NCER 2016

National Conference on Ecosystem Restoration

Ecosystem Restoration in Action

River of Grass - Everglades National Park

PROGRAM & ABSTRACTS

April 18-22, 2016 | Coral Springs, FL

Integrating Partnerships Between Science and Management for Sustainable Ecosystem Restoration.

UF | IFAS
UNIVERSITY *of* FLORIDA

NCER 2016

National Conference on Ecosystem Restoration

Ecosystem Restoration in Action

Breakout Sessions

Great Cypress
Royal Poinciana
Ibis
Egret
Sandpiper

Plenary Session

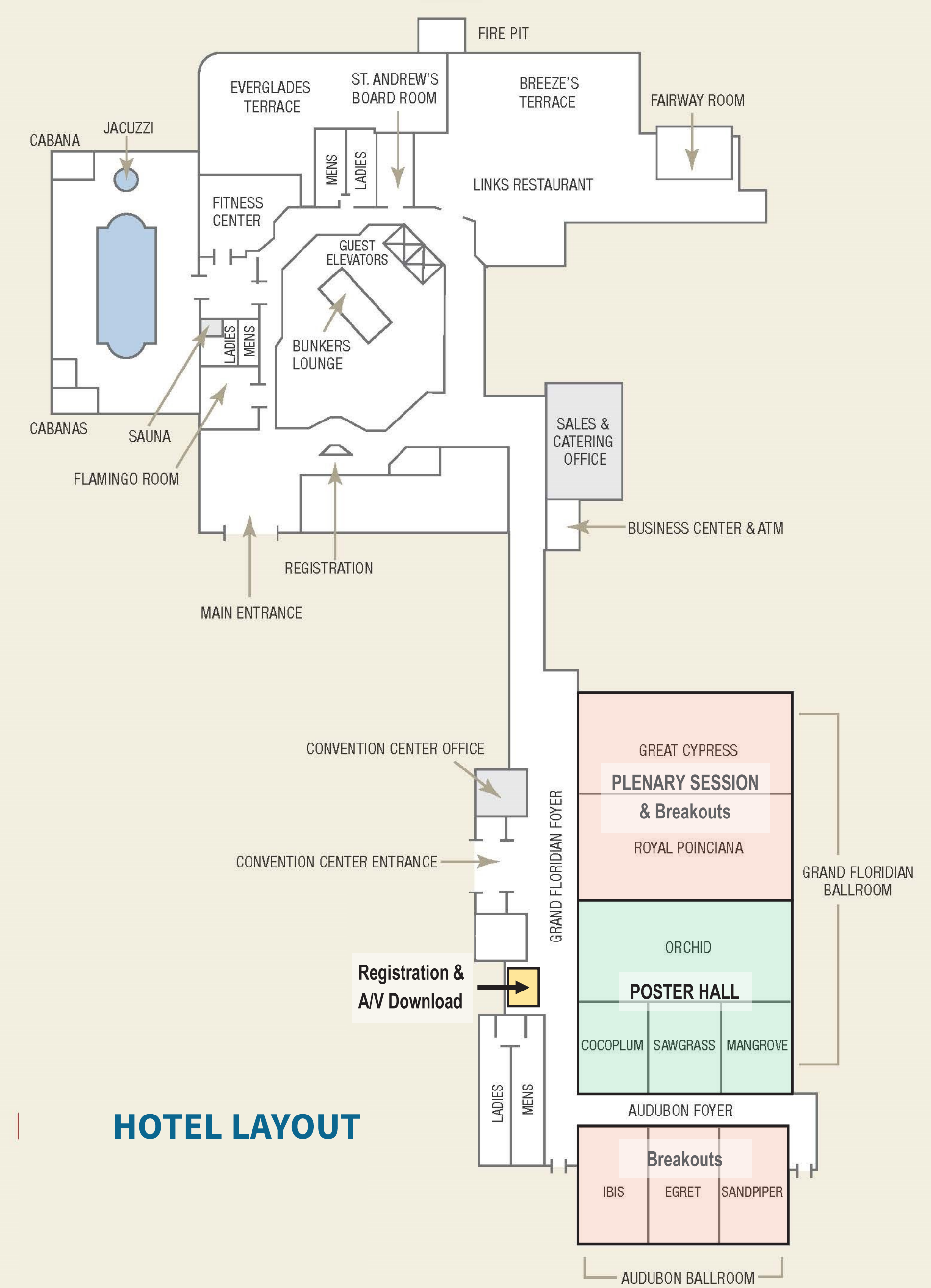
Great Cypress &
Royal Poinciana

Posters, Sponsor Displays & Refreshments

Orchid Ballroom
(Orchid, Cocoplum, Sawgrass & Mangrove)

Registration & A/V Download

Palm Room &
Grand Floridian Foyer



HOTEL LAYOUT

NCER 2016

National Conference on Ecosystem Restoration

Ecosystem Restoration in Action

PROGRAM & ABSTRACTS

April 18-22, 2016

Coral Springs, Florida USA

www.conference.ifas.ufl.edu/NCER2016

ABOUT NCER

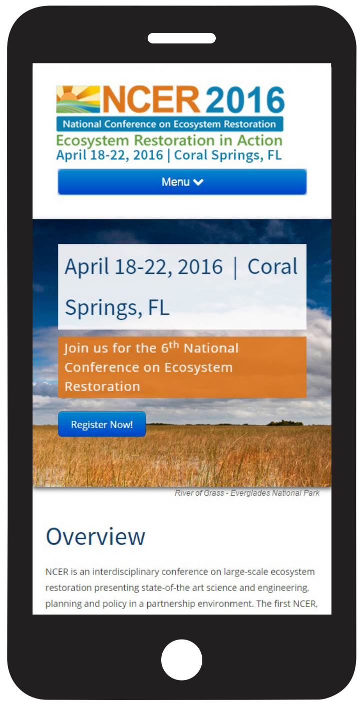
NCER is an interdisciplinary conference on large-scale ecosystem restoration presenting state-of-the art science and engineering, planning and policy in a partnership environment. The first NCER, held in Orlando, FL (2004), led to successful conferences in Kansas City, MO (2007), Los Angeles, CA (2009), Baltimore, MD (2011), and Chicago (2013). NCER brings together scientists, engineers, policy makers, planners and partners from across the country actively involved in large-scale ecosystem restoration.

Since its inception, NCER has become the preeminent conference on ecosystem restoration in the US. Today, we are in a new era, where resources are tight. Renewed vigilance on the use of public funding requires that we demonstrate progress in achieving restoration goals, clearly prove its value, efficiently and effectively share lessons learned and provide better coordination among all stakeholders ensuring the best use of future funding to achieve results.

Centuries of unsustainable activities have damaged and/or eliminated the freshwater, marine, and terrestrial environments that provide vital services to our economies, societal values, and support a diversity of wildlife and plants. This conference aims to provide a venue for ecosystem restoration professionals to convene over efforts to reverse environmental degradation by renewing and/or restoring degraded or destroyed ecosystems and habitats.

Progress in restoring various ecosystems and habitat types has been made around the nation in the 11 years since the first NCER conference was held. NCER 2016 is a forum to share results on what restoration fundamentals and practices have worked and bring new focus on those challenges that remain. It will also allow for collaboration across agencies, non-governmental organizations, and the private sector, bringing together in one location the nation's leading experts in ecosystem restoration to ford new insights and advances to restore and protect ecosystems and habitats nationwide.

We are glad you could be a part of NCER 2016 and we encourage you to get involved in future NCER's by organizing a session and contributing to program development. Thank you for joining us.



GO MOBILE!

Add the NCER 2016 website to your mobile device's home screen for easy access to conference information including our **detailed mobile agenda.**

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www.conference.ifas.ufl.edu/ncer2016

REMEMBER TO JOIN US ON SOCIAL MEDIA!

Folow us on **Twitter @NCERConference** and like us on **Facebook** to see our posts.

Use the hashtag **#NCER2016** to stay connected with your fellow conference attendees and ecosystem restoration professionals.

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NCER 2016

National Conference on Ecosystem Restoration

Ecosystem Restoration in Action

On behalf of the committee, we'd like to take a moment to say welcome to the 6th National Conference on Ecosystem Restoration (NCER 2016).

Since 2004, NCER has been providing a forum for scientists, engineers, practitioners, and policy makers involved in ecosystem restoration from around the country to gather, talk to one another, learn from each other, and enhance collaboration. Outcomes from past NCER meetings have pushed the field of ecosystem restoration forward on a national-level. This year is shaping up to continue the momentum with a jam packed program of presentations, posters and plenaries addressing today's hot topics and issues. The success of every conference is dependent on those who attend – so thank you for coming and wanting to participate at NCER.

Our location here in Coral Springs provides a perfect opportunity to share with you a little bit about the critical issues surrounding restoration of south Florida's beautiful Everglades, one of the world's largest intergovernmental ecosystem restoration efforts of our time. Recognized internationally, the Everglades encompasses nearly 18,000 square miles of the southern tip of the Florida peninsula – from the Kissimmee River basin all the way south to the shores of Florida Bay and the Gulf of Mexico. It's also an ecosystem in peril. Historically this vast, free-flowing, shallow river of grass provided clean water and pristine habitats, supported numerous wading and migratory birds, as well as Florida Panthers, manatees and deer. Today, as a result of the massive Central and South Florida (C&SF) Project completed in the mid-20th century to provide flood protection and water supply for the region, as well as drainage of large areas to support agricultural activities, the Everglades are only a remnant of their past. More than 1,700 miles of canals and levees constructed as part of the C&SF Project and widespread drainage for agriculture vastly changed the landscape, interrupting the Everglades' natural sheetflow, sending valuable freshwater to sea, and causing eutrophication from elevation phosphorus loading. Beginning in the late 1990s, there was an increased recognition and appreciation of the importance and uniqueness of the Everglades system, resulting in the Comprehensive Everglades Restoration Plan (CERP) and companion Long-Term Plan for Everglades Restoration (LTP) that together formed a path to restore the defining characteristics of a healthy Everglades ecosystem. With recent updates, as well as augmentations by several complementary state and Federal initiatives and programs, the success of CERP, the LTP and their companion programs are clearly evident through generations of restoration projects that have been implemented, are under construction, or are currently being planned and designed.

While listening to some of the successes being told of Everglades restoration this week, remember that NCER 2016 is an opportunity for all of us to meet new colleagues, reunite with old ones, and learn what ecosystem restoration programs individuals are working on across the country. NCER attendees are engaged at a variety of levels in most large scale ecosystem restoration programs around the nation, including the coastal Gulf of Mexico, the Sacramento-San Joaquin Bay-Delta, the Platte River, the upper Mississippi and Missouri rivers, the Great Lakes, and Chesapeake Bay. The Conference Planning and Program Committees worked hard to develop a diverse program that includes a stellar line-up of political leaders, agency officials, visionaries and restoration professionals who are speaking in three plenary and five concurrent sessions – yielding a full variety of excellent presentations and opportunities to exchange ideas and discuss strategies to address common problems that we all face. We hope you enjoy what has been put together and have an opportunity to teach others about what you do and where you work.

NCER was originally initiated by the University of Florida, U.S. Geological Survey, U.S. Army Corps of Engineers and U.S. Department of Agriculture's Natural Resources Conservation Service. Since that time, NCER has become recognized as the event to attend if you are involved in large-scale ecosystem restoration in the US. NCER also expanded its reach through collaboration with the Society for Ecological Restoration (SER). In 2014, NCER and SER held a joint Conference on Ecological and Ecosystem Restoration (CEER) in New Orleans, LA, where SER also launched its Large-Scale Ecosystem Restoration Section (LERS). LERS provides a specialized forum for exchanging ideas, approaches and lessons learned, and sharing data relevant to the field of large-scale ecosystem restoration. A number of LERS' 240 members were highly involved in the planning of NCER 2016 and we invite you to learn more about SER and LERS while you're here in Coral Springs. You can do so by coming to the LERS meeting on Wednesday at 5:30 PM in the main ballroom, and for some informal networking afterward on the back patio of the hotel.

Finally, a few words of appreciation. We would like to first thank our generous Sponsors listed on page XX, whose financial support is critical to making NCER a reality. So please make time to stop by and visit with each of our sponsor representatives as their displays in the exhibit hall, and take a moment to thank them for their support. We are also grateful to those who gave of their time and expertise to organize and moderate sessions, and to share their expertise with us. Further, we would be remiss without thanking all of the many individuals recognized on page XX, who volunteered their personal time and energy to organize and plan this conference. And of course, we would also like to thank those who submitted abstracts, are giving talks, presenting posters, and participating in panel sessions. Were it not for you and the work you do, we would not be here.

Have a great week, enjoy yourself, and when you leave, we trust you will take with you new information, new connections, and new tools and knowledge you can use to advance ecosystem restoration in your neck of the woods.

On behalf of the Planning Committee,

Andy LoSchiavo and **Rob Daoust**, *Conference Co-Chairs*

CONFERENCE COMMITTEES

Scientific Advisory Panel

A diverse panel of advisors provided technical input and guided the overall programmatic direction of NCER to ensure coverage of the most critical issues and emerging topics facing large scale restoration programs across the US.

Nick Aumen, *Regional Science Advisor- South Florida*, US Geological Survey, Davie, FL

Don Boesch, *President*, Center for Environmental Science, University of Maryland, Cambridge, MD

Al Cofrancesco, *Technical Director*, Civil Works, Environmental Engineering and Sciences at the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS

Shannon Estenoz, *Director of Everglades Restoration Initiatives*, Department of Interior, Davie, FL

Randy Fiorini, *Chair*, Delta Stewardship Council, Delhi, CA

Campbell Ingram, *Executive Officer*, Sacramento-San Joaquin Delta Conservancy, West Sacramento, CA

Brad Inman, *Acting Chief*, Projects Branch, New Orleans District, U.S. Army Corps of Engineers (USACE), New Orleans, LA

Robert (Bob) Johnson, *Director*, South Florida Natural Resources Center, Everglades National Park, Homestead, FL

Suzette Kimball, *Acting Director*, U.S. Geological Survey, Reston, VA

Scott Phillips, *Chesapeake Bay Coordinator*, U.S. Geological Survey, Baltimore, MD

Ramesh Reddy, *Chair*, Soil and Water Science Department, University of Florida/IFAS, Gainesville, FL

Denise Reed, *Chief Scientist*, The Water Institute, Baton Rouge, LA

Fred Sklar, *Director and Section Administrator*, Everglades Systems Assessment (ESA) Section, South Florida Water Management District (SFWMD)

Buck Sutter, *Director*, Office of Habitat Conservation at NOAA, Washington DC Metro Area

Planning Committee

Nick Aumen, *Regional Science Advisor - South Florida*, US Geological Survey, Davie, FL, and Chair, NCER 2016 Field Trip Committee

Ryan Clark, The Water Institute, Baton Rouge, LA

Robert Daoust, Arcadis, Co-Chair, Planning & Program Committee, Plantation, FL

Terry Doss, Biohabitats, Glen Ridge, NJ

Matt Grabau, *Restoration Scientist*, Colorado River Delta Program, Sonoran Institute, Tucson, AZ

Matthew Harwell, *Chief*, Ecosystem Assessment Branch, Gulf Ecology Division, National Health and Environmental Effects Research Laboratory, US EPA, Office of Research and Development, Gulf Breeze, FL

Andrew "Andy" LoSchiavo, US Army Corps of Engineers (USACE) Jacksonville District, Conference Volunteer Co-Chair, Planning & Program Committee, Jacksonville, FL

Beth Miller-Tipton, University of Florida/IFAS Office of Conferences and Institutes (OCI), Gainesville, FL

Cheryl Ulrich, *Ecosystem Restoration Department Manager*, Dewberry, Atlantic Beach, FL

Program Committee

Nick Aumen, *Regional Science Advisor- South Florida*, US Geological Survey, Davie, FL

Jamie Bartel, *Senior Project Manager*, CDM Smith, Inc, Baton Rouge, LA

Ryan Clark, *Research Associate*, The Water Institute of the Gulf, Baton Rouge, LA

Georganna Collins, *Chief Landscape Architect*, Ecology and Environment Inc, Houston, TX

Robert Daoust, *Associate Vice President*, Arcadis, Plantation, FL, Committee Co-Chair

Paul Davis, *Principal Environmental Scientist*, GZA GeoEnvironmental, Springfield, MA

Heida Diefenderfer, *Senior Research Scientist*, Pacific Northwest National Laboratory, Sequim, WA

Terry Doss, *Bioregional Team Leader/Senior Ecologist*, Biohabitats, Glen Ridge, NJ

Kenneth Duffy, *Program Manager*, BEM Systems, Baton Rouge, LA

Matt Grabau, *Restoration Scientist*, Colorado River Delta Program, Sonoran Institute, Tucson, AZ

Arlene Hopkins, *Educator & Architect, Resilience Strategist*, Arlene Hopkins & Associates, Santa Monica, CA

Fahmida Khatun, *Senior Engineer*, South Florida Water Management District (SFWMD), West Palm Beach, FL

Andrew (Andy) LoSchiavo, *Adaptive Management Coordinator* - Biologist Planning and Policy Division - Environmental Branch - South Florida Section U.S. Army Corps of Engineers - Jacksonville District, Jacksonville, FL, Committee Co-Chair Volunteer

Natalie Peyronnin, *Director of Science Policy*, Environmental Defense Fund, Washington DC

Rich Pfingsten, *Sr. Ecological Restoration Scientist*, Parsons Brinckerhoff, Baltimore, MD

Jennifer Pratt Miles, *Senior Mediator and Program Manager*, Meridian Institute, Dillon, CO

Estelle Robichaux, *Restoration Project Analyst*, Environmental Defense Fund, Washington DC

Jason Shackelford, *Manager*, Ramboll Environ, Baton Rouge, LA

Chadwin Smith, *Director of Natural Resources Decision Support*, Headwaters Corporation, Kearney, NE

Tom St Clair, *Senior Scientist*, Louis Berger, Jacksonville, FL

Kathryn Thomas, *Ecologist*, US Geological Survey, Tucson, AR

Cheryl Ulrich, *Ecosystem Restoration Department Manager*, Dewberry, Atlantic Beach, FL

Chris Warn, *Senior Project Manager*, Dewberry, Sarasota, FL

Field Trip Committee

Nick Aumen, *Regional Science Advisor - South Florida*, US Geological Survey, Davie, FL

Eric Cline, *Environmental Scientist*, South Florida Water Management District (SFWMD), West Palm Beach, FL

Robert (Bob) Johnson, *Director*, South Florida Natural Resources Center, Everglades National Park, Homestead, FL

Fred Sklar, *Director and Section Administrator*, Everglades Systems Assessment (ESA) Section, South Florida Water Management District (SFWMD), West Palm Beach, FL

ABOUT SER & LERS

About the Society for Ecological Restoration

SER is an international nonprofit organization dedicated to promoting ecological restoration as a means of sustaining the diversity of life on Earth and re-establishing an ecologically healthy relationship between nature and culture. SER believes that active, science-based restoration of damaged and degraded ecosystems, in combination with conservation and effective management of key natural areas, is vital to maintaining biological diversity and ecosystem goods and services. Since its founding in 1988, SER has strived to advance the science and practice of restoration by supporting the work of researchers and practitioners around the world; disseminating technical guidance and information on best practices; increasing awareness of, and public support for, restoration; and contributing to policy discussions at the national and international level.

SER has over 2,500 members in more than 70 countries. The Society also has 14 Regional Chapters serving members across Australasia, Asia, North America, and Europe; nine Student Associations serving the United States and Canada; and one Thematic Section serving members interested in large-scale ecosystem restoration. SER's diverse membership includes scientists and practitioners from indigenous groups, the corporate sector, public agencies, conservation groups, university research departments, and environmental consulting firms. SER members are natural and social scientists, policy makers, program managers, environmental engineers, urban and regional planners, landscape architects, educators, and community advocates.

Visit us at the SER/LERS table in the Poster Hall to learn more about the Society | www.ser.org

Join Your Local SER Chapter

The Society works to support restoration at regional and local levels through its 14 regional chapters in Australasia, Asia, North America, and Europe. To learn more about a chapter in your region or to become a member of your local chapter, visit: www.ser.org/membership/chapters.

- **SER Australasia**
  Serving members in throughout Australasia
- **SER Europe**
  Serving members in Europe and the British Isles
- **SER Central Rockies**
  Serving members in Colorado and Wyoming
- **SER Great Basin**
  Serving members in Utah, Nevada, southern Idaho, southeastern Oregon and eastern California
- **SER Mid-Atlantic**
  Serving members in Maryland, New Jersey, New York, Pennsylvania, Delaware, Virginia, West Virginia and the District of Columbia
- **SER Midwest-Great Lakes**
  Serving members in Indiana, Illinois, Ohio, Michigan, Minnesota and Wisconsin
- **SER New England**
  Serving members in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut
- **SER Northwest**
  Serving members in the Cascadia Bioregion, including Alaska, Idaho, Northern California, Montana, Oregon and Washington
- **SER Southeast**
  Serving members in Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina and Tennessee
- **SER Southwest**
  Serving members in Arizona, New Mexico, Utah, southern Nevada and southern California
- **SER Texas**
  Serving members in Texas
- **SER Ontario**
  Serving members in Ontario, Canada
- **SER Western Canada**
  Serving members in British Columbia, Alberta, Saskatchewan, Manitoba and the Yukon and NorthwestTerritories
- **SER Nepal**
  Serving members in Nepal

SER Large-scale Ecosystem Restoration Section (LERS)

Beginning in 2004, a group of large-scale ecosystem restoration practitioners from across the United States began holding the biennial National Conference on Ecosystem Restoration (NCER) under the leadership of the University of Florida, US Geological Survey, the Natural Resources Conservation Service and US Army Corps of Engineers. NCER arose out of the need to share state-of-the art science, best management practices, policy perspective, and innovative ideas related specifically to large-scale, federally funded ecosystem restoration projects. In October 2013, the NCER community of practice formally organized as the Large-scale Ecosystem Restoration Section (LERS) within the Society for Ecological Restoration. SER's first Thematic Section, LERS has over a decade of experience uniting and amplifying the many voices of the large-scale restoration community in order to more effectively influence policy, minimize duplication of efforts, and maximize financial resources for large-scale efforts. NCER will continue as a biennial conference of LERS.

