estuary immediately east of the sheetflow disruption, demonstrate the effects of altered salinity and temperature. The preferred restoration alternative was one whose hydrologic modeling provided the correct distribution of salinities for oyster health.

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Sheet Flow Velocity in Everglades National Park, Florida

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Insight into sheet flow behavior in the Everglades is essential to implementation and evaluation of restoration plans. Dynamics in the magnitude, direction, and nature of sheet flows are attributed to internal and external forcing mechanisms, both locally and regionally driven. Local factors include micro-topography and the type, amount, and properties of vegetation, as well as the density and composition of submersed aquatic vegetation and periphyton. Regional factors include water levels, water-surface slopes, land-surface gradients, and vegetative heterogeneity, as well as the proximity of tree islands, airboat trails, hydraulic structures, roads, and canals.

Flow velocities and related hydrologic conditions were measured, typically bi-hourly, in differing vegetative communities in Everglades National Park during 1999-2003. Flow stations were established in medium-dense assemblages of spikerush (*Eleocharis cellulosa*) and sawgrass (*Cladium jamaicense*) and in areas of sparse and medium-dense spikerush with varying amounts of submersed aquatic vegetation and periphyton. Velocities were measured bi-hourly at fixed depths between 5 and 34 cm above the top of the litter layer over a depth range of 15 to 86 cm.

Data have identified the range of flow velocities in typical Everglades vegetative communities and yielded insight into local and regional factors affecting sheet flow behavior. Daily mean velocities ranged between 0.20 and 5.16 cm/s at all sites, with an overall mean of 1.15 cm/s (Riscassi and Schaffranek, 2002, 2003, 2004). Ninety percent of all daily mean velocities were between 0.46 and 2.29 cm/s. Dynamic velocity fluctuations, typically most evident during low water levels, were considerably damped with increased flow depth. Implications are that when water levels are high, regional factors drive flows more uniformly; however, as water levels fall, flow velocities decrease, momentum is reduced, and the flow becomes more susceptible to local forcing mechanisms. Differences in vegetation composition throughout the water column also were found to influence the vertical flow structure in both magnitude and direction. Intermittent storm and rainfall events mainly exhibited short-term effects on sheet flow behavior.

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Model for Simulation of Surface-Water Flow and Transport through Freshwater-Wetland and Coastal-Marine Ecosystems in Everglades National Park, Florida

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A hydrodynamic/transport model has been developed to simulate flow and salt transport in surface-water systems comprising the land-margin interface of the Everglades with Florida Bay and the Gulf of Mexico. The model encompasses the freshwater wetlands and the saltwater-freshwater mixing zone in the mangrove ecotone of Everglades National Park (Schaffranek, 2001) http://water.usgs.gov/pubs/fs/fs-031-01/. Flow depths in the wetlands are typically less than 1 m, the mean daily water-level range in Florida Bay is about 5 cm, and the mean daily range of mixed diurnal/semi-diurnal tides along the Gulf coast is on the order of 1.5 m. A model grid of 194 (E/W) by 174 (N/S) 500-m-square cells, representing land-surface elevations, was generated from topographic data collected by helicopter Global Positioning System techniques in the wetlands and bathymetric surveys in the tidal embayments. A grid of vegetation types was derived from 1997 Landsat Thematic Mapper data and aggregated into one open-water and seven vegetation classes. In the model, evapotranspiration rates are evaluated from modified Priestly-Taylor equations for each vegetation class by correlating ET to monitored solar radiation and simulated flow depth. Resistance coefficients, determined from field data pro-rated to the 500-m model grid from the 30.5-m Landsat data based on vegetation types and plant characteristics, are varied with simulated flow depth. Sheltering coefficients, based on the extent of emergent vegetation associated with each vegetation class, are assigned to evaluate wind stress effects.

Surface-water levels, flow velocities, salt concentrations, rainfall, and meteorological data have been used to develop the model and conduct the numerical simulations. Wetland, canal, culvert, and hydraulic-structure water levels and flow discharges define inflow conditions at the freshwater model boundaries along Tamiami Trail to the north and canal levees to the east. Tide levels and salt concentrations at coastal stations define flow and transport conditions along the southwest Gulf coast and northern Florida Bay model boundaries. Hourly precipitation grids have been generated for model input using data from 47 rain gages. Wind velocity and solar radiation data collected within the model domain are used to evaluate wind stress and ET effects.

Prominent flow features in the wetlands of Taylor Slough, Shark River Slough, and western sloughs are reasonably captured by the model. Mean measured-minus-simulated water levels are +4 cm at site P37 in central Taylor Slough, +3 and -5 cm at sites P33 and P36 in northern and central Shark River Slough, respectively, and +1 cm at site P34 in central Lostmans Slough for a three-month simulation of June-August 1999. Mean simulated flow velocities in the 500-m cell corresponding to monitoring site S1 in southern Shark River Slough are 0.14 cm/sec smaller in magnitude and 5 degrees more westerly in direction than measured point velocities.

Reference:

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Restoration of Sentinel Mayfly Nymphs, *Hexagenia* spp., in the Great Lakes: Result of Pollution Abatement

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In response to excessive pollution, the largest restoration program ever attempted was initiated in the Great Lakes and elsewhere in North America-- billions of dollars worth of pollution-abatement programs were initiated after Earth Day in 1970. In the Great Lakes, goals of nutrient control were accomplished by meeting target loading of phosphorus in the early 1980s. Since this time, management agencies have been evaluating environmental quality to evaluate the success of pollution-abatement programs, especially in western Lake Erie of the Great Lakes which was declared 'dead' as a result of anoxia that occurred in bottom waters in the mid 1950s. Over the past 50 years, western Lake Erie has been observed much closer than other nearshore waters of the Great Lakes because it was one of the most studied areas before 1950, it received one of the largest pollution-abatement efforts, and it is expected to be among the first to 'recover' as a result of restoration efforts.

In the mid-1950s, endemic species of mayflies (*Hexagenia* spp.) disappeared from many mesotrophic-nearshore waters of the Laurentian Great Lakes including; portions of the St. Marys River of Lake Superior, Green Bay of Lake Michigan, Saginaw Bay of Lake Huron, the Bay of Qunite of Lake Ontario, and western Lake Erie. Extirpation of *Hexagenia* was a result of pollution that occurred during the 75 years before their disappearance. The major hypothesis linked to the extirpation of *Hexagenia* populations is that pollution caused a trophic-cascade effect where increased nutrients increased algal production, which increased decomposition of organic material, which resulted in anoxic conditions and subsequent extirpation. This trophic-cascade has been identified as the cause for extirpations of burrowing mayfly nymphs (including *Hexagenia*) in large rivers and lakes in both North America and Europe.

In 1992, after an absence of forty years, swarms of adult burrowing mayflies (*Hexagenia limbata* and *H. rigida*) were observed by researchers in open waters of the western basin of Lake Erie. Subsequent studies revealed that nymphs were present in sediments in portions of the basin in 1993, were abundant enough to be noted by the general public in 1995, and by 1997 had reached basin-wide densities (350 m^{-2}) similar to those found in the 1930s and early 1950s. By 1996, adult swarms were large enough to disrupt electrical power generation, create automobile hazards, and be of nuisance to near-shore residents and tourists. After what appeared to be a 'full' recovery based on single-site sampling, management agencies began to incorporate specific densities of nymphs (e.g., 400-450/m^2 = good, 350-399/m^2 = fair) into lake-wide management goals as acceptable end-points for pollution-abatement programs. Beginning in 1991, we sampled sediments throughout western Lake Erie to determine if restoration of this fauna had indeed occurred. Two types of mayfly-abundance patterns have been observed: (1) high densities in spring gradually decreasing through late summer and (2) high densities gradually decreasing to mid summer, abruptly decreasing in mid summer, and then increasing between summer and late fall. Length-frequency distributions of nymphs and observations of adults indicate that the primary cause for the two density patterns was failed (first pattern) and successful (second pattern) reproduction. In addition, areas where nymphs were present and absent in the basin changed from year-to-year. Further study revealed that weather and habitat conditions were probably the cause for successful and failed reproduction. Therefore, our results indicate that caution should be used when evaluating progress of pollution-abatement/restoration programs based on limited monitoring information because of temporal and geographic variability. This probably applies to most waters in the Great Lakes and elsewhere throughout the world.

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Restoration of the Florida Mouse to Native and Reclaimed Mined Sites: Assessing Habitat Quality to Improve Translocation Success

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Translocation of non-vagile species to patches of isolated but otherwise suitable habitat has been proposed as a tool for the conservation of threatened populations, but translocation success is known to be highly dependent on habitat quality. To what extent do reclaimed phosphate-mined lands meet the autecological requirements of habitat specific fauna? The Florida mouse (*Podomys floridanus*), a xeric-habitat restricted, gopher tortoise burrow commensal, is threatened by widespread habitat destruction and fragmentation throughout its narrow geographic range. To investigate the ability of reclaimed phosphate-mined land to support self-sustaining Florida mouse populations, we relocated individuals and examined pre-and post-translocation habitat association patterns, with respect to gopher tortoise burrows and vegetation structure, on both donor (native scrubby flatwoods/xeric hammock) and recipient sites (reclaimed and native scrub).

An initial series of translocations involving the “hard” release of 38 Florida mice at random trap stations during the summer on the reclaimed site failed to establish a self-sustaining population. A second series of “soft” release translocations, in which multiple mice were simultaneously released at the entrances of gopher tortoise burrows during the winter, was successful on both the reclaimed site (64 individuals) and the native recipient site (32 individuals). On both recipient sites, similar low densities of translocated mice and their offspring persisted for over one year.

Bayesian habitat association models were developed using the Weights of Evidence extension for ArcView GIS/Spatial Analyst to predict increased or decreased capture probabilities based on the presence or absence of generalized evidential themes (i.e., burrows and habitat structure). Competing univariate and multivariate models developed for one donor site were validated on other donor and recipient sites and compared using the Akaike Information Criterion. Florida mice showed similar patterns of habitat association on both donor and recipient sites. Capture probabilities were increased over the prior probabilities in areas of: greater burrow proximity; higher burrow density (> 14 burrows/ha); less than 20% tree (> 3 m) canopy closure; and higher (taller than 60 cm) and more developed (greater than 44%) shrub cover. Collectively, these habitat characteristics suggest that Florida mice are xeric “edge” species, dependent on fires that prevent succession. Multivariate model predictions that included both burrows and habitat structure elements were identified as closest to the true probability distributions, supporting the importance of both burrows and vegetation structure in assessing Florida mouse habitat quality. The quantitative description of high quality Florida mouse habitat presented here should contribute to the more effective management of extant populations and provide a rigorous assessment of the appropriateness of proposed translocation recipient sites.

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Adaptive Governance of Water Conflicts

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Growth and development in 21st century America impose increasing stress on natural systems that in turn increase conflicts among the multiple users of water resources. The critical problem of governance is how to encourage users to adapt to these problems and to the growing scarcity of water without destroying natural ecosystems. Are the current institutions governing water capable of balancing this intricate interplay between human and natural systems in a manner that is both efficient and equitable?

We present the culmination of a two-year project evaluating adaptive management in the context of water conflicts, including conflicts that threaten habitats as well as habitat restoration efforts. We commissioned intensive case studies of 9 characteristic water conflicts in Florida, and invited ten experts from environmental planning and political science to analyze these cases from their different perspectives in a conference and subsequent workshop at FSU.

Our combined study emphasizes the need to extend the perspective of adaptive management to include the broader challenges of governance facing the new institutions evolving to govern ecosystem restoration and preservation efforts. We focus on five critical challenges faced by the governance system: representation, deliberative process design, scientific learning, public learning, and problem responsiveness. The case studies and analyses are being published next year by Resources for the Future.

The presentation will review the major challenges to the development of effective institutions.

1. Representation: Who should be involved in what decisions, with what resources and what authority?

2. Deliberative process design: How should deliberation be designed to elicit feasible solutions to the problems identified by representatives?

3. Scientific Learning: How can we incorporate recognition of the social nature of science in the design of decision processes, in order to enhance the likelihood of producing consensus on the appropriate scientific definitions that will minimize future surprises?

4. Public Learning: How can the process enhance public learning, which involves not only participation and trust, but in the end also requires the reshaping of incentives to align the interest of the individuals with the mutually agreed goals of the collective?

5. Problem Responsiveness: How can we ensure that the collaborative processes lead to resolutions that will be superior to current regulations imposed by administrative fiat?

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Setting Objectives for Ecosystem Restoration: An Examination of National Wildlife Refuge Comprehensive Conservation Plans

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The mission statement of the National Wildlife Refuge System of the U.S. Fish and Wildlife Service directs the agency to restore, where appropriate, the fish, wildlife, and plant resources and their habitats on refuge lands. A key provision of the 1997 Refuge Improvement Act requires the FWS to "ensure that the biological integrity, diversity, and environmental health of the System are maintained". The subsequent Policy on Integrity notes that in order to promote biological integrity, diversity, and environmental health refuges should promote restoration of historic conditions, where appropriate. A primary method by which the FWS is attempting to implement these restoration directives is through the inclusion of specific, measurable, and science-based objectives in the Comprehensive Conservation Plans (CCP) being developed for each refuge.

I examined completed CCPs to determine the type and nature of ecosystem restoration being planned for NWRs. Whereas the majority of CCPs provide a clear written intent to practice some form of ecosystem restoration, few have the type of specific, measurable objectives by which such efforts could be reliably monitored. Examples of the range of planned ecosystem restoration efforts will be provided, along with examples of objectives from completed CCPs. Recommendations for future ecosystem restoration efforts on NWRs include increasing the use of available science for developing objectives, providing additional detail in ecosystem restoration objectives to ensure they can be monitored, and increasing collaboration and networking with others involved in the restoration of similar ecosystems.

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Quantifying Hydrologic Restoration Effectiveness in the Illinois River Basin

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Because hydrologic regimes are primary driving forces in river and stream ecosystems, evaluation of aquatic restoration plans requires an assessment of the expected changes in specific aspects of disturbed regimes that contribute to ecosystem degradation. Dramatic changes in hydrologic conditions within the Illinois River Basin, arising from factors such as land use changes throughout the basin, inter-basin diversion of flows, isolation of floodplain areas behind levees and impoundment behind run-of-river dams, have resulted in a progressive decline in the ecological integrity of the river and its tributaries. For the Illinois River Basin Restoration Study the Rock Island District and the Illinois State Water Survey (ISWS) conducted a series of analyses to determine specific benefits associated with various restoration efforts.

On the mainstem Illinois River, rapid fluctuations (water level changes over time periods ranging from two hours to several days), especially those occurring during the historical low-water period of late summer and autumn, have been identified as major sources of ecosystem degradation. Another source of degradation is the continuous inundation of areas immediately upstream of the run-of-river dams. In basin tributaries, ecosystem degradation is attributable to both increased peak flows and insufficient baseflows. The measures considered for the restoration effort include providing infiltration or wetland storage in tributary areas; adjusting water level management at mainstem locks and dams; providing storage on the mainstem floodplain; and temporarily drawing down navigation pools. Each of these can be expected to provide a different suite of benefits to basin hydrologic regimes.

The existing unsteady-flow hydraulic model used for river management was used to identify water level regime benefits on the mainstem Illinois River. This model assessed likely changes in fluctuation regime due to changes in management, floodplain storage and tributary inflows. It also was used to evaluate probability of success for various seasonal drawdown scenarios.

A continuous model of the Illinois River Basin developed by the ISWS was modified to evaluate potential benefits for providing additional high-flow storage and infiltration within the basin. Change in tributary hydrologic regimes was evaluated using model simulations of streamflow at two-hour increments with various levels of added storage or infiltration. Basin-wide tributary benefits of increased baseflows and decreased peak flows were estimated using the mean response from several representative rivers, while simulated flows were fed into the unsteady-flow hydraulic model to estimate mainstem benefits from hydrologic restoration within the basin.

These modeling efforts indicate that more intensive water level management holds the potential for significant benefits along the mainstem at relatively low cost, but that improvements in the tributaries would have to be extensively implemented before benefits to the mainstem water level regime would be observed.

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Oyster Reef Restoration

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In Virginia's Chesapeake Bay and other coastal waters, oyster reefs are the foundations for a complex biological community, providing nursery areas and feeding grounds for over 300 species including oysters, blue crabs and other valuable species. Recent attempts to restore and improve this habitat have been undertaken with limited success. In a recent project undertaken by the Virginia Port Authority, a scientific approach coupled with more standardized engineering practices was undertaken to create a successful reef by constructing a 1.5 acre manmade oyster reef in the main stem of the Elizabeth River, a tributary to the Chesapeake Bay.

With no published guidelines or precedent to follow Malcolm Pirnie conducted research and developed a more scientific approach to designing and constructing a functioning Oyster Reef. Rather than using concrete debris from demolition projects as planned, we determined that it would have been cost-prohibitive to break up the concrete slabs to proper substrate size and remove the steel rebar. Instead, the use of properly sized riprap saved in construction costs and was more compatible to reef formation.

Malcolm Pirnie's design included the removal of existing piles and debris and underwater grading to prepare the bottom.. A layer of filter fabric was placed over the sediments, followed by a 12-inch-thick layer of riprap and a layer of shell material obtained from local shucking houses.

Due to seasonal survival issues the oyster reef was not seeded with spat at that time. However studies conducted by the Virginia Marine Resources Commission (VMRC) recently reported a dense colonization of spat on the constructed reef. For 2002 the reef had the highest spat "set" of any of the reefs monitored by VMRC. The 2003 spat was lower however, sampling occurred after hurricane Isabel which my have attributed to lower numbers. With this "natural" recruitment, it is unlikely that additional seeding will be necessary to ensure the reef's success, providing additional cost savings to the VPA.

The success of this effort means that this mitigation approach may be a new direction for mandated mitigation programs. This project also resulted in the development of formal design and contract documents for a proven oyster reef design that can be utilized on future projects.

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Real-Time Water Management Operations in South Florida: The Role of Science

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The South Florida Water Management District (SFWMD) is responsible for regional flood control, water supply, water quality protection, and ecosystem restoration in central and southern Florida from Orlando to Lake Okeechobee, westward to the Gulf of Mexico, eastward to the Atlantic Ocean, and south through the Everglades to the Florida Keys. SFWMD operates and maintains approximately 1,800 miles of canals and levees, 25 major pumping stations and more than 2,000 water control structures. Science has an important role in the operational decision making process, as the needs of the region are often competing and must be balanced.

A weekly forum is provided for state and federal agencies to discuss prevailing and forecasted weather and hydrologic conditions, as well as the ecological status of the major ecosystem components: the Kissimmee River basin, Lake Okeechobee, the Caloosahatchee and St. Lucie estuaries, and the Everglades. Participants use the operational flexibility within established federal requirements to provide specified levels of service for flood control and state guidelines to provide water supply for urban and agricultural users to address fish and wildlife protection and salt water management issues. The meeting concludes with a formal operational recommendation to executive management. A recent success of this protocol is the protection of seagrass and oyster habitat in the estuaries, minimization of adverse impacts to nesting and breeding of threatened and endangered avian species, and continued restoration of the Kissimmee River floodplain ecosystem integrity, all while accomplishing an extreme drawdown and environmental enhancement project for Lake Tohopekaliga.

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Success of Ecosystem Restoration in Estuarine and Coastal Subtidal Habitats: Benthic Abundance and Diversity in Natural and Degraded Shorelines of Chesapeake Bay

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Coastal habitats facilitate critical ecosystem functions including nutrient cycling and nursery habitats. With the human population rising, waterfront property is being developed rapidly, causing severe loss of structured shallow-water habitats (e.g., salt marshes and seagrass beds). Much is known about how habitat degradation affects benthic community structure in structured habitats. However, little is known about the impact of habitat degradation and ecological value of unstructured shallow-water habitats (e.g. subtidal mud flats adjacent to salt marshes), despite their prevalence in coastal ecosystems. In coastal habitats, bivalves are dominant benthos that can comprise over 50% of benthic biomass and are indicative of benthic production. We quantified bivalve diversity, density, and biomass in deep and shallow (< 1.5 m) unstructured, subtidal habitats in two tributaries of lower Chesapeake Bay (Elizabeth-Lafayette River system and York River). We also examined the effects of shoreline alteration in shallow habitats by contrasting the benthos of the subtidal zone adjacent to Natural Marsh, Bulkhead, and Rip-Rap shorelines. Bivalve diversity, density, and biomass were significantly higher in shallow than deep benthic habitats in both systems. Benthic abundance and diversity were higher in subtidal habitats adjacent to Natural Marsh than those adjacent to Bulkhead; abundance and diversity were intermediate in Rip-Rap shorelines, and appeared to depend on landscape features. Predator (e.g., blue crab) density and diversity were also highest adjacent to Natural Marsh. There is thus a crucial link between natural marshes, food availability for predators in subtidal habitats, and predator abundance. Benthic abundance and diversity (i.e., bivalves, the blue crab, and demersal fish) are therefore effective indicators of habitat degradation and restoration.

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Floristic Assessment As An Ecological Restoration Tool

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The Florist Quality Index (FQI) was created in 1979 as a method to repeatedly and dispassionately assess the natural quality of areas in the Chicago region. More recently, a computer application was developed that incorporates traditional botanical measures, such as frequency and coverage, plus the FQI, into a Floristic Quality Assessment (FQA) method. Each application can be used at both the transect and inventory level. The use of FQI and FQA has spread to other states and regions in the U.S. and Canada and a number of evaluations, in different regions, of the validity of the procedure have been performed. In the Chicago region, a large amount of data has been gathered by various agencies, including USACE, from both natural areas and restoration sites through the use of FQI and FQA.

Chicago District has used the procedure since the late 1980s to evaluate areas proposed for fill, violation sites, potential restoration and mitigation sites, and site compliance, as well as to establish performance standards and to predict the potential benefits of restorations. It has proven to be logistically feasible and likely correlates well with a number of ecosystem functions and aspects.

Details of different uses, in both natural areas and restorations, of the procedures in the District will be described, and the results of some of those uses in several different USACE restoration programs will be given. The results of studies that use FQA data show consistent differences between alternative types of hydrologic restoration, as well as between *de novo* restorations and those that occur on sites with some remnant vegetation. The application of FQA in the intensive studies at Lockport Prairie Nature Preserve also revealed strong differences between areas that receive storm water and areas that are principally fed by ground water.

The difficulty of incorporating FQA into the Incremental Cost Assessment procedure will also be discussed.

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Linkage Between Microbial Metabolic Diversity and Restoration Age in the Hole-in-the-Donut, Everglades National Park

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The Hole-in-the-Donut (HID) area of the Everglades National Park was actively farmed until 1975. After farming stopped, the non-native Brazilian pepper (*Schinus terebinthefolius*) invaded the HID and excluded native vegetation. Several restoration approaches were tested since 1997, and the most successful was complete clearing of the *Schinus* and removal of topsoil to bedrock. The HID area is large, such that subsections have been cleared each year. This resulted in sites of different times since clearing, which provides an opportunity to study restoration of the HID with time. Recovery of soil microbial communities that control biogeochemical cycling and the availability of carbon and nitrogen are crucial to recovery of the area. In all HID sites during the wet season, periphyton mats are present and may form an important basis for development of soil and microbial communities. The objective of this study was to characterize microbial assemblages present in HID sites with different restoration ages during wet and dry seasons.

DNA was extracted from mats or soils present in sites restored 0, 3, and 13 years ago, and reference sites. Clone libraries of PCR-amplified ribulose-1,5-bisphophate carboxylase/oxygenase (rubisco) and nitrogenase reductase (*nifH*) were constructed, sequenced and analyzed. All rubisco libraries for the wet season were dominated by cyanobacterial rubisco sequences. However, rubisco libraries for the reference and 13-year-old sites for the dry season were dominated by proteobacterial rubisco. The shift in the representation of autotrophs may be related to the amount and type of reduced compounds that could serve as electron donors to be used by autotrophs during the dry season. *nifH* libraries constructed during the wet season revealed two clusters of cyanobacterial sequences broadly defined as *Anabaena*/*Nostoc*/*Cylindrospermopsis* (Clade 1, heterocystous) and *Plectonema*/*Lyngbya*/*Phormidium* (Clade 2, non-heterocystous). Distribution of *nifH* sequences was related to age of the site, such that a selection toward non-heterocystous cyanobacteria was found with older restoration ages. This may reflect more reduced conditions in older soils.

The use of two metabolic genes allowed us to observe microbial dynamics at the seasonal and site level following restoration. Resident microbial communities clearly responded to their surroundings, suggesting ecological succession of major groups of autotrophs and nitrogen fixers with time since clearing. This type of information provides a greater understanding of fundamental processes controlling restoration of sites such as HID, and may provide indicators of progress toward restoration in the HID.

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Federal Policy Issues In Large-Scale Ecosystem Restoration Initiatives

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In the last few decades, the United States has devoted enormous effort and committed billions of dollars towards restoring some of our most important ecosystems such as the Great Lakes, the Greater Everglades, and the Chesapeake Bay. Issues such as the coordination of multi-agency task forces, public participation, allocation of ecosystem resources (e.g., water supplies), and the science behind restoration projects have all been debated in ecosystem restoration initiatives. Studying and monitoring current restoration initiatives and recording the lessons from these initiatives can be insightful for planning future restoration efforts. This presentation identifies several cross-cutting federal policy issues associated with large-scale ecosystem restoration initiatives and provides an analysis of their potential benefits and disadvantages from a federal policy perspective. Broad issues such as governance, funding, and restoration goals are considered in this analysis; as well as, specific issues such as adaptive management, resource assurances, and program balance. Large-scale ecosystem restoration initiatives considered include the Chesapeake Bay, Greater Everglades, California Bay-Delta, Upper Mississippi River, Great Lakes, Upper Colorado River Basin, Columbia River Basin, and Coastal Louisiana. Appreciating the potential benefits and disadvantages of policy mechanisms used in ongoing ecosystem restoration initiatives will help policymakers develop and shape future large-scale initiatives.

The views expressed in this abstract are not necessarily the those of the Congressional Research Service or the Library of Congress.

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Community Features of the Chesapeake Bay Program's Phase 5 Watershed Model

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The Phase 5 version of the Chesapeake Bay Program's Watershed Model, based on Hydrologic Simulation Program - Fortran (HSFP), is being developed by an affiliation of federal and state government agencies, universities, and non-profit organizations. These groups are cooperating so that the watershed model can be used for multiple purposes and on multiple scales. The Chesapeake Bay Program is interested in a model that predicts nutrient and sediment loads under different management scenarios from each of 37 distinct jurisdictional watersheds in its 64,000 square mile watershed. The governments of Maryland and Virginia are interested in using this model on a smaller scale for local TMDLs. The inclusion of the entire states of Maryland and Virginia has increased the model domain to 90,000 square miles.

To facilitate development and use of the Phase 5 watershed model, several features of community development are included. The Phase 5 implementation is developed on the open source linux platform and runs with all open source and freely available software. All documentation, input data, model code, and related programs are or will be available on a publicly accessible web site.

Several features that are unique to this particular application are central to the community nature of the Phase 5 implementation. Software has been developed that integrates land and river segmentation on different spatial segmentations and allows land use acreages and management practice effects are allowed to vary over the 18 years covered by the calibration and validation periods. It can easily be divided into smaller watersheds for use in state TMDL studies, which allows users to operate at multiple scales, either using the model as developed or adjusting the model to meet specific needs. This software also facilitates the calibration process by automatically generating HSPF input files from databases which can be related to model output statistics.

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Natural Plant Pathogens of Brazilian Pepper (*Schinus terebinthifolius* Raddi) in the Everglades National Park: Potential for Biological Control

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Brazilian pepper (*Schinus terebinthifolius* Raddi) is an invasive exotic hardwood tree species native to Brazil, Argentina and Paraguay. Brazilian pepper now covers hundreds of thousands of acres in south and central Florida, as well as many of the islands on the east and west coasts of the state. Significant infestation of Everglades National Park (ENP) by Brazilian pepper has occurred in an area known as the "Hole-in-the-Donut", (HID) covering over 3,000 hectares (ha) of abandoned agricultural lands in the midst of natural subtropical ecosystems.