LERS addresses ecosystem restoration themes ranging from defining and measuring success, adaptive management, adaptive governance, and linking science with management decision-making. Current issues include novel ecosystems, ecosystem goods and services, urban ecosystem restoration, and climate change and ecosystem resilience. The mission of the LERS community of practice is to:

- *Advance public education and enlightenment concerning large-scale ecosystem resources*
- *Provide a forum for an interchange of ideas, approaches, lessons learned, and data developed relevant to planning, policy, science, and engineering of large-scale ecosystem restoration*
- *Develop and encourage large-scale ecosystem restoration as a discipline by supporting student education, curriculum development, and research; and*
- *Encourage and evaluate the educational, scientific, engineering, and technological development and advancement of all branches of large-scale ecosystem restoration and practice.*

ANNOUNCING: Meeting of LERS – THE LARGE-SCALE ECOSYSTEM RESTORATION SECTION OF SER
Wednesday, April 20th | 5:15 - 6:00 PM | Grand Cypress/Royal Poinciana Ballroom
Please join us for a brief meeting of LERS where you'll have a chance to learn more about us and meet the leadership.

SER members can join LERS for just $10 per year. Learn more & affiliate:

chapter.ser.org/lers

A SPECIAL THANK YOU TO OUR SPONSORS

Without their generous support, this conference would not be possible.

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Society of Wetland Scientists

Tetra Tech

The Water Institute of the Gulf

U.S. Geological Survey

University of Florida/IFAS

University of Maryland Center for Environmental Science

DEDICATED SESSION ORGANIZER RECOGNITION

1 – **Mr. Ryan Clark**, The Water Institute of the Gulf, Baton Rouge, LA

2 – **Dr. Nick Aumen**, USGS, Davie, FL

5 – **Dr. Gary Johnson**, Pacific Northwest National Laboratory, Portland, OR

6 – **Mr. Mark Wingate**, U.S. Army Corps of Engineers, New Orleans District, New Orleans, LA

7 – **Mr. Scott Phillips**, U.S. Geological Survey, Baltimore, MD

8 – **Mr. Christopher Warn**, Dewberry, Sarasota, FL

10 – **Mr. Patrick Pitts**, U.S. Fish and Wildlife Service, Vero Beach, FL

11 – **Dr. Lynn Wingard** and **Dr. Christopher Bernhardt**, U.S. Geological Survey, Eastern Geology & Paleoclimate SC, Reston, VA

12 – **Dr. David Krabbenhoft**, U.S. Geological Survey, Wisconsin Water Science Center, Middleton, WI

13 – **Prof. Thomas Ankersen**, University of Florida, College of Law, Gainesville, FL

14 – **Mr. Leo Lentsch**, ICF International, Georgetown, SC

15 – **Mr. Robert Baron**, Tetra Tech, Boynton Beach, FL

16 – **Dr. Lisa Wainger**, University of Maryland, Solomons, MD

17 – **Ms. Cheryl Ulrich**, Dewberry, Jacksonville, FL

18 – **Mrs. Fahmida Khatun**, South Florida Water Management District, Operations, Engineering and Construction Division, West Palm Beach, FL

19 – **Dr. Craig Palmer**, CSC, Science and Engineering Mission Support, Alexandria, VA

20 – **Dr. Christy Foran**, U.S. Army Corps of Engineers, ERDC, Environmental Laboratory, Concord, MA

21 – **Mr. Judy McCrea**, U.S. Army Corps of Engineers, South Pacific Division, San Francisco, CA

22 – **Mr. Tim Purinton**, Division of Ecological Restoration, Massachusetts Department of Fish and Game, Boston, MA

23 – **Mr. Andrew LoSchiavo**, U.S. Army Corps of Engineers, Jacksonville District, Planning, Jacksonville, FL

24 – **Mr. David Hanson**, HansonRM, Blaine, WA

25 – **Dr. Fred Sklar**, South Florida Water Management District, Everglades Assessment, West Palm Beach, FL

26 – **Mr. Karim Belhadjali**, Coastal Protection and Restoration Authority of Louisiana, Baton Rouge, LA

27 – **Ms. Patricia Gorman**, South Florida Water Management District, West Palm Beach, FL

28 – **Ms. Stacie Auvenshine**, U.S. Army Corps of Engineers, Jacksonville District, Planning, Jacksonville, FL

29 – **Dr. Matt Harwell**, US EPA, Office of Research and Development, Gulf Ecology Division, Gulf Breeze, FL

30 – **Dr. Colin Saunders**, South Florida Water Management District, West Palm Beach, FL

31 – **Dr. Michael Donahue**, AECOM, National Coastal and Ecosystem Restoration Practice, Southfield, MI

32 – **Ms. Sarah Barmeyer**, National Parks Conservation Association, Washington, DC

33 – **Dr. Anna Wachnika**, Southeast Environmental Research Center, Florida International University, & NOAA, Miami, FL

35 – **Mr. Joel Blomquist**, U.S. Geological Survey, Baltimore, MD

37 – **Dr. David Kaplan**, University of Florida, Engineering School of Sustainable Infrastructure and Environment, Gainesville, FL

38 – **Ms. Kelly Smalling**, U.S. Geological Survey, Lawrenceville, NJ

39 – **Mr. David Stites**, Taylor Engineering, Inc., Environmental Services, Jacksonville, FL

40 – **Mr. Paul Conrads**, U.S. Geological Survey, SAWSC, Columbia, SC

41 – **Ms. Cynthia Edwards**, Wildlife Management Institute, Jackson, MS

43 – **Dr. Ehab Meselhe**, The Water Institute of the Gulf, Natural Systems Modeling and Monitoring, Baton Rouge, LA

44 – **Ms. Marcia Fox**, Delaware Department of Natural Resources and Environmental Control, Watershed Stewardship, Dover, DE

45 – **Ms. Georganna Collins**, Ecology and Environment, Inc., Houston, TX, and **Mr. Andrew LoSchiavo**, U.S. Army Corps of Engineers, Jacksonville District, Planning, Jacksonville, FL

PLENARY SESSION DESCRIPTIONS

Tuesday, April 19, 2016

8:00 AM	Opening Remarks – **Rob Daoust**, ARCADIS, *Conference Co-Chair*
8:10 AM – 8:20 AM	Welcome Address – **Jack Payne**, UF/IFAS, *Vice President for Agriculture and Natural Resources*
8:20 AM – 10:00 AM	**The Restoration Story Part One:** Setting the Stage – Federal and State Large Scale Ecosystem Restoration: Implementation, Political Challenges and Lessons Learned

Session Description

This session will facilitate dialogue between the Federal and State representatives of several large-scale ecosystem restoration efforts, including the Everglades, Louisiana's coastal area, the Great Lakes, Chesapeake Bay and the California Delta. Implementation of these programs has identified a number of lessons learned related to improved cooperation at the State and Federal levels while dealing with implementation and political challenges. The challenges are numerous, including both programmatic and project-specific, technical and policy, budgetary, and organizational. Programmatic challenges include implementing a comprehensive restoration effort with multiple interdependent projects while still developing and revising guidance at the highest levels of government – for example, funding, coordination, and maintaining science programs to support restoration planning, implementation, and accountability in supporting decision-making and communication of restoration results and options for improvements. Inherent cultural differences and organizational structures between implementing partners have made communication and collaboration vital in overcoming implementation challenges. Attendees will learn what challenges have been addressed and find out more about the direction of future restoration programs to confront challenges and/or implement recent lessons learned.

Organizer

- **Andrew (Andy) LoSchiavo**, *Adaptive Management Coordinator and Senior Biologist*, Planning and Policy Division, Environmental Branch, South Florida Section, U.S. Army Corps of Engineers - Jacksonville District, Jacksonville, FL

Facilitator

- **Donald Boesch**, *Professor of Marine Science and President*, University of Maryland Center for Environmental Science, Cambridge, MD

Panelists

- **Shannon A. Estenoz**, *Director*, Office of Everglades Restoration Initiatives, U.S. Department of the Interior, Davie, FL
- **Rainer Hoenicke**, *Deputy Executive Officer*, Science Program, Delta Stewardship Council, Sacramento, CA
- **Alan D. Steinman**, *Director*, Robert B. Annis Water Resources Institute (AWRI), Grand Valley State University, Muskegon, MI
- **Ann Swanson**, *Executive Director*, Chesapeake Bay Commission, Annapolis, MD
- **Mark R. Wingate**, *Deputy District Engineer for Programs and Project Management Executive Office*, New Orleans District, U.S. Army Corps of Engineers (USACE), New Orleans, LA

Wednesday, April 20, 2016

8:00 AM – 10:00 AM	**The Restoration Story Part Two**: Linking Science to Decision Making & Governance

Session Description

This session will facilitate dialogue between individuals with diverse perspectives on linking science to decision-making. The panel objectives are to highlight cases in which science has successfully supported decision making, illustrate why science and adaptive management are essential to restoration, and highlight the need to effectively communicate science to decision makers and the public. Panelists will share their stories and successes about using scientific data and analysis to inform decision-making in national-level restoration and management programs, including: the Rangeland Fire Management Strategy which entails multi-stakeholder efforts to restore the sagebrush steppe; the Great Lakes Restoration Initiative, the federal program to fund protection and restoration of the Great Lakes ecosystem; nutrient and hydrologic restoration strategies for Everglades recovery; and Minute 319, a creative approach to modifying Mexico-U.S. hydro-relations over the Colorado River. Development of these project plans has yielded numerous lessons learned about integrating science into the governance process at the state, national, and international level.

Organizers

- **Nicholas G. Aumen**, *Regional Science Advisor - South Florida*, US Geological Survey, Davie, FL -and-
- **Matt Grabau**, Sonoran Institute, Tucson, AZ

Facilitator

- **Neil Santaniello**, Florida Atlantic University (FAU), School of Communication and Multimedia Studies, Boca Raton, FL

Panelists

- **Alyssa Dausman**, *Science Director*, Gulf Coast Ecosystem Restoration Council, Bay Saint Louis, MS
- **Suzette M. Kimball**, *Director*, US Geological Survey, Reston, VA
- **Susan Newman**, *Senior Scientific Section Lead*, Everglades System Assessment Section, South Florida Water Management District (SFWMD), West Palm, FL
- **Jennifer Pitt**, *Director*, Colorado River Project, National Audubon Society, Boulder, CO
- **Mike Shriberg**, *Great Lakes Regional Executive Director for the National Wildlife Federation*, Merrifield, VA

Thursday, April 21, 2016

8:00 AM – 10:00 AM	**The Story Continues**: Ecosystem Restoration as a Tool for Enhancing Resiliency and Ecosystem Services

Session Description

Resiliency is an evolving topic. This session of invited experts will examine where science has moved from theoretical to practical applications in preparing for climate change. We will examine what questions we have been asking about resiliency, find out if we have progressed toward answers, and identify what new questions we should be asking. What is being done at the federal level? How are we prioritizing what is restored and what is not? Panelists will further discuss the role of quantifying benefits and valuing of ecosystem services to advance funding of restoration projects as we prepare for a more resilient future.

Facilitator & Organizer

- **Carl D. Shapiro**, *Chief*, Science and Decisions Center, U.S. Geological Survey, Reston, VA

Panelists

- **Sarah Ryker**, *Acting Deputy Assistant Secretary for Water and Science,* Department of the Interior, Washington D.C. Metro Area
- **Susan Wachter**, Albert Sussman *Professor of Real Estate*, and *Professor of Finance* at The Wharton School of the University of Pennsylvania; *Director* for the Wharton GeoSpatial Initiative and Lab; *Co-director*, Penn Institute for Urban Research; and *Co-director*, Spatial Integration Laboratory for Urban Systems at the University of Pennsylvania
- **David Waggonner**, *President*, Waggonner and Ball, New Orleans, LA
- **Lisa Wainger**, *Research Professor*, University of Maryland, Center for Environmental Science, Solomons, MD

CLOSING KEYNOTE PRESENTATION

Carlton Ward, Jr., Conservation Photographer, Clearwater, FL

Friday, April 22, 2016 | 9:00am – 10:30am

Connecting, Protecting and Restoring

One of the most visible advocates for taking action now to provide the missing land and water links for cross-Florida wildlife corridors, Carlton will share photos from two 100-day expeditions across two proposed Florida wildlife corridors, highlighting the importance of connecting, protecting, and restoring corridors of conserved lands and waters essential for the survival of Florida's diverse wildlife.

Capturing Our World

An environmental photojournalist with graduate training in ecology and anthropology, Carlton Ward aims to promote conservation of natural elements and cultural legacies. For his first book, The Edge of Africa, Carlton spent eight months in the tropical rainforests of Gabon, documenting the unseen wonders of life at the edge of the African continent. Carlton recognizes the power of photographs to influence public perceptions and inspire change. Conservation Photography is a window that sheds light on the people, places and issues that demand our attention so that together, we can ensure their survival.

Join Us!

Don't miss this inspiring presentation and exquisite photography showcase capturing the essence of natural areas in Florida and beyond — highlighting the very species, habitats, ecosystems, and entwined natural/human systems we are trying to restore, enhance, and maintain for our future generations.

Book Signing

Following his presentation, stay for a meet and greet with Carlton. You will also have an opportunity to purchase one or more of his bound photography collection books and have it personally autographed. These three books will be on showcase at the presentation: Florida Cowboys: Keepers of the Last Frontier, Florida Wildlife Corridor Expedition: Everglades to Okefenokee, and The Forgotten Coast: Florida Wildlife Corridor Glades to Gulf Expedition.

www.carltonward.com

UF|IFAS UNIVERSITY of FLORIDA

Thank you to UF/IFAS for sponsoring this Closing Keynote Presentation.

SESSION DESCRIPTIONS

Sessions 1 - 45

1 - Large Scale Ecosystem Restoration Planning

Tuesday, April 19, 2016 | 10:30am - 12noon | Great Cypress

This session presents key strategies and recent developments for large-scale ecosystem restoration, focusing on optimizing success of planning, funding and stakeholder engagement. The focus will be on applying strategies and lessons learned from one ecosystem to another, with a presentation on water quality degradation of Rio de Janeiro's Guanabara Bay, past failed efforts to achieve restoration, and development of a multi-stakeholder long-term restoration plan that will be a successful legacy of Rio's 2016 Olympic games. An overview will be presented of how projects can successfully compete for funding in a changing political climate, how to influence the process along the way, and what the future might hold for ecosystem restoration in the Corps of Engineers. Gulf Coast Ecosystem Restoration Council's accomplishments in getting implementable restoration projects approved and funded amid numerous challenges will also be discussed. The final presentation will provide an overview of the RESTORE Act of 2012 and how Florida counties are beginning to implement its provisions.

2 - Challenges and Science Needs of Managing and Conserving Habitat in the Northern Everglades

Tuesday, April 19, 2016 | 10:30am - 12noon | Royal Poinciana

The northern most remnant of the historical Everglades is managed by the U.S. Fish and Wildlife Service as the Arthur R. Marshall Loxahatchee National Wildlife Refuge (ARMLNWR). Management of this freshwater system presents many challenges relevant to the restoration of freshwater wetland habitats. This session will as serve the ARMLNWR 14^{th} Annual Science Workshop with the purpose of highlighting challenges and science needs linked to management. ARMLNWR provides a relevant case study regarding the conservation and restoration of an essential nutrient-limited freshwater wetland system that may be used as a model for wetland restoration around the world.

3 - Use of Oysters as Living Shorelines for Coastal Protection

Tuesday, April 19, 2016 | 10:30am - 12noon | Ibis

The use of oyster reefs for shoreline protection aids in addressing erosion in lower energy situations by providing long-term protection through strategic placement of structural and organic materials, while also enhancing natural processes. This session will provide information on implementing oyster reef projects and how to maximize their effectiveness for protecting shorelines, as well as providing a review of factors which hinder the widespread adoption of these structures for coastal protection.

4 - Evaluating Restoration through Experimental Replication of Ecological Processes

Tuesday, April 19, 2016 | 10:30am - 12noon | Egret

This session will highlight how the experimental replication of ecological processes can be used to assess restoration techniques and outcomes. It will explore how periodic monitoring and analysis can feed back to improve project outcomes. Planning and implementation of habitat rehabilitation and enhancement projects and the habitat models used to justify them will be presented, as well as the use of active management to accelerate restoration in areas that may not be restored by water management alone. This session will show how the experimental replication of ecological processes helped plan and manage the reintegration of nature into dense urban environments.

5 - Ecosystem Restoration in the Columbia River Basin

Tuesday, April 19, 2016 | 10:30am - 12noon | Sandpiper

This session will feature recent habitat restoration and fish population efforts funded by the Bonneville Power Administration, an evaluation of restoration effectiveness to benefit juvenile salmon, a lessons learned analysis of improving engineering designs and management actions in large-scale ecosystem restoration programs, and the value of incorporating adaptive management for the Columbia and Missouri River basins.

6 - Advancing Louisiana Coastal Restoration Using Work-In-Kind and Cross-Crediting Legislation

Tuesday, April 19, 2016 | 1:30pm - 3:00pm | Great Cypress

The purpose of this session is to provide the status of the Louisiana Coastal Area (LCA) Program and discuss the implications of cross-crediting, as authorized in WRRDA 2014, on advancing LCA projects to construction. LCA consists of 15 large, coastal Louisiana restoration projects. The State of Louisiana has initiated construction of certain LCA projects in advance of U.S. Army Corps of Engineers (USACE) receipt of Federal funding. WRRDA 2014 authorizes credit for non-federal sponsors' (NFS) in-kind contributions for certain authorized projects, and allows for the use of "excess credit" to meet a NFS's cost share requirement on other projects. USACE and the State have conducted extensive coordination on the development of the cross-crediting process, which could prove beneficial to other coastal restoration projects with cross-crediting authorization. Key stakeholders will present the status of LCA projects and their perspectives on cross-crediting, issues and concerns that have arisen, resolutions sought, and lessons learned.

7 - Use of Adaptive Management to Enhance Restoration of the Chesapeake Bay Ecosystem

Tuesday, April 19, 2016 | 1:30pm - 3:00pm | Royal Poinciana

The Chesapeake Bay Program (CBP), a federal-state partnership to restore the Nation's largest estuary, used an adaptive-management framework to formulate a new Chesapeake Bay Watershed Agreement (2014-25). Adaptive management was further used to develop management strategies for each of the 31 outcomes in the Agreement. As the CBP implements the Agreement, science will be critical to provide the information needed for enhanced implementation of restoration and conservation policies and practices. The session will address how adaptive management was used to formulate the Chesapeake Agreement and supporting management strategies.

8 - Restoring Alabama's Coast

Tuesday, April 19, 2016 | 1:30pm - 3:00pm | Ibis

This session will focus on restoring Alabama's coast, which has been significantly impacted by both natural and man-made disasters, including numerous hurricanes and the Deepwater Horizon oil spill. With increasing pressure from population growth, increased storm activity, and sea level rise, it has become paramount that restoration efforts not only look back to what was, but also look forward to prepare for future impacts. The presenters in this session will discuss innovative restoration approaches and methodologies that are relevant to ecosystem restoration programs across the nation. The session will include an overview of a local restoration project of interest to all ecosystem restoration practitioners including planners, scientists, engineers, and managers.

9 - Lessons Learned to Enhance Restoration

Tuesday, April 19, 2016 | 1:30pm - 3:00pm | Egret

This session provides an overview of lessons learned to enhance restoration through review of ongoing or completed works in a variety of habitats, including the riverine, neo-tropical wetlands, and Atlantic coastal saltmarsh. Successes from adaptive management programs in the Missouri River demonstrate how this type of approach facilitates the advancement of restoration science. Similarly, work from smaller riverine systems in southern Quebec shows how strategic valuation of desired outcomes can enhance restoration outcomes. An example of restoration of a neo-tropical lagoon wetland system in the Bahamas demonstrates how restoration programs can simultaneously achieve both positive outcome for both ecological and human health issues. Finally, work recently completed in the Jamaica Bay saltmarsh wetlands in New York City explores how pairing ecosystem functional assessments with site-specific habitat assessments can drive scientific and economic restoration decisions.

10 - Southern Everglades Restoration Progress

Tuesday, April 19, 2016 | 1:30pm - 3:00pm | Sandpiper

This session will highlight early restoration benefits in or near the Southern Coastal System region of the Comprehensive Everglades Restoration Plan. Focal projects included in the session are the Biscayne Bay Coastal Wetlands, C-111 Spreader Canal Western Project, and the Picayune Strand Restoration Project. Presentations will provide updates on project progress and describe realized hydrologic and ecologic restoration benefits evidenced by project-level and system-wide monitoring data. As time allows, presenters will discuss lessons learned regarding planning and implementation.

11 - Surviving in a Changing Environment – What Can the Paleo-record Tell Us About Resiliency?

Tuesday, April 19, 2016 | 3:30pm - 5:00pm | Great Cypress

The purpose of this session is to bring together scientists conducting paleoecologic and paleoclimatologic research in diverse ecosystems from across the country with resource managers concerned about resiliency. The session will focus on how paleo-records can contribute information about how resilient organisms and ecosystems are to past changes in sea level, climate, land-use and other stressors. Questions to be addressed: 1) What types of paleo-data can be provided to resource managers (regime shifts, tipping points, thresholds)? 2) What tools do resource managers need to plan for future stressors and enhance resiliency? 3) What are the limitations of the paleo-record (time averaging, selective preservation, evolving adaptations)? Presentations will be brief, followed by a discussion session between the speakers and the audience aiming to develop a draft strategy for the application of paleo-records to issues of resiliency that directly addresses management needs.

12 - The Intersection and Interactions between Ecosystem Restoration and Mercury Contamination

Tuesday, April 19, 2016 | 3:30pm - 5:00pm | Royal Poinciana

Mercury contamination is a significant issue at the four large ecosystem restoration programs in the US (Florida Everglades, San Francisco Bay, Chesapeake Bay, and the Great Lakes), largely resulting from legacy point-sources (e.g. mining, industrial releases). Mercury contamination is especially challenging and often confrontational because common restoration targets (e.g. reduced nutrient loads, wetland-loss mitigation, dredging) can often exacerbate mercury exposure to local food webs. Thus, environmental researchers and ecosystem restoration managers are especially challenged to derive pathways leading to both the achievement of primary restoration goals and reduced biological exposure to mercury. Researcher and restoration manager presentations will provide a synopsis of the current technical understanding of the intersection and interactions between ecosystem restoration and mercury contamination at large and small scale ecosystem restoration sites.

13 - Policy, Planning and Permitting for Tethered Coastal, Estuarine and Marine Restoration

Tuesday, April 19, 2016 | 3:30pm - 5:00pm | Ibis

Larger scale restoration planning may include multiple similar projects such as several small oyster reefs, or an eco-systemic approach that “tethers” the restoration of diverse habitats including high energy and estuarine beaches, salt marsh, oyster reefs, sea grass beds, and hard bottom. These projects are typically permitted on a project-by-project basis even though they occur over significant temporal and spatial scales. The lack of regulatory certainty that all of the project components will eventually be permitted threatens the integrity of the overall effort of planning at this scale. An interdisciplinary group of researchers will propose a policy paradigm for conceptual restoration planning, borrowing from existing long-term scaled permitting approaches found in the areas of port development and multi-phased residential and commercial development.

14 - Assessment, Placement, and Maintenance of Large Wood in Fluvial Ecosystems: Restoring Process and Function

Tuesday, April 19, 2016 | 3:30pm - 5:00pm | Egret

This session highlights information contained in a new national manual on technical considerations the placement of large wood in streams, developed by the Bureau of Reclamation and USACE. This session will provide resource managers and restoration practitioners with comprehensive information for the planning, design, placement, and maintenance of large wood in rivers and streams.

15 - Miami Harbor Phase III Federal Channel Expansion: Monitoring and Mitigation

Tuesday, April 19, 2016 | 3:30pm - 5:00pm | Sandpiper

The purpose of this session will be to present the lessons learned from the monitoring and mitigation program associated with the Miami Harbor Phase III Federal Channel Expansion Project. This was the first project in the southeastern United States to prepare for the arrival of post Panamax cargo ships through dredging. The session will discuss the biological monitoring program which included monitoring of the sensitive resources located adjacent to the project area and the restoration of the Julia Tuttle dredge hole and the creation of an artificial reef.

16 - Opportunities and Challenges of Measuring Ecosystem Service Benefits for Federal Decision Making

Wednesday, April 20, 2016 | 10:30am - 12noon | Great Cypress

Federal agencies are being advised to use ecosystem services (ES) in targeting and performance reporting of ecological restoration. Yet, many ecosystem services are challenging to either monetize or quantify with benefit indicators, due to data limitations. In particular, quantifying the degree to which restored systems generate outcomes that matter to people – and that reflect restoration quality – can be demanding. This session will explore the state of the science for quantifying benefits with either monetary values or non-monetary benefit indicators and the advantages and limitations of those approaches for supporting decisions by federal agencies.

17 - Leaving a Legacy in the Florida Panhandle

Wednesday, April 20, 2016 | 10:30am - 12noon | Royal Poinciana

After years of litigation, BP reached a settlement from the 2010 Deepwater Horizon oil spill in July 2015. There are four avenues of funding associated with the spill: Natural Resource Damage Assessment, Clean Water Act Fines, Gulf Environmental Benefit Fund and Economic Settlement. In 2012, the RESTORE Act was passed which established a Gulf Coast Restoration Trust Fund to receive 80% of any Clean Water Act fines. As a result, the eight disproportionally affected counties receive 75% of the Direct Component funds allocated to the State of Florida. In addition, a $2 billion economic settlement for Florida is being administered by Triumph Gulf Coast. A panel of key Florida Panhandle leadership will highlight lessons learned from trying to leverage all these funding sources, working with the Department of Treasury during the grant application process and optimizing this opportunity to make a difference for the Panhandle region.

18 - Ecological Restoration Implementation in South Florida using Regional/Sub-regional Modeling Tools

Wednesday, April 20, 2016 | 10:30am - 12noon | Ibis

Computer modeling is a powerful way of enhancing water resource management. The main purpose of this session is to showcase various regional and sub-regional modeling tools to evaluate or restore South Florida's ecosystem. South Florida has multi-agency efforts focusing on ecological restoration of the Everglades that span from the Kissimmee River basin to Florida Bay. The degraded water quality in estuaries and bays and the lessening of water flowing through the Everglades ecosystem today causes serious disruptions to the natural hydrology of the ecosystem. This session will discuss how regional and sub-regional models are applied to support various restoration projects.

19 - Improving the Quality and Reliability of Data Collected for Ecological Restoration Projects

Wednesday, April 20, 2016 | 10:30am - 12noon | Egret

What is the quality of your ecological data? In ecological restoration projects, reliable data are needed to track the progress of a project toward stated restoration goals, determine the appropriateness of restoration techniques, and guide future project management within an adaptive management framework. However, ecological data often are considered as qualitative or semi-quantitative at best when compared to other more traditional types of data collection involving laboratory analysis. In this session, we will share approaches and lessons learned for improving data quality and reliability.

20 - Decision Analysis in Support of Ecosystem Restoration Projects

Wednesday, April 20, 2016 | 10:30am - 12noon | Sandpiper

Uncertainties about future conditions and the effects of chosen actions, as well as increasing resource scarcity, have been driving forces in the use of adaptive management strategies. However, many applications of adaptive management have been criticized for a number of shortcomings. Decision analysis is a well-formulated approach that has been used to facilitate effective adaptive management. The purpose of the session is to showcase the range of application of decision support tools from facilitation of communication to adaptive management. The session will focus on the way in which adaptive management has been used effectively to integrate stakeholder input, focus modeling efforts and improve systemic understanding of restoration projects.

21 - Balancing Multiple Objectives and Interests: Recent Experiences with Large West Coast Water Projects

Wednesday, April 20, 2016 | 1:30pm - 3:00pm | Great Cypress

The session will highlight many of the opportunities and challenges in planning four multipurpose water resources projects currently underway in the San Francisco Bay and California Delta: South San Francisco Bay Shoreline Study, South Bay Salt Ponds Project, Delta Islands and Levees Study, and Sacramento River and Delta Reevaluation Study. Collectively, these case studies offer important lessons learned in addressing and balancing multiple objectives and the interests of many stakeholders. Each addresses aquatic ecosystem restoration as a primary objective, while also seeking synergy with such compatible purposes as coastal storm damage reduction, flood risk management, and recreation.

22 - Creating and Fostering a State-based Aquatic Ecological Restoration Initiative

Wednesday, April 20, 2016 | 1:30pm - 3:00pm | Royal Poinciana

To restore aquatic ecosystem processes at scale, there need to be well-defined support systems driving an ambitious ecosystem restoration agenda. Strong community support, governmental resources, political backing, scientific research, a flexible regulatory environment, multi-disciplinary engineering firms, private sector buy-in, and a steady source of funding are essential for restoration projects to be implemented consistently and successfully. Furthermore, a clearly communicated call to action that multiple entities can rally around is needed. This session will address how support systems were developed and continue to be supported in Massachusetts.

23 - RECOVER Everglades System-wide Monitoring Results Part One

Wednesday, April 20, 2016 | 1:30pm - 3:00pm | Ibis

These sessions will highlight new information from the interagency and interdisciplinary REstoration COordination and VERification (RECOVER) system-wide monitoring program. Key findings from the most recent analyses available and 2014 System Status Report will highlight significant status and trend changes, demonstrate restoration project or operations effects, and offer new knowledge gained. Results will be presented from RECOVER principle investigators from several Everglades regions: Northern Estuaries, Lake Okeechobee, Greater Everglades, and Southern Coastal Systems.

24 - Decision Support Approaches for Incorporating Resilience Planning in Ecosystem Restoration

Wednesday, April 20, 2016 | 1:30pm - 3:00pm | Egret

As the Deepwater Horizon spill settlements move towards implementation, ecosystem restoration planning for the Gulf of Mexico is at unprecedented levels. Strategic goals and objectives for restoration of the Gulf include the need to enhance community and ecosystem resilience from perturbations such as sea level rise and tropical storms. Historically, enhancing and restoring community resilience and ecosystem functions were often viewed as competing, incompatible objectives addressed by separate entities. The session explores some of the critical environmental, social, and economic issues and relationships associated with enhancing community and ecosystem resilience and provides a conceptual decision support system framework to support stakeholders in restoration planning.

25 - Using Physical Models to Manage Uncertainty Part One

Wednesday, April 20, 2016 | 1:30pm - 3:00pm | Sandpiper

This session will highlight the use of physical models to address restoration uncertainties, develop performance measures and establish goals and objectives.

26 - Louisiana's 2017 Coastal Master Plan: Building on Our Commitment to Protect and Restore Our Coast

Wednesday, April 20, 2016 | 3:30pm - 5:00pm | Great Cypress

The Coastal Protection and Restoration Authority (CPRA) is charged with coordinating restoration and protection investments through the development and implementation of Louisiana's Comprehensive Master Plan for a Sustainable Coast. The purpose of this session is to provide an overview of key elements of the Plan, including the decision framework, modeling tools, flood risk and resilience program, and stakeholder engagement. As coastal areas across the nation face increasing threats from flooding, land loss and sea level rise, there is a great need to advance long-term coastal planning and adaptation strategies. Using a science-based and stakeholder-informed decision-making process, the Plan seeks to create a more sustainable coastal Louisiana and enable communities to adapt to a changing landscape. The Plan is a 50-year protection and restoration strategy with two ambitious goals: to restore Louisiana's wetlands and to provide flood protection for coastal citizens. Engineers, modelers, researchers, agency managers, and planners involved in large-scale coastal planning efforts would benefit from attending this session.

27 - Approaches and Tools for Scientist-Decision Maker Collaboration and Actionable Science

Wednesday, April 20, 2016 | 3:30pm - 5:00pm | Royal Poinciana

The purpose of this session is to examine approaches, tools, and structures for scientist and decision maker collaboration for the purpose of co-producing actionable science. Panelists will share stories of obstacles to and strategies for linking science with decision making from the Comprehensive Everglades Restoration Program, the Platte River Recovery Implementation Program, Glen Canyon Dam Adaptive Management Program, and the National Climate Change and Wildlife Science Center. Attendees will learn about emerging tools, such as management matrices, and a how-to-guide for co-producing actionable science. This session will be of interest to agency managers, researchers, and engineers.

28 - RECOVER Everglades System-wide Monitoring Results Part Two

Wednesday, April 20, 2016 | 3:30pm - 5:00pm | Ibis

These sessions will highlight new information from the interagency and interdisciplinary REstoration COordination and VERification (RECOVER) system-wide monitoring program. Key findings from the most recent analyses available and 2014 System Status Report will highlight significant status and trend changes, demonstrate restoration project or operations effects, and offer new knowledge gained. Results will be presented from RECOVER principle investigators from several Everglades regions: Northern Estuaries, Lake Okeechobee, Greater Everglades, and Southern Coastal Systems.

29 - Large Aquatic Ecosystem Restoration Monitoring for Decision Makers: Monitoring to Target and Evaluate Success of Ecosystem Restoration

Wednesday, April 20, 2016 | 3:30pm - 5:00pm | Egret

Monitoring ecosystem restoration at various scales in Large Aquatic Ecosystem (LAEs) can be challenging, frustrating and rewarding. Some major ecosystem restoration monitoring occurring in LAEs include: seagrass change; dead zone sizes; oyster reefs; sea turtle nesting; toxic/nutrient pollution; bacterial contamination; invasive species; function of restored vs. created vs. native wetlands; ecosystem resilience; habitat expansion/contraction; and air deposition that influences restoration. LAE restoration needs its restoration monitoring to relate investments of resources and effort to increased and improved ecosystem condition and function over time in order for funding agencies, especially at the federal level, to justify continued investments. However, ultimate benefits of ecosystem restoration are often realized over longer time periods when more broad-based recovery of ecosystem function occurs. This session shares successful short and long term restoration monitoring as well as the challenges of showing short-term change.

30 - Using Physical Models to Manage Uncertainty Part Two

Wednesday, April 20, 2016 | 3:30pm - 5:00pm | Sandpiper

This session will highlight the use of physical models to address restoration uncertainties, develop performance measures and establish goals and objectives.

31 - Changing Course: Navigating the Future of the Lower Mississippi River

Thursday, April 21, 2016 | 10:30pm - 12noon | Great Cypress

Changing Course is an international competition to “reimagine” a sustainable Lower Mississippi River Delta; among America’s greatest natural resources. Three winning teams (Baird & Associates, Moffatt & Nichol, Studio Misi-Ziibi) were selected from competitors from around the world, each of whom generated designs for how the River’s water and sediment can be used to rebuild delta wetlands while meeting needs of navigation, flood protection, coastal industries and communities. Each winning team offered a different vision, but all identified the same key factors for sustaining the River Delta today and into the future. This session presents an overview of the competition process and outcomes, followed by presentations by the winning teams highlighting similarities and differences in their respective designs.

32 - Innovative Ways to Restore and Enhance National Parks in Their Centennial Year

Thursday, April 21, 2016 | 10:30pm - 12noon | Royal Poinciana

This session will explore how America’s national parks benefit from the protection and restoration of large landscapes within their greater ecosystems, and vice versa. More people now recognize that national parks cannot exist in isolation and that they depend on and contribute to healthy ecosystems beyond their boundaries, which will be a focus in the second century of the National Park System. This session will highlight how specific restoration projects help restore national parks, how many species of birds depend on healthy national parks for migration, and how storytelling through interactive mapping contributes to landscape connectivity in ways that brings partners together.

33 - Biscayne Bay Coastal Restoration

Thursday, April 21, 2016 | 10:30pm - 12noon | Ibis

This session is focused on presenting tools and approaches used in Biscayne Bay restoration-related studies. Tools and approaches presented in this session range from ecological and hydrological modeling, to paleoecological records, to watershed ecosystem monitoring. A major goal of this session is to provide a comprehensive overview about the state of Biscayne Bay ecosystem health.

34 - Science Tools in Support of Restoration

Thursday, April 21, 2016 | 10:30pm - 12noon | Egret

This session will highlight a breadth of science tools used by a range of ecosystem restoration practitioners. Whether planning restoration scenarios, examining current conditions, or monitoring the effectiveness of ecosystem restoration activities, science-driven tools are an informative part of the tool box for ecosystem restoration practitioners. Representing a range of ecosystems and a breadth of science tools, this session presents tools and approaches that may be transferable to other ecosystems; these include food web modeling, hydrology modeling, examining paleo records, and watershed ecosystem condition monitoring.

35 - Assessing Progress in Reducing Pollutant Loads to Chesapeake Bay

Thursday, April 21, 2016 | 10:30pm - 12noon | Sandpiper

The Chesapeake Bay is degraded due to decades of excess inputs of nitrogen, phosphorus, and suspended sediment, which has led to eutrophication and extensive anoxic and hypoxic areas. In 2010, the entire 64,000 square mile watershed became subject to the Environmental Protection Agency’s (EPA) Total Maximum Daily Load (TMDL) regulation calling for a reduction of nutrients and sediment reaching the bay. USGS empirical models estimate that nearly 54 percent of the nitrogen and 43 percent of the phosphorus reaching the bay are attributable to agricultural sources. Most agricultural best management practices (BMP) are implemented through voluntary agreements and state or federal cost share programs. The purpose of this session is to provide scientists and water resource managers an overview of recent activities underway in the bay watershed to characterize and explain changes in nutrient and sediment loads associated with changes in agricultural sources.

36 - Evaluating Climate Change Stressors on Ecosystem Restoration

Thursday, April 21, 2016 | 1:30pm - 3:00pm | Great Cypress

The combination of uncertain climate futures and anthropogenic landscape-scale change presents a daunting challenge for ecological conservation and restoration. Practitioners must now think beyond historic conditions, reference sites, or even current landscape attributes and maximize resiliency in a range of possible futures. The talks in this session demonstrate how modeling and monitoring should be used to better understand and predict future scenarios, and then develop strategies to maximize likelihood of maintaining desired ecosystems.

37 - Managing Freshwater Resources to Restore Coastal Ecosystems

Thursday, April 21, 2016 | 1:30pm - 3:00pm | Royal Poinciana

Coastal ecosystems are vulnerable to sea level rise and changing temperature/rainfall regimes as well as a suite of anthropogenic impacts from increasing freshwater abstraction upstream to changes in land use, water quality degradation, and modifications to river bathymetry. In light of these stressors, a central question for coastal land managers is how to proactively manage and restore coastal ecosystems for the future. This session's presentations synthesize our current understanding of the state and projected trajectory of coastal ecosystem change, with a focus on the potential for improved water management to mitigate the worst impacts of ecosystem degradation. Within this framework, we focus on presentations that address two primary themes: 1) how natural and anthropogenic influences have altered abiotic drivers (i.e., hydrology and water quality) in coastal ecosystems; and 2) how restoration interventions in "degraded" systems can recreate the timing and magnitude of environmental drivers that maintain (or enhance) biotic function.

38 - Strategies to Address Endocrine Disruption in the Chesapeake Bay Watershed

Thursday, April 21, 2016 | 1:30pm - 3:00pm | Ibis

The Chesapeake Bay is the largest estuary in the US, and provides critical resources to fish, wildlife and people that use the 64,000 square mile watershed. For more than a decade, adverse effects associated with exposure to endocrine disrupting chemicals (EDCs) have been observed in the Bay watershed. The USGS has a critical role to provide scientific information and work with Federal, State, and academic science partners to develop research and monitoring strategies and communicate implications to enhance ecosystem management for the Bay. This session aims to link data collected in the Bay Watershed to the approaches necessary to support management decisions to reduce the effects of EDCs to fish and wildlife utilizing this valuable ecosystem. Presentations will include a detailed discussion on chemical, biological and modeling approaches being developed to advance our understanding on the impacts of emerging contaminants in the Bay watershed.

39 - Restoring Large Florida Farms to Wetlands under the NRCS Agricultural Conservation Easement Program

Thursday, April 21, 2016 | 1:30pm - 3:00pm | Egret

This session will present results of the Florida implementation of the NRCS Wetland Reserve Enhancement Program (WREP), part of the USDA Agricultural Conservation Easement Program (ACEP-WRE), restoring natural habitats by assisting governments, NGOs and American Indian tribes through private-public partnerships. This session presents the results of NRCS partnerships with individual land owners supported by the USACE and consulting engineers and scientists to develop wetland restoration projects on farmlands. The session will begin with an overview of the Florida WRE program objectives and its scope in Florida. Following that, we will review approaches to ecological and hydrologic target identification, engineering designs to convert an agricultural landscape to a wetland landscape and permits.

40 - Real-time Evaluation, Modeling, and Reporting of Ecosystem Restoration

Thursday, April 21, 2016 | 1:30pm - 3:00pm | Sandpiper

This session will highlight how real-time evaluation and reporting of ecosystem restoration are being applied to various restoration efforts. Advances in real-time monitoring and data-integration technology provide the opportunity for real-time evaluation, reporting, and modeling of ecosystem response to restoration implementation. Typically, ecosystem response to restoration efforts are evaluated after data from monitoring networks are retrieved, quality assured, and analyzed. Real-time monitoring systems provide the data to evaluate many ecosystem performance measures in near-real time. The integration of disparate database and data streams through web portals facilitate near real-time reporting of an ecosystem response "report card' by using real-time and discrete sampling data. Ecological models can be run in near-real time to provide projection on ecosystem response to inform future monitoring and management decisions. The session will present applications of real-time modeling, evaluation, and reporting of ecosystem restoration.

41 - Using Science to Inform Conservation Decisions at a Landscape Scale

Thursday, April 21, 2016 | 3:30pm - 5:00pm | Great Cypress

This session focuses on the collaborative work of Landscape Conservation Cooperatives (LCCs) to identify science needs, develop projects to address those needs, and use the results to inform conservation planning, design, and delivery. This session will demonstrate how Structured Decision Making can be used to help identify research priorities and biological endpoints in a diverse landscape. It will also highlight ongoing efforts in landscape conservation design to identify where conservation partners should work and what specific actions should be employed to address the priority biological endpoints. The session will include four presentations by LCC staff and partners who are working across the southeastern US to inform ecosystem restoration efforts and ensure those actions are informed by science, monitored to determine effectiveness, and improved over time.

42 - Collaborative Large-Scale Restoration Planning

Thursday, April 21, 2016 | 3:30pm - 5:00pm | Royal Poinciana

This session examines collaborative approaches to ecosystem restoration from a broad range of perspectives, including those from a US federal agency, private consulting firms (both US and international), and city government. The case studies illustrate how public/private partnerships, while sometimes difficult to undertake, can increase the chances of success, even when restoration includes private lands. A combination of field and desktop analyses, including the collection of monitoring data and application of models, were used to determine restoration priorities, and they show how restoration can be made an important part of flood control and water supply ventures.

43 - Ecosystem Numerical Tools

Thursday, April 21, 2016 | 3:30pm - 5:00pm | Ibis

The intent of this session is to present recent developments in ecosystem modeling approaches, their applications to large-scale coastal and deltaic systems, and how to assess the performance of such complex ecosystem models. The session will explore the ability of ecosystem models to capture the effects of climate change and extreme weather events on the sustainability of coastal restoration strategies. Attendees of this session will receive valuable information on a) recent developments of ecosystem models; integration and feedback among various modeling components (e.g. hydrodynamics, morphology, and ecology), b) assessment of the ability of ecosystem models to capture climate change and extreme events and how they might impact restoration projects; c) applications of ecosystem models to coastal and deltaic systems nationally and internationally; d) performance assessment and uncertainty analysis of ecosystem models.

44 - Watch Us WIP, Now Watch Us Bay Bay: Delaware's Choreographed Approach to Chesapeake Bay Restoration

Thursday, April 21, 2016 | 3:30pm - 5:00pm | Egret

This session will focus on Delaware's approach to Chesapeake Bay restoration, including the restoration of man-made tax ditch systems to a natural design that benefits wildlife, research findings into the reuse and reincorporation of removed materials from restoration projects, as well as Delaware's technique to improve soil health in the agriculture sector, thereby reducing nutrient runoff. Being the small state that it is, Delaware has the unique ability to work closely with stakeholders throughout the state, across all agencies, to develop unique and multifaceted conservation and restoration programs to address the rigorous Chesapeake Bay nutrient reduction goals. Achieving these goals is of the utmost importance as all of the bay watershed states come closer to the 2017 Midpoint Assessment.