Biological control is proposed as a tool useful for ecosystem management and compatible with the goals of often competing interests regarding the restoration and maintenance of ecosystems. Most of the potential hazards of classical biocontrol agents (introduced from other regions/countries) can be avoided with microbial herbicides by selecting pathogens that are already endemic in the area where they are to be used. Native pathogens are locally available and locally adapted, and to some extent local agricultural crops/native species have been successfully screened against their pathogenic capabilities. We have initiated studies to discover and develop potential native microbial biocontrol agents of Brazilian pepper. Periodic disease survey of Brazilian pepper trees in the HID are were made to find potential source of native pathogens. Field survey for occurrence of disease were made, putative pathogens were isolated and tested for pathogenicity using detached leaf assay and seedling inoculation. Study findings suggest that native microbial pathogens do exists within the natural ecosystem with capability to cause severe damage to an invasive plant species. During summer 2004 several trees in the HID area found to be severely affected by a leaf spot disease (with more than 50% of the leaves in the tree showing symptoms). The use of native microbial biocontrol agents in the management of invasive plants needs to be augmented along with other restoration alternatives to maintain the habitat quality of plant communities.

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Atmospheric Deposition of African Dust in the Everglades and Florida Bay Ecosystem

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The period of significant degradational changes in the Everglades and Florida Bay ecosystem usually associated with anthropogenic factors such as drainage, agriculture, and construction also coincides with the Sahelian drought and a 4-fold influx of African dust that began impacting Florida in the early 1970s. African soil dust delivers arsenic, phosphorous, sulfates, pesticides, microbes, pollen, and probably seeds and insects to all south Florida environments. Dust-borne elements can also benefit flora and have been shown to deliver essential nutrients to the Amazon rain forest, while Asian dust nurtures the Hawaiian rain forest. Thus, atmospheric dust likely affects south Florida environments both beneficially and detrimentally. Implications are that dust will impact Everglades restoration efforts.

The USGS Global Dust project is attempting to characterize and determine the effects of dust-borne nutrients, toxics, and exotics on south Florida environments. Previous studies have shown that about half the atmospheric particles that settle in south Florida during summer months originate in North Africa.

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Stored Heat Energy Flux and Evapotranspiration Influence on the Water Budget of the Everglades

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Surface energy fluxes are fundamental processes of ecosystem dynamics. At daily to sub-daily time steps in the Everglades, for example, stored heat energy fluxes in wetland surface water create variations in latent heat flux, which is the energy equivalent of evapotranspiration (ET). In localized, regional and global water budgets, ET is the second largest component generally consuming more than 90 percent of rainfall (the largest component). Because of the magnitude of ET in water budgets, successful restoration of the greater Everglades ecosystem will require greater knowledge of ET and its driving mechanisms, including fluxes of stored heat energy. To support restoration efforts, the U.S. Geological Survey and South Florida Water Management District are funding a cooperative study to (1) develop methods for estimating stored heat energy fluxes, and (2) identify the importance of these fluxes in Everglades surface energy budgets.

A method for estimating stored heat energy fluxes was developed that overcomes certain data limitations. Specifically, an insufficient number of water temperature sensors are available to directly measure significant spatial variations in stored heat energy fluxes. Measurements of air temperature, however, are readily available. The method relies on convolution of air temperature changes with a regression-defined transfer function to compute changes in water temperature. The computed water temperature changes are used along with water depth and heat capacity data to estimate stored heat energy fluxes locally and regionally in the Everglades.

The importance of stored heat energy fluxes in Everglades energy budgets is seasonal, affected by wetland surface-water depth and the temporal scale of interest. For example, in the winter season at locations where surface water was roughly greater than 30 centimeters deep, stored heat energy fluxes were a considerable component of the energy budget at daily to sub-daily time steps. In contrast, in the summer or when surface water was generally less than 30 centimeters deep, stored heat energy fluxes were a negligible component of the energy budget, particularly at time steps greater than one day.

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Techniques for Restoring Gorgonians to Coral Reef Injury Areas

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Great attention and energy has been spent investigating reattachment techniques for dislodged and fragmented scleractinian corals; however there has been a lack of controlled experimentation on how to restore dislodged gorgonians following a disturbance event, such as a ship grounding. Unfortunately, reef damage events occur frequently off southeast Florida. As an example, since 1998 at least five freighters have grounded on the reefs near Ft. Lauderdale, Broward County. These freighters dislodged many scleractinian and gorgonian corals and often destroyed thousands of square feet of reef habitat. After these events, restoration efforts concentrated on stabilizing loose debris and rubble, and reattaching scleractinian coral fragments and dislodged colonies. Although southeast Florida's reefs are dominated by gorgonian corals, which are also sheared from the reef when ships ground, restoration efforts generally do not place much emphasis on reattaching dislodged gorgonian colonies.

In order to determine effective techniques for restoring gorgonian populations, 94 gorgonian clippings were transplanted to a reef area in Broward County, Florida in June 2004. The 15-cm clippings were cut from naturally occurring loose colonies of *Pseudopterogorgia americana, Plexaura flexuosa* and *Muricea muricata*, common gorgonians in the southeast Florida reef system. Half of these clippings were attached to the reef substrate using Portland II cement; the other half were transplanted to the reef with two-part marine epoxy. These clippings will be monitored quarterly for a minimum of one year to measure growth and health, and whether the colonies form attachments to the reef over the cement or epoxy. Clipping growth data will be compared to control, 15-20 cm naturally attached, colonies of the same species to determine whether transplant growth is similar to naturally occurring small gorgonian colonies. Data will also be collected on loose control colonies, which are tethered to small pins in the substrate. These controls will indicate whether dislodged colonies left loose on the reef will die, or whether they will reattach and continue to grow.

The goal of this study is to determine effective techniques to restore gorgonian populations. This study aims to create a protocol that resource managers and scientists may follow when determining the most effective way to restore gorgonians to reef habitats following events such as ship groundings. This protocol will take into consideration the condition of each gorgonian colony and the resources available (equipment, money, and time) for restoration.

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Lake Dredging and Beyond: Implication to Agriculture and Environment

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Current dredged material disposal alternatives have several limitations. Options for dealing with dredged materials include leaving them alone, capping them with clean sediments, placing them in confined facilities, disposing of them at upland sites, treating them chemically, or using them for wetlands creation or other beneficial uses The ability to reuse lake-dredge materials (LDM) for agricultural purposes is important because it reduces the need for offshore disposal and provides an alternative to disposal of the materials in landfills. Often these materials can be obtained at little or no cost to the farmers or landowners. Thus, forage production offers an alternative to waste management since nutrients in the LDM are recycled into crops that are not directly consumed by humans. The objective of this study were to: (1) quantify the effect of applied LDM on soil physico-chemical properties (soil quality) at the disposal site; (2) assess LDM as a soil amendment to establish bahiagrass (BG) in a subtropical beef cattle pasture; and (3) determine the effect of LDM application on the crude protein (CP) and nutrient uptake of BG.

The experimental treatments that were evaluated consisted of different ratios of natural soil (**NS**) to LDM: **LDM0** (100% NS:0% LDM); **LDM25** (75% NS:25% LDM); **LDM50** (50% NS:50% LDM); **LDM75** (25% NS:75% LDM); and **LDM100** (0% NS:100% LDM). The Mehlich 1 method (0.05 $\underline{N}$ HCl in 0.025 $\underline{N}$ H_2SO_4) was used for chemical extractions of soils following LDM addition. Soil P, exchangeable cations, and trace metals were analyzed using an inductively coupled plasma spectroscopy. Bahiagrass plots at its early establishment were cut to a 5-cm stubble height on Julian days 112 and harvested to the same stubble height on Julian days 238 and on Julian days 546 following the double-ring method. Field layout was based on the principle of a completely randomized block design with four replications. Ground forage samples were also analyzed for tissue P, K, Ca, Mg, Mn, Cu, Fe, Al, and Mo concentrations using an ICP spectroscopy. The effects of dredged materials addition on soil quality, forage yield, crude protein, and nutrient uptake were analyzed statistically following the PROC ANOVA procedures.

Results have shown the favorable influence that LDM had on soil compaction. The treatment x year interaction effect was not significant, but the average soil compaction varied widely ($p \leq 0.001$) with LDM application. In 2002 and 2003, soil compaction of plots was lowered significantly as a result of LDM additions. The least compacted soils in 2002 and 2003 were observed from plots with LDM75 with mean soil compaction of 300×10^3 and 350×10^3 Pa, respectively. Results showed consistently and significantly ($p \leq 0.001$) higher BG biomass production and CP from plots amended with LDM than those of BG planted on plots with 0% LDM. Forage yield of BG during its establishment increased linearly (**Forage Yield = 1724.3 + 25.6*LDM; R^2 = 0.83; $p \leq 0.0001$**) with increasing rates of LDM application. The CP of BG also varied significantly with varying levels of LDM applications. The tissues of BG with 100% LDM had the greatest CP content while the lowest CP content was from the control plots (LDM0). The CP of BG increased linearly with increasing rates of LDM application. The crude protein response to BG application can be described by a linear equation: **Crude Protein = 10.4 + 0.05*LDM; R^2 = 0.85; $p \leq 0.0001$**. Land application of LDM may provide substantial benefits that will enhance the environment, community, and society. The heavy and trace metal contents of these materials were below the PEL and TEL. As such, the agricultural or livestock industry could utilize these LDM to produce forages. LDM should be regarded as a beneficial resource, as a part of the ecological system.

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Promise and Follow-Through: Instituting Adaptive Management in Restoration of Puget Sound Nearshore Ecosystems

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Adaptive management language is prolific in recent proposals for restoration of nearshore Puget Sound environments. However, actual implementation of most recognized concepts of adaptive management in the resulting projects has been inadequate at best. The lack of follow-through may be the result of: lack of understanding about what is involved in rigorous application of adaptive management; underestimation of the uncertainties involved in restoration approaches and outcomes in these ecosystems; and, an unwillingness on either the proponents or funding entity to allocate significant resources to anything (e.g., monitoring adaptive management "experiments") other than restoration construction costs. We use the recent history of funding by Washington's Salmon Recovery Funding Board to examine the proposed incorporation of adaptive management in nearshore restoration projects, and review some examples of the more mature projects that have been implemented. We reflect upon these results through recommendations for explicit institutionalization of adaptive management in the emerging Puget Sound Nearshore Ecosystem Restoration Program (PSNERP).

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Lessons Learned in Applying Cost Effectiveness and Incremental Cost Analyses to the Indian River Lagoon- South Project

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The Indian River Lagoon – South (IRL-S) Project Implementation Report (PIR), the first of the Comprehensive Everglades Restoration Plan projects submitted for authorization, was completed in March 2004. The project's primary planning objective is the restoration of the IRL-S aquatic ecosystem, demonstrated through increased oyster and seagrass production and suitable habitat for oysters and seagrasses, through an improved salinity regime, reduction in average annual phosphorus and nitrogen loads, and remediation of muck build-up in the St. Lucie River and Estuary and the southern Indian River Lagoon. A secondary objective is an increase in the spatial extent and quality of wetlands in the IRL-S watershed.

Several challenges faced by the Project Delivery team (PDT) were related to developing ecosystem outputs and conducting cost effectiveness and incremental cost analyses (CE/ICA). One critical task necessary to perform CE/ICA was the translation of hydrological and ecological performance measure achievement into quantified ecosystem outputs. Once the PDT had developed habitat units to express the quality and quantity of habitat for six estuarine and watershed ecosystem resources (oyster habitat, submerged aquatic vegetation habitat, benthic habitat, wetlands requiring 100% restoration, wetlands requiring 50% restoration, and uplands habitat), another challenge was conducting CE/ICA on these multiple outputs. Different alternatives favored different output categories. To better interpret CE/ICA results, combined metrics were developed to demonstrate how effectively and efficiently alternatives produced all output categories. Normalization and weighting techniques were employed to combine unlike metrics. CE/ICA results were displayed in a variety of formats and the results were instrumental in the selection and justification of the recommended plan. A final challenge addressed was separating fully formulated "multi-purpose" alternatives into separate "single purpose" features (and estimating costs and ecosystem outputs for those features) to demonstrate the efficiency and synergistic superiority of the "multi-purpose" alternative over the combined "single-purpose" features.

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The Design of Landscape Models for Everglades Restoration

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Restoration of the Everglades is a multi-objective, multi-scale, multi-agency program that requires numerous computer models to test alternatives, understand ecosystem processes, and evaluate restoration performance. There are many different modeling approaches to assess Everglades hydrology and ecology, and to predict the positive and negative impacts of diverting water, or building pumps, removing levees, or creating water quality standards for inflows. Landscape models used for Everglades restoration include hydrologic models, transition probability models, gradient models, distributional mosaic models, and individual-based models. As tools for restoration feasibility and as the backbone of the policies that will drive Everglades restoration for the next 20 years, it is critical that a wide audience evaluate the strengths and weaknesses of these models. The diversity of these models highlight a spectrum of environmental issues and indicate that there can be numerous, sometimes conflicting, policy implications. The primary goal of this paper is to discuss the structure and function of Everglades landscape models as they relate to each other and as they relate to the broader topic of policy and management of water resources.

Never before in the history of biology has landscape modeling been applied at this scale of restoration. What are these models and how are they being used? We will focus on five different dynamic models, each designed to understand, evaluate and predict spatial irregularity, complexity, and patchiness. These models were designed to predict the hydrology, water quality, ecology, and animal distributions in the Everglades so that management guidelines for water control structures (actual and proposed) can be developed to prevent further environmental degradation and restore plants and animals to a more "natural" status. However, each model has a different level of spatial articulation, computational commitment, and ecological realism. The South Florida Water Management Model (SFWMM), for example, can only simulate water depths and general flows because the code is largely devoted to very complex operational rules for hundreds of water control structures. Designed to move water through 1500 kms of canals, this model can address issues of flooding in urban regions but can not simulate marsh biology. On the other hand, gradient models deal with marsh biology by reducing the complexity of the ecological rules/processes. Differences in computational commitment are a reflection of philosophical ideals, data availability, management needs, and funding. This paper will discuss these differences in relation to model function, performance and goals.

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Development of a Conceptual Model for the Potomac Watershed

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The US Army Corps of Engineers, Baltimore District is currently engaged in a comprehensive watershed plan for the Potomac River basin. The Potomac Watershed covers 14,000 square miles and includes a diverse landscape, with urban, rural, and natural areas in six different eco-regions and five local jurisdictions (Maryland, Pennsylvania, Virginia, West Virginia, and the District of Columbia). As the source of nearly a quarter of the flow into the Chesapeake Bay, water quality of the Potomac River is a significant issue in controlling sources of pollution to the Bay. To restore water conditions necessary for the Bay's fish, crabs, oysters, and underwater grasses, the five local jurisdictions have agreed on new caps for loads of nutrients and sediment to the Chesapeake Bay. The goal of the EPA's Chesapeake Bay Program is to reduce nutrient and sediment load to 40% below 1985 levels in the Chesapeake Bay.

While critical to the health of the Bay, these improvements are also critical to the health of the Potomac, as surface water and groundwater resources in the Potomac Basin are the primary source of water supply for many users in the greater Washington, DC region. Data show that withdrawals from the Potomac in 2002 almost exceeded its in-stream flows for September and October of that year. In 2003, withdrawals did exceed historic low-flow events that occurred in 1966, indicating the need for regional planning for projects affecting water quality and supply within the basin. Rapid changes in land use north and west of the DC area have led to habitat and forest fragmentation, wetland loss, increased erosion and sedimentation, and increased imperviousness. This unprecedented growth also led to water supply shortages in 2002 in Maryland and Virginia.

Methods used to create a common knowledge base to develop a sustainable watershed management plan will be discussed. A series of inter-related matrices that describe characteristics of the different Potomac sub-watersheds will aid in the development of a comprehensive strategy. These matrices will provide the groundwork for developing a conceptual model of the Potomac. The conceptual model will describe natural functions and processes within the watershed that provide human and ecological services and how these processes are affected by natural and anthropogenic processes. The conceptual model will be used as a guide for future action in the watershed by providing a better understanding of the system and identifying additional modeling tools and restoration efforts.

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Managing Lake Shorelines: How Do We Put It All Back Together? (Restoration of Aquatic Vegetation in Lakes and Reservoirs)

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Aquatic plants are critically important components of shallow water ecosystems - improving water quality and providing valuable habitat. Unfortunately these shallow water ecosystems are generally heavily disturbed and often completely lacking aquatic plants. While unvegetated, shallow water systems are often turbid and provide relatively poor aquatic habitat and water quality, lakeside property owners often prefer an unvegetated shoreline. Unfortunately for them, the combination of shallow water, exposed sediments, and high concentrations of nutrients act in concert to ensure that something will grow - usually algae or weedy nonindigenous species. Also the high fertility of the environment ensures that, once nondesirable species arrive, they will rapidly grow to problem proportions.

Systems infested with harmful nonindigenous species or chronic algal blooms are often so degraded that they require intensive management intervention involving both removal of the offensive plants and restoration of beneficial native species. While restoration would seem to be a relatively simple matter of planting desired species, there are many obstacles to native plant establishment that must be overcome. These include high levels of turbidity, adverse water quality, water level fluctuations and herbivory or biotic disturbance. In order to overcome these obstacles we have developed what we call the “Founder Colony” approach. This approach employs the development of protected colonies of plants in selected, favorable environments. Once these colonies have established and grown to sustainability, they begin to stabilize the environment, improving conditions for further growth. These protected founder colonies then serve as a continuing source of propagules that will (hopefully) serve to vegetate the rest of the system.

The presentation will feature vegetative restoration projects in several large aquatic ecosystems, and both theory and practice will be discussed. The techniques reported here should enable others to establish founder colonies for restoring diverse native plant communities in a variety of freshwater systems.

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Habitat Conservation Plan Implementation: Keeping Promises for Adaptive Management

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Habitat Conservation Planning was introduced in 1982 as an amendment to the Endangered Species Act (ESA). Administered by the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS), habitat conservation plans (HCPs) are negotiated agreements intended to mitigate the incidental "take" (killing, harming) of endangered and threatened species during a development or resource extraction project. Researchers have questioned the scientific basis of approved HCPs considered to be inadequate and the efficacy of prescribed mitigation measures were found to be untested (Kareiva, et al, 1999, Noss 1997). Adaptive management is a concept that acknowledges uncertainty and involves the iterative testing of hypothesis through experimentation, modeling and research, monitoring and evaluation (Holling 1978, Walters 1986, Lee 1993). Plans, policies or management strategies are then modified based on new information and learning.

An evaluation of adaptive management for endangered species covered in habitat conservation plans (HCP) provides insight into the likelihood of species survival and recovery. This research represents an approved dissertation proposal that investigates the following questions:

1. What is the extent of adaptive management implementation in the HCP?
2. How does the approach to the application of adaptive management influence early stage outcomes?
3. How does the approach to adaptive management vary with ecosystem dynamics, such as human population growth, resource extraction, ecosystem reliability in providing resources for consumptive uses, and the tension between ecosystem health and high resource reliability?

Two in-depth case studies are designed within a formative evaluation framework to: 1) assess the strengths and weaknesses of adaptive management implementation for protecting endangered species and their habitat, and 2) recommend mid-course corrections for improving adaptive management before HCP maturity. Case studies include the Central Cascades HCP that covers a 170K-acre planning area on the east and west of the Cascades (Route I-90) in Washington and the Orange Central Coastal County HCP that covers a 38K acre reserve in Orange County, California. These cases that reflect the diversity of HCPs implementing adaptive management for forest management and urban development, have been in existence for at least five years. Preliminary results are based upon semi-structured interviews and observations of adaptive management approaches. Data analysis and final results will be completed by December 2004.

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Unraveling Trophic Interactions Between the Periphyton Mat Complex and Consumers in the Florida Everglades

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Extensive floating periphyton mats are a unique feature of the Florida Everglades, contributing over half of the system's primary producer standing stock. Floating periphyton mats and their resident macroinvertebrate communities function as self-contained systems in these oligotrophic wetlands. While recent studies have begun to characterize and quantify these macroinvertebrate communities, trophic relationships between the periphyton mat complex and externally feeding macroinvertebrates and fishes remain poorly understood.

We conducted a mesocosm experiment to delineate this relationship with three common consumers from different functional feeding groups and/or with different feeding mechanisms: eastern mosquitofish (*Gambusia holbrooki*, "picking" omnivore), sailfin molly (*Poecilia latipinna*, "picking" herbivore), and grass shrimp (*Palaemonetes paludosus*, "milling" omnivore). We setup four cages in each of 36 mesocosm tanks and stocked them with 962 cm^2 of floating periphyton (≈40% cover). To further understand the relationship between the mat and the consumers, primary productivity was stimulated through a daily load of phosphorus (P) to the water column for two weeks prior to addition of consumers (P levels: low=0, medium=0.6, high=2.0 g $P/m^2/yr$ above ambient). We then added one of four consumer treatments to each cage: no consumers, species A only, species B only, and species A+B. All consumer communities were comprised of 13 individuals and all three pairwise consumer combinations were used.

Analysis of water column and periphyton TP confirmed that P loads were readily assimilated by periphyton. There was no change in average periphyton biomass per cage with enrichment. Periphyton biomass in consumer communities comprised only of *Poecilia* was lower than all other treatments: 4% lower than no-consumer controls in low and medium P tanks and 20% lower in high P tanks. *Poecilia* communities also had the greatest impact on macroinvertebrates (especially amphipods), and impacts were greatest in high P tanks. Analysis of *Gambusia* and *Poecilia* gut contents helped us better understand these interactions. Our results indicate important direct and indirect trophic effects on the periphyton mat complex from externally feeding consumers.

Changes in the composition and physical structure of the periphyton mat are early indicators of P enrichment in Everglades marshes and high levels of enrichment eventually lead to the mat's complete disappearance. A clear understanding of how the periphyton mat complex interacts with other components of the Everglades food web should enhance our knowledge of how eutrophication affects the system.

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Influence of Porewater Salinity and Nutrients on Seedling Recruitment of Mangroves and Invasive Exotic Plants across a Mangrove - Marsh Ecotone on the Harney River, Everglades National Park

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With the threat of global climate change, it is important to understand the consequences sea level rise will have, including shifts from fresher to more saline ecosystems. In Everglades National Park, the mangrove - marsh ecotone acts as a buffer between the coast and interior freshwater wetlands, and the composition of the forest understory is influenced by porewater salinity and sediment nutrient concentrations. The scope and rate of long-term changes occurring between mangrove and halophytic prairie ecosystems are uncertain. A goal of the Comprehensive Everglades Restoration Plan (CERP), section A.3.7, is to study and understand these changes.

Research is being conducted within the mangrove transition zone (ecotone) of the Harney River in Everglades National Park, beginning at the southern edge of the river, a permanent 300-meter transect extends from the estuarine fringe mangrove forest to a coastal sawgrass prairie. Five porewater sampling sites are spaced approximately 75 meters apart along the transect, adjacent to nearby vegetation plots. The understory seedling community composition of mangrove and invasive exotic species, namely *Schinus terebinthifolius,* along with porewater quality parameters at depths of 30 cm, is being analyzed over time across the transition zone. The analysis will help identify relationships that can be used to describe the relative abundance of species in soils with varying porewater quality.

Salinity tolerances for the three species of mangrove are known to be as follows: *Avicennia germinans* > *Laguncularia racemosa* > *Rhizophora mangle*, and their growth rates in soils with high relative nutrient availability follow the same general ranking. By comparing and integrating the data from this study with those from similar ecosystems, we can provide a clearer picture of what changes may occur in these systems in response to climate variability. This meso-scale transect may be able to serve as a model of the relationship between porewater quality and understory composition, therefore allowing prediction of local or landscape community variability in response to sea level changes and upstream hydrological alterations being implemented as part of CERP.

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Trajectories of Mangrove Forest Recovery in the Southwest Everglades a Decade Following Hurricane Andrew: Variable Patterns of Recruitment, Growth, and Mortality

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Hurricane Andrew crossed south Florida in August 1992. The winds of the category five hurricane devastated mangrove forests on both the east and west coasts of the peninsula. Permanent plots were established in the mangrove forests of Everglades National Park, immediately following the hurricane, to study patterns of forest recovery, or lack of recovery. The plots have been sampled annually for more than a decade. Patterns of forest recovery are extremely variable. The white mangrove, *Laguncularia racemosa*, and red mangrove, *Rhizophora mangle*, are most numerous in three plots. The black mangrove, *Avicennia germinans*, is not dominant anywhere in the forest. Stem density of new recruits varies over four orders of magnitude, from less than 10 per hectare to over 10,000 per hectare. The total number of recruits varied among species, between plots and across sampling periods. Survival was also highly variable and differed over years, plots and species. In general *Avicennia* had the highest survival rate, followed by *Rhizophora* and then *Laguncularia*. Cohorts that recruited soon after the hurricane tended to have greater survival than those cohorts that recruited later. Growth, as measured by change in stem diameter, varied as well. For all species and cohorts, mortality could be predicted based on growth. Individuals that had not grown, in the preceding sampling interval, had higher mortality rates than individuals that had grown.

Physical parameters such as flooding frequency, sediment porewater salinity and nutrient concentrations (nitrogen and phosphorus) have been measured in all plots. However, for the first decade following disturbance, patterns of recruitment, survival, and growth do not appear to be related to any of these factors.

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Primary Dune Species of Barrier Islands (e.g. *Amaranthus pumilus*) and the Impact of Increasing Episodic, Extreme Stress Events Linked to Global Change

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Future global change predictions have included scenarios of increased climactic intensity, for example, tropical cyclones that will increase in frequency and amplitude (intensity) in this century. Ecotone habitats such as the barrier island sand dune communities found at the interface between the terrestrial and marine biomes may be particularly susceptible to perturbation. However, little is known regarding the ecological impact on species survival in communities at high risk to episodic disturbance; even less is known about the subsequent effects of increased extinction rates and loss of biodiversity. The overall goal of the current study is to evaluate mechanistically the effects of the frequency and intensity of short-term stressors (day-to-day) versus long-term (episodic) stressors on photosynthetic carbon gain, plant reproduction, and survival in five dominant species representing four major categories of plant form and function. The short-term stress factors evaluated will include typical daily stresses (e.g. temperature, water and light limitations), while the long-term episodic stress factors are those associated with extreme over-wash events generated by natural storms and tidal flux. The species selected for study occur together on the beach and in embryo/primary sand dune communities on barrier islands. *Amaranthus pumilus, Cakile endentula*, *Hydrocotyle bonariensis*, *Iva imbricata*, and *Uniola paniculata* are representative of major categories of life forms (herbaceous, grass, and shrub) and two metabolic types (C_3 and C_4), in addition two of the C_3 species represent two plant functional categories via the variation in reproductive method (sexual/asexual).

In particular, the herbaceous C_4 species *A. pumilus* was designated by the United States Fish and Wildlife Service (USFWS) as a threatened plant in 1993 and is considered a globally imperiled (G2) species. Despite acknowledgment that *A. pumilus* populations were in drastic decline, 75% of the population has been extirpated. Past populations once ranged from Delaware to South Carolina, today only isolated populations remain primarily in North and South Carolina. The primary goal of the USFWS recovery plan (1996) is to remove *A. pumilus* from the threatened species list. Indigenous to the barrier islands of the United States, this species prefers a harsh dynamic shifting terrain acting as a fugitive species that occupies suitable habitat as soon as it becomes available. Unfortunately, very little information exists regarding the basic ecology, eco-physiology, and life history traits that dictate the survival of this threatened species. Data from the past three years will be presented describing the ecology and physiology of this species, as well as effects of storm overwash events, including photosynthetic carbon gain, growth, and reproductive success, with a focus on *A. pumilus.* These parameters will compare daily and episodic stressors to assess the effects of extreme episodic events (e.g. hurricanes) on annual carbon gain and reproduction in the species. It is hypothesized that extreme episodic events may play a dominant role in determining survival in primary dune species of coastal dune habitats while species less vulnerable to episodic stressors may be less susceptible to climate flux.

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Response of Muhly Grass to Different Seasons of Prescribed Fire in Southern Florida

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The Cape Sable seaside sparrow is a Federally listed endangered species confined to seasonally flooded grasslands in extreme southern Florida. Muhly grass (*Muhlenbergia capillaris* var. *filipes*) is often one of the dominant species in this habitat. Fire is a natural and necessary phenomenon in muhly prairies; lightning-ignited fires predominate in May and June, but human-ignited fires can burn at almost any time of the year. The seasonal rainfall pattern generally results in standing water during the summer and fall. Prolonged and excessive flooding due to water-management practices during the 1990's resulted in habitat degradation and substantial declines in sparrow populations. We addressed questions relevant to the restoration and management of Cape Sable seaside sparrow habitat by looking at the response of muhly, one of the dominant grasses, to fire at different times of year. We wanted to know how the season of burning affects the recovery rate of muhly and its ability to tolerate flooding. To accomplish this, we conducted two experiments: one in the field and one under more controlled conditions.