45 - Intergovernmental Collaboration and Stakeholder Collaboration to Restore Ecosystems in the Southwest

Thursday, April 21, 2016 | 3:30pm - 5:00pm | Sandpiper

This session presents two southwest perspectives on how to build capacity for large scale restoration planning and project implementation at multiple scales and across various sectors. Texas focuses an overarching message on intergovernmental and stakeholder dialog and teamwork and how to build on years of restoration experience and apply it now to the RESTORE Act funding opportunities. The Colorado River focuses on how cross-border partnerships, collaborative research and pilot projects, and local community engagement have been fostered. Key takeaways include: how Texas is preparing a comprehensive coast restoration master plan with realistic goals that involve community resiliency and ecosystem sustainability; and how binational partnerships between conservation organizations and government agencies enabled implementation of innovative transboundary water policy.

BIOGRAPHIES

Conference Chairs & Plenary Speakers

CONFERENCE CHAIRS

Robert Daoust

NCER 2016 Conference Co-Chair
Associate Vice President, Arcadis

Mr. Daoust specializes in ecosystem restoration and coastal protection projects as well as climate adaptation studies that focus on sea level rise and storm surge flood risk mitigation. He has almost 20 years of experience in environmental consulting experience with public and private clients, including state, municipal, and federal agencies. He formerly led Arcadis' national Ecosystem Restoration and Coastal Protection practice in the United States where his work involved efforts to restore coastal Louisiana and the Florida Everglades, as well as climate change adaptation to mitigate future flood risk associated with extreme storm events and sea level rise in New York City and south Florida. Currently, Mr. Daoust is responsible for driving the strategic growth of Arcadis' Water practice in southeast Florida. In addition, he is an expert on coastal resilience of southeast Florida, often assisting local municipalities and counties in their effort to plan and adapt to rising seas and storm surge risk. Mr. Daoust's background is in ecosystem ecology and includes extensive experience in experimental design, implementation and optimization of long-term monitoring as part of adaptive management programs, as well as statistical analysis and interpretation of ecological data. He holds a BS degree in Geography from McGill University in Montreal, Canada and an MS from Florida International University, where he did research on the effects of phosphorus on slough and ridge community dynamics in northeastern Everglades National Park. He also completed doctoral research how salinity and plant physiology drives differential nutrient limitation along an estuarine gradient. Originally from suburban Toronto, he's happy to have escaped the grip of Canadian winters and now calls Fort Lauderdale home.

Andrew LoSchiavo

NCER 2016 Conference Co-Chair
Adaptive Management Coordinator, Biologist Planning and Policy Division - Environmental Branch - South Florida Section U.S. Army Corps of Engineers - Jacksonville District

Andrew (Andy) LoSchiavo is a Biologist at Jacksonville District in the Restoration and Resources Section, Environmental Branch, Jacksonville District of the U.S. Army Corps of Engineers (USACE). He holds a Bachelor of Science in Biology and Chemistry minor from Denison University in Ohio, and a Master's of Environmental Management from Duke University with a focus on coastal environmental management. He has 16 years' experience working for the North Carolina Division of Marine Fisheries, National Oceanic and Atmospheric Administration, consulting firms, and the USACE in natural resource management issues spanning from fisheries management to conservation and restoration of freshwater, estuarine, and marine habitats and species. He has led and supported many interagency (Environmental Protection Agency, U.S. Fish and Wildlife, National Marine Fisheries Service, National Park Service, U.S. Department of Agriculture, state entities) planning, regulatory, and science coordination efforts to address these issues. His training and work relate back to a common theme of using applied science to address key ecosystem management questions that help improve policies and management actions to achieve environmental program success. He's worked on several regional and national teams to develop guidance on how to implement adaptive management in large-scale water resource projects. His favorite color is orange, and loves soccer, the great outdoors, and his family.

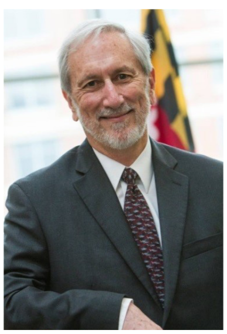
PLENARY SESSION SPEAKERS, FACILITATORS AND ORGANIZERS

(In alphabetical Order by Presenter last Name)

Nicholas G. Aumen

Regional Science Advisor
South Florida, United States Geological Survey

Nick Aumen is Regional Science Advisor for the US Geological Survey (Southeast Region), overseeing the Greater Everglades Priority Ecosystem Sciences program. This program, involving USGS scientists nationwide, provides high quality science in support of Everglades restoration. Nick was an aquatic ecologist for 15 years with Everglades National Park, leading an interagency team of scientists tracking restoration progress. Prior to his National Park Service position, Nick was the Research Director at the South Florida Water Management District, directing a team of 120-plus scientists conducting research in support of ecosystem restoration. Nick received his B.S. and M.S. in biology at the University of West Florida, and his Ph.D. in microbial ecology at Oregon State University. He was a faculty member in the Biology Department at the University of Mississippi, and was a tenured Associate Professor of Biology when he returned to Florida. Nick presently is an affiliate faculty member at Florida Atlantic University (Department of Geosciences), and at the University of Florida (Soil and Water Science Department). He also served five years on the national Board of Directors of the Sierra Club, a 120-yr-old environmental organization with more than 750,000 members, and served two terms as its Vice-President and one as Treasurer.



Don Boesch

Professor of Marine Science and President
University of Maryland Center for Environmental Science, Cambridge, MD

Donald F. Boesch is a Professor of Marine Science and President of the University of Maryland Center for Environmental Science and University System of Maryland's Vice Chancellor for Environmental Sustainability. He earned his B.S. in biology at Tulane University and Ph.D. in oceanography at the College of William and Mary. Don has conducted ecological and oceanographic research on coastal and continental shelf ecosystems along the Atlantic Coast, and in the Gulf of Mexico, eastern Australia, and the East China Sea. He is a past-chairman of the Ocean Studies Board of the National Research Council was appointed by President Obama to the National Commission on the BP Deepwater Oil Spill and the Offshore Drilling. Don has forty years of experience in the application of science in ecosystem restoration, including in the Chesapeake Bay, the Florida Everglades and Coastal Louisiana.

Alyssa Dausman

Science Director
Gulf Coast Ecosystem Restoration Council (Council), Bay Saint Louis, MS

Dr. Dausman is the Science Director for the Gulf Coast Ecosystem Restoration Council (Council), an independent federal agency created by the RESTORE Act in 2012. She is located in Bay Saint Louis, Mississippi focusing on Gulf restoration and science for the Council, comprised of the Governors of the five Gulf states and Cabinet-level officials from six federal agencies. She began her career with the USGS in Fort Lauderdale, FL in 2000 after completing her B.S. at Tulane University and her M.S. at the University of New Orleans. She received her Ph.D. from Florida International University in 2008 while working with the USGS. In 2011 she moved back to her "roots" in Mississippi (born and raised) to work on Gulf restoration. She was staffed to the Gulf Coast Ecosystem Restoration Task Force and supported the Department of Interior advising on science and monitoring related to Early Restoration for NRDAR as well as on the RESTORE Act. In January of 2015 she went on detail to the Council to help draft the Initial Funded Priorities List of projects and programs the Council intended to fund. She subsequently took a permanent job with the Council in May of 2015.

Shannon A. Estenoz

Director
Office of Everglades Restoration Initiatives, U.S. Department of the Interior, Davie, FL

Shannon A. Estenoz is a fifth generation Key West native. She holds degrees in International Affairs as well as Civil Engineering from Florida State University. Shannon's Everglades career spans nineteen years during which she has been an advocate for the restoration and protection of the Everglades. Shannon launched her Everglades'-career as the Executive Director of the Environmental and Land Use Law Center. In 1997 she joined the World Wildlife Fund as its Everglades field representative and would later become its Everglades Program Director and later served as the Sun Coast Regional Director of the National Parks Conserva tion Association. Shannon also served three terms as the National Co-Chair of the Everglades Coalition. In 2007, Florida Governor Charlie Crist appointed Shannon to the Governing Board of the South Florida Water Management District where she served as Vice Chair of the Board, Chair of the Water Resources Advisory Commission, Founding Chair of the Broward Water Resources Task Force, and member of the Broward County Water Advisory Board. In 2010 Shannon was appointed by the US Department of the Interior Secretary, Ken Salazar, as the Department's Director of Everglades Restoration Initiatives where she coordinates the Department's restoration efforts as well as serves as the Executive Director of the South Florida Ecosystem Restoration Task Force. Throughout Shannon's career she has been recognized for her contributions to Everglades Restoration. Most recently she was received the 2009 George Barley Conservationist of the Year Award from the Everglades Coalition, the 2010 Marjory Stoneman Douglas Environmental Award from Friends of the Everglades, and the 2010 Champion of the Everglades Award from Audubon of Florida.

Matt Grabau

Restoration Scientist
Colorado River Delta Program, Sonoran Institute, Tucson, AZ

Matt Grabau is a restoration scientist in the Colorado River Delta Program. He joined the Sonoran Institute in 2015 to assist in the design, implementation, and monitoring and adaptive management of restoration projects. He also leads applied ecological research projects, integrating his hydrology, soil science, and biology background to inform the long-term sustainability of riparian areas. He has been working on riparian restoration projects on the lower Colorado River in the US and Mexico since 2006. Matt has a PhD and MS in Agricultural and Biosystems Engineering from the University of Arizona, where he worked on developing new cottonwood and willow revegetation techniques to enhance genetic diversity and decrease costs. Matt also has a BS degree in Wildlife Science from the University of Arizona, and worked as a biologist prior to beginning graduate studies.

Rainer Hoenicke

Deputy Executive Officer
Science Program, Delta Stewardship Council, Sacramento, CA

Rainer is a limnologist by training and received his Ph.D. from the University of California at Davis. He has worked for the past 30 years at the science-policy interface, first as field logistics coordinator for USEPA's National Acid Precipitation Program, then as lead scientist for the Santa Monica Bay Restoration Project, and as San Francisco Bay Regional Monitoring Program manager. He served as Executive Director of the San Francisco Estuary Institute from 2008-2013, and is now the Deputy Executive Officer for Science at the Delta Stewardship Council, where he oversees implementation of the Delta Science Plan.

Suzette M. Kimball

Director
US Geological Survey, Reston, VA

Dr. Kimball is responsible for leading the Nation's largest water, earth, and biological science, and civilian mapping agency. Prior to becoming the Director, Dr. Kimball was the USGS Deputy Director. In 2008, she became the Acting Associate Director for Geology, and prior to that was the Director of the USGS Eastern Region, starting in 2004. She joined the USGS as Eastern Regional Executive for Biology. In that position, she built many partnerships, helped shape programs, and led the establishment of the USGS Florida Integrated Science Center. She came to the USGS from the National Park Service in Atlanta, where she was Associate Regional Director. She entered the National Park Service as a research coordinator in the Global Climate Change Program, became Southeast Regional Chief Scientist, and then Associate Regional Director.

She was assistant professor of environmental sciences at the University of Virginia, co-director of the Center for Coastal Management and Policy and marine scientist at the Virginia Institute of Marine Science, and managed coastal morphology and barrier island studies in the U.S. Army Corps of Engineers.

She serves on executive boards and many State and national committees, including the Consortium for Coastal Restoration through Science & Technology, the Council of Examiners of the National Association of State Boards of Geology, and the DOI Senior Executive Service Advisory Council. She was on the board of directors of the Coastal Society and has served as secretary of the American Geophysical Union's Ocean Sciences Section.

She has authored numerous publications on barrier island dynamics, coastal ecosystem science, coastal zone management and policy, and natural resource exploration, evaluation, and management. She has received the Presidential Rank Award and the Secretary of the Interior's Meritorious Service Award.

Dr. Kimball has a doctorate in environmental sciences with a specialty in coastal processes from the University of Virginia, a master's in geology and geophysics from Ball State University, and a bachelor's in English and geology from the College of William & Mary.

Susan Newman

Senior Scientific Section Lead
Everglades System Assessment Section, South Florida Water Management District (SFWMD), West Palm, FL

Dr. Sue Newman is the Section Leader of the Marsh Ecology Research Group within the Everglades Systems Assessment (ESA) Section of the South Florida Water Management District (SFWMD). Sue has been a scientist at SFWMD for 25 years, during which time she has been actively involved in quantifying the effects of phosphorus on the Everglades ecosystem, specifically the establishment of the phosphorus criterion for surface waters. The current foci of her research group are large-scale multi-disciplinary projects designed to support Everglades restoration by rehabilitating ecological function in nutrient enriched areas and examining key uncertainties associated with restoring flow to the ecosystem. The synthesis of these programs may be used to understand and evaluate potential tradeoffs associated with restoration activities. Outside of her research in the natural system, Sue is the co-lead of multi-disciplinary studies designed to optimize phosphorus removal in the stormwater treatment areas. Sue obtained her Ph.D. degree in soil and water science from the University of Florida. Her specialties include aquatic biogeochemistry, wetland ecology, and more recently food web interactions. Sue is a member of the Graduate Faculty of the University of Florida and Florida Atlantic University.

Jack M. Payne

Senior Vice President for Agriculture and Natural Resources
University of Florida, Institute of Food and Agricultural Sciences (IFAS), Gainesville, FL

Jack Payne is the Senior Vice President for Agriculture and Natural Resources at the University of Florida and the Administrative Head for the Institute of Food and Agricultural Sciences. Prior to his current position he served as a Vice President at Iowa State University, and, previous to Iowa State, he was a Vice President and Dean at Utah State University. Jack also has experience at two other land-grant institutions: Pennsylvania State University, where he served on the faculty of the School of Forest Resources, and, later, at Texas A&M University, where he served as a faculty member in the Fisheries and Wildlife Department.

After leaving Texas A&M University, Payne had a long career with Ducks Unlimited (DU), as their National Director of Conservation. While at Ducks Unlimited, some of his successes included the development of DU's private lands program with agriculture, the development of a national conservation easement program and the expansion of their Mexican program to Central and South America.

Payne received his M.S. in Aquatic Ecology and his Ph.D. in Wildlife Ecology from Utah State University and is a graduate of the Institute for Educational Management at Harvard University. He is a tenured professor in the Department of Wildlife Ecology and Conservation at the University of Florida.

Jennifer Pitt

Director
Colorado River Project, National Audubon Society, Boulder, CO

Jennifer Pitt is Director of the Colorado River Project at the National Audubon Society, where she focuses efforts to protect and restore freshwater and riparian habitats and reform water policy in the Colorado River Basin. She works with water users throughout the Colorado Basin to develop practical programs to restore river habitats and to dedicate water to critical environmental resources. Her expertise includes U.S.-Mexico border environmental issues, the legal and policy framework for Colorado River management, water markets, and the science of river restoration. Before joining Audubon, Jennifer worked on protection and restoration of Colorado River Basin freshwater resources for 17 years at the Environmental Defense Fund.

Sarah J. Ryker

Acting Deputy Assistant Secretary for Water and Science
Department of the Interior

Dr. Sarah J. Ryker began her career at the U.S. Geological Survey studying water quality, and is now USGS Senior Science Advisor for Climate and Land Use Change. She has also worked for the White House Office of Science and Technology Policy's research center, where she led a team focused on energy and environmental research and policy; and at the White House Council on Environmental Quality, where she coauthored recent guidance to agencies on incorporating ecosystem services into federal decision-making. She is currently on assignment as Counselor to the U.S. Department of the Interior's Assistant Secretary for Water and Science. Her PhD is from Carnegie Mellon University's Department of Engineering and Public Policy, and was supported by a National Science Foundation Graduate Research Fellowship.

Neil Santaniello

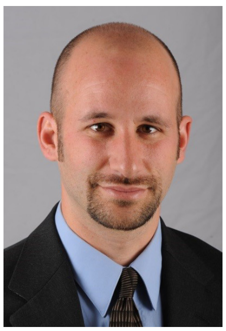
Florida Atlantic University (FAU), School of Communication and Multimedia Studies, Boca Raton, FL

Neil Santaniello is a senior instructor for the School of Communication and Multimedia Studies at Florida Atlantic University. He also serves as a faculty adviser to FAU student media, including the University Press. He is the former director of FAU's Scripps Howard Institute on the Environment, a summer educational fellowship for professional environmental journalists that ran from 2006 to 2012 and drew more than 100 members of the working news media. During that period he also managed FAU's Environmental Writers speaker series, which featured authors of non-fiction environment-themed books. Before joining FAU's journalism faculty 10 years ago, he worked as a staff writer for the South Florida Sun-Sentinel, where he had a byline for more than two decades, spending the latter portion of his time there covering environment and water-management issues for the paper. In addition to advising, he has taught courses in basic news writing, environmental journalism, news media ethics, feature writing and web research for journalists. He holds a master's degree in journalism from Northwestern University and a bachelor's degree in English Literature and Philosophy from Boston College.

Carl D. Shapiro

Chief
Science and Decisions Center, U.S. Geological Survey, Reston, VA

Carl Shapiro has been an economist with the U.S. Geological Survey (USGS) for over 25 years. He is Senior Economist, Energy and Minerals, and Environmental Health and is Director of the USGS Science and Decisions Center, a multidisciplinary center that advances the use of science in resource management decision making. Previously, he spent about 15 years as the principal economist in the USGS Director's Office, where he led and participated in analytical studies on topics ranging from interagency wetland data consistency to institutional issues associated with map revision and pricing. He is an adjunct associate professor of economics in the School of Public Affairs at American University in Washington, DC, where he has taught graduate courses in economics and public management for over 15 years. In that role, he led and participated in economic and interdisciplinary studies on public policy issues, resources, and natural hazards.



Mike Shriberg

Great Lakes Regional Executive Director
National Wildlife Federation, Merrifield, VA

Mike Shriberg, Ph.D., is the Great Lakes Regional Executive Director for the National Wildlife Federation. Mike's work focuses on Great Lakes protection, energy policy and campus sustainability. He is currently co-chair of the Healing Our Waters – Great Lakes coalition, which consists of more than 125 environmental, conservation, and outdoor recreation organizations which share a common goal: restoring and protecting the Great Lakes. Mike has published over 20 articles, testified in many hearings and been quoted in papers ranging from the New York Times to the Detroit Free Press.

Mike came to NWF in 2015 from the University of Michigan, where he served as the Education Director at the Graham Sustainability Institute and as a Lecturer in the Program in the Environment and Earth & Environmental Sciences. Previously, he was the Policy Director at the Ecology Center and the Director of Environment Michigan as well as the Environmental Studies Program Director and an Assistant Professor at Chatham University. Mike earned his MS and PhD in Resource Policy & Behavior from the University of Michigan's School of Natural Resources & Environment. He earned his B.S. in Biology & Society with a concentration in Environment & Business from Cornell University.

Alan D. Steinman

Director
Robert B. Annis Water Resources Institute (AWRI), Grand Valley State University, Muskegon, MI

Alan (Al) Steinman has been Director of Grand Valley State University's Annis Water Resources Institute since 2001. Previously, he was Director of the Lake Okeechobee Restoration Program at the South Florida Water Management District. Steinman has published over 140 scientific articles and book chapters and has testified before Congress and the Michigan and Florida state legislatures. Currently he is a member of science advisory boards for the U.S. EPA, the International Joint Commission, Michigan DEQ, Sea Grant, Healing our Waters, University of Michigan's Water Center, NOAA's Cooperative Institute for Limnology and Ecosystems Research, and the National Estuarine Research Reserve System, and is an Associate Editor for Freshwater Biology. Steinman received his PhD from Oregon State University and did his Postdoctoral work at Oak Ridge National Laboratory.

Ann Swanson

Executive Director
Chesapeake Bay Commission, Annapolis, MD

Ann Swanson has served as a leader in the Bay restoration for over 30 years, the last 28 as the Executive Director of the Chesapeake Bay Commission, a tri-state legislative authority serving the states of Pennsylvania, Maryland and Virginia. It is the Commission's responsibility to sponsor legislation at the state level and to work with state legislators, members of the U.S. Congress, and the federal and state regulatory agencies to coordinate programs aimed at restoring the Chesapeake Bay. Although Ann operates in a highly political environment, she is trained in the sciences. A trained wildlife biologist and forest ecologist, she graduated with honors from the University of Vermont and Yale University; she served as a member of the University of Vermont's Rubenstein School of Environment and Natural Resources for 23 years and as its Chairman for 11. Among her many awards, in 2001, she was awarded the Bay region's highest Conservation Award, Conservationist of the Year, in 2008 was recognized by general assembly resolutions in Pennsylvania, Maryland and Virginia, in 2011 was awarded the YMCA Outstanding Women in Industry Twin Award, in May 2012 received an honorary doctorate from the University of Vermont, in 2013 received the Alliance for the Chesapeake Bay Environmental Leadership Award, and in 2015 she was recognized as an Admiral of the Chesapeake Bay in the state of Maryland. Ann has been married for 29 years, is a published illustrator, an accomplished gardener, backpacker and sea kayaker, and is a mother of two boys.

Susan Wachter

Albert Sussman *Professor of Real Estate*, and *Professor of Finance* at The Wharton School of the University of Pennsylvania; *Director* for the Wharton GeoSpatial Initiative and Lab; *Co-director*, Penn Institute for Urban Research; and *Co-director*, Spatial Integration Laboratory for Urban Systems at the University of Pennsylvania

Dr. Susan Wachter is Sussman Professor of Real Estate and Professor of Finance at The Wharton School of the University of Pennsylvania. From 1999 to 2001, Dr. Wachter served as the Assistant Secretary for Policy Development and Research at the Department of Housing and Urban Development. Additionally, Dr. Wachter was a member of the White House Interagency Task Force on Smart Growth and is recognized for her role in the studies on land use decision making and housing price outcomes. Prior to her appointment as Assistant Secretary, Dr. Wachter was Chairperson of the Wharton Real Estate Department and Professor of Real Estate and Finance at the Wharton School. She holds an appointment as Professor of City and Regional Planning at the School of Design of the University of Pennsylvania and is the author of more than 200 scientific publications. Dr. Wachter is on the editorial board of several academic journals and was the editor of Real Estate Economics and former President of the American Real Estate and Urban Economics Association. Dr. Wachter has been Faculty Fellow of the Urban Land Institute, Faculty Fellow at the Weimar Institute, and Visiting Fellow at the Brookings Institution. Dr. Wachter is Founder and currently serves as Director of Wharton's Geospatial Initiative as well as Co –Founder and Co-Director of the Penn Institute for Urban Research.

David Waggonner

President
Waggonner and Ball, New Orleans, LA

David Waggonner is president of Waggonner and Ball, an award-winning, internationally active architecture and environment practice located in New Orleans. The firm's architectural work varies from historic preservation to modern institutional projects. In the aftermath of Hurricane Katrina, David saw an opportunity for New Orleans to reinvent itself as a sustainable city that embraces its lifeblood, water. He championed a process that examines history, soils, biodiversity, infrastructure networks, urban space and habitation, along with the forces of water. This combination serves as a holistic foundation for design, initiated during the Dutch Dialogues, developed through the Greater New Orleans Urban Water Plan, and continued into implementation, including the National Disaster Resilience Competition (NDRC) award to New Orleans. Related processes and efforts have produced Rebuild by Design and other NDRC awards for Bridgeport and the States of Louisiana, Connecticut, and Virginia.

Lisa Wainger

Research Professor
University of Maryland, Center for Environmental Science, Solomons, MD

Lisa Wainger is an environmental economist with over 20 years of experience analyzing changes in ecological conditions in terms of socio-economic outcomes. In her research, she integrates human behavior and ecological change to project risks and evaluate potential policy solutions. As a Research Professor at the University of Maryland Center for Environmental Science, Chesapeake Biological Lab, she uses innovative spatial modeling techniques to advance environmental economic analysis and support decisions of government agencies, NGOs and private businesses. Her PhD, from the University of Maryland, College Park, combined environmental economics and landscape ecology and she has applied this multi-disciplinary background to enhancing hedonic and benefit transfer economic valuation methods and non-monetary benefit indicators used for cost-effectiveness analysis and ecosystem service benefits assessment. Current areas of research include water quality trading and offsets, non-native invasive species control, biodiversity conservation under climate change, and cost-efficient ecological restoration of wetlands and oyster reefs. she is a frequent economics advisor to government agencies (e.g., White House Council on Environmental Quality, National Academies of Science), is Chair of the Scientific and Technical Advisory Committee to the US EPA Chesapeake Bay Program, and serves on several other science advisory boards.

Mark R. Wingate

Deputy District Engineer
Programs and Project Management Executive Office, New Orleans District, U.S. Army Corps of Engineers (USACE), New Orleans, LA

Mark R. Wingate, P.E. serves as the Deputy District Engineer for Programs and Project Management for the U.S. Army Corps of Engineers New Orleans District. Mr. Wingate is delegated full authority for management decisions related to all major District Civil, Environmental and Support for Others programs and projects. Projects include flood risk management, storm damage prevention, navigational projects such as channel improvements and lock & dam construction, environmental and coastal restoration/sustainability, river stabilization and harbor development.

With over 25 years of project management, planning and engineering expertise, Mr. Wingate brings firsthand knowledge of USACE traditional and non-traditional Civil Works programs, policies and regulations and the know-how and commitment to drive successful project delivery. He is responsible for delivering the New Orleans District Civil Works program with an annual program estimated at $300M in close coordination and collaboration with a variety of sponsors and stakeholders at all levels of government.

Mr. Wingate joined USACE in 1993 and has held past positions within the New Orleans District as Project Management Branch Chief, Senior Project Manager, Study Manager and Hydraulic Engineer. Prior to joining USACE, Mr. Wingate served as a Civil/Hydraulic Engineer in the private sector with a focus on Hydrologic and Hydraulic modeling.

He graduated from the University of New Orleans in 1989 with a Bachelor of Science in Civil Engineering and is a licensed Professional Engineer in the State of Louisiana. He is married to Lori Wingate and has 2 children, Kyle and Lindsey.

2016 PROGRAM AGENDA

	Monday, April 18, 2016
7:00am-5:00pm	**Optional Pre-Conference Field Trip to LILA** *[Morning refreshments will be served at 7am. The bus loads at 7:45am and departs for LILA promptly at 8am from the Conference Center Entrance.]*
3:00pm-6:00pm	**Conference Registration Opens** **Move-in of Sponsor Displays and Poster Presentations**

	Tuesday, April 19, 2016
7:00am-6:00pm	**Conference Registration Open**
7:00am-8:00am	**Early Morning Refreshments in Poster Hall**
8:00am-10:00am	**Opening Plenary Session** [Great Cypress & Royal Poinciana] **Opening Remarks - Conference Co-Chairs** **Rob Daoust**, Associate Vice President, Arcadis *-and-* **Andrew (Andy) LoSchiavo**, Adaptive Management Coordinator and Senior Biologist, Planning and Policy Division, Environmental Branch, South Florida Section, U.S. Army Corps of Engineers - Jacksonville District, Jacksonville, FL **Welcome Address** **Jack M. Payne**, Senior Vice President of Agriculture and Natural Resources, University of Florida/IFAS, Gainesville, FL **PANEL: The Restoration Story Part One - Setting the Stage** **Federal and State Large Scale Ecosystem Restoration – Implementation, Political Challenges and Lessons Learned** **ORGANIZER: Andrew (Andy) LoSchiavo,** Adaptive Management Coordinator and Senior Biologist, Planning and Policy Division, Environmental Branch, South Florida Section, U.S. Army Corps of Engineers - Jacksonville District, Jacksonville, FL **FACILITATOR: Donald Boesch,** Professor of Marine Science and President, University of Maryland Center for Environmental Science, Cambridge, MD **PANELISTS:** **Shannon A. Estenoz**, Director, Office of Everglades Restoration Initiatives, U.S. Department of the Interior, Davie, FL **Rainer Hoenicke**, Deputy Executive Officer, Science Program, Delta Stewardship Council, Sacramento, CA **Alan D. Steinman**, Director, Robert B. Annis Water Resources Institute (AWRI), Grand Valley State University, Muskegon, MI **Ann Swanson,** Executive Director, Chesapeake Bay Commission, Annapolis, MD **Mark R. Wingate**, Deputy District Engineer for Programs and Project Management Executive Office, New Orleans District, U.S. Army Corps of Engineers (USACE), New Orleans, LA
10:00am-10:30am	**AM Refreshment Break in Poster Hall**

Tuesday, April 19, 2016

Concurrent Sessions — 10:30am - 12noon

	Session 1	Session 2	Session 3	Session 4	Session 5
	Large-Scale Ecosystem Restoration Planning	**Challenges and Science Needs of Managing and Conserving Habitat in the Northern Everglades**	**Use of Oysters as Living Shorelines for Coastal Protection**	**Evaluating Restoration Through Experimental Replication of Ecological Processes**	**Ecosystem Restoration in the Columbia River Basin**
	Great Cypress	**Royal Poinciana**	**Ibis**	**Egret**	**Sandpiper**
	Ryan Clark	**Nick Aumen**	**Cameron Morris**	**Mark Hester**	**Gary Johnson**
10:30am	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**
10:40am	**Robert Summers** Development of a Large-Scale Restoration Plan for Rio De Janeiro's Guanabara Bay Based on Maryland's Chesapeake Bay Experience	**Brian Benscoter** **LeRoy Rodgers** **Donatto Surratt** **Rebekah Gibble** This panel session is the A.R.M. Loxahatchee National Wildlife Refuge Annual Science Workshop. The invited panel will discuss varying aspects of managing the refuge to support the USFWS mission and trust species.	**Peter Frederick** Effects of Durable Substrate on Establishment of Oyster Populations, Reef Elevations, and Aquatic Bird Use in the Big Bend of Florida	**Michael Manna** Active Marsh Improvement: A Decade of Rehabilitating Cattail Impacted Areas	**Ben Zelinsky** Applying Research, Monitoring, and Evaluation to Habitat Restoration in the Columbia Basin
11:00am	**Mindy Simmons** Ecosystem Restoration and the US Army Corps of Engineers: What Does the Future Hold?		**Kari Servold** Implementing Low-Crested Artificial Oyster Reef Breakwaters into Restoration Practice	**David Potter** Habitat Rehabilitation and Enhancement Projects and the Models Used to Justify Them for the Upper Mississippi River Restoration Program, Pools 1 through 10	**Gary Johnson** Effectiveness of a Channel Habitat Reconnection in Tidal Freshwater of the Columbia River: Sandy River Delta
11:20am	**Jessica Henkel** Gulf Coast Ecosystem Restoration Council: Holistic Restoration Approached Watershed by Watershed		**Erin Hague** Mulberry Phosphate Trustees Achieve Oyster Reef Restoration in Hillsborough Bay, Florida	**Christa Zweig** Active Management in Support of Ecosystem Restoration	**Heida Diefenderfer** Roles of Critical Uncertainties Research in Large-Scale Restoration: Examples from the Columbia Estuary Ecosystem Restoration Program
11:40am	**Estelle Wilson** Gulf County Restore Act Multi-Year Implementation Plan: Restoration Planning Through Structured Decision Making		**Taylor Sloey** Maximizing Shoreline Protection Using Vegetation and Artificial Oyster Reef Structures: Lessons Learned	**Dendy Lofton** Reintegrating Nature in a Dense Urban Environment: Restoration of Waller Creek	**Kate Buenau** The Role of Evidence in Adaptive Management: Examples from the Missouri River and Columbia River Estuary Restoration Programs
12noon-1:30pm	**Lunch Buffet Provided** **[Buffet stations and seating are in the poster hall, grand ballroom foyer, and the restaurant.** **A Vegetarian/Vegan Buffet Station is in the Lobby Atrium.]**				

	Tuesday, April 19, 2016				
	Concurrent Sessions — 1:30pm - 3:00pm				
	Session 6	**Session 7**	**Session 8**	**Session 9**	**Session 10**
	Advancing Louisiana Coastal Restoration Using Work-In Kind and Cross-Crediting Legislation	**Use of Adaptive Management to Enhance Restoration of the Chesapeake Bay Ecosystem**	**Restoring Alabama's Coast**	**Lessons Learned to Enhance Restoration**	**Southern Everglades Restoration Progress**
	Great Cypress	**Royal Poinciana**	**Ibis**	**Egret**	**Sandpiper**
	Mark Wingate	**Scott Phillips**	**Chris Warn**	**Rob Daoust**	**Patrick Pitts**
1:30pm	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**
1:40pm	**Darrel Broussard** US Army Corps of Engineers Perspective: Opportunities and Challenges of Implementing Coastal Restoration Work-In Kind and Cross-Crediting Legislation	**Carin Bisland** Overview of the Chesapeake Bay Watershed Agreement	**Roberta Swann** Regional Challenges, Regional Solutions: A Watershed Approach	**Tom St. Clair** Using Lessons Learned to Build a Robust Adaptive Management Plan for Large-Scale Ecosystem Restoration Programs	**Janet Starnes** Hydrological and Ecological Benefits Observed from the Picayune Strand Restoration Project
2:00pm	**Bren Haase** State of Louisiana's Perspective of Advancing Coastal Restoration Using Work-In Kind and Cross Crediting Legislation	**Carl Hershner** Use of Decision Framework to Formulate the Chesapeake Agreement and Management Strategies	**Bret Webb** The Importance of Ecology and Engineering in Coastal Restoration: Lessons Learned in Alabama	**Joanna Eyquem** The Economic Value of Establishing Freedom Space for Rivers	**Bahram Charkhian** Restoration Benefits Observed from the Biscayne Bay Coastal Wetlands Project
2:20pm	**James T. B. Tripp** Mississippi River Delta Restoration, Corps-State Relations and WRDA Crediting	**Doreen Vetter** Developing Indicators to Assess Progress and Environmental Conditions Related to Chesapeake Bay Agreement Outcomes	**Just Cebrian** Restoring Coastal Alabama: Different Approaches for Different Needs	**Kathleen Sealey** Coastal Wetland Restoration to Enhance Fisheries Production and Flood Resilience: The Victoria Pond Eco-Hydrology Project, the Bahamas	**Jerome Lorenz** Estuarine Fish and Submerged Aquatic Vegetation Response from the C-111 Spreader Canal Western Project
2:40pm	**Mitch Marmande** Aligning Programs and Policies to Facilitate Priority Project Implementation: A Local Sponsor's Perspective	**Scott Phillips** Providing Science to Support Decision Making for the Chesapeake Ecosystem	**Justin Barrett** Restoring Alabama's Coast	**Doug Partridge** Ecological Valuation of Alternatives and Assessment of Mitigation Requirements – U.S. Army Corps of Engineers, New York District's Hurricane Sandy Coastal Recovery Planning	**Christopher Madden** Ecological and Hydrological Response of Florida Bay to the C-111 Spreader Canal Western Project
3:00pm-3:30pm	**PM Refreshment Break in Poster Hall**				

Tuesday, April 19, 2016

Ted-Style Concurrent Sessions — 3:30pm - 5:00pm

	Session 11	Session 12	Session 13	Session 14	Session 15
	Surviving in a Changing Environment – What Can the Paleo-record Tell Us About Resiliency	**The Intersection and Interactions Between Ecosystem Restoration and Mercury Contamination**	**Policy, Planning and Permitting for Tethered Coastal, Estuarine and Marine Restoration**	**Assessment, Placement, and Maintenance of Large Wood in Fluvial Ecosystems**	**Miami Harbor Phase III Federal Channel Expansion: Monitoring and Mitigation**
	Great Cypress	**Royal Poinciana**	**Ibis**	**Egret**	**Sandpiper**
	Lynn Wingard & Christopher Bernhardt	**David Krabbenhoft**	**Thomas Ankersen**	**Leo Lentsch**	**Robert Baron**
3:30pm	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**
3:40pm	**Michal Kowalewski** Paleoecological Perspective on Ecological Resilience: The Youngest Fossil Record as a Historical Archive of Ecosystems	**Lisamarie Windham-Myers** Reconciling Coastal Wetland Restoration With Methylmercury Exposure: How Does San Francisco Bay Compare To Other Estuaries?	**Aubree Hershorin** Restoration by Design: The USACE Regional Sediment Management Program	**Willis McConnaha** Ecological Considerations Associated with Large Wood in Streams and Rivers	**Martha Robbart** Seagrass Monitoring at Two Different Sites for the Miami Harbor Phase III Federal Channel Expansion Project
3:50pm	**Evelyn Gaiser** Combining Paleoecological, Observational and High-frequency Information Sources to Improve Predictions of Ecosystem Resilience	**James Hurley** Understanding Mercury Sources to The Great Lakes Using Stable Isotopes: Critical Information For Restoration Planners	**William Lindberg** Restoring and Enhancing Life History Habitats Through Large Area Permitting	**Tim Abbe** The Role of Wood in Fluvial Geomorphology	**Michael Barnett** Julia Tuttle Seagrass Mitigation Site - Restoration of a Historic Dredge Hole in Biscayne Bay, Florida
4:00pm	**Letitia Grenier** Taking Some Pointers from Eden: How Analyzing the Past Can Help Us Envision a More Resilient Future	**Carrie Austin** Role of Ecosystem Restoration in Addition to Mercury Pollution Controls in California Reservoirs	**Robert Swett** The Regional Waterway Management System: Incorporating Restoration into a General Permit for Maintenance Dredging	**Jock Conyngham** Watershed-Scale and Long-Term Consideration in Restoring Large Wood to Riverine Ecosystems	**Mark Fonseca** Seagrass Transplantation at the Julia Tuttle Seagrass Mitigation Site
4:10pm	**Robert Johnson** Defining everglades Restoration Targets: Using Our Knowledge of the Past to Create a Sustainable Future	**Jacob Fleck** Mercury Source Complexity Challenges The Modalities Of Mercury Management And Regulation In The Sacramento-San Joaquin Delta	**Amy Langston** Natural Resource Adaptation Action Areas: A Planning Framework for Restoration	**Doug Shields** Engineering Considerations for Placing Wood in Streams and Rivers	**Jesse Davis** Miami Harbor Mitigative Artificial Reef

4:20pm	**Discussion**	**William Orem** The Role of Sulfur in Methylmercury Contamination	**Thomas Ankersen** Conceptual Permitting: Adapting Florida's Approach to Long-term, Large Scale Permitting to Restoration	**David Bandrowski** Large Wood Precision Prototyping and 3D-Hydraulic Modeling to Evaluate River Processes and Enhance Engineering Guidelines	**Anne McCarthy** Coral Relocation and Advanced Compensatory Mitigation
4:30pm		**George Aiken** Dissolved Organic Matter and Mercury: Implications for Ecosystem Restoration	**Discussion**	**Leif Embertson** Risk Considerations Associated with Placing Wood in Streams and Rivers	**William Precht** Deciphering Between Project-Related and Regional Impacts to Coral Reef Communities Near the Miami Harbor Dredging Project - The Science Behind the Story
4:40pm		**Discussion**		**Discussion**	**Discussion**
5:00pm - 7:00pm	**Poster Session One & Networking Reception** *(To allow for greater interaction and ease of discussion, presenters located at odd numbered boards are to stand at their posters from 5:30pm - 6:15pm. Presenters located at even numbered boards are to stand at their posters from 6:15pm - 7pm.)*				

	Wednesday, April 20, 2016
7:00am-5:30pm	**Conference Registration Open**
7:00am-8:00am	**Early Morning Refreshments in Poster Hall**
8:00am-10:00am	**Plenary Session** [Great Cypress & Royal Poinciana] **PANEL: The Restoration Story Part Two: Linking Science to Decision Making & Governance** **FACILITATOR: Neil Santaniello,** Florida Atlantic University (FAU), School of Communication and Multimedia Studies, Boca Raton, FL **ORGANIZERS: Nicholas G. Aumen,** Regional Science Advisor - South Florida, US Geological Survey, Davie, FL *-and-* **Matt Grabau,** Sonoran Institute, Tucson, AZ **PANELISTS:** **Alyssa Dausman,** Science Director, Gulf Coast Ecosystem Restoration Council, Bay Saint Louis, MS **Suzette M. Kimball,** Director, US Geological Survey, Reston, VA **Susan Newman,** Senior Scientific Section Lead, Everglades System Assessment Section, South Florida Water Management District (SFWMD), West Palm, FL **Jennifer Pitt,** Director, Colorado River Project, National Audubon Society, Boulder, CO **Mike Shriberg,** Great Lakes Regional Executive Director for the National Wildlife Federation, Merrifield, VA
10:00am-10:30am	**AM Refreshment Break in Poster Hall** **(Attention Session One Poster Presenters: Please remove your poster during the break.)**

	Wednesday, April 20, 2016				
	Concurrent Sessions — 10:30am - 12noon				
	Session 16	Session 17	Session 18	Session 19	Session 20
	Opportunities and Challenges of Measuring Ecosystem Service Benefits for Federal Decision Making	Leaving a Legacy in the Florida Panhandle	Ecological Restoration Implementation in South Florida using Regional/Sub-regional Modeling Tools	Improving the Quality and Reliability of Data Collected for Ecological Restoration Projects	Decision Analysis in Support of Ecosystem Restoration
	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Lisa Wainger	Cheryl Ulrich	Fahmida Khatun	Craig Palmer	Christy Foran
10:30am	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
10:40am	**Elizabeth Murray** The Need for Scalable, Robust Tools and Benefit Indicators, and Current Tool Availability	**Grover Robinson** **Warren Yeager** **Sheree Keeler** **Bryon Griffith** After years of litigation, BP reached a settlement from the 2010 Deepwater Horizon oil spill in July 2015. A panel of key Florida Panhandle leadership will highlight lessons learned from trying to leverage RESTORE, NRDA and NFWF funding sources, working with the Department of Treasury during the grant application process and ensuring this once of a lifetime opportunity to truly make a difference for the Panhandle region is optimized.	**Kiren Bahm & Amy Cook** Application of the MIKE Marsh Model of Everglades National Park (M3ENP) to Evaluate Restoration Alternatives	**Louis Blume** Can We Obtain Reliable Data When Implementing Ecological Restoration Projects?	**Christine Shepard** Building Coastal Resilience in the Gulf of Mexico: Decision Support Tools for Assessing the Costs and Effectiveness of Ecosystem Restoration
11:00am	**Jeff Kline** Evaluating Ecosystem Goods and Services in National Forest Planning: Balancing Rigor and Efficacy		**Sandeep Dabral** An Application of the Northern Everglades Simulation Model (NERSM) to the St. Lucie and Caloosahatchee River Watersheds to Evaluate Measures that Will Improve Hydrology and Water Quality Within the Study Area	**Timothy Lewis** Zen and the Art of Ecosystem Restoration: Assessing Precision and Accuracy in the Lab and Field	**Christy Foran** Decision Analytical Tools in Support of Restoration
11:20am	**Frank Casey & Emily Pindilli** Valuing Ecosystem Services: The US Geological Survey Experience		**Angela Montoya** Application of the Northern Palm Beach County Version of the Lower East Coast Subregional Hydrologic Model (LECSR-NP) to Determine Interim Restoration Benefits for the Northwest Fork of the Loxahatchee River	**Marty Boote** Watervliet Dams Removal: A Case Study for Monitoring in a Complex Non-Wadable River	**Michael Runge** Using Multicriteria Decision Analysis to Explore Management Options in the Grand Canyon
11:40am	**Lisa Wainger** Lessons Learned from Valuing Ecosystem Service Benefits of Invasive Plant Control		**Fahmida Khatun** Application of the Regional Simulation Model to the Everglades and Lower East Coast for the Modified Water Deliveries and C-111 South Dade Projects	**Lynde Dodd** Dallas Floodway Extension Lower Chain of Wetlands and Grasslands: A Case Study of the Adaptive Management Approach in Ecosystem Restoration	**Cecilia Mancini** Learnings from Implementation of a Comprehensive Monitoring Program in the South River
12noon-1:30pm	**Lunch Buffet Provided** **[Buffet stations and seating are in the poster hall, grand ballroom foyer, and the restaurant. A Vegetarian/Vegan Buffet Station is in the Lobby Atrium.]** **[Attention Session Two Poster Presenters: Please put your posters up during the lunch break.]**				