Experimental plots containing 120 marked muhly plants were established at three sites in Big Cypress National Preserve. We burned individual muhly clumps in the field by placing a cylinder (constructed from a 55-gallon steel drum with the ends removed) over the plant and igniting it with a driptorch. On six dates from January 22 to May 27, 2003, 10 randomly chosen plants were burned at each site. Plants burned during the winter recovered more slowly than those burned in the spring. There was considerable flood-induced mortality of plants burned late in the season, although the response differed among sites. There was no standing water at Sites 2 and 3 on May 27, but by May 30 there were 13, 9, and 25 cm of water at Sites 1, 2, and 3, respectively, and all plants burned May 27 died. Even though Sites 2 and 3 became inundated at the same time, the deeper flooding at Site 3 resulted in 50% mortality of plants burned April 17, whereas at Site 2, all plants except those burned on May 27 survived.

Because hydrologic conditions in the field are unpredictable and highly variable, we set up a more controlled experiment using potted plants and tanks. The nursery experiment combined seasonal burning treatments with flooding treatments. On six dates from March 4 to June 4, 2003, we burned 10 potted plants with a propane torch. Three flooding treatments were used: water level at ground surface (low), water 8-10 cm above soil (medium), and water 18-20 cm above soil surface (high). Each flooding treatment was replicated in three tanks with two plants from each burning treatment in each tank. The flooding treatments were applied two days after the sixth burn treatment. Plants completely inundated (medium and high) within a week of burning died; plants burned 15 days before flooding survived medium but not high flooding; and plants burned 29 days before flooding all survived. The key to survival appears to be having at least a few leaves that are tall enough to extend above the standing water.

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Poplar Island Environmental Restoration Project, Talbot County Maryland

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Poplar Island is located just off Maryland's Eastern Shore in the Chesapeake Bay, about 34 miles south of Baltimore. It was inhabited in the colonial period and was over 1,000 acres in size. Prior to restoration beginning in 1998 it was down to a few acres. The Corps of Engineers, the State of Maryland, and an interagency team have worked to restore the island using clean dredged material. The project will produce 570 acres of wetlands and 570 acres of upland habitat and hold 40 million cubic yards of dredged material. It is an example of how economic and environmental interests can be combined. The project won a 2003 Presidential Coastal America Partnership Award.

The historical erosion of Poplar Island is representative of the dwindling amount of island habitat in the mid-Chesapeake Bay area. The Poplar Island Environmental Restoration Project has demonstrated it's potential to restore this type of habitat. Lesson's learned from the construction and vegetation of Poplar Island will be useful for similar projects. It has also served as an educational opportunity for citizens of all ages, researchers, elementary and secondary students and teachers, and has provided opportunities for children to participate in habitat creation.

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Restoration of Island Habitat though the Beneficial Use of Dredged Material: A Community Approach

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The Mid-Chesapeake Bay Island Environmental Restoration feasibility study is focused on restoring island habitat to provide hundreds of acres of wetland and terrestrial habitat for fish, shellfish, reptiles, amphibians, birds, and mammals through the beneficial use of dredged material. This will provide direct benefits of improved health, richness, and sustainability to aquatic and wildlife species. In addition, it will provide indirect benefits of navigational safety, education, passive recreation and, perhaps, increased tourism. The feasibility study evaluates various combinations of wetland and upland habitat percentages. Habitat quantified and evaluated include areas for submerged aquatic vegetation or shallow water, intertidal, low marsh, high marsh, and uplands.

In the last 150 years, it has been estimated that 10,500 acres have been lost in the middle-eastern portion of Chesapeake Bay, and most island habitats will be completely eroded and lost to the Bay in the next 10 to 20 years. Land subsidence, rising sea level, and wave action are causing valuable island habitats to be lost. Islands and their surrounding habitat are preferentially selected by many migratory birds, as well as other fish and wildlife species. Even though similar vegetative communities may occur on the mainland, isolation, lack of human disturbance, and fewer predators make islands more attractive. If the present rate of land loss continues unabated, the island habitats, particularly upland islands, will probably disappear by the turn of the century.

In the Chesapeake Bay region, 4-5 million cubic yards of silt and sediment area dredged annually from maintenance projects, and placement areas are estimated to reach their designed capacity around 2010. Current projections estimate a 34-million cubic yard shortfall in dredged material placement volume over the next 20 years. Therefore, the analyses conducted during the feasibility study investigate the restoration of island habitat through the beneficial use of dredged material.

To support flexible, measurable, attainable, and congruent objectives, specific analyses conducted included developing a screening process and criteria for island restoration, ranking islands, using a GIS, evaluating habitat ratios (percent uplands vs. percent wetlands), quantifying community habitat benefits, weighting guilds, formulating around engineering and ecological constraints, and cost-effective and incremental comparisons.

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Spoil Island Renovation

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The Florida Aquarium is working in partnership with the Tampa Port Authority to rehabilitate and enhance a small man-made island (approximately three acres), located in upper Tampa Bay. It is an offshoot of two main spoil islands (islands created by deposition of dredged materials) owned by the Port. It was overrun with exotic vegetation and had problems with significant shoreline erosion. The rehabilitation activities designed for this project were to create a stand-alone, functioning educational tool for interpreting native local habitats. Microhabitats representative of the bay were planted including inter-tidal zones, upland scrub, mangrove forest and salt marsh.

Funding for removal of invasive species and replanting native vegetation was obtained through the Gardinier Settlement Trust Fund, administered through the Florida Department of Environmental Protection and the Environmental Protection Commission. The physical components of the project were initiated in June of 2001 by evaluating existing plant communities and physical characteristics of the island using aerial photographs and GPS/GIS satellite image techniques. 80% of the island was covered with invasive plant species, primarily the Brazilian pepper, *Schinus terebinthifoolius*. In August of 2001, the actual removal process began. Removed plant material was mulched on site and used for creating trails. Over 4,000 native trees, shrubs and grasses (see Appendix for species list) were transported by barge to the island and planted by an enormous volunteer effort (200+) over a three-day period at the end of August. Periodic maintenance is ongoing. With the assistance of Tampa BayWatch in November 2001, middle school students planted saltmarsh grass, *Spartina alterniflora* along the southern margin of the island and later that month, deposition of 12 tons of natural oyster (American oyster, *Crassostrea virginica*) shells and artificial reef balls were conducted on the south side of the island. Both efforts were done in order to help with the stabilization of areas subject to erosion. A dock (to accommodate the Aquarium's ecotour boat) and a covered educational pavilion were built through funds donated by the Tampa Electric Company (TECO) Bayside project and its partners. Educational programming has been developed through a grant from the GE Foundation and educational interpretive signs are being added along trails.

As a member of the Tampa Bay community, The Florida Aquarium is dedicated to the conservation and preservation of Florida's aquatic ecosystems. This important project provides a unique opportunity for increasing public awareness of Tampa Bay's unique habitats and the positive impact made possible by individuals. In addition, the project has created a collective stewardship – an amazing partnership of a wide variety of organizations (public, private and non-for profit) working together for the protection and preservation of Florida's fragile habitats.

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Ecosystem Restoration Needs for the Great Lakes Region: Detecting Change Across Different Spatial and Trophic Scales

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The Laurentian Great Lakes contain more than 90 percent of the nation's surface fresh water and more than 20 percent of the world's supply. In addition, more than 30 million people live in the Great Lakes basin - roughly 10 percent of the U.S. population and more than 30 percent of the Canadian population. These lakes provide water for human consumption, agriculture, industry, transportation, power, and recreation. As a consequence, environmental degradation of this complex ecosystem has major implications for the natural, economic, and social sectors.

Unlike the restoration effort in the Everglades, which involves only one state and focuses primarily on restoring the hydrology of the system, ecosystem restoration in the Great Lakes involves two provinces, eight states, multiple tribes, and must focus on numerous stressors. Hence, detecting ecological change in the Great Lakes presents substantial logistical and political challenges. The major steps in developing and implementing an effective and comprehensive monitoring system to detect change in the Great Lakes Basin include: 1) identifying the major threats facing the ecosystem; 2) developing specific monitoring strategies for each threat; and 3) coordinating these strategies.

A substantial body of work has been devoted to identifying the major threats facing the Great Lakes Basin; these include non-native invasive species; nonpoint source pollution; contaminated sediments; habitat loss; climate change; and water withdrawal/diversion issues. A plethora of monitoring strategies exists for these stressors, and attempts have been made to coordinate them (e.g. SOLEC), but a systematic and comprehensive approach, geared toward early detection systems of change, is needed. A matrix that describes monitoring approaches for each stressor, based on the scale of observation, is proposed. For example, change detection associated with nonpoint source pollution may include techniques ranging in scale from remote sensing (to detect algal pigment concentrations) to molecular fingerprinting of bacteria or chemicals (to detect sources).

Irrespective of the specific details in the matrix, the successful development and implementation of a monitoring program to detect change across such a variety of threats and spatial scales must ensure that the plan: is comprehensive, coordinated, and flexible; remains accountable; contains effective education and outreach strategies to engage all sectors of the public; and receives dedicated funding that to ensure its continuity and scope.

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The Salton Sea Ecosystem: the Role of Science in Restoration

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Restoration of the Salton Sea and its immediate environs is a vision shared by many government agencies, academic institutions, NGOs, tribes, private institutions, as well as the general public. The Sea itself is a relatively simple ecosystem, beset with a myriad of complex environmental issues, most of which are human generated. Science-related activities such as basic and applied research and monitoring have focused our knowledge and understanding of the Salton Sea ecosystem and aided administrators and managers in making sound decisions for recovery of the Sea.

The Salton Sea, California's largest inland lake, is located in a closed desert basin east of San Diego. Drainwater from intensive agricultural areas in the Coachella and Imperial valleys provides the primary source of water. The current lake has supported a unique marine fishery and other recreational, ecological, and economic benefits. The area is a critical component of the Pacific Flyway, particularly for migrating and wintering birds. More than 400 species of birds have been recorded from the Salton Sea and its adjacent areas. Increasing levels of salinity and nutrients and decreasing inflows provide serious threats to the future of the system. These changes are threatening fish and wildlife populations. Algal blooms and the accompanying odors, coupled with high salinity, also limit the Sea's appeal as a recreational destination.

Plans for restoration of the Salton Sea have been developed and are being evaluated. The goal is for the area to foster diverse ecological benefits while providing the potential for recreational and economic development. A multi-organization and multi-disciplinary consortium of interested parties has been working together to achieve this goal. Credible, peer-reviewed science information has contributed to the success of this effort. In 1997 the Secretary of the Interior established a Research Management Committee and its technical advisory subcommittee, the Science Subcommittee, to provide science input for the restoration process. These interim organizations evolved into the current Salton Sea Science Office of the U.S. Geological Survey, located in La Quinta, California. The primary function of this independent body is providing sound scientific information to management agencies responsible for restoration of the Salton. This has been accomplished by synthesis of existing information, identifying data gaps, contracting for high priority research needs, evaluating ongoing and completed research, and providing technical assistance. The activities of the Science Office have focused research attention on the Sea, which will contribute to its successful restoration.

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Long Term Evaluation of Sponge Population Recovery Following a Widespread Mortality: Will We Ever Know When Recovery Has Occurred? Is Restoration Necessary?

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One of the most dramatic manifestations of the perceived deterioration of the Florida Bay ecosystem has been widespread sponge mortalities caused by cyanobacteria blooms. During 1992 and 1993, widespread sponge mortalities significantly impacted sponge populations in the Florida Keys, U.S.A. The extent of the impacted area was estimated to be approximately 1,000 km^2. The work described here (initiated prior to the mortalities) documented a highly significant reduction (over 90%) in sponge community volumetric biomass. Sponge numerical abundance data has been collected annually since 1991, allowing for the development of a unique, truly long-term (1991-2004) picture of sponge population dynamics following the mortalities. One of the project goals was to determine if restoration of hard-bottom sponge communities would be necessary.

As the project has evolved into a long-term picture of sponge population recovery, it is now possible to sort out natural sponge population abundance variability. The data identified several sponge species that are short-lived, and that widely fluctuate in abundance (*Adocia* sp., *Cinachyra* sp., *Halichondria melanadocia*, *Haliclona molitiba*, *Hyrtios* sp., *Niphates erecta,* and *Tedania ignis*). In a sense, it may be impossible to conclude that these species have recovered because their abundance is probably constantly changing. On the other hand, the data indicate that there are several long-lived sponge species that show gradual consistent recruitment. These species dominate sponge community biomass in the study area. Two species, the loggerhead sponge (*Spheciospongia vesparia*) and vase sponge (*Ircinia campana*) represented 59% of sponge community biomass prior to the mortalities. It is apparent that only a few species, such as these, are important from a resource management perspective because they constitute the bulk of sponge habitat and ability to filter water. If these long-lived species successfully recruit, then sponge population recovery can be considered complete, as the abundance of other short-lived species will continue to fluctuate.

After ten years there has been significant recovery of sponge populations. However, certain key species (in terms of biomass) have not recovered fully, but their reestablishment appears to have begun. In this case, recovery of the sponge community biomass, unaided by human intervention, appears to be a decades long process. W do not yet know if human assistance in this type of sponge community would speed up the restoration process.

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A Historical Perspective for Determining Changes in the Distribution of Oyster Habitats in Southwest Florida Using Archived Maps and Charts of Federal Agencies

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A key issue in oyster reef restoration and fisheries enhancement in southwest Florida is to establish a historical baseline showing pre-development location and extent of this hard-bottom habitat within a bay system. Our project discusses the utility of using U.S. Army Corps of Engineers waterway surveys and U.S. Coast & Geodetic Survey H (hydrographic) and T (topographic) Smooth Sheets as source documents for delineating antecedent oyster reefs. Coupled with recent (2001) habitat mapping conducted by the Sarasota Bay National Estuary Program we were able to develop a picture of oyster reef evolution over 120 years. Our methodology includes scanning the source maps, identifying and digitizing oyster polygons, and creating GIS coverages. This historical information is compared with contemporary conditions, derived from interpretation of 2001 color aerial photograph, to create a change analysis oyster reef map. Examples of the historical source maps and GIS coverage are shown for Little Sarasota Bay, Florida, USA. This work has provided a valuable tool for planning oyster reef and fisheries enhancement work by the Sarasota Bay National Estuary Program.

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Establishment of Poplar Island: A Large Marsh Restoration Project in Chesapeake Bay

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Chesapeake Bay has experienced high relative sea-level rise over the last century ranging from 3 mm/yr in the upper bay to over 6 mm/yr in the lower Bay. It now appears from satellite imagery that over ½ marshes of the Chesapeake have been impacted by rising sea-level, with highest losses occurring where sediment supplies are low (emanating from flat topography of the eastern shore). Another consequence of rising sea-level is the loss of low lying islands, which were important rookeries for birds and helped nurture fish populations in the Bay. In order to compensate for tidal marshes and islands already lost, a partnership of state and federal agencies agreed to restore Poplar Island, near the middle of the Upper Bay, using relatively clean fine-grained sediment dredged from the approach channels to Baltimore Harbour. Poplar I. is being restored to its 1847 area, ½ of the 461 ha is designated for creation of tidal wetlands with 20% high marsh and 80% low marsh, in an adaptive management framework.

In the fall of 2002 there was an attempt to establish marsh plants in dredged material using seeds, with no success. In 2003 sand was spread over the dredged material in experimental cell 4 DX and transplanted (via plugs) in spring. Also a series of test plots was established in which sand was mixed with dredged material in varying degrees to determine an optimal balance of aeration and fertility. *Spartina alterniflora* was planted in the low marsh with *Spartina patens*, *Distichlis spicata* and several other species in the high marsh (*Baccharis halimifolia*, Iva *frutescens* and *Schoenoplectus americanus).* Growth in 2003 was robust with many plants exceeding 1 m in height at the end of the growing season. Sulfides, measured at various depths in the substrate (using dialysis samplers), were an order of magnitiude lower in our created marshes (<0.08 mM) than in a nearby reference marsh (~2 mM). Furthermore, diel sampling of dissolved oxygen in the artificially constructed creek, draining the created mash was >4 mg/l, (i.e. never hypoxic). Thus far all indications are that the new marsh in Cell 4DX is very productive, and appears healthier than reference marshes which are more water-logged and impacted by sea-level rise.

The next phase of restoration will attempt marsh establishment directly into consolidated dredged materials in another cell which will not be amended with sand (which is in short supply). Preliminary results using plugs of *Spartina alterniflora*, *S. patens*, and *Distichlis spicata* in dredged substrate from the cell placed in an environmental growth chamber (under artificial spring conditions) suggest that establishment will be more difficult in the dry environment of the high marsh than that of the low wet marsh. Furthermore seed germination is particularly low in high bulk density dredged materials. Although viability of *Spartina patens* seeds was determined to be low, germination of highly viable *Distichlis spicata* seeds was only marginally higher. *Spartina alterniflora* had successful germination only under the most flooded conditions. Therefore, the high marsh at Poplar I. may have to be largely established using costly transplanting, rather than less expensive broadcasting of seeds (as in the low marsh).

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Response of the Louisiana Deltaic Landscape to Riverine Reintroduction

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Freshwater reintroductions are important tools for counteracting extensive wetland degradation and loss resulting from subsidence, sediment deprivation and saltwater intrusion in coastal Louisiana. The Caernarvon freshwater diversion, operational since 1991, has introduced fresh water, sediments, and nutrients from the Mississippi River into marshes in Breton Sound estuary. An analysis of land to water change from 1990 to 2001 was conducted to determine the influence of the diversion on landscape pattern along a longitudinal gradient. A weighted, stratified random sample of 36 sites from the two photo-acquisition dates was compared. There was not a significant difference in land change (p=0.11), although from 1990 to 2001 there was a net total land gain of 148.88 acres. Contrary to our postulated hypothesis that land gains would be greatest closest to the structure, we found no significant relationship between land change rates and distance from the diversion structure. Land losses in the immediate outfall correspond to areas of floating marsh that developed after 1990 and may be an artifact of geographic analysis techniques. Apparent water-level differences between time periods also confound land change calculations. Even with error uncertainties, there is evidence from Thematic Mapper satellite imagery and field studies to suggest that the reintroductions of freshwater through the diversion have stabilized the landscape in the Caernarvon project area compared to historic rates of loss and compared to losses in adjacent estuarine landscapes.

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Modeling Manatee Response to Restoration in the Ten Thousand Islands and Everglades National Park

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We are developing a spatially explicit, individual-based model of the Florida manatee (*Trichechus manatus latirostris*) in southwestern Florida. This model is being used to project the potential effects of altered hydrologic regimes on manatees in southwest Florida. This model is parameterized with telemetry data for 30 manatees tracked between June 2000 and Dec 2003 in the Ten Thousand Islands area. These manatees showed a consistent pattern of feeding on marine seagrass beds in offshore zones for 1 to 7 days, followed by large movements of 5 to 30 km or more up rivers and canals to assess fresh water. A network data structure is used to model manatee movement between nodes representing destination sites for feeding, drinking, and thermal sheltering, all connected by arcs representing travel corridors. The travel corridors were developed from GPS telemetry points fixed at 15-30 minute intervals. The movement of manatees between different zones is simulated using a Markov Chain approach to transition manatees into different behavioral states that drive the movement patterns of individuals. Transition probabilities are derived using a mark-recapture (program MARK) Multi-State model. Virtual manatees are allocated home ranges comprising different portions of the total network that includes one or more freshwater sites, thermal refugia, and offshore seagrass beds. Salinities, water temperature, and water depth also are modeled along this network to reflect natural environmental variation and changes due to restoration. Manatees can shift their home range to different parts of the network if freshwater, thermal refugia, or seagrass become unavailable within their home range. These shifts are modeled using a reinforcement model which controls how manatees respond to changes in the availability of critical resources. Sensitivity analyses are used to evaluate the importance of different assumptions and uncertainty associated with poorly understood model parameters. As additional telemetry data are collected, the model will be refined to incorporate new insights from these data. Radiotracking and aerial surveys will provide an important means of monitoring manatee response to natural environmental fluctuations and human-induced alterations associated with restoration activities.

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Buried Beneath Downtown: Daylighting Salt Lake City's City Creek

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The City Creek, Utah, Daylighting Project is being done by the Corps of Engineers (Corps) under authority of Section 206 - Aquatic Ecosystem Restoration, of the Water Resources Development Act of 1996. The project was initiated in 1998 and is currently in the feasibility investigation phase. Salt Lake City is the non-Federal sponsor. The Environmental Protection Agency (EPA) is also implementing the adjacent Gateway District project under its Brownfields authority. The collaboration of the Corps, with its ecosystem restoration project for City Creek and the EPA, with its Brownfields project, will greatly intensify the benefits of both programs in this part of the city. These Federal programs build on the substantial efforts underway by the city and by private interests in this same area, and have received the support of numerous local, state, and Federal organizations and agencies. The overall project is a highly collaborative one.

The City Creek Project will daylight and otherwise restore an ecosystem that was completely eliminated in 1910 when the urban portion of City Creek was encased in a concrete culvert below North Temple Street through downtown Salt Lake City. The project area contains a 1.5-mile stretch of railroad right-of-way that traverses a residential and commercial area of the city that is in transition. Under the proposed plan, the existing rails would be relocated and the restored Creek will lie between the Brownfields Showcase Project on the east and the Jordan River on the west. The trail planned adjacent to the creek will connect the area with the 20-mile-long regional Jordan River Trail System. Although the daylighting project is primarily for the restoration of the ecosystem, the maintenance/recreation trail will have several access nodes to the creek that will provide recreational use as well as environmental education opportunities for students at three nearby inner-city schools. The nodes will also provide access for an urban fishery during part of the year. The daylighted creek and overbank areas will be planted with native plants and vegetation to provide riparian and other habitat for wildlife.

As the second driest state in the Nation, Utah has relatively little high quality riparian habitat. Restoring this habitat to the now-urban area will allow the benefits to be enjoyed by those who do not have the means to travel to more-distant riparian areas of the State. This project will provide a significant amount of highly valued riparian habitat along the 7,900 feet of daylighted and restored creek. Restoration of aquatic and riparian habitat will provide home to an array of invertebrates, amphibians, reptiles, mammals, and birds. Water quality of the creek will also be improved. The incidental recreation provided by the restored stream and the connection to recreational and commuting trails will be substantial. The combined beneficial effects of the City Creek restoration project and the Gateway District Brownfields project on the environment and on the overall well-being of the community will be much greater than could be realized if these projects were pursued separately.

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"Getting the Structure Right": Adaptive Management for the Everglades Restoration

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The Florida Everglades is the focus of one of the largest ecosystem restoration efforts in history due to recent anthropogenic disturbance. Water resources are critical to the survival of the Everglades ecosystem, but the management of this unique region must take into account diverse human and ecosystem needs. Adaptive management (AM) is a novel but increasingly accepted method of managing renewable natural resources. The 2000 Comprehensive Everglades Restoration Plan (CERP) legislation mandates the use of an adaptive management approach to be implemented during the thirty- to forty-year projected time span of restoration in order to integrate diverse needs. The Everglades Adaptive Management Workshops One and Two were convened June 18-19, 2003 and October 22-23, 2003, respectively. Everglades scientists and managers worked together to question uncertainties inherent in the application of the method, examined components of successful adaptive management attempts, and drew conclusions regarding essential components of such a program for CERP. This thesis chronicles the making of the current endangered ecosystem, evaluates the utility of adaptive management in solving large-scale ecosystem management problems, and specifies how CERP is integrating specific components of AM necessary for restoration success. Qualitative methods, including interviews and meeting observations, are utilized to draw conclusions regarding what components are necessary and how a large-scale ecosystem management program can be structured for success. The findings of this research will be invaluable, as the Everglades Restoration will be the focal point of the country with regard to implementation of large-scale adaptive management programs for the next several decades.

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The Relationship Between Soil Moisture and Nutrient Availability in Tree Islands of Shark Slough, Everglades National Park

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Tree islands are an important component of the Everglades ecosystem and should be considered when formulating water management policy. Limited information exists on the influence of hydrology upon tree islands and in particular tree island soil dynamics. The purpose of this study was to investigate the relationship between soil moisture and nutrient availability in tree island soils of Shark Slough, Everglades National Park. To meet this objective, soil samples were collected from three tree islands, incubated under different soil moisture regimes (-50kPa, -1500kPa, Flooded, Air-Dried, and an alternating Wetting and Drying schedule), and analyzed for available phosphorus and nitrogen after 10, 30, 60, and 120 days. Moisture treatments significantly affected only available nitrogen while incubation time had a significant influence upon both nutrients. The greatest amount of nitrate was found in the field capacity samples while ammonium was more prevalent in the flooded samples. The greatest change in nitrogen availability occurred within the first 60 days for all moisture treatments; changes between 60 and 120 days were minimal compared to the first 60 days. Although ammonium initially increased when flooded, a decrease was seen after 60 days of flooding. Ammonium decreased over time in the air-dried treatment though nitrate did not appear to change much over time with this particular treatment. Phosphorus availability steadily decreased over the 120 day period for all moisture treatments. These results indicate that soil moisture plays an important role in determining nitrogen availability in tree islands and that the effects of wetting and/or drying are more pronounced in the first 60 days following the event. These results also indicate that there may be another mechanism besides soil moisture that is influencing the availability of phosphorus. More research is needed to determine the relationship between soil-available nutrients and overall plant growth and success in Everglades tree islands.

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Effect of Surface Cover on Surface Radiation Balance in the Florida Everglades

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Net radiation is the most important determinant of the temporal variability of evapotranspiration in the Florida Everglades. Quantification of evapotranspiration, a large component of the hydrologic budget in south Florida, is critical to an understanding of the hydrologic flow system needed for strategic ecosystem restoration in the Everglades. Net radiation varies with surface cover because of cover-to-cover variations in surface reflectance and surface temperature that cause variations in reflected shortwave and upwelling longwave radiation, respectively. The patchy composition of vegetated and open-water surfaces in the Everglades complicates efforts to measure areally representative values of net radiation in the field.

Beginning in June 2003, field measurements of net radiation were made at a site in Water Conservation Area 3A within the Everglades. Two net radiometers were placed about 10 meters apart - one with a downward-looking source area of sawgrass and the other with a source area of open water with some lily pads. The diurnal cycles of net radiation for the two covers were distinct from one another. Daytime net radiation (positive incoming to surface) generally was higher over water than over sawgrass, presumably because of the relatively low reflectance of water and relatively lower daytime temperature of water. Nighttime net radiation was lower (more negative) over water than over sawgrass, presumably because of the relatively higher nighttime temperature of water. Interestingly, on a daily basis, the relatively higher incoming daytime net radiation over water was nearly compensated by the relatively higher outgoing nighttime net radiation; daily composited values of net radiation for the open water and sawgrass covers were similar (averaging within 5 percent), despite the expected three-fold difference in surface reflectance.

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Using a Hydrologic/Ecological Model Linkage to Evaluate the Influence of Ecosystem Restoration on Everglades Fish Populations

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Predictive modeling is an essential tool for evaluating how proposed regional restoration changes will affect the Everglades ecosystem. Hydrologic models that use the Flow and Transport in a Linked Overland-Aquifer Density Dependent System (FTLOADDS) code, compute flow and water levels for the coastal wetlands and the underlying ground water based on relevant flow equations. Ecological models such as the Across Trophic Level System Simulation (ATLSS) modeling suite predict species population dynamics based on the effect of relevant forcing-functions on species production and die-off. The interrelationship between these models is important because the forcing-functions for the ecological models include parameters such as water-level and salinity that are predicted by the hydrologic model.

An example of such an interrelationship exists between the Southern Inland and Coastal Systems (SICS) and ALFISHES models. SICS utilizes the FTLOADDS code which couples the SWIFT2D two-dimensional dynamic wave model with SEAWAT, a variant of the three-dimensional ground-water flow model MODFLOW. In order to be applicable to the southeastern coastal Everglades, the SWIFT2D code was modified to account for rainfall, evapotranspiration, the wind sheltering effect of vegetation, and other factors unique to the Everglades. The modified model can represent discharge velocities with an improved spatial and temporal resolution, and can account for more forcing functions and effects than pre-existing models. SICS can be used to represent the hydrologic effects of various restoration alternatives proposed for the region.