Wednesday, April 20, 2016

Concurrent Sessions — 1:30pm - 3:00pm

	Session 21	Session 22	Session 23	Session 24	Session 25
	Balancing Multiple Objectives and Interests: Recent Experiences with Large West Coast Water Projects	Creating and Fostering a State-based Aquatic Ecological Restoration Initiative	RECOVER Everglades System-wide Monitoring Results Part One	Building Community and Ecosystem Resilience through Restoring Landscape Connectivity	Using Physical Models to Manage Uncertainty Part One
	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Judy McCrea	Bethanie Walder	Andy LoSchiavo	David Hanson	Fred Sklar
1:30pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
1:40pm	**Anne Morkill** Large Scale and Long Term: The Role of Science and Collaboration in Large Ecosystem Restoration Projects	**Paul Davis** **Tim Purinton** **Samantha Woods** This panel will focus on the structural support systems needed to bolster an ambitious, landscape-scale ecosystem restoration initiative. Panelists will draw upon examples in Massachusetts where the essential components of support are in place and how controversial and complex projects, such as dam removals, can move forward given the network of support.	**April Patterson** System-wide Science Coordination and Reporting	**Brian Murphy** Creating Resiliency in Urban Streams: Restoration and Floodplain Reconnection	**Carlos Coronado-Molina** Tree Islands as Physical Models of Nutrient Sequestration
2:00pm	**Judy McCrea** Integrating Ecosystem Restoration and Flood Risk Management Along the South San Francisco Bay Shoreline		**Paul Conrads** Computing Water-Level Gradient Vectors to Assess System Changes in Sheet Flow and Direction	**Peter Murdoch** Practical First Steps in Understanding and Measuring Changes in Coastal Resilience: The DOI Hurricane Sandy Response Program	**Tiffany Troxler** Mesocosms for Estimating Climate-Change-Induced Peat Collapse
2:20pm	**Scott Miner** Federal Investment in the California Bay-Delta: Opportunities and Challenges		**Pablo Ruiz** The Everglades National Park and Big Cypress National Preserve Vegetation Mapping Project	**Justin Bousquin** Benefit Indicators to Promote and Prioritize Wetlands Restoration	**Colin Saunders** How Does DPM Help Move Everglades Restoration Forward?
2:40pm	**Sara Schultz** Balancing Life Safety with Ecological Health and Economic Sustainability: Challenging the Status Quo in the Sacramento River Valley and Delta		**Jay Sah** Recent Hydrologically-driven Vegetation Succession in Shark River Slough, the Southern Compartment of the Everglades Ridge and Slough Landscape	**David Hanson** Decision Support Framework for Restoring Landscape Connectivity and Enhancing Resilience as Part of Gulf Coast Ecosystem Restoration	**Erich Mueller** Science-Based Strategies for Experimental Flooding in Grand Canyon
3:00pm-3:30pm	**PM Refreshment Break in Poster Hall**				

Wednesday, April 20, 2016

Concurrent Sessions — 3:30pm - 5:00pm

	Session 26	Session 27	Session 28	Session 29	Session 30
	Louisiana's 2017 Coastal Master Plan: Building on Our Commitment to Protect and Restore Our Coast	**Approaches and Tools for Scientist-Decision Maker Collaboration and Actionable Science**	**RECOVER Everglades System-wide Monitoring Results Part Two**	**Large Aquatic Ecosystem Restoration Monitoring for Decision Makers: Targeting and Evaluating Success**	**Using Physical Models to Manage Uncertainty Part Two**
	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Karim Belhadjali	Patricia Gorman	Stacie Auvenshine	Troy Pierce & Matt Harwell	Colin Saunders
3:30pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
3:40pm	**Karim Belhadjali** Louisiana's Coastal Master Plan: Planning for an Uncertain Future	**Jerry Kenny** **April Patterson** **Craig Fischenich** **Jennifer Pratt Miles** This panel will examine approaches, tools, and structures for scientist and decision maker collaboration and actionable science. Panelists will share experience from the Comprehensive Everglades Restoration Program, Platte River Recovery Implementation Program, Glen Canyon Dam Adaptive Management Program, Missouri River Recovery Program, and the National Climate Change and Wildlife Science Center.	**Chris Kelble** Restoration Targets for Juvenile Sportfish in Florida Bay	**Don Boesch** Coastal Hypoxia in the Northern Gulf of Mexico: The Benefits of Long-term Study	**Duncan Bryant** Wave Attenuation by Vegetation: Role in Sediment Trapping and Retention
4:00pm	**Mandy Green** Louisiana's Coastal Master Plan: Modeling in a Systems Context		**Laura Brandt** Alligators, Hydrology, and Aquatic Fauna, Oh My! Integrating Ecosystem Responses	**Troy Pierce** Water Quality and *E. coli* Monitoring for a Gulf of Mexico Community's Restoration Decision Makers	**Walter Wilcox** Hydraulic Pulsing in Managed Wetlands to Identify Physical Parameters
4:20pm	**Melanie Saucier** Louisiana's Coastal Master Plan: Reducing Flood Risk and Increasing Community Resilience		**Joel Trexler** Food Webs, Interaction Webs, and Monitoring: Using a Trophic Conceptual Model to Select Ecological Indicators	**Kevin Keeler** Monitoring the Aquatic Environment of a Bi-national Connecting Channel (St. Clair-Detroit River System)	**Ehab Meselhe** Mississippi River Delta Management Study: Analysis and Evaluation of Proposed Land Building Strategies
4:40pm	**Nick Speyrer** Louisiana's Coastal Master Plan: Collaborative Decision Making and Stakeholder Engagement		**Bruce Sharfstein** Improving Lake Okeechobee Ecology	**James Boase** A Scientific Basis for Restoring Fish Spawning Habitat in the St. Clair and Detroit Rivers of the Laurentian Great Lakes	**Fred Sklar** The Role of LILA (Loxahatchee Impoundment Landscape Assessment) in Everglades Restoration

5:15pm - 6:00pm

Meeting of the Large-Scale Ecosystem Restoration Section (LERS) of the Society for Ecological Restoration (SER)
[Great Cypress & Royal Poinciana]

MODERATOR: Ryan Clark, LERS President

All NCER attendees involved in large scale restoration are invited to attend this session and learn how you can collaborate with the best and brightest from across the globe to advance ecosystem restoration.
LERS provides a forum for exchanging ideas, approaches, lessons learned, and data relevant to the planning, policy, science, and engineering of large-scale ecosystem restoration programs. ***Please join us!***

6:00pm

Evening on Own

	Thursday, April 21, 2016
7:00am-5:30pm	**Conference Registration Open**
7:00am-8:00am	**Early Morning Refreshments in Poster Hall**
8:00am-10:00am	**Plenary Session** [Great Cypress & Royal Poinciana] **PANEL: The Story Continues: Ecosystem Restoration as a Tool for Enhancing Resiliency and Ecosystem Services** **FACILITATOR & ORGANIZER:** **Carl D. Shapiro**, Chief, Science and Decisions Center, U.S. Geological Survey, Reston, VA **PANELISTS:** **Sarah Ryker**, *Acting Deputy Assistant Secretary for Water and Science*, Department of the Interior, Washington D.C. Metro Area **Susan Wachter,** Albert Sussman Professor of Real Estate, and Professor of Finance at The Wharton School of the University of Pennsylvania; Director for the Wharton GeoSpatial Initiative and Lab; Co-director, Penn Institute for Urban Research; and Co-director, Spatial Integration Laboratory for Urban Systems at the University of Pennsylvania **David Waggonner,** President, Waggonner and Ball, New Orleans, LA **Lisa Wainger,** Research Professor, University of Maryland, Center for Environmental Science, Solomons, MD
10:00am-10:30am	**AM Refreshment Break in Poster Hall**

Thursday, April 21, 2016

Concurrent Sessions — 10:30am - 12noon

	Session 31	Session 32	Session 33	Session 34	Session 35
	Changing Course: Navigating the Future of the Lower Mississippi River	**Innovative Ways to Restore and Enhance National Parks in Their Centennial Year**	**Biscayne Bay Coastal Restoration**	**Science Tools in Support of Restoration**	**Assessing Progress in Reducing Pollutant Loads to Chesapeake Bay**
	Great Cypress	**Royal Poinciana**	**Ibis**	**Egret**	**Sandpiper**
	Michael Donahue	**Sarah Barmeyer**	**Anna Wachnicka**	**Tomma Barnes**	**Joel Blomquist**
10:30am	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**
10:40am	**Alan Travers** Changing Course: Navigating the Future of the Lower Mississippi River	**Raymond Sauvajot** Restoring Large Landscapes to Benefit National Parks	**Joan Browder** Rainwater Killifish in Nearshore Epifaunal Communities of Southern Biscayne Bay: Indicator of Ecosystem Change for South Florida Restoration Assessments	**Stefanie Kroll** Monitoring and Data Management to Inform Conservation in the Delaware River Watershed Initiative	**Douglas Moyer** Measuring Changes In Nutrient and Sediment Load in the Chesapeake Bay Watershed
11:00am	**Rob Nairn** Changing Course Design Competition: The Baird Team Solution - A Delta for All	**Shannon Estenoz** Everglades Restoration: Keys to Success	**Henry Briceňo** High Tide on Miami Beach: A Peek into the Future of Biscayne Bay	**Shaye Sable** Comprehensive Aquatic Systems Model (CASM) for Evaluating Coastal Restoration Projects in Coastal Louisiana	**Jeni Keisman** Drivers of Change in Nutrient Inputs to the Chesapeake Bay Watershed: 1950-2012
11:20am	**Jeff Shelden** The Giving Delta: A 'Systems Approach' to a Consolidated and Sustainable Lower Mississippi River Delta	**Ryan Valdez** Utilizing Online Mapping Tools for Partnership Engagement	**Sarah Bellmund** Downstream Water Quality as an Indicator of Restoration Conditions and Ecosystem Change for Biscayne Bay	**Eric Swain** Comparing Physics-Based and Empirical-Statistical Methods of Representing Hydrology	**Scott Ator** Application of SPARROW Modeling to Understanding Water-Quality Trends in the Chesapeake Bay Watershed
11:40am	**John Hoal** The New MISI-ZIIBI Living Delta: An Eco 3D Approach to a Self Organizing Sustainable Delta	**Kristen Hart** Tracking Marine Turtles Throughout the Seascape Reveals Connections Among U.S. Parks and Protected Areas	**Anna Wachnicka** Microalgae as a Powerful Tool in Assessment of Ecological Health of Biscayne Bay Nearshore Habitats in Support of the Biscayne Bay Coastal Wetlands Restoration Project	**Chris Bernhardt** How the "Paleo" Record Can Assist Wetland Restoration in Light of Current Climate and Sea Level Change	**Jimmy Webber** Water-Quality Results From Three Chesapeake Bay Showcase Watersheds: Monitoring and Analysis Designed to Assess and Inform Restoration
12noon-1:30pm	**Lunch Buffet Provided [Buffet stations and seating are in the poster hall, grand ballroom foyer, and the restaurant. A Vegan Station is in the Lobby Atrium.]**				

Thursday, April 21, 2016

Concurrent Sessions — 1:30pm - 3:00pm

	Session 36	Session 37	Session 38	Session 39	Session 40
	Evaluating Climate Change Stressors on Ecosystem Restoration	**Managing Freshwater Resources to Restore Coastal Ecosystems**	**Strategies to Address Endocrine Disruption in the Chesapeake Bay Watershed**	**Restoring Large Florida Farms to Wetlands Under the NRCS Agricultural Conservation Easement Program**	**Real-time Evaluation, Modeling, and Reporting of Ecosystem Restoration**
	Great Cypress	Royal Poinciana	Ibis	Egret	Sandpiper
	Terry Doss	David Kaplan	Kelly Smalling	David Stites	Paul Conrads
1:30pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
1:40pm	**Don DeAngelis** Coupled Vegetation Competition and Groundwater Simulation Model to Study Effects of Sea Level Rise and Storm Surges on Coastal Vegetation	**Yongshan Wan** Optimizing Freshwater Delivery Into Coastal Ecosystems With a Fuzzy Rule-based Operation Control Model	**Patrick Phillips** Endocrine Disrupting Compounds in the Chesapeake Bay Watershed - Where Are We Going and Where Should We Go?	**J. Scott Kuipers** Wetland Restoration Under the Agricultural Conservation Easement Program in Florida	**Bryan McCloskey** Real-time Evaluation Tools: Cape Sable Seaside Sparrow Habitat Viewer and Tree Island Inundation Monitoring
2:00pm	**Peter Rubec** Modeling to Assess Influence of Water Withdrawals on Estuarine Species in Charlotte Harbor, Florida	**Beth Middleton** Hydrologic Remediation to Revive Stressed Freshwater Species in Tidal Swamps	**Vicki Blazer** Biological Effects Monitoring to Identify Consequences of Exposure to Endocrine Disruptors	**David Stites** Ecological, Hydrologic, and Engineering Design Principles for ACEP-WRE Restoration Projects	**Leonard Pearlstine** Everglades Spatially-Explicit Hydrological Near-Term Forecasts for Ecological Modeling
2:20pm	**Kimberly Artita and Heather Schwar** Changing Hydrologic Conditions in the Mississippi River Basin: Implications for Restoration and Ecological Processes	**Mark Zucker** Evaluating Changes in Freshwater Flows into Florida Bay and the Coastal Estuaries of Southwestern Everglades National Park in Support of the Comprehensive Everglades Restoration Plan	**Jennifer Brennan** Effects Directed Analysis of Endocrine Disrupting Compounds in the Chesapeake Bay Watershed: An Important Step on the Road to Managing Fish Health in the Watershed	**Jennifer Klich** Case Studies of Ongoing NRCS Wetland Restoration Projects in Florida	**James Beerens** Multi-Species Management and Decision Support Using the Everglades Forecasting (EVERFOR) Application
2:40pm	**Linnea Spears-Lebrun** Response of Invasive Weeds in Southern California to the Historic California State-Wide Drought	**David Kaplan** Restored Oyster Reefs Enhance Estuarine Ecosystem Services	**Yan Li** Assessing the Impacts of Endocrine Disrupting Compounds on Fish Population Dynamics: A Case Study of Smallmouth Bass in Pennsylvania, USA	**Scott Turgeon** Long-Term Monitoring and Management of Restored Wetlands in Florida	**Johnna Infanti** Near Real-time Availability of the North American Multi-Model Ensemble: An Introduction
3:00pm-3:30pm	**PM Refreshment Break in Poster Hall**				

Thursday, April 21, 2016

Concurrent Sessions — 3:30pm - 5:00pm

	Session 41	Session 42	Session 43	Session 44	Session 45
	Using Science to Inform Conservation Decisions at a Landscape Scale	**Collaborative Large-Scale Restoration Planning**	**Ecosystem Numerical Tools**	**Watch Us WIP, Now Watch Us Bay Bay: Delaware's Choreographed Approach to Chesapeake Bay Restoration**	**Intergovernmental Collaboration and Stakeholder Collaboration to Restore Ecosystems in the Southwest**
	Great Cypress	**Royal Poinciana**	**Ibis**	**Egret**	**Sandpiper**
	Cynthia Kallio Edwards	**Nanciann Regalado**	**Ehab Meselhe**	**Marcia Fox**	**Georganna Collins**
3:30pm	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**	**Introduction & Overview**
3:40pm	**John Tirpak** Establishing Explicit Biological Objectives to Guide Strategic Habitat Conservation for the Gulf Coast: Case Study with the Brown Pelican	**Brenda Bachman** Contributing to the Recovery of an Inland Sea: The Remediation and Restoration of Urban Rivers	**Cameron Ainsworth** Ecosystem Recovery Following the DWH Oil Spill Evaluated Using an End-to-end Model	**Marcia Fox** Delaware's Chesapeake Bay Watershed Implementation Plan (WIP): It's Not too Late to WIP It, WIP It Good!	**Edmond Russo** Regionally Integrated, Sustainable, and Resilient Development of Nationally Significant Water Resources on the Texas Coast
4:00pm	**Steve Traxler** Coastal Resilience and Landscape Conservation Design in SW Florida	**Thomas Ries** A New Era in Ecosystem Restoration - Public-Private-Partnerships (P3S), Use of Habitat Mitigation to Restore Large Scale Ecosystems	**Scott Duke-Sylvester** Modeling Landscape Scale Plant Community Response to Climate Change and Human Management	**Brooks Cahall** Not Your Father's Tax Ditch: Enhancing Delaware's Drainage Network Through the Use of Natural Channel Design Techniques	**Georganna Collins** Application of NRDA to Large Scale Restoration in Texas
4:20pm	**Todd Jones-Farrand** How Much Restoration & Where? Using Structured Decision Making to Turn Landscape Priorities Into Efficient Adaptation Strategies in the Ozarks	**Marit Larson** NYC Salt Marsh Assessment for Restoration and Resiliency Planning: Strategies for Identifying and Prioritizing Restoration Needs and Opportunities	**Scott Hagen** Assessing and Enhancing Salt Marsh Resiliency Under Climate Change for Fluvial vs. Marine Fed Systems	**Melissa Hubert** Reducing Nonpoint Source Pollution through Effective Ditch Management	**Matt Grabau** Binational Restoration Efforts to Revive the Colorado River Delta
4:40pm	**Mark Woodrey** Application of Structured Decision Making in Development of a Gulf-Wide Avian Monitoring Network	**Jo Cullis** Enhancement or Just Good Design? A Collaborative Approach to River and Wetland Restoration	**Eric White** Linking Downscaled Global Climate Models to Planning Level Ecosystem Models	**Tyler Monteith** Improving Soil Health One Grain at a Time: Innovative Cropland Methods to Increase and Track Cover Crops	**Discussion**
5:00pm-7:00pm	**Poster Session Two & Networking Reception** *[To allow for greater interaction and ease of discussion, presenters located at odd numbered boards are to stand at their posters from 5:30pm - 6:15pm. Presenters located on even numbered boards are to stand at their posters from 6:15pm - 7pm. Please remove your poster displays at the end of the reception. Poster boards will be removed at 8pm.]*				

	Friday, April 22, 2016
7:30am-10:00am	**Conference Registration Open**
7:30am-8:30am	**Early Morning Refreshments in Plenary Session Room** *[Attention Sponsors: Please remove display materials from poster hall by 12noon.]*
8:30am - 9:00am	**Plenary Session** **Synthesis Discussion — The Essence of NCER 2016** **Rob Daoust,** Associate Vice President, Arcadis, NCER 2016 Conference Co-Chair *-and-* **Andrew (Andy) LoSchiavo,** Adaptive Management Coordinator and Senior Biologist, Planning and Policy Division, Environmental Branch, South Florida Section, U.S. Army Corps of Engineers - Jacksonville District, Jacksonville, FL
9:00am-9:45am	**CLOSING KEYNOTE PRESENTATION -** **Carlton Ward, Jr., Conservation Photographer, Clearwater, FL** *Sponsored by the University of Florida/IFAS Office of the Vice President for Agriculture and Natural Resources* An environmental photojournalist with graduate training in ecology and anthropology, Carlton Ward aims to promote conservation of natural elements and cultural legacies. At home and abroad, he seeks stories where he can use photographs to make a difference. For his first book, The Edge of Africa, Carlton spent eight months in the tropical rainforests of Gabon, documenting the unseen wonders of life at the edge of the African continent. Beyond the value of scientific record, Carlton recognizes the power of photographs to influence public perceptions and inspire change. Conservation Photography is a window that sheds light on the people, places and issues that demand our collective attention so that together, we can ensure the survival of essential natural and cultural legacies. One of the most visible advocates for taking action now to provide the missing land and water links for cross-Florida wildlife corridors, Carlton will share photos from two 100-day expeditions across two proposed Florida wildlife corridors, highlighting the importance of connecting, protecting, and restoring corridors of conserved lands and waters essential for the survival of Florida's diverse wildlife. Don't miss this inspiring presentation and exquisite photography capturing the essence of natural areas in Florida and beyond — highlighting the very species, habitats, ecosystems, and entwined natural/human systems we are trying to restore, enhance, and maintain for future generations.
9:45am-10:30am	**Book Signing and Meet & Greet with Carlton Ward, Jr.**
10:30am	**Depart for Optional Field Trip into the Everglades** [The bus boards outside the conference center entrance at 10:15am, and departs promptly at 10:30am.]
10:30am	**CONFERENCE CONCLUDES** **Happy Earth Day!**

POSTER DISPLAY INFORMATION

Poster presentations play a key role in the success of a conference. Much time will be dedicated for viewing posters, allowing scientists, policy makers, planners, practitioners and managers to interact and use these opportunities to share details of their work, successes and lessons learned.

Early morning, mid-day and afternoon refreshments will be served in the poster session room each day, and one of four lunch buffet stations will be located in this room each day. In addition, a formal reception for each poster session will take place in the poster room. (See detailed schedule below.)

Poster Session One:

Poster Set Up: Monday, April 18 | 3:00pm – 6:00pm
(If you arrive after this time, you can set it up during breakfast the next morning.)

Poster Reception: Tuesday, April 19 | 5:00pm-7:00pm*

Poster Removal: Wednesday, April 20 | 10:00am-10:30am
(At the end of the AM break)

Poster Session Two:

Poster Set Up: Wednesday, April 20, 12:00pm – 1:00pm
(During lunch before the afternoon session begins.)

Poster Reception: Thursday, April 21, 5:00pm-7:00pm *

Poster Removal: Thursday, April 21
(Immediately following the poster session reception.)

Important details to note:

- *Please stand at your poster during the applicable Poster Session Reception as follows:
  - **Presenters at ODD NUMBERED BOARDS: 5:30pm - 6:15pm.**
  - **Presenters at EVEN NUMBERED BOARDS: 6:15pm – 7:00pm.**

  This is the primary opportunity for attendees to meet with you personally and ask questions about your work, so please be available at your poster during the appointed time.

- Poster display boards will be dismantled and removed by the vendor on Thursday evening at the end of the reception. Please remove your poster when leaving the reception.

- Conference organizers are not responsible for lost or damaged posters removed by the display board vendor. Posters not removed and left behind will be discarded.)