ALFISHES is an extension of a pre-existing ATLSS model (ALFISH) for functional fish groups in freshwater marshes in the Greater Everglades area of southern Florida. ALFISHES was designed to evaluate the spatial and temporal patterns of fish density in the Everglades mangrove zone of Florida Bay. Each of the ALFISHES model cells is divided into two habitat types: flats that are flooded only during the wet season, and creeks that are always wet and serve as refugia during the dry season. Fish movement, production, and die-out are a function of flooding and drying, and salinity. Water level and salinity data generated by the SICS model are used as input to the ALFISHES model to define these interactions. With the development of restoration scenario capabilities in the SICS model, the SICS/ALFISHES coupling is an effective tool for evaluating the potential effect of hydrologic changes on fish population in the Everglades mangrove zone.

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The Reserve; Planning a Major New Restoration Site at Archbold Biological Station, FL

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In July 2002, Archbold Biological Station <http://www.archbold-station.org>, an independent ecological research station in southern Highlands County, Florida, purchased the neighboring 1,476 ha along the Station's west boundary approximately 3¾ miles N-S by 1½ mile E-W. The site, known as the Reserve, includes Florida scrub habitat, pine flatwoods, cutthroat seeps, and extensive *Bahia* grass pasture. It supports many species of conservation concern such as Florida scrub-jays, sand skinks, burrowing owls, and crested caracaras. The Reserve provides a buffer for the pristine scrub habitats of the Station and provides an important conservation landscape linkage between Archbold and adjacent properties that drain west and then south into Fisheating Creek. Archbold's long-term goals for the property are to restore natural communities and ecological processes on this site while retaining some cattle grazing.

In this paper I describe the planning process Archbold employed to help set restoration goals for this project. Archbold was awarded a National Science Foundation planning grant to establish future research, education and land management activities on this site. We held three peer-review workshops that addressed eight objectives. Objective 1. Determine the desired future ecological conditions for the Reserve. This site has been degraded by both abiotic (hydrology, fire regimes) and biotic changes (grazing, planting forage grasses, invasive exotics). We describe an ecological response model with goals that focus on desired future conditions, not simply a reconstruction of what was there in the past. This is based on extensive data collected to date including natural communities, aerial photography, soils maps, and a history of land use changes that have lead to current conditions. It incorporates management opportunities including: manipulate hydrology, cattle grazing, prescribed fire; and re-vegetation. Objective 2. Determine key questions in restoration ecology that we may address as part of restoration, and identify core datasets needed to answer these questions. We wish to go beyond a general monitoring and focus on how we can use this landscape scale restoration to address fundamental questions about controls on restoring biodiversity and ecosystem processes. Objective 3. Develop an experimental design, at the landscape scale, to allow us, and succeeding generations of scientists, to address these key questions. Objective 4. Design research and monitoring protocols to take advantage of recent advances ecological data collection such as wireless communication and new sensor networks. Objective 5. Determine whether current facilities at Archbold are sufficient to support the new activities. Objective 6. Consider how to incorporate the needs of K-12, college students, graduate research and other outreach and training needs into the development of the site. Objective 7. Establish collaborative partnerships to achieve our research goals. Objective 8. Develop a Financial Plan and identify potential outside funding for restoration and research activities.

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The Chesapeake Bay: Restoring the Nation's Largest Estuary

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The Chesapeake Bay is America's largest and most productive estuary; with the ability to produce over half a billion pounds of seafood each year. Nutrient pollution remains its greatest concern. These water quality problems derive from two salient characteristics. First, it is a remarkably shallow body of water, and second, it drains productivity. The second characteristic is the immense watershed draining into this shallow tidal system; 64,000 square miles flowing through more than 110,000 miles of streams and rivers, into a mere 18 trillion gallons of water. Together these factors give the Bay a ratio of land area to water volume that is nearly an order of magnitude greater than the next closest body of water on earth. This makes the Bay's vulnerability to the influence of land use unparalleled worldwide.

It was here in the Chesapeake that the role of excess nutrients as a cause of algae blooms, oxygen reduction and loss of water clarity was first well understood. These classic conditions of eutrophication first appeared in the Chesapeake nearly 50 years ago.

Given the size and importance of this ecosystem, it has received a great deal of public attention. In 1976, growing concern spurred Congress to fund a five-year, $25 million study of the Bay's environmental health. The EPA study that followed found substantial deterioration of the Bay and called for government action to protect this endangered ecosystem, kicking-off one of the largest and longest running environmental monitoring and restoration projects in American history. The efforts to save the Bay have included governmental action at the federal, regional, state, and local levels, as well as extensive work by nongovernmental actors.

The state governments of Maryland and Virginia responded first to the mounting evidence of environmental decline in the Chesapeake Bay. In 1980, they established the Chesapeake Bay Commission to help coordinate their environmental protection efforts. Pennsylvania, a major player in the Bay watershed, joined the Commission in 1985.

Another major move toward restoration occurred in 1983, when the governors of Maryland, Virginia, Pennsylvania, the mayor of the District of Columbia, the administrator of the EPA, and the chair of the Chesapeake Bay Commission signed the first Chesapeake Bay Agreement. Since that time, two subsequent agreements have been signed, in 1987 and 2000, each adding clarity and challenge to the restoration process.

The Chesapeake Bay case study explores what has occurred during the more than two decades of effort. It looks at the progress made, the cost and the consensus along the way.

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Freshwater Signals in Coral Skeletons: A Method for the Reconstruction of Past Freshwater Levels in Biscayne National Park

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We have compared the stable oxygen isotopic composition and Sr/Ca ratios in skeletons from specimens of the coral *Montastraea faveolata* collected from near Elliot Key to reconstruct temperature and salinity over the past 100 years. These corals were originally drilled in 1986 and have recently been re-cored (September 2003). The oxygen isotopic composition is this species has been calibrated to temperature and salinity, while the Sr/Ca ratio predominantly reflects temperature. Utilizing the Sr/Ca ratio as a temperature indicator, the oxygen isotopic can be corrected for temperature and related to salinity. Conversion of the oxygen isotopic composition of the skeletal material corrected for temperature to the salinity requires knowledge of the relationship between salinity and the oxygen isotopic composition of the water. This information can be obtained from the monthly salinity values provided by FIU/SERC and stable oxygen isotopic measurement on the water samples which are made at RSMAS. Utilizing this approach we can calculate over the past 25 years the maximum salinity values were reached in 1989-1990, with periods of high salinity also present between1977-1978 and 1995-1996. Further work will enable this comparison to be extended back in time to the limit of the coral record which at Bache Shoal is 1880 and at Alina's Reef is 1745.

Extreme deviations from these patterns are suggested to be a result of the input of groundwater which our results indicate as significantly elevated Ca values. Utilizing this method we hope to be able to not only derived a long term history of freshwater input into Biscayne National Park, but also assesses the relative importance of groundwater.

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Submarine Groundwater Discharge - Its Role Ii Coastal Processes and as a Potential New Proxy for Ecosystem Restoration

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Submarine groundwater discharge (SGD) has been widely recognized as a phenomenon that can strongly influence coastal water and geochemical budgets, and also drive ecosystem change. For example, the discharge of nutrient-enriched groundwater into coastal waters may contribute to eutrophication and the onset of harmful algae blooms. Similarly, SGD can also affect the dynamics of the freshwater/saltwater interface, impact fragile coastal ecosystems such as estuaries and coral reefs, and influence the geomorphology of shoreline features.

Since the pioneering work by Frank Manheim and colleagues, much recent effort has been devoted to developing new tracer techniques and methods for the identification and quantification of SGD. Because the discharge of coastal groundwater (defined implicitly as a composite of meteoric -, connate- and sea-water) commonly occurs as diffuse seepage rather than focused discharge through identifiable springs, assessing SGD has remained difficult for both oceanographers and hydrologists alike. Rigorous intercalibration experiments, such as those conducted in coastal waters off Australia, Brazil, and Long Island, NY, demonstrate that careful measurements can accurately quantify SGD, confirm some of the driving mechanisms (e.g. climatic and tidal forcing), and constrain the spatial and temporal scales at which these mechanisms operate. Armed with these tools, scientists can now investigate a wide variety of coastal processes directly affected by SGD, and can attempt to utilize SGD as a reliable proxy for ecosystem change and restoration.

We have examined SGD in select coastal waters and estuaries of Florida that are variably impacted by industry, shipping and agriculture. Natural hydrogeologic controls on SGD are also affected or constrained by coastal anthropogenic activities. Using autonomous seepage meters, continuous water column ^{222}Rn surveys and a quartet of Ra isotopes, we have been able to separate SGD in Tampa Bay into two (onshore and offshore) processes that respond very differently to external forces. In the Loxahatchee River estuary, we have been able to identify the variable contribution of groundwater in the surface water composition of the river. Using both ^{222}Rn and streaming resistivity, we were able to pinpoint sites of active SGD in Biscayne Bay in the context of the underlying strata. Because SGD responds to both natural and anthropogenic influences, one can utilize SGD as a proxy for ecosystem change and possibly ecosystem restoration.

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Dealing with Uncertainty in Realtime Water Management and Future Everglades Restoration Projects

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The Central and Southern Florida (C&SF) Project is a multi-purpose water resource project built by the U.S. Army Corps of Engineers (USACE-SAJ) to provide flood control; water supply for municipal, industrial, and agricultural uses; groundwater recharge for well fields; prevention of saltwater intrusion; water supply for Everglades National Park; protection of fish and wildlife resources; and navigation. The C&SF project was first authorized by Congress in 1948 and has been modified over time to include approximately 1,000 miles of levees, 720 miles of canals, 150 water control structures and 16 pump stations. The project encompasses a spatial area of approximately 18,000 square miles from Orlando to Florida Bay. The Comprehensive Everglades Restoration Plan (CERP), formerly known as the "Restudy", will modify this system with the goal of improving the quantity, quality, timing and distribution of water for the Everglades.

The four key uncertainties identified during the Restudy, were 1) Uncertainties about the models; 2) Uncertainties about the linkage between hydrologic change and changes in the ecosystem; 3) Uncertainties about new technologies; and, 4) Uncertainties about the risks associated with the recommended plan (USACE 1999a). Water managers must take these analytical uncertainties into account along with the uncertainty of the realtime nature of project operations.

A compounding factor in water management operations is the inherent uncertainty that can never be eliminated by strict adherence to the operational guidance of regulation schedules and water control plans. The uncertainty is not only a factor of the realtime nature of project operations which include weather, antecedent conditions, construction activities, design deficiencies and environmental factors, but also the result of inherent uncertainty in the modeling and development of water control operational criteria, regulation schedules and water control plans. These uncertainties can be attenuated by use of open avenues of communication; making information available through multiple venues; robust, flexible plans; and adaptive management .

The role of Restoration Coordination and Verification (RECOVER) is to organize and apply scientific and technical information in ways that are most effective in supporting the objectives of the CERP plan. RECOVER links science and the tools of science to a set of system-wide planning, evaluation and assessment tasks. These links provide RECOVER with the scientific basis for meeting its overall objectives of evaluating and assessing Comprehensive Plan performance, refining and improving the plan during the implementation period, and ensuring that a system-wide perspective is maintained throughout the restoration program.

The views and opinions expressed herein are those of the authors and do not necessarily state or reflect those of the United States government or any agency thereof.

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Telling Stories: Using Narrative to Communicate Science

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We urge scientists to share their research with people outside the scientific community. In fact, grant makers often require it. And agencies frequently set up programs or offices to promote the work their scientists accomplish. Despite the widespread desire to communicate science, few efforts seem to generate enthusiasm among the audiences they are intended to reach.

To communicate science to non-scientists, we need to do more than just “dumb down” an abstract, science paper, or piece of gray literature. Instead, we need to turn to a different tool, a tool well-known to practicing writers, cognitive scientists, and anthropologists: Narrative.

Scientific papers follow rules of organization that are useful to scientists, but cumbersome to non-scientists. Similarly, while great scientific papers explain how their findings fit into the context of past research and theory, they do not (nor are they intended to) explain why their findings should be meaningful to society at large. In contrast, most successful narratives use a structure that is universally understood. And, through narrative, an author can explore what science means to policy-makers or the public.

Narrative requires that we assemble the facts in a different (but still accurate) way and use tools familiar to writers – suspense or tension, character, action, and concrete places and things. Often, using narrative requires us to do additional “research” – visiting field sites to gather vivid details, getting to know the researcher themselves, or searching for the cultural or intellectual back-story.

My colleagues, Cheva Heck, Erik Hutchins, and I produce a monthly science television program called Waterways. This program is supported by the Florida Keys National Marine Sanctuary, the U.S. Environmental Protection Agency, and Everglades National Park. By word of mouth (no active promotion), Waterways has spread from 2 channels to 18 channels throughout the state of Florida. We are even shown on one channel in New York and one in Washington State. I also write regular articles for Florida Keys newspapers. Together, the television program and news articles won the Freeman Tilden Award, an award given by the National Parks Conservation Association for excellence in communication.

We use narrative in both Waterways TV and our newspaper articles to explore ecosystem restoration. Using examples from my own work and that of others, I will discuss how to use narrative tools to communicate science.

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Fast Growing Tree Bridge Crops for Ecological Restoration of Phosphate Mined Lands

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Fast growing *Eucalyptus grandis, E. amplifolia* and cottonwood may be effective bridge crops for controlling cogongrass by creating favorable environments for the growth of native species. In 2000 and 2001, these three species were planted in a 50-ha cogongrass-infested closed phosphate mined area at Lakeland, Florida to evaluate their ability to control cogongrass and stabilize/remediate soil. Beginning in 2004 in a series of 50 15 x 15m plots distributed across the area, species composition was assessed separately as herbs and shrubs in different age-class and species blocks. A modified Daubenmire (1959) scale was used to study understory cover. Species diversity was determined using Shannon-Wiener (1963) diversity index. Similarity indices were also calculated between different age-class and species using Jaccard (1912) method. Soil samples were taken at different depths to calculate cogongrass rhizome biomass. Soil pH, bulk density, organic matter, water holding capacity and nutrients were also characterized. Regression analyses were conducted to predict species composition.

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Is Roller Chopping an Alternative Management Practice to Fire in Restoring Dry Prairie?

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Florida's dry prairie ecosystems are threatened in large part by human activities beginning in the early twentieth century that included suppression of natural fire regimens, overgrazing, and conversion to other agricultural or development uses. Remaining dry prairie sites have experienced a proliferation of woody plants and a loss of herbaceous species dominance. Fire-suppressed, shrub-dominated dry prairie sites possibly represent an alternate steady state condition. A study was initiated in 1988 to compare vegetative responses to fire (at 3-yr intervals), roller chopping (at 6-yr intervals), and the combination of these treatments applied in the dormant season (Jan./Feb.) and during the growing season (June/July). Treatments were applied on a dry prairie site on the Myakka River State Park that had been fire suppressed for approximately 25 years. We report comparisons of vegetative composition within these treatments after 12 to 13 years of iterative treatment application and within two reference sites. We found neither roller chopping nor prescribed burning treatments alone to restore long-unburned dry prairie. However, the combination of these treatments increased the similarity of plant composition to that of the reference sites. Effects of season of treatment were mixed. We conclude that fire is an essential component in restoring and managing dry prairies, but and additional disturbance, such as roller chopping, is required to reverse the shift in dominance from woody to herbaceous plants.

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Removing the Sands (Sins?) of Our Past: Dredge-Spoil and Saltmarsh Restoration along the Indian River Lagoon, Florida

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Estuarine saltmarshes are widely recognized as highly productive and biologically diverse marine systems. The Indian River Lagoon (IRL) is a 256 km long "Estuary of National Significance" along Florida's east coast and is known as one of North America's most diverse estuaries, with over 4,300 associated species, including 35 that are either Threatened or Endangered. Like most North American estuaries, the IRL is facing a number of problems, among them loss of emergent wetlands. Between 75-90% of the original mangrove and saltmarsh acreage historically bordering the IRL has been lost or impacted, either through direct filling for development or impoundment for mosquito control. This loss has impacted IRL water quality and fisheries, since these once formerly productive nursery habitats are now removed from the estuarine system. Active programs are now underway to 'restore' mosquito impoundments by reconnection with culverts or removal of dikes, but restoration of dredge spoils is more problematic, as many of these sites have been developed. However, where undeveloped spoils are found on public lands, restoration is a possibility. One such site, Pine Island Conservation Area, jointly owned by the Brevard County Environmentally Endangered Lands Program and the St. Johns River Water Management District, contained over 60 acres of dredge spoil originating from 1969, when the property was owned by a development company. Following public acquisition in 1996, plans were developed to remove the spoil and restore the site to historic conditions, high saltmarsh. Using both mitigation funds and in-kind contributions, we have moved forward with the project and report on the status of this multi-year, multi-agency cooperative project.

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Reflecting on Fish Screens: Using Modern Concepts of Organizational Learning to Examine Adaptive Management in CALFED

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The CALFED Bay Delta Program began as a six-year collaborative effort to design a solution for a number of long-standing, interconnected resource management problems in the Sacramento-San Joaquin Delta. A number of engineering projects intended to keep more fish out of the large state and federal water diversion systems--and improve survival of fish that do get caught—were part of the overall vision for allowing more flexibility in diversion pumping rates while improving protection for at-risk fish species. The CALFED agencies also committed to adaptive management, agreeing to adjust projects and approaches as new information warranted and providing new funds for science.

Two years after the initial CALFED agreement, senior agency managers and stakeholders alike began questioning the expected benefits of proposed fish facility engineering projects, largely because of the $300 million price tag and lower-than-expected funding levels. They established a new public forum and led an open dialog about what the envisioned facilities could potentially achieve, how those benefits fit in the overall context of population-level effects and ecosystem restoration investments, and the information value of proposed experiments on fish stress and different configurations of pumps, lifts, and tanks. The result of this dialog was an agreement to change course from the initial set of projects, and a significant shift in the shared vision of how diversion facilities fit into natural processes in the Delta. In other words, it is a clear example of organizational learning, and change based on learning.

Two modern concepts of organizational change explain this feedback and learning part of adaptive management much better than the 1950s-era model embedded in Walters' version of adaptive management (Johnson, 1999). The first concept is that people from different professional communities transfer knowledge and develop shared understandings of natural systems when they collaborate (Susskind, et al., 1999). The second is that knowledge gets woven into management plans and projects through a process of reflective problem solving (Schön, 1983). Using these models, it appears that conditions which enabled organizational learning in CALFED were the ability of managers and stakeholders to consider options beyond the engineering projects in question, direct communication of scientific understandings between researchers and decision makers, and an established practice of problem-solving through collaborative processes.

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Restoration of the Columbia River Estuary Ecosystem: Comprehensive Planning and Adaptive Management

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Over the past four years we have been assisting the Corps of Engineers, Bonneville Power Administration and the Lower Columbia River Estuary Partnership to develop components of a comprehensive restoration plan for the Columbia River estuary. The estuary spans 225km from its mouth to Bonneville Dam. Through flow regulation by several major dams and diking of tidal swamp forests and marshes, the state of the ecosystem has been altered. Faced with the immense cost for restoration projects, there is a critical need to plan projects that have a high probability of achieving goals and to verify success through monitoring. In order to facilitate major planned restoration efforts we have developed a systematic approach to project selection and restoration strategy. Within the next year we will develop an assessment of conditions and a restoration prioritization plan for property bordering the system. To help organize the information on the system, and guide restoration actions, we developed a conceptual model of the ecosystem, as well as habitat monitoring protocols. We are presently investigating methods for assessing the cumulative impact of multiple restoration projects on restoring the fundamental processes and functions lost because of past impacts. The difficulty with this latter effort is whether we can detect a signal in the estuarine system resulting from multiple restoration projects. The entire program is couched in an adaptive management framework. This framework will facilitate learning from projects to improve success.

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Benthic Periphyton Recovery and Phosphorus Dynamics upon Artificial Flooding in a Newly Burned Freshwater Marl Prairie (Everglades National Park, FL, USA)

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The mosaic of wetlands comprising the Everglades includes freshwater marl prairies, which are situated on relatively elevated limestone and are, therefore, prone to prolonged episodes of drying. Flooded between 3 and 7 months a year during the subtropical rainy season, the marl prairie is colonized by a sparse yet diverse plant community which is tolerant of periodic and/or sustained drying. Lighted surfaces between plants and exposed stems and leaves are colonized during the flooding season by periphyton, a group of algae, bacteria and fungi, which grows when water is present but is mostly dormant the remainder of time. As the dominant primary producer in the system, periphyton forms the base of the food web, provides oxygen to the shallow water and produces marl soils. Aside from hydrology that mainly drives this system, fire is also an important, yet episodic event. Natural fires resulting from lightening strikes in the early rainy season (May-June) can enhance nutrient release and clear dead vegetation promoting new re-growth. In recent years, water management has decreased freshwater input into the marl prairie and altered the natural fire pattern in the Everglades. As a result, fire planning is now an important component of Everglades management, and timing and periodicity of controlled burns are scheduled to maximize the benefits of fire while minimizing its impacts on the system.

A fair number of studies have been conducted to examine the vegetation recovery after fire. Yet, to our knowledge, none has addressed periphyton recovery and its effect on phosphorus (P) biochemistry after fire and re-flooding. Thus, we followed the 19-day revival of benthic periphyton from a newly burned freshwater oligotrophic marl prairie of Everglades National Park prior to the 2003 rainy season. Periphyton of varying degrees of wetness (dry crust on top of marl mounds, wet mat and submerged mat in small depressions) were sampled from adjacent burned and unburned areas. Similar amounts of each periphyton type were artificially rewetted with artificial marsh water containing no P in small enclosures in a green house. Periphyton revival (biomass, metabolism and algal taxonomic composition) as well as dynamics of P in the water were examined. P dynamics in periphyton treatments were compared to (abiotic) P-desorption from oven-dried ground subsample of each periphyton type.

We found similar rates of abiotic P-desorption from the different types of dried ground mats and less than 1% of the mat P-content desorbed to the water. Burned periphyton from emerged surfaces did not recover photosynthetically and desorbed P to the water column at rates similar to dried material. Burned periphyton from submerged substrates desorbed P rapidly in the first 10 days but increasingly reabsorbed P thereafter subsequent to patchy algal recovery. Unburned mats did not desorb P because of high photosynthetic rates and P uptake subsequent to flooding. Therefore, healthy periphyton mats regulate water P dynamics but P-buffering in burned areas is delayed in time and dependent on submersed patches that are less susceptible to fire.

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Partnering for Success in Submerged Aquatic Vegetation Research, Restoration, and Education in the Chesapeake Bay Watershed

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There is an old adage, “Two heads are better than one,” so, then why not join many heads to get the best result? In response to increasing interest in freshwater, tidal fresh, and oligohaline submerged aquatic vegetation (SAV) in the Chesapeake Bay watershed, the Chesapeake Research Consortium (CRC) was asked to form a collaborative partnership to facilitate research on these taxa as well as restoration technologies. At its inception in 2002, the Freshwater (FW) SAV Partnership outlined its mission to expand current knowledge and research on 1) basic biology, physiology, and ecology of freshwater, tidal fresh, and oligohaline SAV and 2) new approaches to restoring these taxa. With support from the U.S. Army Environmental Center, Aberdeen Proving Ground, CRC is overseeing activities of the FW SAV Partnership, which is currently comprised of 21 Federal and State agencies, academic institutions, and other non-governmental organizations.

In its two years of existence, the FW SAV Partnership has demonstrated through multiple collaborative projects that the benefits of forming or joining a partnership can be productive, and the results, positive. These projects include a multi-partner effort that authored, *A Handbook for Submerged Aquatic Vegetation Restoration, Monitoring, and Support*, for Department of Defense installations in the Chesapeake Bay Basin, as well as several newly initiated multi-partner collaborations for SAV restoration and outreach/education projects. In addition, the Partnership website (http://www.chesapeake.org/SAV/about_the_partnership.html) has become a valuable tool for partner organizations and other interested parties by providing rapid distribution of relevant FW SAV information, such as online and printed reference materials, funding opportunities, current and past restoration project summaries, conference and workshop announcements, and contact information for area SAV experts and supply vendors. In these ways, the Partnership continues to act as a visible advocate for and facilitator of freshwater aquatic vegetation restoration and the important role that it plays in reaching the Bay-wide goal of restoring 185,000 acres of Bay grasses by the year 2010.

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If You Build It, Will They Come? - Use of Paradigms in Justifying Restoration Projects

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Many habitat restoration projects are planned, justified, and implemented in the absence of quantitative data that demonstrates the feasibility and presumed biological benefit to the ecosystem. Often funding mechanisms do not provide for pre-project investigation to guide planning, determine feasibility, and predict the outcome of restoration. Consequently, many projects rely on existing paradigms of ecosystem function for justification. These paradigms are often well supported by the literature and results from past studies, but they cannot substitute for both site-specific pre- and post-restoration monitoring necessary to gage project success. A difficulty arises when post-restoration monitoring may quantitatively measure success at the project scale, but does not prove success at the ecosystem scale. This may have important socio-economic implications for future restoration activities depending on how success is measured.

Since habitat loss is one reason for the decline of many stocks of anadromous salmon in the Columbia River Basin, the U.S. Army Corps of Engineers (USACE) and the Bonneville Power Administration have been tasked with protecting and enhancing at least 10,000 acres in the lower Columbia River estuary by 2010. In response, the USACE is restoring 203 acres of tidal marsh habitat on Crims Island, near the Columbia River estuary, to benefit ESA-listed juvenile salmon and Columbian white-tailed deer. The guiding paradigm for this project is that if functioning, tidal marsh habitat is added to the Columbia River, then juvenile salmon will respond by using that habitat and benefiting from it. We have collected two years of pre-restoration monitoring data to measure the current biological status in both a marsh reference site and a degraded drainage ditch in the proposed restoration area. To date, the use of both habitats by juvenile salmon and consumption of food items common to both habitats support the notion that fish will use restored habitats.

At the project level, success of the Crims Island restoration will be measured in terms of relative abundance of juvenile salmon in the restored habitat compared to the reference site and the degraded habitat before restoration. Similarities in diet, growth, fish residence time, and detrital export between reference and restored habitats will serve as additional measures that would support the paradigm that functional processes can be restored at the local habitat level. However, an ecosystem response such as an increase in Chinook salmon production and survival to adulthood is not likely to be quantified, and may only be accomplished through more comprehensive life-cycle and ecosystem monitoring. The USACE is currently developing standardized monitoring protocols to ensure that more comprehensive analyses of the cumulative effects of restoration efforts in the Columbia River estuary can be conducted at the ecosystem scale.

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Permanent Habitat Changes on Cape Sable, Everglades National Park

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Historically, the interior region of Cape Sable, Florida was a freshwater, marl prairie marsh. It provided habitat for the endangered Cape Sable Seaside Sparrow (*Ammodramus maritimus mirabilis*). Since the late 1920s, the area immediately to the north and east of Lake Ingraham on Cape Sable has converted from marsh habitat to open water. The total area of marsh loss is estimated to be from 25-40,000 hectares. Habitat loss such as this has been directly linked to the decline of the Cape Sable Seaside Sparrow. Hypotheses suggested for this change include the following: subsidence, catastrophic storm events, salt water intrusion from canal construction or a combination of these factors.

We determined open water and marsh habitat in 1928 and in 1999 (based on topographic sheets and on USGS Digital Ortho-photo Quarter Quadrangles (DOQQs)). From this, we mapped areas of conversion from marsh to open water and identified specific areas having large or small degrees of habitat change. We then related these areas (and the degree of change) to the sedimentary stratigraphy reported from cores taken in the study area, to test the possible hypotheses.

Our findings indicate little correlation between the recent sedimentary records of Cape Sable with areas of conversion from marsh to water. Regardless of cause, it is almost certain that the habitat conversion is permanent and that a large tract has been lost to the endangered Cape Sable Seaside Sparrow. In this initial work we did not determine rates of habitat change. Resource managers need to know if this habitat conversion is continuing, and if so, at what rate. Our future work will use historic and recent aerial photos to address this question. Additionally we will address alternate hypotheses concerning causal mechanisms including erosion and compaction of sediment.

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Extinction, Recolonization, and Metacommunity Structure in Everglades Wetlands: Spatial Dynamics of Aquatic Communities Driven by Recurrent Disturbance

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Management of hydrology in the Everglades has a pervasive effect on its aquatic communities that is mediated by their ability to survive marsh drying and re-populate afterwards. For several years we have been studying the spatial dynamics of fish community structure as a function of hydrology in an effort to develop a predictive understanding of their relationship. Dispersal into and out of aquatic refuges is a key component of this effort, but the most common fishes of the Everglades are too small to mark and track individually. We have used a combination of analysis of population dynamics and population genetic structure to infer population structure for these small-fish species. Analyses of synchrony of population dynamics and ephemeral population genetic structure indicate a source-sink population structure model to best describe most of these species. Further, population genetic analysis indicates that the pattern of exchange between long and short hydroperiod habitats varies among species and is a predictable function of their life-history patterns. Collectively, these results help us to better parameterize spatially structured simulation models of community dynamics in the Everglades, with the potential to improve our ability to assess the merits of alternative management scenarios.

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Moving from Retrospective to Prospective Monitoring: The Critical Role of Model Development in Designing Efficient Monitoring

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Distinguishing between retrospective and prospective monitoring is useful in planning a long-term monitoring program. Retrospective monitoring is descriptive and reactionary, gathering data correlated to stressors affected by management, but without a clear cause-and-effect linkage. In contrast, prospective monitoring targets leading indicators known to be predictive of ecosystem change through a sequence of causality. By necessity, monitoring programs tend to be retrospective, or effects-oriented, at the outset of an ecoregional management initiative. This starting point is necessary because cause-and-effect relationships in ecosystems are often poorly known and historical ecological data are either scarce or unusable for management. Ideally, investment in effects-based monitoring over time yields a payoff in lower cost, provided that a transition toward the sampling of fewer and prospective indicators can be made. Shifting to prospective monitoring not only requires the development of robust data on cause-and-effect, but also requires research leading to models that elucidate linkages between physical and biotic components of the ecosystem. Unfortunately, there appear to be few cases where the transition from retrospective to prospective monitoring has been accomplished. Moreover, it appears unlikely that this sort of transition can be achieved completely in many instances. It may be best to envision monitoring programs that strive toward the efficiency and lower cost of prospective monitoring of causal factors, but retain elements of effects-based monitoring to validate models, test assumptions, and support research that is critical for science-based monitoring programs. This type of "balanced" approach to monitoring programs is more likely to ensure the continued interest and involvement of scientists in ecoregional monitoring programs and limit "surprises" emerging from management actions. In this presentation, we will discuss the challenges to making the transition from retrospective to prospective monitoring and review an example from our work monitoring restoration of the Florida Everglades.

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Planning for Ecosystem Restoration: Science Integration for the South Bay Salt Pond Restoration Project

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In March of 2003, state and federal agencies acquired over 16,000 acres of solar evaporation ponds in South San Francisco Bay. This acquisition clears the way for the largest wetland restoration effort on the West Coast of North America, the South Bay Salt Pond Restoration Project. The general objectives of this large-scale, complex ecosystem project are to restore and manage diverse habitats for fish and wildlife species, especially those that are endangered and threatened, while providing opportunities for wildlife-oriented recreation and assuring flood protection. The Project is in the second year of a five-year planning process that will result in initial implementation in 2008.

Integrating the best science into all restoration phases is a central feature of the Project and the Project Management Team (PMT) has developed an organizational structure for achieving this goal. However, this project presents significant challenges for adequate science integration due to the complexity of the endeavor and the extremely fast timeline set for planning and implementation. A Science Team, comprised of local ecologists and restoration experts, is developing a science plan, founded on ecosystem-based management and adaptive management principles, to guide science integration during all Project phases. The scientific foundation developed by the plan will help Project participants resolve conflicts between objectives, develop feasible restoration/management targets and performance measures, and guide monitoring and research to help reduce scientific uncertainty. The science plan is based on 10 key scientific issues, directly tied to the Project Objectives and conceptual models. Analysis of these key issues lays out what we know, what we don't know, and what we need to know to achieve the Project Objectives. The key issues are evaluated at multiple spatial scales, from landscape to pond level, and over a 50-year restoration time horizon. They also lay the groundwork for developing and implementing an adaptive management/assessment plan.

Science strategies for other large ecosystem restoration efforts, especially the Greater Everglades Ecosystem Restoration and CALFED Bay-Delta Ecosystem Restoration Program, provide models for integrating science into ecosystem restoration planning. This talk describes the science structure of the South Bay Salt Pond Restoration Project, the elements of the science plan being developed for the Project, and lessons learned from other ecosystem restoration work.

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Biological Quality of Stream Water in Response to Land Use Practices

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Biological contamination of surface water by agricultural effluent and runoff has become a problem because of its associated health and environmental impacts. Field and lab-based studies were conducted to evaluate the effects of land use practices on biological contamination of stream water in the Wheeler Lake Watershed basin in Alabama. Biological oxygen demand, dissolved oxygen, number of fecal coliform bacteria, and ratios of number of fecal coliform bacteria over concentration of dissolved oxygen, total nitrogen, total and soluble phosphorus of stream water were analyzed or calculated, and the values were integrated into a simple index to evaluate biological quality of water. A biological index of water quality (WQB_{index}) was calculated by normalization and summing the measured and calculated biological properties of various stream water. Datum of each individual water parameter (W_x) measured or calculated was normalized (W_i) relative to the maximum value (W_{max}) of that water quality parameter in the data set, $W_i = (W_x W_{max}^{-1})$ except dissolved oxygen concentration. An inverse relationship based on lower values of dissolved oxygen are better indicators of water quality was used, $W_i = [1- (W_x W_{max}^{-1})]$. Summing all the Wi's and then dividing with the total number of Wi's calculated the $WQB_{index} = \Sigma(W_x W_{max}^{-1}) n^{-1}$. The WQB_{index} could range from > 0 to 1 with 1 being extremely poor quality water and 0 having excellent quality stream water. Results show that season, location, land use practices, county, and streams have significant main and interactive effects on biological quality of stream water in Wheeler Lake Watershed basin.

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Assessment of American Crocodile Populations of Southern Florida: Trends in Population and Reproduction Rates

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The American crocodile is a primarily coastal crocodilian that occurs in parts of Mexico, Central and South America, the Caribbean, and, at the northern end of its range in southern Florida. The current distribution of the American crocodile in Florida is limited to extreme southern Florida, including coastal areas of Miami-Dade, Monroe, Collier, and Lee counties.

The primary factor endangering the Florida populations of the American crocodile has been loss of nesting habitat due to human development. Nesting populations were restricted to portions of the shoreline of northeastern Florida Bay in 1975, including one population on the northwestern shore within Everglades National Park and one on the southeastern shore in northern Key Largo. At that time, crocodiles were declared federally endangered. In 1978 a third nesting colony was discovered in the cooling water canal system at the Florida Power and Light Company's (FPL) Turkey Point Generating Station. It appears likely this population colonized the site after development of the cooling canal system, utilizing the artificial substrates of the canal berms as nesting substrate. There are three primary nesting areas in southern Florida, in Everglades National Park (ENP), Turkey Point, and Key Largo. These populations are monitored, and nesting habitat managed to minimize disturbance of nesting areas, by the National Park Service, FPL, and the US Fish and Wildlife Service, respectively.

From 1978 to 1982, more than 60% of Florida's crocodile nests were in ENP. During the past 5 years, however, less than half the nests were in ENP as nesting effort and success has increased dramatically at Turkey Point. The number of successful nests has increased significantly since 1978. The rate of increase has averaged 1 additional successful nest per year from 1978 to 1999. Approximately 70% of the increase in successful nests has occurred at the Turkey Point nesting area.

The number of hatchlings also increased significantly over the period from 1978 to 1999, with an additional 12 hatchlings per year. The number of surviving hatchlings (after 1 year) has also increased significantly in the southern Florida population and at the Turkey Point nesting area. All of the increases in hatchlings and surviving hatchlings have occurred at the Turkey Point nesting area.

In summary, populations of the American crocodile are recovering in southern Florida since 1978. The increases in population are primarily due to the utilization of artificial nesting substrates in the cooling canal system at the Turkey Point Generating Station. This nesting area is responsible for virtually the entire increase in the population over the 22 year evaluation period (1978 to 1999).

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Green River - Reversing Three Decades of Ecological and Hydrological Impacts, Green River, Kentucky

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Known locally as the Handy Riparian Habitat Restoration Project, this was the first cost shared environmental restoration project between the Army Corps of Engineers and The Nature Conservancy in the country. The project is located along the right descending bank of Green River at its confluence with Russell Creek in Green County, Kentucky.

At their confluence, Green River and Russell Creek have watersheds of 743 and 289 square miles, respectively. The uncontrolled watershed of Green River was reduced to 61 square miles with impoundment of a Corps flood control reservoir, i.e., Green River Lake. Russell Creek became the dominant stream much of the year as its watershed is not controlled by any reservoir. For 33 years Russell Creek directly impacted the project site, eroding soils and removing riparian or bottomland hardwoods while increasing sediment load and degrading aquatic habitat downstream.

Green River Lake eliminated out-of-bank flooding in the project area. Prior to impoundment, the project area experienced out-of-bank flooding with each 5-year storm event. Post impoundment out-of-bank flooding occurs only with a 100-year event. In thirty plus years existence of Green River Lake there has been no flooding of the bottomlands. This lack of flooding severely restricted natural recruitment and reforestation as floods are the primary method of seed dispersal for many native trees.

The riverbank was stabilized using a combination of grading, plantings, rock protection and bendway weirs. These weirs were designed to intercept flow from Russell Creek and redirect the combined flows toward the middle of river away from the eroding bank. Graded areas were planted with native grasses, shrubs, and trees. Seventy-five additional acres were planted with native hardwoods. Tree species used are representative of those found in stands of riparian or bottomland hardwoods on the remaining 68 forested acres of the project site, all of which are protected by conservation easement.

Excess soils were used to create a small dike. This dike enhanced a small existing wetland through increased retention of surface runoff thereby benefiting amphibians and their predators. Soil moisture and some open water is retained through the summer enhancing habitat conditions for the existing wetland plant community and the insect fauna associated with this wetland.

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Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) Program

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Louisiana is experiencing the most critical coastal wetland erosion and land loss problem in the United States. There are many causes for this loss, but reductions in freshwater and sediment inputs have been identified as key factors. In response to this accelerated wetland loss, the Louisiana Coastal Area (LCA) study provides a significant opportunity to address the nationally significant coastal land loss and related problems of Louisiana and the central Gulf Coast. State and national support of a comprehensive restoration plan depends on defensible science that can forecast the ecological benefits that accrue over a 50 yr project time period and demonstrate the ability of various restoration measures to sustain the coastal landscape.

The LCA Comprehensive Ecosystem Restoration Plan will establish a framework for solution of the Louisiana coastal problems and opportunities for wetland rehabilitation. In support of this plan, preliminary conceptual ecological models were developed which generated clear statements of problems, needs, and opportunity. The initial step of this conceptual model was to define disturbances, sources of ecosystem stress, and development of desired ecosystem response. These assumptions were based on clear causal linkages between disturbances, ecological effects, and desired ecological endpoints or restoration responses. These responses require an understanding of present ecosystem state, desired endpoints, and necessary site conditions to obtain specific endpoints. Initial work on this conceptual model accomplished a description of these objectives, targets, and desired endpoints; the results of this effort are described in each of the five modules used to simulate system response.

As this project developed, tools were used to connect ecosystem needs and opportunity with engineering design. These tools included a combination of hydrodynamic and ecological modeling that predicted the endpoints of salinity, hydroperiod, and in some cases, sediment distribution. From these geophysical footprints, ecological conceptual models were used to estimate ecosystem response. This work provides a tool by which alternatives of engineering design may be linked to ecological response in order to reduce scientific uncertainty of the chosen coastwide restoration plan. The development of this framework supports a strong adaptive management format as part of the comprehensive restoration plan, so that these hypotheses and assumptions will be continuously evaluated to incrementally reduce uncertainty. In addition, there is a need to establish links between these modeling tools to assist state and federal agencies in developing an integrated Adaptive Environmental Assessment and Management Program.

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Confronting Social Impediments to Adaptive Management, Lessons from the Grand Canyon Ecosystem

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The construction of large-scale water management projects and the introduction of exotic fish have resulted in substantial changes to the riverine environment of Grand Canyon. Since Glen Canyon Dam's (GCD) construction in the 1960's social values have evolved to seek additional project purposes for dam management. The Adaptive Management Program (AMP) for GCD was created in 1996 by the Department of Interior in recognition of emergent social desires to extend multiple-use values to management of this reach of the Colorado River. The AMP is to advise the Interior Secretary on how to mitigate downstream dam impacts that compromise the integrity of Grand Canyon National Park and, pursuant to the Grand Canyon Protection Act of 1992, how to enhance the values for which the Park was established. The AMP, itself is evidence of a shifting paradigm in water resource management. The new paradigm reshuffles the management process, creating a social dichotomy and transferring substantial economic rents to non-traditional stakeholders (environmental non-profits, recreation and Native Nations) at the expense of traditional stakeholders (water and power). Identified are two negative aspects this dichotomy adds to AMP decision-making. (i) Stakeholders are over reliant upon biological, technological, and engineering methods of science so as to avoid addressing sociological value of the program, even though social choices will be needed to fulfill the intent of enabling legislation and regulation. (ii) Since current operations at GCD still degrade valuable biological, physical and cultural resources, this dichotomy not only reduces management flexibility but also, threatens the ability to retain or restore ecosystem resilience.

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Is This Really Adaptive Management? A Comparative Review of "Adaptive Management" Programs across the USA and Canada

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Since the beginning of its' conceptual development in the 1970's, a number of natural resource agencies, across a range of spatial scales, have implemented various forms of "adaptive management". Originally designed as a rigorous means for testing hypotheses about ecosystem scale dynamics (Holling 1978), today adaptive management takes on larger than life dimensions, promising anything to anyone, similar to other nouveau concepts like sustainability, ecosystem management or ecological restoration. At best adaptive management offers the most democratic alternative to managers confronting the impasse of uncertainty in renewing resilience to degraded ecosystems (Lee 1992). At worst it is applied as a buzzword, lending credibility or a perception of change, to programs that are otherwise designed to benefit extant power relationships by maintaining the status quo (Lee 1999).

Our purpose is to comparatively review natural resource management or ecosystem restoration programs across the USA and Canada that purport to practice "adaptive management". Our work provides a comparative framework for evaluating specific programs using a matrix based on criteria regarded as representing 'successful' implementation of adaptive management. We developed the matrix through reviewing case studies and literature on adaptive management. Ultimately, we focus on five metrics, we believe are most helpful in reviewing natural resource programs that employ adaptive management. (i) Have participants agreed on a set of questions that should be answered? (ii) Are these programs winnowing uncertainty through advances in scientific knowledge? (iii) Are political barriers to change being crossed? (iv) Are the institutions that are being used in adaptive management applying lessons learned? And (v) have management actions produced ecological responses that suggest the ecosystem is moving in a direction that meets the goals of the program? Results are mixed. Our work has found only a small number of programs that passed our litmus test for the first four metrics but there are many more programs that stumble along without clear direction. For our last metric we found virtually no programs that achieved the criteria we call the bottom line. Although many of these programs are in their infancy we find it discouraging there has been so little success in meeting the goals of achieving a more desirable ecological condition. We discuss several likely reasons for this poor rate of accomplishment.

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The Spatial Distribution and Relative Abundance of Larval Dragonflies (Anisoptera) Found in the Freshwater Marshes of the Florida Everglades

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Aquatic macroinvertebrates are often used as indicators of habitat quality. Dragonflies (Order Odonata, suborder Anisoptera) could make good candidates for assessing changes in water quality because the winged adults can disperse long distances and evaluate large areas when making oviposition decisions. Currently, little is known about the spatial distribution and relative abundance of dragonflies found in the Everglades and we present the first comprehensive spatial survey for southern Everglades marshes. In 2003, we sampled 22 sites scattered across three water management units: Water Conservation Area 3 (WCA3), Shark River Slough (SRS) and Taylor Slough (TS). Using a 1-m^2 throw-trap we collected a total of 25-105 samples from each site (depending on water levels), incorporating wet and dry season dynamics (>1600 total samples). We collected and identified 3,911 dragonfly naiads, consisting of twelve species (five families). Here we describe the distributions and abundance of these species based on their spatial extent (# of sites at which they were collected) and density (annual average # individuals/m^2). We have categorized the density patterns at sites and across water management units, based on a log scale, as rare (<0.01), occasional (0.01-0.1), common (0.1-1) and very common (>1).

Three species, *Idiataphe cubensis*, *Nasiaeschna pentacantha*, and *Anax junius*, were extremely rare in our samples, being represented by a total of only 1-3 individuals. *Erythemis simplicicollis*, *Celithemis eponina*, and *Libellula needhami*, were extremely widespread, being found at 18, 21, and 22 of our sites respectively. Three other species, *Brachymesia gravida*, *Coryphaeschna ingens* and *Arigomphus pallidus*, though less widespread, were collected from all three water-management units. The remaining three species had ranges restricted to a single water-management unit. *Pachydiplax longipennis* and *Epitheca stella* were only found in WCA3, while *Aphylla williamsoni* was found only in SRS.

C. eponina was the most frequently encountered dragonfly (common or very common at all sites except one) and was the numerically dominant species at 20 of 22 sites, ranging from 44%-88% of all collected specimens. The two sites where *C. eponina* did not dominate the assemblage were both high productivity sites with high stem densities. At one of the sites, in southern SRS, *C. eponina* was less abundant than *L. needhami* and *B. gravida*, two otherwise common species. At the other site, in northwest WCA3, *C. eponina* was completely absent and the site was dominated by *P. longipennis* and *E. simplicicollis* (very common and common at that site), species that were abnormally dense at that location (at least 10X and 3.6X greater than their respective densities at any other sites).

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Effects of Estuary Fragmentation and Restoration on Fish Assemblage Characteristics and Secondary Production on Andros Island, the Bahamas

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Estuarine systems, semi-enclosed water bodies where fresh and marine waters mix, are important nursery and feeding areas for many fishes. Disruption of hydrologic connectivity between estuaries and the ocean can have substantial effects on the structure and ecological function of estuarine communities. In the Bahamas, many estuaries have been fragmented by road construction, disrupting tidal flooding and species movements into upstream areas. On Andros Island, local community-based efforts are in progress to restore hydrologic connectivity (i.e. tidal flow) in these systems by installing culverts or removing obstructions, with the ultimate goal of restoring fragmented creeks to a functional level comparable to reference (unaltered) estuaries in the area. Over the past four years we have characterized fish assemblages in unaltered, fragmented, and restored estuaries on Andros Island using underwater visual census techniques. We have observed statistically significant differences in fish assemblage characteristics between fragmented and unaltered estuaries. Fragmented estuaries, those with reduced hydrologic connectivity, are characterized by a decrease in fish species richness, a decline in the occurrence of economically important fish species (e.g. grouper), and a decrease in reef-associated fish species. In restored estuaries, fish assemblage characteristics (e.g., species richness) often are intermediate between fragmented and unaltered estuaries. In general, fragmentation shifts the fish assemblage from one heavily influenced by juveniles of reef-associated species to one dominated by species tolerant of high salinity and temperature (e.g. sheepshead minnow), whereas restoration of hydrologic connectivity increases fish species richness primarily through the renewed influx of reef-associated species. Our preliminary data suggests estuary fragmentation also reduces secondary production and ultimately the export of juvenile reef-associated fishes (e.g. Nassau grouper) to off-shore reefs. Ongoing work will track changes in secondary production as restored estuaries move along the restoration trajectory.

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Creation and Restoration of Tree Islands in The Everglades

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Because they are essential for the survival of a high percentage of the plant and animal species found in The Everglades, tree islands are an indispensable feature of The Everglades. Tree islands develop as a result of physical and ecological processes in large peatlands with directional water flow. The highest part of a tree island, to which the trees are largely confined, is called the head, and the rest of the island that develops downstream from the head is called the tail. In the central and southern Everglades, the heads of many fixed tree islands are associated with local topographic highs in the limestone bedrock. In The Everglades, about 60% of fixed tree islands have been lost since the 1950s in Water Conservation Area (WCA) 3 and over 85% in WCA-2A. This loss is a direct or indirect result of human manipulation of the hydrology of these areas. The restoration of The Everglades can not be accomplished without significant efforts to restore or create tree islands.

Assuming that suitable hydrological conditions are re-established, the two major impediments to restoring tree islands are inadequate head elevations due to fire or oxidation of peat and absence of nearby sources of tree seed. Depending on the condition and location of damaged islands, one of four different restoration scenarios would be appropriate: natural recovery (no intercession; head elevations adequate and seed sources nearby), assisted recovery (establish tree species; elevation suitable, but no nearby seed sources), limited restoration (raising the elevation of part of the head; elevation inadequate), and full restoration (raising the elevation of the entire head). In order to reduce transportation costs and potential environmental impacts, materials (peat, limestone) needed to raise head elevations should be obtained on or adjacent to tree islands being restored. Tree island creation, establishing a tree island in an area previously devoid of tree islands, is also feasible in a few areas, especially in conjunction with levee removal projects.

There have been very few attempts to restore or create tree islands. Consequently, essential information needed to design and implement a tree island restoration/creation program is not available. To obtain this information, a tree island creation project was made part of the Loxahatchee Impoundment Landscape Assessment (LILA) project. As part of LILA, 8 fixed tree islands were constructed, 4 with and 4 without a limestone core. The LILA tree island studies are designed to determine (1) how much a limestone core affects the development of tree islands; (2) why and how the tails of tree islands develop; and (3). the flooding tolerances of the major woody species found on tree islands.

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Recharging the Edwards - Cibolo Creek, Texas, Watershed Study

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The Cibolo Creek Watershed study is multi-objective study with emphasis on restoration of degraded ecosystems, flood damage reduction/attenuation, aquifer recharge, and watershed management through various best-management practices (BMPs).

The Cibolo Creek watershed is located on the outskirts of the city of San Antonio, Texas. The city is solely dependent on groundwater (the Edwards Aquifer) for its water supply. The Edwards aquifer is one of the most productive carbonate aquifers in the country. In addition to providing public water supply for over a million people in south-central Texas, the Edwards aquifer supplies large quantities of water for agriculture, industry, military installations, and recreational activities. The aquifer is also a source of water to major springs in the region. These springs supply flow to downstream users and provide habitat for several threatened and endangered species such as the Texas Blind Salamander, Texas Wild Rice, San Marcos Gambusia, Comal Springs Riffle Beetle, Comal Springs Dryopid Beetle, and Peck's Cave Amphipod.

Urbanization has increased water demand from the Edwards aquifer thus severely jeopardizing ecosystems dependent upon the spring flows from the Edwards aquifer. Other land use changes have altered the recharge and catchment area characteristics. Urban development can have an appreciable influence on the quality of surface water and water that recharges the aquifer. Increasing impervious land cover in rapidly developing areas can result in increased storm water runoff conveying contaminants from nonpoint sources to streams.

Using a watershed approach, this study seeks to investigate the effects/benefits of measures that increase recharge into the Edwards aquifer as a means to mitigating water demands from human activities. Measures include strategically located structures to retain stream flows over recharge zone and BMPs such as prescribed burning, installation of filter strips, brush control, grazing, range seeding, irrigation water management that will protect surface- and groundwater quality and quantity.

The two models used for analysis of effectiveness of measures considered are the Hydrological Simulation Program-FORTRAN (HSPF) and Ecological Dynamic Simulation (EDYS). These models will be used to model the effectiveness of BMPs and recharge structures relative to restoration of terrestrial and aquatic ecosystems, flood damage reduction and water supply. Partners with the Corps in this modeling effort include the U.S. Geological Survey, the Natural Resources Conservation Service and the local sponsors.

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From Design to Maintenance: Case Studies in Adaptive Management for Restoration Success

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Sarasota County Government's largest and most successful restoration projects have used an adaptive management approach to restore wetlands and other native habitats. Project management by restoration biologists, careful design, monitoring, and contingency planning provided the basis for meeting multiple objectives and implementing mid-project modifications. Two unique restoration projects are presented as examples of adaptive approaches to ecosystem restoration efforts with very different objectives and circumstances. The Deer Prairie Slough Restoration Project (DPSRP) restored over 3,200 acres of a freshwater slough. The DPSRP and associated watershed lie in a rural setting with major public holdings and a few large-parcel landowners. In contrast, the Lemon Bay Ecosystem Restoration Project (LBERP) restored a 50-acre estuarine wetland system. The LBERP had an additional level of complexity because of its proximity to a medium density residential area and combination with a stormwater drainage project.

The DPSRP design focused on utilization of on-site, natural materials to fill over 8 miles of historic drainage ditches, to restore a natural hydroperiod and reduce exotic plant coverage. Emphasis was placed on seed bank recruitment and transplant material for erosion control and revegetation. The magnitude of the project required flexibility in contracting mechanisms, phasing earthwork for suitable weather, and ongoing monitoring of results. Other important factors contributing to the success of the project included field-locating for final grades, retaining natural features and seed source, on-site water management, and re-engineering based on monitoring data. A final phase utilizing experienced, in-house operators allowed for the greatest flexibility and field adjustments to design features.

Our primary goals for the LBERP were to alleviate flooding upstream and restore a wetland system that had been impacted by the diversion of freshwater flows. Stormwater modeling was conducted to find design solutions to these often contradictory goals. Many of the field adaptations for this project were similar to those employed in the DPSRP. Further, project design required environmental scientists and stormwater engineers to address stormwater flooding, threatened and endangered species, water quality and multiple stakeholder interests. The complexity of the project required a contractor qualified in drainage conveyance and wetland restoration with the flexibility to work within the adaptive management context. Hydrological and biological monitoring data were used to assist with design modifications for subsequent phases.

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National Ecosystem Center of Expertise (ECO-CX)

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In August 2003, the Corp's Director of Civil Works directed the establishment of national centers to conduct larger, complex planning studies for inland navigation, deep-draft navigation, ecosystem restoration, water supply, and flood damage reduction. The national centers are part of a national initiative to improve the quality and effectiveness of the planning process for water resources projects called the Planning Excellence Program (PEP). The PEP includes training and work force capability improvement, enhanced quality assurance and control efforts, process improvement and regional and national planning centers. The Mississippi Valley Division was assigned the ECO-CX.

The ECO-CX is to support the Corps ecosystem restoration needs at both the national and international levels. Basically, the ECO-CX will serve as a clearinghouse for ecosystem restoration needs, interacting with project delivery teams and matching-up needs with resources. The ECO-CX will improve quality and timeliness of ecosystem restoration studies by providing services that supplement the needs of customers. The purpose is to develop, maintain and apply the best and most appropriate national and regional expertise and science and engineering technology to the planning of ecosystem restoration projects.

The Center will have the following roles and responsibilities, subject to change based on experience, direction and guidance through the PEP: provide environmental and ecosystem restoration planning consulting services at the request of a project delivery team; conduct key environmental analytical components of ecosystem restoration planning studies as requested by customers; provide independent policy and technical review support as requested, to supplement the capabilities of any project delivery team; provide advice to HQUSACE, the laboratories and other stakeholders on significant regional and nation-wide planning and ecosystem restoration issues; assist in establishing research and development priorities in ecosystem restoration planning; coordinate and have oversight of the certification, validation and peer review of planning models for ecosystem restoration; coordinate development of training related to ecosystem restoration planning; develop and manage a program of 'lessons learned' through coordination with the MSC planning expertise centers, sponsoring workshops, technology transfer, and web based support; supplement the HQUSACE staff in policy compliance review for ecosystem restoration planning on projects as requested; enhance basic planning expertise throughout the Corps by providing or creating developmental opportunities for individuals having specialized planning expertise in ecosystem restoration planning.

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A Multi-Criteria, GIS Tool for Evaluation of Impacts to Fish and Wildlife When Planning Large Ecosystem Restoration Projects

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A primary tenet of large-scale restoration projects is to do no harm to existing natural habitats during the restoration of degraded habitats. However, current restoration projects often require the use of large constructed features to alleviate societal demands on water quantity and impacts to water quality. Resource agencies are often challenged with making recommendations for siting large water storage reservoirs and treatment wetlands for water quality improvements as part of ecosystem restoration projects. Because there is a limited amount of land available for siting these large features, several factors must be considered when attempting to minimize impact to fish and wildlife habitat. We developed a multi-criteria, GIS tool to help select sites for the C-43 Reservoir component of the Comprehensive Everglades Restoration Project. The tool integrates values for threatened and endangered species, general fish and wildlife habitat value and biodiversity, and presence of rare and endangered habitat. The tool can assist resource agencies in making consistent, repeatable, and comparable recommendations when selecting alternative sites with the lowest ecological value.