DIRECTORY OF POSTER PRESENTATIONS

Session One: #'s 1 - 41 | Session Two: #'s 42 - 83 | Listed Alphabetically by Presenting Author

Poster #	Prefix	First Name	Last Name	Organization	City	ST	Abstract Title	Final Session #
29	Mrs.	Cara	Abbott	The Institute for Regional Conservation	Delray Beach	FL	THE EFFECT OF SEA LEVEL RISE ON JUNCUS ROEMERIANUS IN A HIGH NUTRIENT ENVIRONMENT	Session One
71	Ms.	Katherine	Abbott	Louisiana State University	Baton Rouge	LA	BLUE CARBON ACCUMULATION AND MICROBIAL COMMUNITY DEVELOPMENT IN A CHRONOSEQUENCE OF RESTORED SALT MARSHES IN SW LOUISIANA	Session Two
22	Mr.	Joshua	Allen	Florida International University	Miami	FL	HYDROLOGIC AND NUTRIENT CONDITIONS IN WEST AND SEVEN PALM LAKE DRAINAGES IN THE FLORIDA EVERGLADES	Session One
42	Mr.	Eric	Anderson	Palm Beach County	West Palm Beach	FL	Grassy Flats Restortation: Creatively Capping Muck to Restore Lake Worth Lagoon	Session Two
17	Ms.	Megan	Bartholomew	Auburn University	Auburn	AL	LONG TERM VEGETATION RESPONSE TO HYDROLOGIC RECOVERY IN ISOLATED CYPRESS DOMES OF WEST-CENTRAL FLORIDA	Session One
59	Mr.	Tyler	Bassett	Michigan State University	Hickory Corners	MI	Achieving diversity and function in tallgrass prairie restoration	Session Two
3	Dr.	James	Beerens	US Geological Survey	Fort Lauderdale	FL	WADER DISTRIBUTION EVALUATION MODELING (WADEM) AS A GREATER EVERGLADES RESTORATION PERFORMANCE MEASURE	Session One
41	Dr.	Nur	BELKAYALI	Kastamonu University	Kastamonu		Evaluation of Open-Green Spaces in Turkey Kastamonu Region in terms of Ecological Restoration	Session One
11	Ms.	Lesley	Bertolotti	South Florida Water Management District	West Palm Beach	FL	INNOVATION FOR RESTORATION: THE C-43 WATER QUALITY TREATMENT AND TESTING PROJECT	Session One
79	Mr.	William	Brammell	Mosaic Fertilizer, LLC	Lithia	FL	HORSE CREEK ENHANCEMENT PLAN	Session Two
50	Dr.	John	Brazner	Nova Scotia Department of Natural Resources	Kentville	NS	RESTORATION OF BIG MEADOW BOG AND RECOVERY OF THE ENDANGERED EASTERN MOUNTAIN AVENS	Session Two
6	Mr.	Aaron	Brown	University of South Florida	Tampa	FL	Designing for Success: Long-term Trends of Constructed Freshwater Wetlands in Hillsborough County, Florida	Session One

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82	Mr.	Ansel	Bubel	Florida Department of Environmental Protection	Tallahassee	FL	Development of a new methodology for setting lacustrine restoration targets based on phytoplankton community assemblages	Session Two
4	Dr.	Kate	Buenau	Pacific Northwest National Laboratory	Sequim	WA	USING "EFFECTS ANALYSIS" TO BUILD SCIENCE-BASED ADAPTIVE MANAGEMENT ON THE MISSOURI RIVER	Session One
74	Ms.	Gwen	Burzycki	Miami-Dade County RER-DERM	Miami	FL	RESTORATION OF SEASONALLY-FARMED EVERGLADES PRAIRIE WITHOUT REMOVAL OF DISTURBED SOIL	Session Two
36	Ms.	Sahale	Casebolt	Florida Museum of Natural History	Gainesville	FL	MOLLUSK DEATH ASSEMBLAGES CAN RECORD FINE-SCALE SPATIAL VARIABILITY IN MARINE COMMUNITIES	Session One
12	Ms.	Julia	Chapman	US Geological Survey	Davie	FL	Small Mammal Communities as Indicators of Restoration Success in the Greater Everglades	Session One
62	Dr.	Hongjun	Chen	South Florida Water Management District	West Palm Beach	FL	Hypoxia in the post-phase I Kissimmee River channel and implications for discharge management	Session Two
63	Mr.	Paul	Conrads	USGS	Columbia	SC	APPLICATION OF THE COASTAL DROUGHT INDEX TO SITES IN FLORIDA BAY AND THE GULF OF MEXICO	Session Two
37	Ms.	Katherine	Cummings	University of Florida	Gainesville	FL	MOLLUSK ASSEMBLAGES AS PROXY FOR WITHIN-HABITAT DIFFERENCES IN SEAGRASS BEDS	Session One
68	Dr.	Nora	Demers	Florida Gulf Coast University	Fort Myers	FL	CHALLENGES OF COMPETING INTERESTS, LOGISTICS, AND PAYOFFS IN TWO DIFFERENT RESTORATION PROJECTS IN SOUTHWEST FLORIDA.	Session Two
72	Ms.	Rachael	Dunn	University of Florida Levin College of Law	Gainesville	FL	Policy, Planning, and Permitting for Tethered Coastal, Estuarine, and Marine Restoration	Session Two
13	Mr.	Ralph	Elliott	Enviro Water Restoration, LLC	Jacksonville	FL	WHY WOULD YOU EVER DREDGE ORGANIC SEDIMENT FROM AN ECOSYSTEM?	Session One
27	Mr.	Thomas	Frankovich	Florida International University	Key Largo	FL	LIGHT ATTENUATION IN ESTUARINE MANGROVE LAKES	Session One
51	Ms.	Emma	Garrison	University of Miami	Brooklyn	NY	A COMPARATIVE STUDY OF SUMMER GROWTH OF SPAT AND JUVENILE CRASSOSTREA VIRGINICA IN NEW YORK HARBOR AND IMPLICATIONS FOR URBAN OYSTER RESTORATION	Session Two

Poster #	Prefix	First Name	Last Name	Organization	City	ST	Abstract Title	Final Session #
60	Mr.	Sergio	Gonzalez	Florida Fish & Wildlife Conservation Commission	Sunrise	FL	Assessing impacts of an active water schedule on vegetation and mammal communities in Holey Land Wildlife Management Area	Session Two
75	Dr.	Andrew	Gottlieb	SFEC	West Palm Beach	FL	ESTIMATION OF PREDEVELOPMENT AND CURRENT HYDROLOGY FOR ECOLOGICAL RESTORATION OF A FLORIDA PINE FLATWOODS	Session Two
1	Dr.	Matthew	Grabau	Sonoran Institute	Tucson	AZ	BINATIONAL RESTORATION EFFORTS TO REVIVE THE COLORADO RIVER DELTA	Session One
40	Dr.	Yavuz	GULOGLU	Kastamonu University	Kastamonu		The Effects of Supreme Courts' Decisions on Environmental Protection in Turkey	Session One
44	Mr.	Kelly	Haggar	Riparian, Inc.	Baton Rouge	LA	Some Critical Legal Aspects of Coastal Change Resulting from Both Anthropogenic and Natural Causes	Session Two
18	Dr.	Dennis	Hanisak	FAU Harbor Branch	Fort Pierce	FL	DEVELOPMENT OF A SEAGRASS NURSERY FOR RESTORATION OF SEAGRASS IN THE INDIAN RIVER LAGOON	Session One
73	Dr.	Matthew	Harwell	USEPA Office of Research and Development	Gulf Breeze	FL	THE SCIENCE OF STRATEGIC COMMUNICATION AND ITS UTILITY IN NATURAL RESOURCE MANAGEMENT	Session Two
7	Dr.	Mark	Hester	University of Louisiana	Lafayette	LA	Vegetation Colonization Thresholds and Marsh Platform Expansion Dynamics at a Tidal Freshwater Restoration Site in the Sacramento-San Joaquin Delta, California, USA	Session One
64	Mr.	Daniel	Hope	Florida Institute of Technology	Melbourne	FL	THE IMPACT OF EUTROPHIC ESTUARINE SEDIMENTS ON BENTHIC INFAUNAL DIVERSITY IN THE INDIAN RIVER LAGOON	Session Two
76	Dr.	Tonya	Howington	Everglades National Park	Homestead	FL	Does What We Know About Biodiversity Have a Place in Ecosystem Restoration Planning?	Session Two
45	Mrs.	Ondrea	Hummel	US Army Corps of Engineers	Albuquerque	NM	Restoration and Monitoring Techniques in the Middle Rio Grande	Session Two
26	Mrs.	Amber	Inggs	The Louis Berger Group	Morristown	NJ	Eye-Opening Outcomes through the Power of Modeling in the Holly Pond Watershed	Session One
30	Mr.	Moses	Katkowski	The Nature Conservancy	Delmont	NJ	Demonstrating oyster reef breakwaters and other living shoreline techniques in the Delaware Estuary as part of a Tidal Marsh Resilience Program	Session One

Poster #	Prefix	First Name	Last Name	Organization	City	ST	Abstract Title	Final Session #
39	Mr.	Kevin	Keeler	US Geological Survey	Ann Arbor	MI	EVALUATING HABITAT RESTORATION IN THE ST. CLAIR-DETROIT RIVER SYSTEM USING EGG DEPOSITION ON SPAWNING REEFS AND LARVAL DRIFT OF NATIVE FISHES	Session One
33	Ms.	Elizabeth	Kelly	University of Miami	Coral Gables	FL	BACTERIAL LEVELS AT RECREATIONAL BEACHES INFLUENCED BY OUTFLOWS FROM FLORIDA BAY AND THE CALOOSAHATCHEE AND ST. LUCIE RIVERS	Session One
16	Mr.	Dan	Kelner	US Army Corps of Engineers	St. Paul	MN	RESTORING THE FEDERALLY ENDANGERED HIGGINS EYE PEARLYMUSSEL (LAMPSILIS HIGGINSII) IN THE UPPER MISSISSIPPI RIVER – PROPAGATION AND REINTRODUCTION.	Session One
19	Dr.	Sean	King	Southwest Florida Water Management District	Brooksville	FL	Submerged aquatic vegetation restoration in Florida spring systems	Session One
25	Mr.	Peter	Kotulak	Moffatt & Nichol	Baltimore	MD	MASONVILLE COVE MITIGATION DESIGN AND CONSTRUCTION	Session One
23	Ms.	Joelle	Laing	University of Florida	Gainesville	FL	Restoration strategies for reestablishing submerged aquatic vegetation on sites high in sediment organic matter.	Session One
80	Ms.	Carolyn	Lanza	Clemson University	Clemson	SC	Choose Your Weapon: Comparing Invasive Removal Methods in an Urban Watershed	Session Two
81	Ms.	Marit	Larson	NYC Parks	New York	NY	Urban Salt Marsh Restoration over two decades in NYC: Assessment Strategies and Preliminary Results	Session Two
83	Mr.	Jabari	Lee	Florida Gulf Coast University	Fort Myers	FL	Using Native Cottonwood to Improve Water Quality in Urban Streams	Session Two
52	Dr.	Bill	Louda	Florida Atlantic University	Boca Raton	FL	PIGMENT-BASED CHEMOTAXONOMY: A RELATIVELY EASY AND ECONOMICAL METHOD FOR MICROALGAL COMMUNITY ASSESMENT AND ADAPTIVE MANAGEMENT.	Session Two
53	Dr.	Frank	Marshall	Cetacean Logic Foundation	New Smyrna Beach	FL	COUPLING PALEOECOLOGICAL DATA AND MODEL-PRODUCED HYDROLOGY TO ESTIMATE CIRCA 1900 CE CONDITIONS IN FRESHWATER MARSHES AND MARL PRAIRIES WITHIN EVERGLADES NATIONAL PARK (ENP)	Session Two
70	Mr.	Mark	McKelvy	US Geological Survey	Gainesville	FL	Web Tools to Support the Upcoming EverVIEW Lite Visualization Platform	Session Two

Poster #	Prefix	First Name	Last Name	Organization	City	ST	Abstract Title	Final Session #
54	Ms.	Agnes	McLean	NPS/EVER	Homestead	FL	ESTABLISHING INTERIM GOALS AS TOOLS FOR ASSESSING RESTORATION SUCCESS FOR THE COMPREHENSIVE EVERGLADES RESTORATION PLAN	Session Two
10	Mr.	Damon	Moore	Manatee County Parks and Natural Resources Department	Bradenton	FL	PLANNING, IMPLEMENTATION, AND ADAPTIVE MANAGMENT FOR RESTORATION OF FORMER AGRICULTURAL LANDS AT PERICO PRESERVE IN COASTAL SOUTHWEST FLORIDA	Session One
9	Mr.	Peter	Murdoch	US Geological Survey	Troy	NY	PRACTICAL FIRST STEPS IN UNDERSTANDING AND MEASURING CHANGES IN COASTAL RESILIENCE: THE DOI HURRICANE SANDY RESPONSE PROGRAM	Session One
31	Mr.	Brian	Murphy	CDM Smith	Denver	CO	CREATING RESILIENCY IN URBAN STREAMS: RESTORATION AND FLOODPLAIN RECONNECTION	Session One
43	Ms.	Kim	O'Dell	South Florida Water Management District	West Palm Beach	FL	ALTERNATIVE TREATMENT TECHNOLOGIES EVALUATION	Session Two
5	Mr.	William	Precht	Dial Cordy & Assoc., Inc.	Miami	FL	DECIPHERING PATTERNS OF CORAL HEALTH AND MORTALITY USING A REPEATED MEASURES MONITORING PROTOCOL – LESSONS FROM MIAMI HARBOR	Session One
49	Dr.	Rene	Price	Florida International University	Miami	FL	CONTROLS ON GROUNDWATER DISCHARGE IN TAYLOR SLOUGH/C-111 BASIN OF EVERGLADES NATIONAL PARK	Session Two
20	Mr.	Andres Eduardo	Prieto Estrada	Florida International University	Miami	FL	EVAPOTRANSPIRATION EFFECTS ON THE ACCUMULATION OF CARBONATE MINERALS IN RECREATED EVERGLADES' TREE ISLANDS	Session One
84	Ms.	Alison	Rehfus	Clemson University	Clemson	SC	IDENTIFYING PLANT INVASION HOTSPOTS TO PRIORITIZE RESTORATION IN A MULTIPLE USE FOREST	Session Two
8	Mr.	Doug	Robison	Environmental Science Associates	Tampa	FL	PLANNING FOR LARGE-SCALE COASTAL RESTORATION: DEVELOPMENT OF THE FLORIDA STATE EXPENDITURE PLAN	Session One
46	Dr.	Stephanie	Romañach	US Geological Survey	Fort Lauderdale	FL	DESIGNING THE EVERGLADES HEADWATERS NATIONAL WILDLIFE REFUGE FOR HABITAT NEEDS CONSIDERING URBANIZATION ENCROACHMENT	Session Two
38	Dr.	Shaye	Sable	Dynamic Solutions, LLC	Baton Rouge	LA	DEVELOPMENT OF COMPREHENSIVE AQUATIC SYSTEMS MODELS (CASMS) FOR COASTAL LOUISIANA	Session One

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35	Mr.	Brad	Schonhoff	Florida International University	Miami	FL	Gaseous Carbon Emissions (Methane and Carbon Dioxide) from Wetland Soils in a Re-created Everglades Landscape	Session One
14	Ms.	Anne	Sexton	University of Florida	Belle Glade	FL	Reducing labile phosphorus in agricultural drainage canal sediments by suppressing floating aquatic vegetation in the Everglades Agricultural Area	Session One
55	Dr.	Dilip	Shinde	Everglades National Park	Homestead	FL	Modeling the probability of alligator nest-sighting to evaluate and anticipate effects of water-management decisions on the everglades ecosystem	Session Two
47	Ms.	Alison	Simon	FIU	Miami	FL	CHEMICAL AND CANINE ANALYSIS AS COMPLIMENTARY TECHNIQUES FOR THE IDENTIFICATION OF ACTIVE ODORS IN AN INVASIVE PATHOGEN, RAFFAELEA LAURICOLA	Session Two
56	Dr.	Lawrence	Spencer	South Florida Water Management District	West Palm Beach	FL	OBJECT-ORIENTED CLASSIFICATION OF WETLAND VEGETATION: MAPPING FASTER ON A BUDGET ON THE KISSIMMEE RIVER FLOODPLAIN	Session Two
77	Mr.	Anthony	St Aubin	Cardno	West Olive	MI	Building Habitat: Post-Dredging Restoration Design Considerations at Onondaga Lake	Session Two
78	Mr.	Anthony	St Aubin	Cardno	West Olive	MI	REVITILIZATION OF THE EAST BRANCH GRAND CALUMET RIVER REACHES 4A & 4B	Session Two
65	Mrs.	Bethany	Stackhouse	US Geological Survey	Reston	VA	Habitat Response Due to Seagrass Die-off in Western Florida Bay	Session Two
24	Dr.	Theresa	Strazisar	Florida Atlantic University	Boca Raton	FL	LINKING WATER QUALITY TO VEGETATION RESTORATION: A CASE STUDY OF RUPPIA MARITIMA (WIGEONGRASS) AT THE HIGHLY VARIABLE EVERGLADES-FLORIDA BAY ECOTONE	Session One
21	Mr.	Erik	Tate-Boldt	South Florida Water Management District	West Palm Beach	FL	Application of Synthetic Floc to Evaluate Sediment Transport within the Everglades ridge and slough landscape as part of the Decompartmentalization Physical Model Project	Session One
57	Mr.	Seth	Theuerkauf	North Carolina State University	Morehead City	NC	A GIS-based decision support tool for oyster reef habitat restoration	Session Two
32	Mr.	Taylor	Theulen	Stanley Consultants, Inc.	Des Moines	IA	DRAINAGEWAY IMPROVEMENTS AND LAKE DREDGING CLEAR THE WATER AT FORT DES MOINES PARK	Session One

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2	Dr.	Cassondra	Thomas	South Florida Water Management District	West Palm Beach	FL	SERFIS: AN ECOSYSTEM MONITORING TOOL FOR RAPID ASSESSMENT OF ESTUARINE HABITAT RESPONSE TO FRESHWATER INFLOW MANAGEMENT	Session One
48	Mrs.	Ashlee	Tyce	EA Engineering, Science, and Technology Inc., PBC	Warwick	RI	Photointerpretation - How an Old-School Method Still has Relevance and Benefit to Ecosystem-Scale Habitat Restoration	Session Two
58	Dr.	Dean	Whitman	Florida International University	Miami	FL	Electromagnetic Surveying in the Mangrove Lakes Region of Everglades National Park	Session Two
34	Dr.	Lynn	Wingard	US Geological Survey	Reston	VA	SURVIVAL AND EXTINCTION DURING PAST CLIMATE CHANGES – INSIGHTS FROM THE PALEONTOLOGICAL RECORD	Session One
28	Mr.	Simeon	Yurek	University of Miami	Miami	FL	PERSISTENCE AND DIVERSITY OF DIRECTIONAL LANDSCAPE CONNECTIVITY IMPROVES BIOMASS PULSING IN EXPANDING AND CONTRACTING WETLANDS	Session One
66	Ms.	Angelica	Zamora-Duran	Florida Institute of Technology	Melbourne	FL	Benthic foraminifera as bioindicators of environmental conditions in the Indian River Lagoon	Session Two
15	Mr.	Manuel	Zamorano	South Florida Water Management Disrtrict	West Palm Beach	FL	Investigation of STA-3/4 PSTA Performance, Design, and Operational Factors	Session One
67	Prof.	Caiyun	Zhang	Florida Atlantic University	Boca Raton	FL	A FRAMEWORK TO COMBINE THREE REMOTELY SENSED DATA SOURCES FOR VEGETATION MAPPING IN THE CENTRAL FLORIDA EVERGLADES	Session Two
61	Ms.	BO	ZHANG	University of Miami	MIAMI	FL	MODELING THE DYNAMICS OF THE INVASIVE TREE, MELALEUCA QUINQUENERVIA, IN THE EVERGLADES, WITH AND WITHOUT BIOLOGICAL CONTROL	Session Two

ABSTRACTS

(Alphabetical by presenting author’s last name)

THE ROLE OF WOOD IN FLUVIAL GEOMORPHOLOGY

Tim Abbe
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Wood material can be a primary control on the morphology and processes of a fluvial system from headwater streams to large lowland rivers. Almost all climatic areas found in the United States naturally have riparian forests and in-stream wood. The size and shape of the wood material relative to the channel it enters has a direct linkage to the wood's geomorphic influence. Large snags, logjams, and beaver dams all offer examples of how wood can re-structure channel morphology, water flow, and substrate conditions. Wood accumulations can control channel patterns, pool frequency, channel bed composition, the frequency and magnitude of inundation, rates of bank erosion, and rates of channel incision or aggradation. Frictional resistance, drag and grade control within a channel are all influenced by wood. This in-turn influences hydraulic conditions and sediment transport. Wood loading in fluvial environments increases physical complexity, water and sediment retention, and hyporheic groundwater exchange. Historical removal of wood has led to many cases of severe channel incision, floodplain disconnection, habitat simplification, and accelerated rates of bank erosion. The re-introduction of wood can be done with the placement of in-stream structures or passively with the reforestation of riparian areas. While re-establishing riparian forests within channel migration zones is essential for long-term recovery and stability, in-stream actions such as engineered logjams may be necessary to reverse historical impacts. Engineered wood placements intended to emulate natural systems have been successfully used to decrease channel gradient, treat incision, reconnect floodplains, increase channel length through anabranching and sinuosity, increase substrate and bedform variability while decreasing the median grain size of the bed. Indirect restoration of in-stream wood through riparian reforestation and beaver reintroduction has also contributed to geomorphic changes that improve stream health. These effects not only directly increase ecological diversity and productivity, but are beneficial to human communities by improving water quality, diminishing downstream flood peaks, and enhancing recreational opportunities. Informed planning and design of fluvial corridors and wood management can help communities improve stream quality, reduce flood hazards, restore natural fisheries, and adapt to climate change.

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THE EFFECT OF SEA LEVEL RISE ON JUNCUS ROEMERIANUS IN A HIGH NUTRIENT ENVIRONMENT

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As sea levels continue to rise, the projected damage that will ensue presents a great challenge for conservation and management of coastal ecosystems in Florida. Since *Juncus roemerianus* is a common marsh plant throughout Florida with unique growing characteristics that make it a popular restoration plant, this study implemented a 20 week greenhouse split plot experiment to examine the effects of sea level rise on *J. roemerianus* and ultimately determine it's tolerance ranges to salinity and inundation in a high nutrient environment. Overall, salinity level and the interaction effect of salinity level and water level had the greatest effects on measured growth parameters including average mature height, maximum height, density, basal area, root length, and biomass. An inverse relationship between increasing salinity and the measured growth variables was observed with the greatest growth and survivability in 0 ppt water, survivability and reduced growth in 20 ppt water, survivability and little growth in 30 ppt water, and nearly complete senesce in 40 ppt water. This was the first laboratory study to determine the effect of 40 ppt water on J. roemerianus.