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Bird Island Field Pipeline Removal – Kleberg County, Texas

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Between 1954 and 1990, Fina Oil and Chemical Company (Fina) or its predecessor acquired various permits from both the U.S. Army Corps of Engineers (USACE) and the Texas General Land Office (TxGLO) to install and maintain certain well production platforms and associated production pipelines in the Bird Island Field, located in Kleberg County in the Laguna Madre near Corpus Christi, Texas. The area represents a sensitive seagrass habitat.

TOTAL E&P USA, Inc. (TOTAL) acquired these assets from Fina in 2000 and thereafter assumed management of the production system and responsibility for its maintenance. In 2001 TOTAL concluded that production from the field was no longer commercial and ceased operations. The wells were plugged and abandoned and the well guard structures were removed by November 2001. The pipelines were temporarily capped.

The USACE and the TxGLO (which manages the submerged lands of the State) indicated in 2002 they wanted the pipelines to be removed as required by the original permits. They recognized that a certain amount of damage to the seagrass vegetation would be unavoidable during removal operations; however, they directed this damage should be limited to pre-defined work corridors.

The TxGLO further required that the bay bottom be returned to “pre-project” elevations, in order to create favorable conditions in which the seagrass could recover naturally. Satisfying this requirement meant backfilling trenches that had been formed in the past by pipeline burial jetting operations.

To this effect, specific pipeline removal techniques, trench backfilling methods, and work procedures were developed by TOTAL E&P USA Inc., their consulting firm Shiner Moseley and Associates, Inc., and the selected contractors. Removal operations began in April 2004 and backfilling operations were successfully completed in July 2004.

By virtue of the field being located in an environmentally sensitive area, the project provided challenges in developing best practices for pipeline removal, trench backfilling, and environmental monitoring. This presentation considers some key issues associated with removing the “foot print” left by with oil and gas production operations after the end of economic project life and TOTAL’s commitment to sustainable development.

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A Conceptual Model to Predict Coastal Wetland Vegetation Composition and Production under Different Management Scenarios

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In order to evaluate coastal restoration options, a conceptual model of the controlling physical factors and the function of the resulting system structure is necessary. Here, we report a method to derive a conceptual model for habitat type and primary production and the resulting model. This model is a component of a larger model that provides inputs on the area of wetland with varying salinity and water levels.

Our habitat switching algorithm is based on currently available but limited data combined with expert opinions on salinity and flood tolerance of the dominant vegetation in each habitat. Uncertainty analysis was performed to determine the effect of variations in salinity threshold. This analysis showed that up to 10% variations in threshold levels did not have noticeable effect, while larger variations (>10%) in threshold levels did change the variation in habitat composition. This indicated that a "10% error in the estimation of the threshold levels of salinity may be acceptable and would not alter the dominant vegetation within the habitat. The effect of uncertainty of salinity input was also evaluated. Due to the use of average annual salinity as an index, there is a possibility that large uncertainties within monthly variations may have been averaged (scaled down) before input yielding relatively minor effect on habitat distribution.

Extensive literature was available on the effect of salinity on the productivity of the dominant species in each habitat type in coastal Louisiana. On the contrary, limited literature on the effect of inundation existed. Earlier studies used measurements of productivity as total biomass, stem/leaf elongation, photosynthesis etc. To combine these different productivity estimates, the measurements were scaled using the maximum productivity estimate in each study. For the algorithm, the relationship of salinity and percentage of maximum productivity was determined by fitting a linear regression with an artificial forcing through 100% production at a certain level of salinity. We assumed that the highest production occurs with normal tidal inundation and is reduced at highest inundations. Because of the restriction in nutrients delivery and removal of toxic compounds, it was further assumed that the production is slightly depressed at very low to no inundation.

The resulting conceptual model was used to evaluate the effect of different management actions on wetland composition and primary production.

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Wetland and Tidal Channel Evolution Affecting Critical Habitats at Cape Sable, Everglades National Park, Florida

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Tidal wetlands and marshes are extremely heterogeneous environments influenced by a range of variables that act across several spatial and temporal scales. The organic/carbonate coastlines of southwest Florida include vulnerable ecosystems that provide valuable information on the nature and dynamics of coastal change in anthropogenically modified systems. In these complicated systems, subtle changes in boundary conditions (creek attributes, sea level) appear to drive large hydrodynamic and morphological changes. The purpose of this research is to 1) document historical patterns and rates of change of the various subenvironments in the Cape Sable area; 2) define the relative roles of day-to-day processes and major storms in geomorphologic and ecosystem evolution; 3) establish principles for system dynamics to be used as a protocol for the evolution of other sensitive channeled mangrove-to-freshwater wetland complexes. This project utilizes aerial photography and high-resolution satellite imagery, and links sedimentologic core data to hydrodynamic measurements (current velocities, discharge and suspended sediment concentrations).

Portions of Cape Sable, a large coastal wetland complex in Everglades National Park, have undergone rapid changes over the past 80 years. Subtle human modifications, such as canals dredged in the 1920s, act in concert with changes driven by recent sea-level rise. Before the 1920s, there was no connection from a large (~ 20 km^2) inland freshwater lake and marshes to the marine environments of Florida Bay and the Gulf of Mexico. Since the opening of the canals, the freshwater lake has transformed into an estuary. Sediments have been deposited in the estuary, filling ~ 25% of its area from 2 meters depth to supratidal levels. The rapid rate of widening of the canals (up to 4 ft/year) and natural creeks reflects a system out of equilibrium in which the channels are still seeking to accommodate the increased tidal prism.

Especially critical is the incursion of marine waters across a bounding marl ridge that used to separate the interior freshwater marsh from the marine environment. With saline water intrusion, large areas of the freshwater marsh have died out. The organic matter has oxidized and disappeared, which has resulted in the collapse of the marsh and conversion to a shallow subtidal water body. With continued relative sea level rise and saline water intrusion, the loss of freshwater marsh and collapse of the wetland into an aquatic environment is extending further into the interior of Cape Sable.

Detailed hydrodynamic studies have been carried out in the summer and winter of 2003-2004. Preliminary results reveal that with each tidal cycle, approximately 200 x 10^3 kg of sediment is redistributed from former interior freshwater wetlands to the marine environments of the estuary. The results illustrate the complicated connectivity of processes and products on low-energy tidal wetlands.

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The Role of Oysters, Oyster Reef-Associated Organisms, and Adaptive Resource Management in Setting Water Quality Targets in the Caloosahatchee Estuary, Florida

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Ecosystem restoration and management seek to repair or improve a suite of desired environmental conditions for a specific ecosystem. Alterations in freshwater inflow, resulting from watershed development and water management practices, have impacted salinity and water quality within southwest Florida estuaries. For example, in the Caloosahatchee estuary, where oyster abundances have declined precipitously from historic values, altered hydrology including unnatural high and low water deliveries to the estuary have been identified as key stressors. To investigate the effects of watershed management on oysters and oyster-reef associated organisms, reproductive patterns, disease incidence of *Perkinsus marinus*, spat recruitment, juvenile growth of oysters, as well as abundance, diversity, biomass, and species richness of associated decapod crustaceans and fishes were investigated.

Comparison of observed salinities and freshwater flows suggests that releases of 1000 CFS decrease salinities by 3.6-6.0 ppt at the locations sampled. Results indicate that oysters in the Caloosahatchee estuary spawn continuously from April-October, a period that coincides with freshwater releases into the estuary. Upstream, sub-tidal locations exhibited good spat recruitment, low disease intensity, and higher juvenile growth rates compared to downstream, intertidal sites. High freshwater flows during summer either flush out oyster larvae and spat from areas with suitable cultch and/or reduce salinities to levels that are unfavorable for spat settlement and survival. Abundance, biomass, as well as diversity of reef-resident organisms increased downstream, and appeared to be unrelated to the density of living oysters present. In addition, measures of biodiversity were higher during the dry season.

We predict that freshwater releases in the range of 500 to 2000 CFS will result in optimum salinities for oysters and oyster reef-resident organisms downstream in the Caloosahatchee estuary. Results further suggest that well-timed freshwater releases into the Caloosahatchee River may lower *P. marinus* infections to non-lethal levels in oysters, thereby increasing survival. Limited freshwater releases during winter coupled with decreased releases in summer should result in suitable conditions for survival and enhancement of oyster reefs in the Caloosahatchee River. These results suggest that the responses of both oysters and oyster-reef organisms can be a useful tool for managing Southwest Florida estuaries. This project illustrates a collaborative approach between resource managers and scientists in regulating water quality conditions that sustain and enhance oyster reefs and reef-resident organisms in the Caloosahatchee estuary.

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The Importance of Flow in Restoring and Maintaining the Ridge-Slough-Tree Island Landscape Pattern in the Florida Everglades

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We proposed that spatially coupled positive and negative feedbacks among vegetation, peat accumulation, and hydrology drive the self-assembly of the slough-ridge-tree island patterning in the Florida Everglades. The Everglades are currently going through a landscape-scale 30-year restoration effort and a detailed understanding of these feedbacks is fundamental to any attempt to predict the ecological effects of proposed hydrological changes. We hypothesized that streamlined islands, ridges, and sloughs are a self-organizing landscape pattern that is largely independent of fluctuations in the elevation of the underlying calcareous substrate, and that (with some critical caveats) may be analogous to certain kinds of patterning seen in extensive boreal peatlands. We are now (1) mapping the current landscape patterning of vegetation of ca. 45 km^2 in the central Everglades; (2) relating vegetational composition and structure to water depth and soil thickness; (3) quantifying flow regimes in representative areas of the wetland complex; (4) developing a predictive model that will allow the specification of a suite of abiotic parameters required to maintain the plant assemblages characteristic of a healthy marsh ecosystem; and (5) using this information, as well as newly available data on topography, to develop a spatially explicit model that can be used to evaluate the effect of changes in various parameters on landscape vegetation patterns. We have found distinctive patterns in the distribution of slough-ridge-tree island communities that support our hypothesis that positive and negative feedbacks help determine the self-assembly of the slough-ridge-tree island assembly.

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Environmental Alterations in Florida Bay in the Past 3000 Years Based on Diatom Assemblages Extracted from Sediment Cores

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Florida Bay has been greatly affected by changes in water quality in the last century due to anthropogenic modification of water flow and nutrient input, resulting in alterations in the distribution and composition of marine organisms including algae, seagrass and invertebrates.

We used diatom assemblages to determine fluctuations in salinity and water quality over the past 3000 yrs in order to determine whether modern changes exceed natural variability in the system. The ecological affinities of Florida Bay diatoms were determined from modern surveys and used to develop inference models to interpret past environments from the flora contained in chronologically calibrated sediment cores from four sites distributed throughout the bay (Trout Cove, Bob Allen Key, Russell Bank and Nine Mile Bank).

Basal material in Bob Allen, Russell Bank and Nine Mile Bank cores were dominated by species that tolerate low salinity, commonly recorded in the Everglades (eg. *Mastogloia smithi*, *Fragilaria synegrotesca*, *Encyonema evergladianum*), indicating that freshwater to slightly brackish conditions proliferated throughout this area ca. 2000-3000 YBP. Younger material (ca. 1500 YBP-present) was dominated by marine taxa (eg. *Diploneis didyma*, *Amphora corpulenta* var. *capitata, Mastogloia discontinua*) which indicate increased influence of marine conditions. Fluctuations in abundance of epiphytic species (eg. *Grammatophora oceanica, Grammatophora macilenta, Cocconeis placentula*) at several depths in the upper portion of the Trout Cove, Bob Allen, Russell Bank and Nine Mile Bank cores reflect fluctuations in the abundance of macrophytes available for colonization by epiphytic taxa. Increased abundance of planktonic species (eg. *Cyclotella litoralis, Cyclotella* cf. *distinguenda*) from ca. AD 1900-present can be related to increased salinity and to planktonic algae blooms which have been related to increased nutrient availability.

The interpretation of the environmental changes in Florida Bay based on diatoms coincide with the inferences made from stable isotopes and chemical analysis of biomarkers, which also show distinct changes in the environmental conditions ca. 2000 YBP, and fluctuations in salinity and nutrients in the middle and upper portion of the cores.

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Threats to Amphibian Populations in South Florida

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Amphibians are widely recognized as useful as indicators of ecosystem health. Aspects of their life history and ecology make them particularly vulnerable to perturbations of natural systems. We have identified three major threats to amphibian species in the protected natural areas of South Florida: introduced species, alteration of the predevelopment hydrologic regime, and recreational off-road vehicle (ORV) use. We will present research on each of these threats and demonstrate how amphibians can be used as indicators of ecosystem restoration success.

Many reptile and amphibian species have been introduced to South Florida and are capable of becoming a major threat to native frog species. For example, the Cuban treefrog (*Osteopilus septentrionalis*) has become established in natural areas within Everglades National Park. Our research on this species involves a project in which Cuban treefrogs and native treefrog populations were monitored using capture-mark-recapture techniques. After 1 year of monitoring, Cuban treefrogs were removed and the recovery of native frogs was monitored. Results from this study indicate that Cuban treefrogs can cause severe reductions in native treefrog abundance and survival in areas where Cuban treefrog abundance is high. Understanding the potential of Cuban treefrogs to impact native species is an important part of using amphibians as indicators of ecosystem restoration success

Alteration of predevelopment hydrologic patterns has been widespread throughout the natural areas of South Florida. We are conducting several lines of research into amphibian ecology in relation to hydrology. The goal of this research program is to better understand how amphibian populations and individuals respond to short term hydrologic changes in order to better predict how they may respond to hydrologic restoration in South Florida. We have begun a radiotelemetry project on the greater siren (*Siren lacertina*) to determine how its movement patterns change as water levels rise and recede in the short-hydroperiod marshes used by this species. We are also using capture-mark-recapture techniques to examine the movement patterns of treefrogs, especially the transition between habitats, in relation to hydrology.

The use of off-road vehicles is a major management concern in Big Cypress National Preserve, but almost no research has been conducted to date on the impacts ORVs may have on vertebrate wildlife. We have completed a landscape-scale analysis of anuran distribution within Big Cypress in relation to an index of ORV use. The results indicate that some species appear to be strongly negatively associated with ORV use, some are strongly positively associated, and many do not appear to be affected by ORV use.

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Addressing Data Needs for Ecosystem Management: Enhancing an Existing Long-Term Water Quality Monitoring Network for the Northern Everglades

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Monitoring is an important component of any restoration or management program. It provides the necessary feedback to determine if desired results are achieved and if unanticipated impacts are occurring. In the Everglades, routine water quality monitoring has been conducted since the 1970s, often for monitoring permit compliance and compliance with a Federal Consent Decree. Although the network of stations set up for permit compliance has utility for assessment of impacts of Everglades restoration, it does not meet all restoration monitoring needs. In particular, permit monitoring is not designed to test causal relationships or hypotheses about water management decisions - information needed to guide restoration. Water quality monitoring at the Arthur R. Marshall Loxahatchee National Wildlife Refuge provides a case study of these observations. Although routine water quality monitoring has occurred since the late 1970s, the monitoring is inadequate for supporting management decisions that must be addressed. The existing monitoring program has focused on inflow and outflow structures, and on the water quality in the interior, the most pristine component of the refuge. The most impacted marsh, that adjacent to the canals and inflows, is the least understood and the most likely area to be positively or negatively impacted by water management decisions.

Historically, the Refuge developed as a rainfall-driven system with surface waters low in nutrients, especially phosphorus, and inorganic ions such as chloride, sodium, and calcium (low conductivity), making it a unique component of the remaining Everglades. The Refuge is surrounded by canals transporting agriculture and urban runoff. As such, there is concern that increases in canal water intrusion into the Refuge interior may cause negative ecological consequences because research demonstrated that changes in major ions may cause undesirable ecological changes in flora and fauna.

In FY04, Congress specifically appropriated funds for a multi-year enhanced water quality monitoring effort and for development of water quality models. This project will address management related questions, including: (1) When does canal water move into the marsh? (2) How far does water from the canal move into the marsh? (3) What water management operations minimize movement of canal water into the interior of the Refuge? (4) What are the ecological effects of canal water on Refuge resources? Combined with historic monitoring, data collected during this project will make public an unusually extensive wetland hydrology and water quality dataset, statistical analyses, and models. In addition to meeting the management related goals of the project, this project can provide a foundation for other independent or collaborative Everglades research.

The opinions expressed herein do not necessarily reflect those of the U.S. Department of Interior.

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Environmental Restoration of Munyon Island

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Munyon Island, located in the Lake Worth Lagoon Estuary in North Palm Beach, Florida has been the site of major restoration efforts since 1992. Historically, Munyon Island was a 15 acre island, which was severely altered due to placement of 30 acres of dredged materials on and around the island's wetlands in the 1930's and 1960's, in association with the construction and maintenance of the Intracoastal Waterway.

Palm Beach County has successfully created 20 acres of mangrove/spartina wetlands and 5 acres of seagrass habitat on Munyon Island between 1992 and 1997. Restoration and enhancement efforts involved removing exotic plants and dredged spoil material; grading down to wetland elevations; excavating tidal channels and ponds; and revegetating with native wetland and upland plant species. Dredged spoil material generated through project construction was removed from the island and placed in a nearby anoxic dredged hole to enhance 9 acres of submerged lands. In addition to the wetland work, restoration efforts on the island included 23 acres of upland restoration involving extensive exotic plant removal, chipping and revegetating with native plant species to restore the existing maritime hammock. The Munyon Island Environmental Restoration Project provides fisheries and wildlife habitat and has rejuvenated Lake Worth Lagoon Estuary by increasing habitat and food supply for estuarine dependent fauna and flora.

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New Ecosystem Modeling Service Suite for Regional Ecosystem Restoration

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The landscape of South Florida is a complex environment that has been subjected for decades to extensive modification that led to alterations of the natural hydrologic flows in the region. Restoration planning is now ongoing that includes attempts to alter water flow so as to enhance the sustainability of the ecosystem. The effects of these altered water flow plans are modeled to analyze alternative detailed management plans and assist in the planning process. Addressing this requires components spanning a wide variety of spatial, temporal and organismal scales, The Across Trophic Level System Simulation (ATLSS[1]), a family of linked models, was developed to assist in planning for restoration. ATLSS is a multiscale ecological multimodel designed to assess the impacts on key biota of alternative water management plans across the Everglades landscape. Models included are spatially explicit, accounting for heterogeneity across the landscape.

A challenge encountered in the ATLSS effort to contribute to the discourse on restoration is the diversity of stakeholders and the various management goals and interests they must address. From a computational perspective, ecosystem modeling for regional ecosystem restoration is a non-trivial task, requiring significant computing facilities with large-scale data storage and management capacity, which most stakeholders have neither access to nor the desire or funding to implement and support. To improve access to ATLSS model results for natural resource managers, a new ecosystem modeling service suite has been developed. This utilizes grid computing technologies[2], network based middleware access control, and visualization resources to remove the impediments for application by stakeholder agencies. This service suite also provides new tools that enhance the ability of stakeholders to carry out assessments based in part upon criteria they choose. The goal of the suite is to assist stakeholder groups in applying both current and future models by: (a) incorporating new data in the models; (b) comparing models to data; (c) contrasting results from different scenarios; (d) incorporating and contrasting results for two different trophic levels (such as wading bird and fish). Specifically, the ecosystem modeling service suite allows natural resource managers in South Florida to remotely launch ecosystem modeling tasks on, and harvest model results from, a high performance computing grid at the University of Tennessee with the use of minimal local resources.

Reference:

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A Coupled Surface- and Ground-Water Model of the Everglades System for Predicting Flows to the Coast under Existing Conditions and CERP Scenarios

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The dynamics of the Everglades hydrologic system in south Florida is driven by a complex set of interrelated physical processes. Water input to the system is a combination of rainfall and discharge from control structures, which has replaced historical upstream overland inflow. On the water's path through the Everglades evapotranspiration is a major sink often removing as much or more water volume than the rainfall adds on an annual basis. The highly permeable subsoil is a unique feature of the Everglades and results in a closer coupling between surface- and ground-water than most other places in the world. Because of this feature, the construction of a canal network in the coastal developed areas has led to detrimental changes in the quantity and timing of water flows in the present-day Everglades.

A major objective of the Comprehensive Everglades Restoration Plan (CERP) is to use historic conditions as a guide to restore flows through the Everglades and to the coast. In order to assess existing and planned future conditions, the USGS has developed a coupled surface- and ground-water model called "TIME" (Tides and Inflows in the Mangroves of the Everglades) for the Everglades based on the Flow and Transport in a Linked Overland/Aquifer Density Dependent System (FTLOADDS) model code. The present TIME model covers a greater area of Everglades National Park (ENP) than an earlier FTLOADDS application for Taylor Slough. A standard data period from 1996 to 2002 is the basis for model testing and calibration. Water level data from approximately 100 locations within the model domain are used for calibration. Observations of flow and salinity in the coastal rivers are also used for calibration and model testing. Upon completion of calibration and testing, the TIME model can be used with boundary conditions representing CERP restoration scenarios to predict the effect of operational changes on flows, water levels, and hydroperiods.

The "TIME" model uses a 500m x 500m square grid with one layer above land surface and 10 layers below land surface. Model topography was derived from USGS survey and NOAA data. Vegetation density and type was obtained from remote sensing efforts (John Jones, USGS, private communication). Rainfall, stage, structure discharge, flow and salinity were compiled from a number of sources including ENP, South Florida Water Management District (SFWMD), and USGS. Evapotranspiration is parameterized in the model based on data obtained at 9 locations in the Everglades by Edward German, (USGS, written communication).

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Surface Water Quality Monitoring in Everglades, Florida

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The poster displays how to set up a surface water quality monitoring system and procedures. It mainly consists of the following sections: standard operating procedures (SOPs) for sampling and chemical analysis; site selection and fundamental construction; power supply and essential equipment required for some water quality parameter *in situ* monitoring; flow measurement, data logger recording, telecommunicating and automatic sampler programming; procedures to collect grab samples and composite samples with flow proportional techniques; marsh area sampling skills, transportation, sample preservation and chemical analysis; quality control and assurance for low level of interested elements, especially phosphorus. It also provides some examples and general information in equipment selection and basic knowledge for surface water quality monitoring, sampling and chemical analysis.

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Forest Structure and Vital Rates of Mangrove Communities in the Everglades: Implications for Restoration

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Theoretical models of forest dynamics require explicit descriptions of vital rates, including recruitment and mortality estimates. The contribution of either of these characteristics can have profound impacts on recovery trajectories, effectively controlling species replacement during successional processes. In forested communities, size structured dynamics can play a pivotal role in determining the fate of individual trees. Recruitment and mortality of trees within a minimum size class is highly dependent on the contribution of larger sized individuals to the forest structure.

Multi-year census data of 11 permanent mangrove plots within Everglades National Park were used to establish relationships between forest structure and sapling vital rates. Mangroves of this region exhibited a decrease in mean stem diameter with increasing stem density. This relationship was reflected in stem size frequency distributions, which were used to describe spatial resource availability. Recruitment of mangroves to the sapling stage diminished with decreasing spatial resource availability, while whole plot mortality increased. Additionally, highly variability in forest turnover estimates diminished as spatial resource availability decreased. This research provides guidance in identifying mangrove forest successional phases, and modeling recovery trajectories.

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Growth Curve Estimates of *A. germinans*, *L. racemosa*, and *R. mangle* in Relation to Salinity and Nutrient Gradients Across the Mangrove Intertidal Zone

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The Comprehensive Everglades Restoration Plan (CERP), section 3.1.4.3, calls for research to explore factors that influence productivity within the mangrove salinity transition zone. The implementation of CERP is expected to result in reduced salinities, and increased production within this area. Understanding and interpreting the growth of tropical mangroves is made difficult by the absence of clear annual growth rings. Quantitative growth rate models must therefore be derived through long-term monitoring of trees over periodic increments. Estimates of tree growth-rate variability along environmental gradients are essential to the accuracy of productivity models within this region.

Here we provide long-term growth curve estimates of mangroves from sites located across the Harney River mangrove intertidal transition zone in Everglades National Park, Florida. Trees were monitored periodically, and species-specific growth curve variation examined in relation to soil pore-water nutrient and salinity concentrations. This information may be used to refine forest theoretical models in response to altered management practices, and provide a more solid basis for regional accuracy in primary production and carbon sequestration estimates.

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Getting Ecological Knowledge into Decision Making

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There are constant challenges to applying the most current scientific understanding to policy development or program management. Certainly one of the impediments to applying more science in support of water resource management decision making is the difficulty of integrating highly detailed ecological knowledge (and associated uncertainty) with the structured and established realm of water management operations. One of the early successes of the Sustainable Rivers Project (SRP) – the national Corps-TNC collaboration to re-operate dams – has been an effective blending of ecological and engineering knowledge and tools. This presentation will illustrate with a case study how the ecological-engineering gap is being bridged at one SRP site and summarize both challenges that have been overcome and those that remain.

Learning from its own experience and observing that of many others, The Nature Conservancy (TNC) has established a framework for developing and testing more ecologically sustainable alternatives for riverine flow regimes. Referred to as “Ecologically Sustainable Water Management” (ESWM), part of what is accomplished through this framework is the definition of quantified ecosystem flow requirements. An engineering counterpart to this has come from the U.S. Army Corps of Engineers (Corps), Hydrologic Engineering Center (HEC). HEC has long been involved in water resources planning and specializes in the development of computer models designed to analyze water management alternatives to support decision makers. The Corps and TNC are currently synthesizing a number of products and tools from ESWM and HEC to analyze flow regime alternatives for the Savannah River (GA/SC). The Savannah effort is presented here as a case study, with discussion of the work’s general applicability.

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The Economics of Restoration: Using Cost-Effectiveness and Incremental Cost Analyses to Evaluate Restoration Alternatives

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Most tidal systems in northern New Jersey have been impacted by urban development and flood control measures. These impacts have resulted in severe impacts to the character and nature of the tidal rivers and adjacent wetlands. These, in turn, have caused an acceleration of stream bank and channel erosion, increases in river flow rates and sediment loading, loss of riparian habitat, and degradation of salt marsh communities. A tool to assist in planning to ameliorate the adverse environmental impacts associated with these impacts is to use cost-effectiveness and incremental cost analyses in alternatives analysis and plan selection.

Primary components of a “composite” example project include restoration of a tidally restricted salt marsh currently dominated by invasive *Phragmites australis*, removal of historic fill material along the shoreline to create new wetland and intertidal habitat, stabilization of the existing structurally and environmentally degraded shoreline bank, and use of bioengineering and replanting to improve riparian habitat conditions. A secondary component of the example project includes improvement and promotion of recreational use of the area.

Costs of the alternatives were calculated based on estimates of location, mobilization/ demobilization, site access, site preparation and excavation, disposal, planting, erosion and sediment control and monitoring costs. Benefits achieved by the alternatives were calculated using the Evaluation for Planned Wetlands (EPW) assessment method (Bartoldus et al. 1994). Costs and benefits for the alternatives were entered into the Institute for Water Resources (IWR) decision support software, the IWR-PLAN, to formulate and compare alternatives using cost-effectiveness and incremental cost analyses (CE/ICA).

The IWR-PLAN selected four unique combinations of alternatives as the "best buy" plans. The “best-buy” plans were further evaluated using a ranking matrix to score each alternative based on the plan’s institutional significance, public significance, technical significance, acceptability, completeness, effectiveness, efficiency, relative risk, relative uncertainty, constructability, and opportunity cost. Of the cost-effective and incrementally justified plans, the plan that was ranked the highest is the recommended plan.

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Space-based Hydrology of the Everglades Wetland, South Florida

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The Everglades region in south Florida is a unique ecological environment. Anthropogenic changes in the past 50 years, mainly for water supply, agricultural development and flood control purposes, have disrupted natural water flow and severely impacted the regional ecosystem. Currently, Everglades' flow is controlled by a series of structures (e.g., levies, gates), which provide a large-scale natural laboratory for monitoring and modeling wetland surface flow. Everglades' water level is currently monitored by about 100 stations, about half of which provide real-time data.

We use space-based Interferometric Synthetic Aperture Radar (InSAR) to monitor water level variations in the entire Everglades region with a high spatial resolution (~30 x 30 m^2). Our data consists of three 225x75 km^2 swaths of eastern South Florida, acquired in June, August and December 1994 by the L-band (1.275 GHz) JERS satellite. A comparison between the space-based InSAR observations and 20 ground-truth stage station data points shows a remarkable agreement. The most significant water level changes are obtained in the northern section of the study area, known as Water Conservation Areas (WCA) 1, 2A, and 2B. Our results show dynamic water topography caused by gate operation on man-made levees. The data show up to 1 m of elevation difference across 5-15 km length scale. We detected both regional N-S unidirectional and radial topography patterns.

We model the observed dynamic water topography using 1-D unidirectional diffusion flow model. Using a best-fit algorithm, we obtain quantitative estimates of flow diffusivity (23-91 m^2/s) and Manning's friction coefficient (0.9-2.3), the first space-based estimates of such hydrologic parameters for the Everglades. Our results demonstrate that space-based hydrologic observations can provide critical information for monitoring, understanding and managing wetland sheet flow, and thus contribute significantly to wetland restoration.

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EXHEP: Expert Habitat Evaluation Procedures (HEP) Software

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Ecosystem-based project design is strengthened and enhanced by techniques that rapidly assess changing habitat conditions at a species or community level. The U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP) were designed to evaluate and predict the suitability of changing habitats for species and communities. HEP is an objective and reliable biological accounting system that quantifies environmental effects in a well-documented fashion. The U. S. Army Engineers (Corps) newly developed Expert Habitat Evaluation Procedures (EXHEP) program provides an automated means to rapidly conduct HEP assessments in a MS Windows-compatible environment.

The EXHEP software is a flexible tool that allows both baseline HEP assessments and with-project vs. without-project comparisons. The software module accommodates all current HEP model calculations, and provides several interfaces to encourage adaptations to these as regional conditions present themselves. The system can handle large amounts of data quickly and efficiently, dramatically reducing computation time. The software accommodates a variety of data input and output file formats. Technical support, in the form of training, documentation and online access to guidebooks and software, promotes easy access and effective application of this tool in the user's day-to-day HEP activities. A demonstration of the software will be presented at the poster session of the conference.

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Lessons Learned From Assessing Ecosystem Restoration Studies across the Nation

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The U.S. Army Engineer Research and Development Center (ERDC) has participated and supported numerous Districts over the years in the assessment and design of ecosystem restoration and flood damage reduction studies across the country. Garnering information and experience through these efforts, ERDC scientists have accumulated a list of creative solutions to handle potentially study-killing issues that have arisen as they navigated through the USACE Planning and Approval Process. Based on positive feedback from Internal Technical Review Teams and Headquarters personnel, the success stories suggest that ERDC's strategies (i.e., Lessons Learned) could help other Districts better prepare for the complexities they face as they develop landscape-level projects in the coming years. Techniques for planning the studies on a watershed scale, as well as suggestions in selecting and modifying assessment tools will be presented. Case studies will be used to demonstrate both the positive and negative results of these approaches, and innovative solutions will be offered to assist Districts in avoiding these same pitfalls in future studies. Applications using assessment techniques such as Habitat Evaluation Procedures will be highlighted, and suggestions for streamlining these tools will be presented as well. Creative approaches to addressing cost analyses requirements in planning studies will be provided, and a discussion of tradeoff approaches for handling multiple assessment techniques and results will be discussed.

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Setting a New SAV Restoration Goal for the Chesapeake Bay by Analyzing the Historical Record

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Submerged Aquatic Vegetation (SAV) is vital to a healthy Chesapeake Bay ecosystem. It performs many roles including nursery areas for juvenile fish, and protection for molting crabs, providing food for waterfowl, protecting shoreline from erosion, filtering and trapping sediment, and removing excess nutrients from the water.

SAV once covered much of the Chesapeake Bay and its tidal tributaries to depths of 2 meters or more (there are 640,926 acres of potential habitat out to 2 meters in depth). However, a 1984 aerial survey conducted by the Virginia Institute of Marine Science (VIMS) found only 38,226 acres of SAV in the Bay and its tributaries. In 1992 the Chesapeake Bay Program developed a goal for SAV restoration of 113,720 acres. While this goal has yet to be met, the Bay Program's Chesapeake 2000 agreement called for a revised SAV restoration goal that would "reflect historic abundance measured as acreage and density from the 1930s to the present. The revised goals will include specific levels of water clarity which are to be met in 2010."

VIMS had conducted aerial surveys of SAV abundance in the Chesapeake Bay annually since 1978 with only a few years in which no survey was performed. The results of these surveys had been converted to digital data. In 2003, SAV experts in Maryland and Virginia completed an historical SAV data layer using photographs from the 1930s to the 1960s. These datasets have proven an invaluable record of SAV abundance, status and trends over time.

ARC/INFO geographic information system (GIS) software was used to analyze all of the historical and recent SAV survey data. Each year's SAV data were subdivided by Chesapeake Bay Program monitoring segment. The year with the most SAV in a given segment was determined to be the single best year for that segment. This was the maximum amount of SAV known to have existed in a given area for a single year. (The pre-1978 aggregated data were treated the same as a single year.) For the majority of segments (45 of 65 segments having SAV at some time during the period of record) the single best year was from the historical (pre-1978) dataset.

Criteria were developed through an iterative process with stakeholders to determine at what depth SAV was likely to occur in significant amounts in each segment given the amount of single best year SAV acreage and the acreage of potential SAV habitat at three different depths. This depth became the water clarity application depth; the depth at which water clarity would need to be achieved to be able to restore enough SAV in a segment to meet the restoration goal. Once the final criteria were accepted and the analysis re-run the new restoration goal was set at 184,889 acres, a 63% increase over the previous goal's acreage.

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The Relationship Between Hydrodynamic Numerical Models and Adaptive Management in Marsh Restoration Design

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In an ideal situation, all marsh restoration projects would restore marsh function. However, defining and developing quantifiers that assess marsh function remains illusive. As a result, a restoration project usually strives to restore the form/structure of the marsh system in the hope that restored function will follow. The restoration design may include specifications for restoring topography (landscape scale), microtopography, channel density, and/or floral assemblages (landscapes on larger scales). The main components of a preliminary design normally specify structural components such as number of openings and/or inlets, number of channels, and other physical macro-design features and types of desired vegetation. However, in order obtain the desired species within the restoration project, it is necessary to design a marsh environment in which the desired species will grow. To achieve this goal, it is necessary to restore a hydroperiod that is favorable to the desired marsh species that will ultimately vegetate the marsh plain. Incorporation of self design or ecological engineering into the design process supposes that the restoration will be allowed to evolve after the initial construction has been completed. Hydrodynamic numerical models and Adaptive Management are two powerful tools that play an important part in the design and implementation of marsh restoration projects. Hydrodynamic numerical models provide a powerful feed-back mechanism between design and Adaptive Management that help ensure a projects success.

Two-dimensional hydrodynamic numerical models were used in the design of 3 marsh restoration projects. These projects varied in size from 300 to 2,800 acres. In each of the restoration projects, a two-dimensional numerical model was used to formulate design parameters, such as the number of opening/tidal inlets, the size of the marsh channels, and the expected velocities within tidal channels. Additionally, these models were used to assess the post restoration hydroperiod and depth of tidal inundation on the marsh plain. These results were in-turn used to predict post restoration vegetative landscape by vegetation type. Once the design was finalized, construction was begun. During the construction phase an Adaptive Management was used to modify the initial design in order to facilitate unanticipated construction difficulties. A single design modification may not alter the ability of the project to obtain success. However, multiple design modifications may either slow down the restoration timeline, or in the most extreme example, may completely alter the outcome of the project thus, preventing it from obtaining success. Additional simulations using the model with the new parameters could provide a feedback mechanism to aid the Adaptive Management decision making process.

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Changes in Groundwater Influence Soil Surface Elevation in a Mangrove Forest along the Shark River, Everglades National Park

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The influence of hydrology on specific soil zones and absolute elevation change is an important consideration when investigating the impact of disturbances, sea level rise, and water-management decisions on coastal wetland systems. Hydrology is known to affect the overall soil surface elevation of wetlands, but it is unclear how the different zones within a single soil profile respond to changes in local hydrology. Recent improvements in surface elevation table (SET) instrumentation allow the partitioning of the influence of specific zones, such as the shallow root zone and deeper soil zones, on the change in soil surface elevation. We used an original-design surface elevation table (Original-SET), a shallow-rod surface elevation table (Shallow-RSET), and a deep-rod surface elevation table (Deep-RSET) to separately track changes in the middle zone (0-400 cm), the shallow root zone (0-35 cm), and the full sediment profile (0-600 cm), respectively, in response to changes in site hydrology. Here we incorporate the shallower soil depths in the monitoring of the deeper soil zones.

In the mangrove forest along the Shark River of Everglades National Park, there was a strong seasonal signal in soil surface elevation. The greatest positive elevation was observed at the end of the wet season, and is attributed to soil swelling caused by wet-season increases in ground-water levels. Individual soil zones within a profile responded differently to changes in groundwater levels. The relationship between hydrologic change and soil surface elevation was strongest for the entire soil profile, followed by a weaker coupling with the middle zone. Groundwater hydrology did not have an influence on the shallow soil zone. The depth of the shallow soil zone showed a slight negative correlation with river stage. In addition to differences observed in the vertical soil zones, we encountered horizontal spatial variability in the change of soil elevation, even on the small spatial scale used in this study. This short-term study emphases the importance of understanding how changes in local hydrology affect absolute elevation and the constituent soil zones especially when there is interest in interpreting the effects of upstream water management decisions on coastal mangroves.

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TAME Melaleuca: An Integrated Pest Management Approach for Control of *Melaleuca quinquenervia*

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Originally imported as an ornamental plant, the native Australian tree *Melaleuca quinquenervia* (Cav.) S.T. Blake (Myrtaceae) has become an invasive weed threatening native and agricultural systems throughout South Florida. Having already invaded nearly 200,000 ha in Florida, *M. quinquenervia* has the potential to replace native plant communities with dense, nearly monospecific stands of the tree.

Various methods have been used to combat the increasing threat of *M. quinquenervia* and other invasive weeds, with each method having its own strengths and weaknesses. Mechanical and chemical control can quickly reduce populations of invasive plants, but require regular follow-up treatments, can be costly, and may negatively effect non-target vegetation. Classical biological control can provide long-term management due to its self-perpetuating nature, but may take years to implement and achieve desired level of suppression. Integrated pest management (IPM) practices are widely acknowledged as the most sustainable and effective means for controlling invasive species, particularly when implemented by partnerships between private land managers and federal, state, and local agencies. In 2001, the US Department of Agriculture's Agricultural Research Service (USDA-ARS) established The Areawide Management and Evaluation of Melaleuca (TAME Melaleuca) as an interagency effort to demonstrate and promote practical, integrated management strategies for *M. quinquenervia*, with an emphasis on biological control.

TAME Melaleuca has developed nine demonstration sites throughout South Florida to promote *M. quinquenervia* management options for landowners and land managers. In addition, project activities include assessing the impacts and non-target effects of various control tactics and investigating the socio-economic factors associated with adopting current and proposed control tactics. By combining several control tactics across the region invaded by *M. quinquenervia*, rather than on a site-by-site basis, TAME Melaleuca aims to achieve effective, long-term management of this invasive tree.

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Short and Long-Term Salmonid Habitat Restoration in California's San Joaquin River Basin

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The San Joaquin River was once one of California's largest rivers and supported annual salmon runs in excess of 300,000 fish. San Joaquin River Basin salmonid populations have declined significantly since the mid 1800's. Construction of low elevation dams blocked access to upstream habitat and reduced flows and impairing fluvial and riparian processes. Un-screened water diversions entrained salmonid fry and smolts into canals and agricultural fields. Riparian habitat lost to agriculture and development increased water temperatures and reduced available salmonid food resources. In-stream and flood-plain gravel mining converted riffles into large pits and degraded channels. These impacts contributed to the extirpation of spring-run Chinook salmon (*Oncorhynchus tshawytscha*), the threatened status of steelhead (*O. mykiss*) and candidate status of fall-run Chinook (*O. tshawytscha*).

Restoration projects may be classified by the project goals and timeline. Short-term river restoration projects typically target easily perceived problems such as the need for additional spawning habitat, rearing habitat or large woody debris. Short-term projects often produce rapid, measurable results and may last for only a few years. Siltation, floods or fluvial processes potentially reduce or eliminate short-term project benefits. Long-term restoration actions focus on restoring hydrogeomorphological conditions and ecological structure and function. Examples of long-term projects include large-scale channel restructuring to improve sediment transport and fish passage and revegetation of riparian habitat. Long-term projects may require numerous years before fisheries benefits are realized.

Two case studies are presented of short and long-term approaches to habitat restoration. A short-term spawning gravel augmentation demonstration project improved the quantity and quality of spawning and incubation habitat for fall-run Chinook salmon by adding 13,000 tons of gravel to the streambed, restoring a small fraction of the historical spawning habitat. A long-term ecosystem process project restored two and one-half miles of degraded channel, providing passage for both fish and sediment.

The expense and benefits of restoration projects are increasingly being scrutinized by the public. Successfully implemented project monitoring serves to justify expenditures, allows tracking of progress and supports the application of adaptive management techniques. Monitoring also provides an opportunity to educate diverse stakeholders about the importance of both short and long-term restoration projects, and to garner support from water districts, local landowners, resource agencies, anglers and other stakeholders. Ultimately, many in-river and riparian projects, both short and long-term, are necessary to recover native salmonids.

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Impacts of Land-Cover and Hydrologic Change on Vegetation of the South Florida Coast

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Land-cover changes in South Florida during the 19th and 20th centuries include altered freshwater flow across the Everglades, introduction of exotic plant species, clearance of extensive tracts of forest and wetland for agriculture and housing, and accompanying increases in population density. The impacts of such changes on the Everglades wetland (sawgrass marshes, tree islands, ridge and slough) has been well-documented, but less is known about their affect on coastal wetlands. Recent studies of sediment cores collected in Biscayne Bay provide evidence of vegetational changes associated with clearance of pine forests for urban and agricultural development and with hydrologic changes due to water management practices.

Pollen assemblages were examined from sediment cores collected on Chicken Key, No Name Key, Featherbed Bank, Black Point, Card Bank, and Middle Key in Biscayne Bay. These include six cores collected in bay sediments and two cores collected on shore. Age models for the bay cores were developed using ^{210}Pb (lead-210) and ^{14}C (carbon-14) dating. Four vegetational phases were observed from these cores based on palynological evidence. In the first phase (pre-1930 AD), *Pinus* (pine) strongly dominates assemblages. Between 1930 and 1950, *Pinus* pollen abundance decreased sharply, and generic diversity increased. *Casuarina* (Australian pine) pollen became a common component of assemblages, and initial increases in abundance of *Myrica* (wax myrtle), herbaceous plants including the Asteraceae, Chenopodiaceae/Amaranthaceae, and ferns occurred. *Quercus* pollen abundance increased between 1950 and 1970, and assemblages deposited after 1970 are characterized by the highest documented percentages of *Quercus* pollen and other, more localized, floristic changes. In northern sites near Miami and its suburbs, these recent changes represent a record of land-cover change tied to urban development. In southern sites distant from disturbance associated with urban development, the post-1950 changes indicate expansion of mangrove forests and coastal marshes, probably representing drier or more saline conditions due to diversion of freshwater flow. An inland migration of mangroves during the last five decades also has been documented in northernmost Florida Bay.

The timing of the changes in coastal plant communities along both Biscayne and Florida Bays is coincident with increased water impoundment in the northern Everglades and decreased freshwater flow southward to the bays. These data provide insights into the degree of tolerance of coastal wetland communities for freshwater flow reduction and the lag time between hydrologic changes and vegetational response.

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Hydrodynamic Simulation for a Mudflat Dominated Coastal Lagoon Restoration Project

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San Elijo Lagoon (SEL), located on the shoreline of N. San Diego County, is a salt water dominated tidal system and includes approximately 1,000 acres of mudflat, salt marsh, and similar wetland habitat. During normal weather conditions, freshwater inflows to the lagoon are insignificant compared to tidal circulation. Long term sediment deposition has reduced the tidal prism of the lagoon and severely degraded the tidal dependent habitats. In order to restore the lagoons natural functionality, two alternatives were developed to increase tidal action and circulation. The first alternative includes dredging the inlet and main channels, establishing a sediment trap, creating several new channels, and lowering the mudflat elevations. The second alternative involves the relocation of the tidal inlet to improve the exchange rate, in addition to the channel dredging and mudflat grading of the first alternative.

The RMA2 numerical model developed by the Corps of Engineers was utilized to study the water circulation and inundation frequencies within the lagoon for each alternative. The RMA2 model is a two-dimensional depth averaged finite element model, which solves the Reynolds form of the Navier-Stokes Equation and predicts water surface elevation and flow velocities. Four computational grid systems were generated to study the hydrodynamics of the lagoon. One uniform depth of -3m (MSL) grid was generated over the entire lagoon to establish a basis for understanding the hydrodynamic characteristics of extremely shallow lagoons, which are difficult to model. One grid was established for existing conditions and two grids were established for the two alternative plans.

The ocean boundary condition was established by tidal elevation as the driving force for hydrodynamic simulation. The observed time series of tide elevation taken at five stations inside the lagoon on August 22, 2002, by the San Elijo Lagoon Conservancy (SELC) were used for model verification. Based on a comparison of the model calculated results with the field data, the predicted water elevations fall within the expected range and are assumed adequate for design reference. The simulation results calculated from the 3 meter depth grid showed very little muting effect or phase lag between the ocean and lagoon tides. This indicates that under a tidal driven force, and with adequate channel depths, tidal exchange should be sufficient to accomplish lagoon restoration goals. The predicted time series of tide elevations at La Jolla in January, 2005 was selected as the hydrodynamic simulation input conditions, which includes neap, spring, and average tide conditions, adequate for a valid hydrodynamic and statistical properties analysis.

Water elevation, velocity, volumetric exchange rate, and muting effects at ten selected control stations along the main channels and in the major basins were analyzed. Up to 70% muting effect was found at I-5 bridge crossing with existing conditions. At the same location, the model projected only 20% and 10% muting for Alternatives 1 and 2, respectively. This indicates that with sufficient dredging of the main channels and grading of the major basins, a much improved tidal circulation system can be achieved. Similarly, the average volumetric exchange rate for the lagoon for both alternatives was roughly three times that of existing conditions. Inundation frequency maps generated by the model served as the basis for biologists to develop site specific habitat maps.

In conclusion, RMA2 can be applied for the establishment of water elevations, flow velocities, and inundation frequency mapping for a shallow, mudflat dominated lagoon. The results of the modeling indicate that the goals of habitat creation can be achieved with either alternative, although the costs of construction and maintenance will differ.

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Recent Changes to an Estuarine-Marine Ecosystem: Using Benthic Foraminiferal Assemblage Data toward a Predictive Model of Ecosystem Change, Central and Southern Biscayne Bay, Florida

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Ecosystem restoration requires some understanding of natural variability within a natural system so that comparison to and contrast with anthropogenic-induced changes is possible. Restoration must account for anthropogenic effects, which are irreversible based upon current patterns of land use for sustainability and cost-effectiveness of any proposed transformation of land use. The goals of the Comprehensive Everglades Restoration Program (CERP) are to restore natural conditions of freshwater input to the Biscayne Bay and Florida Bay ecosystems. The goals of the foraminiferal research have been to identify assemblage variability between modern environments and in shallow (<2m) cores from central and southern Biscayne Bay, which will show temporal changes at particular sites. Changes in the assemblage data are then interpreted to reveal changes in salinity and nutrient conditions in Biscayne Bay.

Two cores from the mid-bay of central Biscayne Bay and three nearshore sites from central and southern Biscayne Bay have been analyzed for foraminiferal assemblage studies. The core assemblage data compared to modern foraminiferal assemblage data from Biscayne Bay is used to characterize down core environmental changes. Mid-bay sites at Featherbed and No Name Banks have revealed an overall shift to more marine salinities, as indicated by significant influxes of *Archaias* and *Articulina*, which are most prevalent from approximately 1958 to 1998, and an inverse decline in *Cribroelphidium* and *Elphidium*. Furthermore, an increase in *Bolivina* between 1934 and 1998 are indicative of enriched nutrient conditions in central Biscayne Bay. The mid-bay cores have much higher species diversity with a mixture of marine and estuarine foraminifera. Two nearshore cores reveal a distinct change from a freshwater environment with extremely low foraminiferal counts or barren, to a low salinity, brackish modern environment. A third core indicates brackish conditions up to 86cm, higher salinities up to 72cm, and then is brackish again to the modern environment at the top of the core. The nearshore cores are dominated by the presence of *Ammonia* and *Elphidium* in the low salinity environments, several samples having nearly 100% representation by these two genera alone. The more marine assemblages have increased quantities of the genera *Miliolinella*, *Quinqueloculina* and *Triloculina*.

The application of non-parametric trend analyses to the down core foraminiferal data will be used to identify trends in the data toward specific environmental conditions, i.e. salinity. Successful results from these analyses will provide a useful technique in utilizing foraminiferal data as indicators to monitor the success of restoration efforts, as well as help to develop a predictive model of ecosystem change.

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Initial Responses of Wading Birds to Phase I of the Kissimmee River Restoration Project

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Prior to channelization, the 1 - 3 km wide floodplain of the Kissimmee River was regularly inundated and provided foraging and nesting habitat for a suite of aquatic wading bird species. From 1962 - 1971, the C-38 canal was excavated through the middle of the Kissimmee floodplain, reducing the frequency and extent of flood-pulse events and draining the majority of floodplain wetlands. Surveys of the floodplain conducted from 1978 - 1980 reported low densities of all wading bird species except cattle egrets. The Kissimmee River Restoration Project seeks to restore the ecological integrity of the river/floodplain system by backfilling approximately 35 km of the C-38 canal and reestablishing pre-channelization hydrologic characteristics. Backfilling will be accomplished in four phases, the first of which was completed in February 2001. Here I report baseline pre-restoration (Before) and post-Phase I (After) wading bird use of restored (Impact) and un-restored (Control) portions of the river/floodplain system.

Monthly helicopter surveys were conducted Before and After to estimate relative abundances and densities of wading birds using the river/floodplain system. Jolly's ratio method was used to estimate Before and After wading bird densities in Impact and Control areas. Restoration-related differences in wading bird densities were evaluated using the BACI design and Welch t-tests. Wet (Jun - Nov) and dry (Dec - May) season data were analyzed separately.

The same fourteen species of wading birds were encountered during the Before and After periods, but relative abundances differed. Wet season cattle egret/aquatic wading bird ratios in the Impact area decreased from 0.71 to 0.20 ($P = 0.003$), while dry season ratios decreased from 0.42 to 0.06 ($P = 0.04$); no significant wet or dry season differences in this ratio were detected in the Control area. The white ibis has replaced the cattle egret as the most abundant species in the Impact area, while the cattle egret remains the most abundant species in the Control area. Wet and dry season densities of aquatic wading birds in the Impact area increased relative to the Control area following restoration ($P = 0.02$ and $P < 0.001$, respectively). Annual densities of aquatic wading birds in the Impact area averaged 20 and 24 birds/km^2 during 2002 and 2003, respectively, thus exceeding the restoration expectation of $\geq$ 19 birds/ km^2 in both years. These initial response data suggest that increases in wading bird densities and decreases in cattle egret relative abundance are directly attributable to restoration. The reestablished, periodic flood-pulse cycle in the Impact area provides a shifting mosaic of available foraging habitats. The long-term viability of these habitats will be assessed through continued monitoring that extends five years beyond completion of the last backfilling phase. Future research will refine the understanding of wading bird dynamics on the Kissimmee floodplain by examining integrated responses of wading birds, fish, invertebrates, and dissolved oxygen in the water column to seasonal flood-pulses in the Impact area.

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Stream and Wetland Restoration in Delaware - the Sequel

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Ecological restoration work by the Delaware Department of Natural Resources and Environmental Control began in the early 1990s with the conversion of some marginal agricultural fields into wetlands. Since then, efforts have expanded to include the restoration of tidal and freshwater wetlands, streams, man-made drainage channels (tax ditches), riparian corridors, and the connection of forest tracts. By 2003 the Department had at least seven different groups within the organization working on ecological restoration to some degree with minimal interactions between the various units.

Recognizing the importance of ecological restoration, the Secretary of the Department established an Ecological Restoration and Protection Team in the fall of 2003. Responsible for implementing stream and wetland restoration projects, the Team brings together the expertise and resources from various agencies within and outside the Department to accomplish the goals of the restoration initiative. The presenter serves as the Ecological Restoration Coordinator for the Department and is responsible for harnessing the right mix of expertise and resources on projects to ensure that the maximum level of environmental results are being derived to enhance water quality, provide flood control/water management, and establish wildlife habitat to yield biodiversity benefits. The goals of the Team include restoration and protection of streams, drainage ditches, wetlands, and riparian corridors in a coordinated effort.

The Team is comprised of individuals representing all the Divisions within the Department as well as outside agencies such as the U. S. Fish and Wildlife Service, Conservation Districts, Delaware Center for the Inland Bays, Delaware Department of Transportation, Natural Resources Conservation Service, and the Delaware Department of Agriculture. Team members possess expertise from all the applicable scientific fields required for evaluating sites and implementing ecological restoration projects.

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Natural Variability versus Anthropogenic Change: A Case Study in Biscayne Bay, Florida

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The natural range of variability of an ecosystem must be documented before evaluating the effects of anthropogenic-induced change against natural change. Sustainable and cost-effective restoration efforts must focus on remediating anthropogenic change, while allowing natural systems to evolve. Current goals of the Comprehensive Everglades Restoration Plan (CERP) include restoration of the natural freshwater flow into Biscayne and Florida Bays and the establishment of targets and performance measures for restoration. The goal of our research has been to provide the land-management agencies with information on the sources and timing of changes in freshwater influx, salinity, water quality, and benthic habitat over decadal to centennial time scales.

Shallow (<2m) sediment cores were collected in 2002 from sites in central and southern Biscayne, radiometrically dated, and analyzed for faunal and floral assemblages, ostracode-shell chemistry, and geochemistry. Core assemblage data are compared to modern census data from different salinities to provide ecological interpretations of down-core proxies. The results indicate that the salinity of central Biscayne Bay has become increasingly marine and increasingly stable, with fewer fluctuations in salinity, over the last one hundred years. At Card Bank, in southern Biscayne Bay, marine influence also has increased over the last century, but with relatively large (compared to central Biscayne Bay) fluctuations in salinity occurring over multi-decadal and centennial time scales. Total carbon (TC), organic carbon (OC), total nitrogen (TN) and total phosphorous (TP) concentrations were significantly higher at Card Bank, compared to the central Biscayne sites. The downcore profiles show a significant increase in TP flux into the sediments, when superimposed on the normal diagenetic recycling of P. Because this apparent increase is larger in the south, it is possible that the increased P is entering the system through the C-111 canal, south of Card Bank.

In order to determine the sequence and timing of changes in discharge into the Bay, additional cores were collected in 2003 from nearshore sites located in proximity to historical freshwater influx. These cores currently are being analyzed, but preliminary results show significant changes in the fauna from freshwater forms in the lower portion of the cores to more estuarine fauna in the upper portion. Correlation of these cores to the 2002 cores and to outflow and rainfall data will provide insight into the role of anthropogenic influences on the more marine, more stable salinities noted in the central bay cores. Interpretations of the data from the two sets of cores will provide agencies responsible for restoration with the background information necessary to set realistic targets and performance measures for freshwater discharge into Biscayne Bay.

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The National Map Initiative: Strategic On-Line Defense Geography Repository for Use in Environmental Restoration

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The National Map *is* a consistent framework for geographic knowledge representing the Nation. It provides public access to high quality, geospatial data and information from multiple partners to help inform decision-making by resource managers and the public. ***The National Map*** is the product of a consortium of Federal, State, and local partners who provide geospatial data to enhance America's ability to access, integrate, and apply geospatial data at global, national, and local scales.

The USGS Department of Defense Earth Science Program is exploiting ***The National Map*** through the **S**trategic **O**n-**L**ine **D**efense **G**eography **R**epository (**SOLDGR**). **SOLDGR** is a password-protected geospatial viewer that allows DoD access to USGS, other Federal, state, and local agency data, and secure DoD data through partnership agreements. **SOLDGR** is specifically designed to give the DoD environmental and engineering community a one-stop source for geospatial data through a thin-client mechanism. **SOLDGR** utilizes the web service based architecture of ***The National Map***, and data projections are supported by disparate servers located nationwide.

A few of the data layers that are available to support environmental restoration community include the National Wetlands Inventory, digital imagery, the National Hydrography Dataset, USGS real-time stream gages, the National Geochemical Inventory, regional aquifers, locations of military installations, NEXRAD radar feeds, high-resolution imagery over urban areas, historical imagery for selected military facilities, and geographic names. The list of data layers is too long to present here, but many additional layers and partnerships are planned for this application. **SOLDGR** is a prime example of how ***The National Map*** can support other Federal and state agencies, industry, and the public with current geographic base layers for using along with their current suite of decision support tools.

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Integrating Ecological Restoration in Conservation Design of Suburban Communities

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The lack of restored natural areas within larger cities and towns has contributed to the decrease of biodiversity, floodplains, wetlands, natural communities and the increase of stormwater pollutants, invasive species, ambient air temperatures and water use.

By working with local planning commissioners, developers, citizens, and ecological professionals, both in the private and public sectors, large segments of land can be restored and incorporated into the local residential, commercial and business development process.

This process assimilates the need for suburban growth while considering the project's potential impact to wildlife, native plant communities, wetlands, riparian corridors, floodplain storage, surficial aquifers, water tables, existing topographic features and its connectivity to other natural areas.

Typical subdivisions allocate large lots to residents, while sacrificing the need for open space and wildlife habitat. Large lots are characteristically demarcated by non-native grasses and forbs that require intense management practices through the use of fossil fuels, pesticides and application of fertilizers to maintain a particular horticultural code.

Conservation Design concepts allow for the density of a typical community to be maintained while at the same time increasing opportunities for wildlife utilization such as foraging and/or breeding. Through the reduction of lot sizes, less energy is expended to maintain an individual yard. The additional acreage is typically combined in larger areas within the community such as preserved wetland areas, restored riparian systems or the creation of a new community such as a native wildflower and tallgrass prairie.

Two examples illustrate this practice: The Coffee Creek Center located in Northwest Indiana, a 640-acre planned unit development that has preserved, restored, enhanced and created approximately 167 acres of wetlands, forested floodplain and prairie habitat. Fox Haven, a 380-acre mixed residential community located within the metropolitan area of Indianapolis, Indiana is currently being designed to apportion approximately 150 acres of open space to the preservation, enhancement and restoration of wetland systems, creation of native prairie, and the restoration and enhancement of a degraded riparian system. These two communities will be discussed in detail to demonstrate the need and the techniques used to increase natural ecological systems within suburban communities.

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Applying the Penman-Monteith Equation in the Everglades to Calculate the Actual Evapotranspiration in Order to Improve Predictions for Restoration Scenarios

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Evapotranspiration (ET) is a major component of the water budget in the Everglades. Due to the importance of ET, a predictive model should represent ET as accurately as possible by including all significant physical processes. When the required data for calculation is available, the bulk energy balance approach embodied in the Penman combination method for open water and the Penman-Monteith formula for vegetated sites appear to provide widely accepted parameterizations of the three dominant physical processes: net radiation, sensible heat flux and latent heat flux. A joint study has been initiated by the U.S. Geological Survey and the University of Miami to test the suitability of these methods for estimating actual ET in the Everglades. Appling the physics-based ET formulations in models can help extend the application range of the models to time periods that fall outside of the calibration and to ponding conditions that are different from those during the observation period. Climatic conditions during the spring of 2004 were characterized by extended dry and windy conditions. This period is one example of the Penman-Monteith formulation possibly providing a better estimation of ET as opposed to other more simplified methods that do not explicitly depend on humidity and wind speed.

In order to make the Penman combination and the Penman-Monteith ET models useful for calculation of actual ET, the stomatal resistance was modified by a function of water level. Then an analysis was performed that included the calibration of these ET models to values of ET measured using Bowen ratios and energy balance methods (German, 2000) at several different data collection stations. These stations are characterized as being open water (2 stations) and vegetated sites(7 stations). Additional data collected recently by German (unpublished) were also used in this analysis. Each of these stations was located in areas of varying density and vegetation type. The vegetated sites also varied in their hydrologic conditions; some were wet all year, while others transitioned between wet and completely dry. This allowed for the testing of the Penman-Monteith equation under a variety of conditions. Data collection for this study began in January 1996 and continued until December 2002. During this time period, some stations stopped collecting data; therefore, the record analyzed at these stations was of shorter duration.

References:

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Evaluating the Effects of Everglades Restoration Scenarios by Linking the Local-Scale Southern Inland and Coastal Systems (SICS) Model to the Regional South Florida Water Management Model (SFWMM)

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The South Florida Water Management District is using its regional hydrologic model, the South Florida Water Management Model (SFWMM), to evaluate different hydrologic restoration scenarios for the Comprehensive Everglades Restoration Plan (CERP). The SFWMM was designed primarily for the inland freshwater areas in southern Florida. The U.S. Geological Survey developed the Southern Inland and Coastal Systems (SICS) model, an integrated surface-water and ground-water model, in order to simulate flows, stages, and salinities in the southern Everglades and into northeastern Florida Bay. Modifications to the SICS boundary conditions allow the local-scale SICS model to be linked to the regional-scale SFWMM. The linked model will be used to quantify the effects of restoration alternatives on flows, water-levels, and salinities in the SICS area as well as freshwater flows to the coast.

The SICS surface-water module utilizes areally distributed boundaries (unchanged) and four types of lateral boundaries (discharge, water level, no flow, and salinity). Two discharge boundaries (at Taylor Slough Bridge and C-111 Canal) in the SICS model domain are converted to water-level boundaries in order to use SFWMM water-level data instead of field data. The third discharge boundary (at Levee 31W) now uses flow data derived from SFWMM model output instead of using field-measured flows. The SICS wetlands water-level boundaries are modified to use SFWMM model output data. The two marine water-level boundaries, the no-flow boundaries, and the Florida Bay salinity boundary all remain unchanged.

The SICS ground-water module contains a general-head boundary, which extends along the edges of the wetlands part of the SICS model domain, and a no-flow boundary under Florida Bay. The general-head boundary cells are modified to use water-level values from corresponding SFWMM cells. These values are bilinearly interpolated from surrounding SFWMM model cells and assigned to the SICS general-head boundary cells in all layers of the ground-water model. The no-flow boundary in Florida Bay is unaltered.

A 5-year simulation, of existing conditions, was developed to test the SICS-SFWMM linkage. Results from the linked model are similar to those obtained from the original SICS model in which boundaries are assigned using field data. The simulated discharges at the coastal creeks along Florida Bay are about 5 percent lower than the field data simulation; water levels in the wetlands are about 4 percent lower, and salinities at the various coastal creeks are slightly higher.

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Patterns of Movement of Florida Gar (*Lepisosteus platyrhincus*) in the Everglades Revealed by Radio Telemetry

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Since March 2002, we monitored the movements of 96 Florida gar in the Everglades Wildlife Management Area, Conservation Area No. 3A (WCA-3A) and the Everglades National Park (ENP), Shark River Slough (SRS). A total of 56 gar were tracked in WCA-3A during three different monitoring periods: Group 1 (30 individuals, 3/2002 - 7/2002, mean = 55 d), Group 2 (21 ind., 8/2002 - 4/2003, mean= 140 days), and Group 3 (5 ind., 4/2003 - 7/2003, mean= 48 days). To compare movement patterns observed in WCA-3A, two additional groups were monitored in SRS: Group 4 (20 ind., 9/2003 - 5/2004, Avg. 183 days) and Group 5 (20 ind., 4/2004 - present).

We collected gar using standard electrofishing techniques from an airboat in two widely separated areas of WCA-3A, one short-hydroperiod area in the west (Site 3; 26.01 N, -80.82 W), and a second, long-hydroperiod area in central 3-A (Site 1; 25.86 N, -80.73 W). Similarly, we collected fish in two areas in SRS, a long-hydroperiod area in the north (Site 6, 25.63 N, -80.73 W) and a short-hydroperiod area in the southwest (Site 37, 25.47 N, -80.85 W), which is associated with the northeastern tributaries of the Shark River. Fish were anesthetized in a solution of MS-222 for surgical implantation of transmitters (SB-2, Holohil Systems, Ltd.) through a ventral incision posterior to the pelvic girdle. This incision was closed with three to five sutures and SuperGlue. We tracked individuals from their release/collection point using a Wildlife Systems receiver from an airboat or using a Communications Specialists R-1000 receiver from an airplane.

In WCA-3A, fish monitored at short-hydroperiod areas moved farther on average from the point of release (4.1 km, Site 3) than those fish at long-hydroperiod areas (1.8 km, Site 1). The opposite was observed in SRS, where fish traveled further in the long-hydroperiod region (4.1 km, Site 6) than the short-hydroperiod region (0.93 km, Site 37). However, local hydrological variation may influence movement patterns. For observations collected during the Everglades dry season, gar moved less in the short-hydroperiod region (mean = 1.1 km) of WCA-3A than the long-hydroperiod region (mean = 1.8 km), utilizing local canals and alligator holes as refuges from the drier surrounding areas. During the wet season, this pattern reverses, with gar moving large distances (mean = 8.4 km) in the short-hydroperiod regions compared to the long-hydroperiod regions (mean = 1.8 km). Most of these movements were to the southeast, which corresponds to local water flow. This variation indicates that hydroperiod, water flow, and weekly variation in water depth at a particular site play an integral role in movement patterns of Florida gar. By collecting and analyzing observations of fish movement, we aim to develop a deeper understanding of survival, dispersal, and habitat use by large fish in the Everglades.

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The Field of Dreams Dilemma, "Will They Stay?" Avian Response to Tidal Marsh Restorations in San Pablo Bay, CA

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The San Francisco Bay estuary is a highly modified ecosystem where over 95% of historic tidal salt marshes have been diked or filled. Many restoration projects have been initiated recently to reclaim salt marshes and have reached the stage where assessment is critical for adaptive management. Restoration "success" is commonly assessed by the endpoint coverage of pickleweed (*Salicornia virginica*) in the marsh plain and cordgrass (*Spartina foliosa*) in the low marsh. Tidal wetlands are hydrogeomorphically dynamic, constantly changing ecosystems; yet the criteria for restoration "success" often neglect the biological significance of transitory habitats, particularly mudflats. Restoration activities to increase tidal circulation at Tolay Creek were initiated in the winter of 1998. We detected substantial sediment accretion and mudflat formation and subsequent increase in shorebird use. Shorebird abundance during low tide approached nearly 13,000 birds (300 birds/ha) during a single survey. Though waterbirds typically respond quickly to restored tidal wetlands, their utilization of the area can be as transient as mud flats themselves. At the Guadalcanal wetland mitigation site, bird utilization of increased following the restoration of tidal flow. Several months later; however, bird use declined coinciding with a levee breach into an adjacent salt pond. Greater numbers of shorebirds were attracted to this new accidental restoration, and we observed fewer birds at the Guadalcanal Restoration Site.

San Francisco Bay estuary is a major Pacific Flyway wintering area for shorebirds. Mudflats, although transitory, are important foraging habitats in tidal restoration projects. The transient nature of migratory shorebirds suggest that the planned restoration of several salt evaporation ponds in San Pablo Bay should be staggered and phased to maximize waterbird use over time.

The potential loss of mudflats as they become vegetated, in addition to the loss of existing bay mudflats because of sediment decrease or sea level rise may heighten the importance of mudflats for waterbird conservation and management.

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Assessing Restoration Efforts in the Lake Okeechobee Watershed through a Nutrient Load Monitoring Program

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Lake Okeechobee is the heart of South Florida's water supply and flood control system and is a major source of water for the Everglades. Agricultural development in the watershed and canal construction during the last century have resulted in excess nutrient inputs and more efficient delivery of stormwater to the lake, causing a decline in ecosystem health. The 2000 Lake Okeechobee Protection Act (Chapter 00-130, Laws of Florida) and the congressionally-authorized Comprehensive Everglades Restoration Plan/Lake Okeechobee Watershed Project (LOWP) have committed the State of Florida and the Federal Government to restoring and protecting Lake Okeechobee through a coordinated effort among the South Florida Water Management District, the State of Florida, and the U.S. Army Corps of Engineers. Restoration activities will include the construction of stormwater treatment areas and reservoirs, restoration of wetlands, and dredging of sediment from canals. To assess restoration efforts, the U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers and South Florida Water Management District, is operating a 10-year water-quality and streamflow monitoring program at the sub-basin scale in the LOWP area.

The LOWP area is a low-gradient watershed with numerous flow-control structures. Streams in the watershed are subject to bi-directional flow and backwater conditions. These factors pose unique challenges to the data collection process which must be overcome through the use of hydroacoustic Doppler instruments that measure stream velocity and flow. Nutrient loads are characterized on a weekly basis through an intensive sampling program, including the collection of manual "grab" samples and the collection of flow-weighted composite samples using automatic samplers.

Streamflow data collection began in June 2003. Collection of water quality samples began in December 2003. In the future, the monitoring network will be used to answer questions such as:

- What are the baseline water quality conditions at the sub-basin level?
- How well do watershed water-quality models represent true conditions?
- How do nutrient loads change temporally and spatially in response to restoration efforts in the watershed?

This monitoring network was developed based on the input of numerous local, state, and federal agencies and public stakeholders. Multi-agency collaboration and diverse expertise are critical to the success of the LOWP and other Everglades restoration projects.

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Planning, Design, and Construction of a Tidal Wetland Restoration Project in a Highly Urbanized Estuary, Woodbridge, NJ

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Restoration of tidal wetlands in the highly urbanized Hudson-Raritan Estuary raises significant challenges because of the presence of multiple contaminants, lack of adequate space for disposal of fill removal, and a high degree of freshwater runoff. The Woodbridge River Wetland Restoration Project is a multi-partner project sponsored by NOAA's Restoration Center, the New Jersey Department of Environmental Protection and the Township of Woodbridge, NJ. The project site is a 15-acre Phragmites dominated wetland on the Woodbridge River, a tributary to the Arthur Kill. A dike was constructed ~ 40 years ago forming a perimeter around the site and ranges from 3.5-7.5 feet above the low marsh plane. This dike prevents daily- and spring-tidal inundation of most of the marsh surface and has led to the expansion of *Phragmites* and a reduction in fisheries habitat. The sponsoring agencies determined that this was an appropriate site to conduct a restoration project using settlement funds resulting from the 1991 Exxon Bayway oil spill in the Arthur Kill which injured over 100 acres of salt marsh. To determine an appropriate project design with the goal of restoring normal tidal hydrology and a more "natural" salt marsh community for this site, the agencies contracted for: (1) development of a model characterizing the existing tidal and salinity regimes and predicting changes resulting from several different restoration scenarios; and (2) collection of ecological and physical data on the marsh to characterize baseline conditions against which to measure post-restoration success. Baseline data collection included surface and pore-water salinity, porewater sulfide, plant community structure and function, marsh soil development, and benthic infauna species abundance and composition.

Findings from these analyses indicate that the project site does not provide the same level of water quality functions, such as sediment and nutrient retention, as adjacent natural marshes that experience tidal inundation. Removal of the dike surrounding the restoration site will result in improved hydrologic connectivity and enhanced water quality functions of this marsh. The site experiences a highly variable salinity regime (0-28 ppt) and is sensitive to rainfall events. The project design calls for the removal of approximately 26,000 cubic yards of material from the existing site and regrading it to a low-marsh elevation. Approximately 3 acres of the site will be replanted with *Spartina alterniflora* and other marsh species tolerant of brackish conditions. In addition, approximately 8 acres will be seeded with a mixture of *Scirpus, Salicornia, Spartina*, and *Juncus* species. Long-term post-restoration monitoring will help evaluate plant species colonization and community succession and provide information for any necessary mid-course corrections.

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Mangrove Assessments as an Indicator of Restoration Success in Die-Off Areas Located Adjacent to Development

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Mangroves have the potential to serve as indicators of the success or failure of restoration efforts. Mangroves surrounding Clam Bay in Naples, Florida (USA) serves as an example. This mangrove system consists of approximately 242.82 hectares (600 acres) of bay and mangrove preserve and is one of the few dynamic estuarine systems remaining in the Cocohatchee-Gordon River Drainage System. Recent, large-scale die-offs of black mangroves suggest that impacts of intense development over the past three decades may be influencing the demise of portions, if not all, of the formerly pristine mangrove forests. In 1999, local government instigated a ten-year restoration project that consisted primarily of improving tidal flow by dredging the main arteries and by channelization within mangrove die-off areas. A long-term mangrove monitoring project was established to assess recovery and growth to gauge restoration success. The primary objectives of the monitoring project were to: 1) Evaluate the general health of the Clam Bay estuary overtime. 2) Gauge mangrove recovery in areas that have died out. 3) Compare pre and post restoration project recovery throughout Clam Bay. To accomplish these goals, semi-annual floristic estimates were conducted at twelve plots scattered throughout Clam Bay. Data were analyzed for species occurrence, growth and recruitment by plot overtime. Results after five years of monitoring indicate that although the large die-off areas in the north and northeast part of this estuary show indications of recovery, areas in the south are show signs of stress and deterioration. Long-term prognosis for the recovery mangroves in this system and subsequently the estuary is guarded. In this case, mangroves served as a useful indicator in evaluating changes in the overall health of the estuary, both spatially and over time and have utility in determining estuarine restoration success.

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Modeling Three-Dimensional Coastal Water Quality with a General Paradigm

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This paper presents the development of a numerical water quality transport model in three-dimensional coastal waters using a general paradigm. The temporal-spatial distribution of water quality is described mathematically with a system of *M* reactive transport equations, one for each of the *M* biogeochemical constituents (species). For each species, its governing advection-dispersion equation is coupled with rate equations of contributing reactions that describe biogeochemical processes. Through the decomposition of the system of species transport equations via Gauss-Jordan column reduction of the reaction network, (1) redundant fast reactions and irrelevant kinetic reactions are removed from the system, which alleviates the problem of unnecessary and erroneous formulation and parameterization of these reactions, and (2) fast reactions and slow reactions are decoupled, which enables robust numerical integrations. The system of reactive transport equations of species are transformed into two sets: algebraic equations (either mass action equations or users' specified) of equilibrium variables and reactive transport equations of kinetic variables. As a result, the model uses kinetic-variables instead of biogeochemical species as primary dependent variables, which reduces the number of transport equations and simplifies reaction terms in these equations. With the reaction-based approach, the model is quite generic and flexible. It embeds most widely used water quality models (such as WASP5, QUAL2E, CE-QUAL-ICM, etc.) as specific examples. With the diagonalization strategy, it makes the inclusion of arbitrary number of fast and kinetic reactions relatively easy, and, more importantly, it enables the formulation and parameterization of reactions one by one. The eutrophication model in WASP 5 is employed, as an example, to demonstrate the flexibility of the general paradigm and the robustness of numerical simulations. Based on this example application, the deficiencies of current practices in water quality modeling are discussed and the actions that must be taken to improve these practices are addressed.

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Tracking the Effects of Salt-Water Encroachment on South Florida Coastal Ecotones using Mollusks

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Many coastal wetland communities of south Florida have been cut off from freshwater sheet flow for decades and are migrating landward due to salt-water encroachment. A paleoecological study using mollusks was conducted to assess the rates and effects of salt-water encroachment due to freshwater diversion and sea level rise on coastal wetland basins in Biscayne National Park.

The study was conducted in a 7.5 km long strip of wetlands that can be divided into five broad vegetation zones that parallel the coastline, including, from the shoreline to the interior, fringing mangrove forest, transitional mangrove forest, dwarf mangrove forest, freshwater gramminoid marsh and freshwater swamp forest. Salinity generally decreases from the coast to interior, with the freshwater wetlands being hydrologically separated from the coastline by a drainage canal constructed in 1960.

We determined habitat affinities of the resident mollusk community by collecting surface assemblages from 226 sites and relating composition to measured salinity and vegetation characteristics. Mollusk distribution was highly correlated with salinity and habitat type allowing for the construction of reliable quantitative models to infer past environmental conditions from mollusks preserved in sediment cores.

Wetland soils were cored to bedrock at 36 locations that were arrayed in transects running perpendicular to the 5 vegetation zones. Cores ranged from 0.5 to 1.5 m deep and most contained surficial mangrove peat overlying marl soil, indicating mangrove encroachment into the shallow coastal wetlands. Chronological calibration using ^{210}Pb confirmed that the transition from marl to peat deposition coincided with the construction of drainage canals in the 1950's and 60's, and also allowed for estimation of basal age of soil formation in the wetland band approximately 2-3000 YBP. Mollusks were abundant throughout the cores and 15 of the 20 most abundant taxa served as indicators of salinity and habitat. Historic accounts coupled with mollusk based inference models indicate (1) increasing salinity levels along the coast and encroaching into the interior with mangroves communities currently migrating westward, (2) replacement of a mixed graminoid-mangrove zone by a dense monoculture of dwarf mangroves, and (3) a confinement of freshwater and freshwater graminoid marsh to landward areas between urban developments and drainage canals. The rate of lateral encroachment of the mangrove-freshwater ecotone ranges from 3-30 m per year, relative to a pre-drainage rate of 0.5 m per year. Plans for rehydrating these basins with freshwater will require high-magnitude diversion from drainage canals and a long-term perspective to restoration.

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The Proposed Panama City – Bay County International Airport Relocation: Wetland Permitting and Mitigation Aspects

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All aspects of state environmental permitting for the proposed Panama City – Bay County International Airport relocation are being addressed through the State of Florida's Ecosystem Team Permitting (ETP) process. Under ETP, the Panama City – Bay County Airport and Industrial District, Bechtel Infrastructure, PBS&J and the Florida Department of Environmental Protection are working together in conjunction with other contributors to holistically address environmental considerations. Wetlands permitting and mitigation form one of the more complex components of the project. The proposed site will provide for current and future airport and related industrial development over a 50-year time-period. Future development is planned over sequential 10-year phases, each corresponding to separate portions of the site. Roughly half of the wetlands on site consist of wet planted pine that has been under intensive timber management for more than 30 years. Other habitats include titi strands, mixed swamps, cypress domes, and flatwoods marshes. The proposed mitigation area comprises roughly 10,000 acres with similar ecological communities, including wet planted pine, but also including natural wet pine flatwoods, tidal marsh, and shoreline habitats not found on the proposed airport site. Unique wetland aspects of the project include: a pro-active wildlife management program which entails monitoring and management of higher quality wetlands (impact avoidance areas) on the proposed project site to address potential wildlife-aircraft strike hazards; a complex temporal and spatial functional assessment of impacts and mitigation credit; and phased mitigation over a 10-15 year time-period. Positive wetland-related benefits resulting from the project will include: substantially more mitigation than required to compensate for impacts at full airport build out; mitigation for secondary impacts far in excess of typical state permitting requirements; voluntary mitigation for non-jurisdictional isolated wetlands; mitigation for wetland avoidance areas that may or may not be affected by wildlife hazard management; restoration of extensive upland buffers (upland pine flatwoods and sandhills); and mitigation implementation and maturity years to decades in advance of future construction phases. The major restoration action in the mitigation area involves the conversion of planted pine timber stands to natural wet pine flatwoods, wet pine savanna, and wet prairie. The ecological enhancement of cypress domes, gum ponds, forested wetland strands, mixed swamps, wet pine flatwoods, flatwoods marshes, and tidal marsh is also planned. The mitigation design phase of the project is currently underway, and includes: photo-interpretation of recent and historic (1940-1950s) aerial photographs, ecological field assessments at roughly 500 field stations, hydrologic assessments at roughly 100 stations, land survey, geotechnical work, installation and monitoring of staff gauges and peizometers, and ecological and engineering design plans. Design plans will address: planted pine harvest and thinning; hydrologic restoration; tree planting (longleaf pine, pond cypress); prescribed fire; wildlife management; exotic control (Chinese tallow, cogon grass, feral hogs); short and long-term ecological monitoring; and long-term ecosystem management. Restoration implementation is scheduled to begin in 2005-2006.

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Airborne Laser Mapping of Mangroves on the Biscayne Bay Coast, Miami, Florida

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Mangroves are an important component of the coastal ecosystem in south Florida. Mangrove trees there underwent major ecological changes in response to sea level rise, weather events such as hurricanes, and human modifications of inland wetland water flow. An accurate inventory of mangrove attributes is essential to detect mangrove changes and to estimate the effect of ongoing hydrologic restoration of Biscayne Bay Coastal Wetlands.

Deriving quantitative measurements of mangrove attributes such as canopy height, tree density, and sub-canopy topography is a challenging task because mangrove areas are usually difficult to reach on the ground. Field survey of mangroves for a large area is logistically very demanding and cost prohibitive. A high-resolution remote sensing method such as airborne LIDAR (LIght Detection And Ranging) offers an accurate and cost-effective alternative to map large areas of mangroves. We present data from an airborne LIDAR survey of Biscayne Bay Coastal Wetland in Miami-Dade County, FL, and demonstrate how this data can be used to produce a better mangrove forest map.

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Nutrients Inputs along Coastal Transects within Everglades National Park, Florida

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In October 2003, the U.S. Geological Survey (USGS) initiated a project to assess flow, salinity, and nutrients along transects from the freshwater wetlands towards the coastal areas of northeastern Florida Bay and the southwestern coast of Everglades National Park (ENP). The Coastal Gradients Project is comprised of ten surface-water monitoring stations and three co-located water-quality platforms to monitor nutrients. The water-quality stations are located along estuarine rivers where no continuous nutrient information was previously available. For example, a new surface-water/water-quality station was constructed upstream of North River near the freshwater transition zone to compliment the existing downstream surface-water station. An additional water-quality platform was constructed at the downstream North River station. These stations will be used to assess nutrient inputs from the freshwater wetlands through the mangrove zone and into Whitewater Bay.

Individual water samples for total phosphorus and total nitrogen are collected over 3-day periods (sub-sample every eighteen hours) using automatic samplers. Samples bottles are pre-treated with sulfuric acid (H_2SO_4) and shipped on ice to the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado every 21 days. Total phosphorus analyses are performed following Environmental Protection Agency method 365.1 (reporting limit 0.004 mg/L), and total nitrogen analyses are performed following the USGS Kjeldahl digestion method (reporting limit 0.10 mg/L). During field trips to service the automatic samplers, multiple vertical samples are collected for the following constituents: total phosphorus, ortho-phosphorus, total nitrogen (ammonia + organic), nitrite, nitrite + nitrate, and ammonia.

Nutrient data is currently being collected by the USGS at the following locations:

1. West Highway Creek (25° 14' 39.94" 80° 26' 51.75")
2. North River (25° 20' 17.82" 80° 54' 48.73")
3. Upstream North River (25° 21' 29.86" 80° 54' 1.53")

These data will be available on the USGS South Florida Information Access (SOFIA) web page (<http://sofia.usgs.gov/>). The USGS water-quality network is a small component of a larger water-quality effort led by South Florida Water Management District and Florida International University. An expanded, long term water-quality network will examine nutrient inputs from the freshwater Everglades to Florida Bay and the Gulf of Mexico and assess the quality of coastal waters as upstream hydrologic systems are restored under the Comprehensive Everglades Restoration Plan (CERP).

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Tracking and Predicting Vegetation Response to Hydrologic Alternatives across an Everglades Landscape Using Artificial Neural Networks

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In response to Everglades restoration management needs, we have initiated a long-term monitoring and modeling project to develop an artificial neural network (ANN) to characterize the effects of restoration alternatives on vegetation community assemblages. This model is intended for use as a support tool for the adaptive management procedures outlined by the Science Subgroup (1994). Using spatial, temporal, and physical characteristics (i.e. pattern, location, size, species composition, soils, elevation, hydroperiod characteristics), the model will be able to forecast the changes in structure of the wetland communities on a landscape scale for multiple hydrologic alternatives. The ability of this model to be integrated with a hydrologic model will also give it the power to hindcast vegetation community structure to pre-restoration and pre-drainage conditions.

The current interim restoration hydrologic regime (IOP-Alt. 7R) inundates our study area, Water Conservation Area 3A, significantly longer than either the previous regime or the natural systems model. Accordingly, we expect the conversion of wet prairies to slough and current sloughs to deepen, affecting their structure and function. The ANN will model the shifts in community compositions and distributions that can be expected with the increased water levels. High-resolution satellite imagery and community level field data-species composition, biomass, and density-will provide input and support for the model. The predictive power of the ANN combined with the spatial aspect of this model will make it an valuable ecological assessment tool for restoration of the Everglades ecosystem.

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Author Index

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