Elevated water levels resulted in higher growth variables in the 20 ppt, 30 ppt, and 40 ppt treatments while inundated water levels produced higher growth variables in the 0 ppt treatment despite previous research finding inundation to have completely adverse effects on J. roemerianus. It is likely that the high nutrient environment provided for this study is the cause for this anomaly. The results of this study have major implications for the future of coastal ecosystems that are dominated by stands of *J. roemerianus* in South Florida and can be used in conjunction with studies on bordering marsh plants to predict shifts in the ecosystems of Florida that are responding to sea level rise scenarios.

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BLUE CARBON ACCUMULATION AND MICROBIAL COMMUNITY DEVELOPMENT IN A CHRONOSEQUENCE OF RESTORED SALT MARSHES IN SW LOUISIANA

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Marsh restoration is increasingly used to mitigate for the degradation and loss of natural salt marshes. An important function of natural marshes is their ability to accumulate blue carbon (C) at relatively high rates, which is then preserved for long time periods in anaerobic soils. As marshes are lost, so too are the stored C and the active C accumulation potential. For created marshes, it is unclear as to the timescale and capacity for these areas to function as C sinks. As soil C develops over time, there may also be a co-occurring increase in microbial community diversity. To evaluate soil C development in created marshes, we collected soil cores for refractory and labile organic C and total nitrogen (N) accumulation along a chronosequence of 1- to 32-year-old created marshes and two natural reference marshes in Sabine NWR in southwest Louisiana. At the same locations, cores were collected for microbial community diversity using fatty acid analysis. Preliminary results illustrate variable bulk density in sub-surface soils (0.041 to 1.293 g/cm^3) of created marshes, above and below that found in natural marshes (0.314 and 0.339 g/cm^3). Grain size composition in the 0 – 4 cm depth of created sites ranged from 19 to 68% clay, 10 to 48 % silt, and 11 to 33% sand. From our initial measurements, we expect that as created marshes age, organic carbon accumulation rates will decline, C storage in soils will increase over time, but both accumulation rates and C storage will vary spatially due to environmental factors such as salinity, elevation, macrophyte communities, porewater chemistry, and sedimentation rates. We also predict a positive relationship between soil C densities and microbial community diversity, which are predicted to increase with marsh age. Our findings will provide a greater understanding of spatial and temporal variables influencing C accumulation, and may also be used to create predictive models for soil C development and accumulation in restoration sites.

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DISSOLVED ORGANIC MATTER AND MERCURY: IMPLICATIONS FOR ECOSYSTEM RESTORATION

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Biogeochemical processes that influence the fate, bioavailability and transport of mercury (Hg) in the environment are often mediated by interactions with dissolved organic matter (DOM). Interactions of Hg with DOM have been shown to play important roles in controlling the chemical speciation and geochemistry of Hg in surface waters, wetland soils, and porewaters; the partitioning of Hg and methylmercury (MeHg) between dissolved and particulate phases and biota in the water column; the bioavailability of Hg and MeHg, and the photoreactivity of Hg and MeHg. In addition, the compounds that comprise DOM in aqueous systems serve as substrates for microbially mediated reactions, thereby influencing redox conditions and exert strong chemical controls on geochemical and photochemical reactions. Beyond a general recognition of the importance of DOM in the environmental fate of Hg, defining the roles played by DOM has been slow in coming due to the chemical complexity of DOM, generally low Hg concentrations, and the inherent complexity of natural systems. Recent advances in experimental design and analytical capabilities, however, are leading to greater process level understanding of these interactions, especially with regard to the biogeochemistry of Hg. Understanding the nature of these interactions is important in ecosystem modelling and decision making related to ecosystem restoration efforts. The chemistry of DOM itself is a factor controlling the interactions influencing Hg biogeochemistry. As such, understanding the drivers that control the concentrations and chemistry of DOM resulting from management decisions is also relevant for the successful execution of restoration plans. This is particularly important with regard to constructed wetlands and the return of lands formerly devoted to agriculture to water storage and nutrient removal purposes. To assist with the measurement and interpretation of DOM data, the link between the nature and reactivity of DOM and its optical properties can be exploited to provide powerful monitoring tools to assess the impacts of management practices on overall water quality, on DOM transport and transformation and on the transport and fate of constituents, such as Hg. In this presentation, advances in understanding the critical processes controlling the fate of Hg and the drivers controlling DOM chemistry and concentrations will be summarized. Examples of the importance of these factors will be drawn primarily from restoration projects in the Florida Evergaldes and the Sacramento-San Joachin Delta.

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ECOSYSTEM RECOVERY FOLLOWING THE DWH OIL SPILL EVALUATED USING AN END-TO-END MODEL

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We developed a Gulf of Mexico Atlantis model to examine ecosystem-level impacts of the Deepwater Horizon oil spill. Model training uses a historical reconstruction from 1980 to 2010 driven by time series of catch and spatial-temporal fishing restrictions. Forecasts from 2010 to 2030 examine ecological and economic impacts of the oil spill. Oil location and density is provided by a coupled Lagrangian particle transport model, while toxicological studies inform the functional responses used to model growth and mortality impacts on fish. Recent improvements in methodology include use of an uptake-depuration model and an examination of larvae-oil interactions to represent recruitment effects based on SEAMAP Ichthyoplankton surveys and surface oil observations. We estimate recovery time for various species and present evidence for trophic cascades and fisheries losses. A new Campeche Bay Atlantis model in development will examine the 1979 IXTOC oil spill as an analog to Deepwater Horizon.

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HYDROLOGIC AND NUTRIENT CONDITIONS IN WEST AND SEVEN PALM LAKE DRAINAGES IN THE FLORIDA EVERGLADES

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In the Florida Everglades, sea level rise and reduced freshwater inputs have altered the hydrologic and chemical conditions in coastal estuaries. Brackish coastal groundwater discharge, an inland intrusion of submarine groundwater discharge, has been shown to occur seasonally along the coastal wetlands of the Everglades. This brackish groundwater is enriched in total phosphorus, the limiting nutrient in the Everglades. A major component of the Comprehensive Everglades Restoration Plan is to increase freshwater delivery to the southern coastal Everglades and adjacent bays, in an effort to restore a salinity and nutrient regime conducive for the development of submerged aquatic vegetation. This study is being conducted within the two drainage systems of estuarine lakes in the Everglades that connect to Florida Bay. Water quality in these lakes has diminished over time, potentially due to increased nutrient deliveries from coastal groundwater discharge.

Current hydrologic and chemical conditions are being established within the lakes in order to gain a better understanding of the effects of restoration efforts through time. Water chemistry and levels in the lakes and groundwater are being monitored to determine the influence of groundwater-surface water exchange on salinity and nutrient conditions in the lakes. Total phosphorus (TP) concentrations in the groundwater exhibit an increasing trend as salinity increases. Likewise, TP in the surface water of the lakes tends to increase along with salinity. This data suggests brackish coastal groundwater discharge may be affecting nutrient concentrations in the lakes, which could be lessened by an increased delivery of fresh water to the region. The results of this study can be used to assess the influence of restoration efforts over time on the hydrochemical conditions of downstream coastal areas affected by coastal groundwater discharge and sea level rise.

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GRASSY FLATS RESTORATION: CREATIVELY CAPPING MUCK TO RESTORE LAKE WORTH LAGOON

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The success of the 13-acre Grassy Flats restoration project lies in the successful implementation of innovative construction methods, the beneficial re-use of 50,000 cubic yards of sand, and collaboration of ten public and private partners. Over the past century, development in and around Palm Beach County's largest estuary, Lake Worth Lagoon, has resulted in water quality degradation and an extensive loss of coastal habitats. To improve conditions, the Palm Beach County Department of Environmental Resources Management (PBC ERM) capped nearly 13 acres of anoxic organic sediments (muck), creating eleven acres of seagrass habitat and two intertidal islands totaling two acres. The islands were designed to provide mangrove, cordgrass, and oyster habitat, in addition to areas for coastal shorebirds to nest. Muck released in stormwater discharges reduces benthic habitat, decreases biodiversity and creates noxious conditions for wildlife. PBC ERM capped the muck bottom with clean sand, which allows for natural recruitment of seagrasses, creating a more diverse habitat. The site's shallow water conditions required creative and innovative construction methods to transport sand to the site. 50,000 cubic yards of sand was barged to deep water immediately adjacent to the project site, where up to 800 feet of conveyors were used to offload the sand from the barges to the project site. A sand broadcaster (high speed conveyor system) was used to spray 25,000 cubic yards of sand out over the water's surface to create the 12 to 18-inch sand cap without displacing the muck sediments.

The project is a $3.6 million multi-partner collaboration supported by the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, Florida Fish and Wildlife Conservation Commission, Florida Department of Environmental Protection, and Palm Beach County. The project received $2.6 million in federal and state grant dollars and in 2013 was ranked number one nationwide to receive funding by the Estuary Habitat Restoration Council. In addition to the funding partners, the project was supported by the Town of Palm Beach, City of Lake Worth, Marine Industries of Palm Beach County, and the West Palm Beach Fishing Club. Signs of the restoration's success are immediately apparent. Upon completion of the project, a pair of American oystercatchers and several pairs of least terns, both State-listed imperiled species, left their stamp of approval by nesting on the newly-created islands.

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WHAT'S GOOD FOR THE GOOSE IS GOOD FOR THE GANDER: ADAPTING FLORIDA'S CONCEPTUAL PERMITTING APPROACH TO LONG-TERM, LARGE SCALE RESTORATION EFFORTS

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Florida law provides a unique approach to permitting long-term large-scale projects. Termed a "conceptual environmental resource permit" this approach has typically been used for large multiphase developments, stormwater master plans and for ports. However, the approach also lends itself to restoration projects, particularly those projects which involve multiple sites and habitat types within a defined area such as a bay or estuary. The applicant benefits from regulatory certainty that individual permits will be issued if circumstances do not significantly change at the time the individual permit is sought. In the context of restoration, using a conceptual permitting framework may enhance the opportunity to seek long-term funding for a suite of "shovel-ready" restoration projects that achieve an ecosystem-based restoration goal. This presentation examines the current legal basis for conceptual permitting in Florida and suggests that it be made explicit for long-term large-scale restoration projects.

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APPLICATION OF SPARROW MODELING TO UNDERSTANDING WATER-QUALITY TRENDS IN THE CHESAPEAKE BAY WATERSHED

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Restoration of water quality in large streams and estuaries is often complicated by uncertainty about the effectiveness of land-management practices under various landscape and hydrogeologic conditions. Chesapeake Bay receives an estimated 132,000 metric tons of nitrogen and 9,740 metric tons of phosphorus annually from its watershed. The majority (54 percent) of nitrogen and nearly half (43 percent) of phosphorus contributions originate from agricultural sources. Although nitrogen and phosphorus concentrations have decreased in the estuary and in many non-tidal tributaries since the 1980s, ecological standards for water clarity and dissolved oxygen and chlorophyll concentrations in Chesapeake Bay have not been achieved. Improving the effectiveness and efficiency of watershed management requires a more thorough understanding of natural and human factors contributing to water quality, such as (in particular) the relation between recent observed trends in surface-water quality and changes in the location, extent, and intensity of agricultural operations in contributing watersheds.

Spatially-referenced regression (SPARROW) modeling is being applied to improve the understanding of anthropogenic factors contributing to recent trends in water quality in Chesapeake Bay tributaries. SPARROW is a spatially-explicit, mass-balance watershed model that uses nonlinear regression to quantify the relation between observed constituent (such as nitrogen or phosphorus) fluxes in nontidal streams and sources and factors affecting their fate and transport from upland watershed sources to and within streams. Previous SPARROW models calibrated for the Chesapeake Bay watershed and elsewhere provide a static representation of conditions for a single time period. Although individual models have been calibrated representing various time periods between the late 1980s and early 2000s in the bay watershed, substantial differences in model structure, specification, and calibration and explanatory data preclude the comparison of model predictions to explain water-quality trends. Newly available data on changing land use and agricultural practices in the bay watershed in recent decades provide the opportunity to calibrate comparable SPARROW models over multiple time steps that quantify relations between observed water-quality trends and anthropogenic changes in contributing watersheds. Such models illustrate contributions of various nutrient sources to increasing or decreasing concentrations in streams, for example, and the relative importance of changing land-use patterns or changing practices within particular land-use settings to observed water-quality trends.

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ROLE OF ECOSYSTEM RESTORATION IN ADDITION TO MERCURY POLLUTION CONTROLS IN CALIFORNIA RESERVOIRS

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Mercury in fish is a widespread problem and mercury source control alone will not solve this problem in most California reservoirs in a reasonable amount of time. Therefore, California's Environmental Protection Agency (Cal/EPA) is developing an innovative statewide mercury control program for reservoirs.

This talk will focus on fisheries management; specifically, restoration actions for highly oligotrophic reservoirs. This set of reservoirs may benefit from nutrient addition.

Fish methylmercury levels are elevated in about half of all California lakes and reservoirs sampled. In addition, the California Office of Environmental Health Hazard Assessment has issued many advisories for limited or no consumption of many popular sport fish in California lakes and reservoirs. The inability to safely consume fish from many California lakes and reservoirs devalues California fisheries as a food source for humans and wildlife. Mercury impairment is due to several inter-related factors: inorganic mercury sources; conditions in reservoirs that cause the conversion of inorganic mercury to methylmercury and its subsequent bioaccumulation in the food web; fish species present; and in some cases depressed primary and secondary production. Reservoir creation and management may exacerbate the mercury impairment by increasing methylmercury production and bioaccumulation. The project involves: identifying mercury sources to reservoirs; evaluating reservoir, watershed, and fisheries conditions; determining the linkage between reservoir fish methylmercury levels, reservoir and watershed conditions, and mercury sources; and identifying controllable factors that determine reservoir fish methylmercury levels.

Potential solutions to reduce fish methylmercury concentrations include: mercury source controls, reservoir water chemistry management, and fisheries management. This proposed statewide mercury control program for reservoirs encourages innovation in reservoir water chemistry and fisheries management, in addition to source control actions.

The program begins with pilot tests in a few reservoirs. In fact, pilot tests of oxygenation are already underway in several reservoirs downstream of legacy mercury mines. No nutrient addition pilot tests are underway (and none are yet contemplated). The program is flexible and designed to incorporate new scientific information and control technologies through adaptive implementation and program reviews.

The program website is: www.waterboards.ca.gov/water_issues/programs/mercury/reservoirs/

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CONTRIBUTING TO THE RECOVERY OF AN INLAND SEA: THE REMEDIATION AND RESTORATION OF URBAN RIVERS

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The lower Duwamish River is an urban river in Seattle, Washington that is subject to a complex suite of historical and current injuries, regulatory requirements, potentially responsible parties, and restoration efforts. The lower five miles of river are a major superfund site, along with multiple additional superfund sites near the mouth of the river where it enters Puget Sound. Historical land conversion has left the river with legacy industrial contamination, upstream urban runoff, and ongoing surface water inputs. Trust resources, with multiple trustees, include five listed species. The cumulative losses of ecosystem processes, functions, and habitats are well documented. Against this backdrop, the lower Duwamish River was subject to some of the earliest wetland restoration activities on Puget Sound (1980s) and there are currently more than twenty restoration sites along the lower seven miles of river, focused on the net gain of habitat function. Multiple federal, tribal, state, and other entities are developing integrated restoration strategies to increase ecosystem structure and function, and assure coordination of restoration efforts to maximize restoration potential and the preservation of restored habitat. The primary restoration focus is salmonid habitat. Success criteria include total restored intertidal area, marsh and riparian vegetation establishment, invertebrate production, and fish use. This paper will present an overview of restoration, remediation, and community interests and activities occurring on the river, highlight successful strategies for restoration and coordination, and explain how efforts to restore urban rivers including the Duwamish relate to strategic planning for the long-term recovery of a major regional resource, the Puget Sound.

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APPLICATION OF THE MIKE MARSH MODEL OF EVERGLADES NATIONAL PARK (M3ENP) TO EVALUATE RESTORATION ALTERNATIVES

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The MIKE Marsh Model of Everglades National Park (M3ENP) is a fully coupled surface/subsurface hydrological model used to evaluate the impact of current and proposed changes in the South Florida Water Management System on the water resources of Everglades National Park (ENP). The M3ENP was developed using the MIKE SHE and MIKE 11 software from the Danish Hydrologic Institute (DHI). It is a sub-regional model which covers approximately 800 square miles of Everglades National Park, and another 400 square miles surrounding the park, where most of the water management features are located. The MIKE SHE component is a three-dimensional integrated surface water/groundwater model, incorporating the dynamics of the unsaturated zone. The MIKE 11 component models all of the primary canal system, structures, and detention areas used for water management in the model area, including operational rules for all control structures.

Current applications of the M3ENP provide insight into effects of restoration alternatives such as installation of seepage barriers, changes in management of canal stages, and operation of water detention areas bordering the Park. Analysis of strategies to minimize seepage out of the Park are presented through water budget calculations, transect flows, volume exchange between the groundwater and canal systems, and hydroperiod calculations, among others. These analyses allow for evaluation of impacts on the natural resources of ENP.

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LARGE WOOD PRECISION PROTOTYPING AND 3D-HYDRAULIC MODELING TO EVALUATE RIVER PROCESSES AND ENHANCE ENGINEERING GUIDELINES

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Over the past decade, the utilization of large wood in the river restoration projects has evolved quickly and has now become a mainstream technique within the restoration community. This evolution has challenged restoration practitioners to develop new technologies to aid in the planning and design of large wood projects that help create habitat for fish species. Just recently in 2016 a collaborative effort between Federal and Private sectors has culminated with final release of the Large Wood National Manual (LWNM) to establish guidelines for planning, design, placement, and maintenance of large wood in fluvial ecosystems through restoring process, function, and structure.

The LWNM is an important step, although with many resource agencies continued to recommend more ecological approaches for restoration actions, there is a continued need for on-going research and scientific evaluation of the complexities of large wood placement in rivers. An example, is the need to model and predict detailed hydraulic and geomorphic response evolution on proposed large wood designs. Modeling evolution of wood is complex but can help restructure how designers and managers make informed decisions and balance important factors of both benefit and risk.

Recently a joint effort between the Yurok Tribe, Bureau of Reclamation, and the U.S. Army Corps of Engineers is underway to research and develop new tools for three dimensional (3D) hydraulic modeling of Large Wood in river systems. This hydraulic research focuses on replicating existing large wood structures on river systems by creating 3D solid models and evaluating them hydraulically using both Computational Fluid Dynamic (CFD) numerical models and laboratory-based physical flume models.
In order to replicate large wood structures and emulate natural river processes there needs be a refined method for capturing the complex geometries. Therefore, a process called “Precision Prototyping” has been harnessed from the manufacturing industry and is being applied to river engineering science. Precision Prototyping is the process of re-creating solid objects using reverse engineering methodology through a workflow of 3D scanning to 3D Modeling technologies. This research will demonstrate how 3D laser scanners or Structure for Motion (SfM) Photogrammetry tools can accurately replicate large wood and resolve complex geometric shapes that are characteristic of rootwads and branches of trees. Accurate 3D computer generated solid models of large wood elements can be created from this scanning process and imported into CFD numerical models. Once the wood structure and surrounding topography/bathymetry is 3D printed into a physical model it can be evaluated within a hydraulic flume to resolve detailed hydraulic properties. Therefore, hydraulic results can be evaluated across a continuum of modeling approaches and compared to field measured results of large wood found in nature.

Three dimensional modeling technologies will now allow designers to make more informed decisions and help predict impacts of sediment transport and scour evolution. With these emerging tools, engineers and scientists will have the ability to accurately evaluate hydraulic properties for river restoration project designs and their impact on future evolution.

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JULIA TUTTLE SEAGRASS MITIGATION SITE – RESTORATION OF A HISTORIC DREDGE HOLE IN BISCAYNE BAY, FLORIDA

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As a component of mitigation for anticipated impacts to seagrass resources in Biscayne Bay, Florida associated with the Miami Harbor Phase III Dredging Project (Project), the U.S. Army Corps of Engineers, Jacksonville District identified the filling of a dredge hole that was left behind subsequent to the construction of the Julia Tuttle Causeway in the late 1950s. The Great Lakes Dredge and Dock Company, LLC (GLDD) Team awarded the project determined that approximately 700,000 cubic yards of sediments would be required to fill a large portion of the bathymetric depression to comply with the contract and permit-stipulated minimum of 16.6 acres of restoration. This element of the Project was accomplished in two separate and distinct phases that were completed prior to the transplantation of seagrasses into the placed substrate.

The GLDD Team determined that the sediment characteristics of the materials to be dredged from the Project footprint were not of a consistent quality to ensure compliance with the Contract Document technical specifications. The majority (approximately 85%) of the required volume was derived from dredged sediments from within the Project limits (termed "Base Fill"), with the balance of the sediment obtained from an upland mine (quarry) located in Miami-Dade County. The contract and permit requirements were such that a two-foot vertical 'cap' of consistently high-quality mined sediments (termed "Select Fill" to distinguish between the two phases of material placement in the dredge hole) was needed to meet the lines and grades specified.

Prior to the placement of sediments, and to ensure compliance with State of Florida water quality standards in an Aquatic Preserve, GLDD constructed a pipe pile perimeter around the site and affixed turbidity curtains to the pilings. Dredge scows were pushed via tug from the dredge site to the Julia Tuttle fill area, and the loads were placed in the hole. Bathymetric surveys were conducted on an approximately weekly basis to track progress and ensure compliance with lines, grades and schedule. Once the Base Fill was completed, the operation transitioned to the Select Fill activities. Sand from the mine was trucked to an upland staging area located north of the site and placed onto multiple barges via a conveyor system. Long-reach excavators secured to the barge decks were then utilized to carefully place the Select Fill within the established template. As with the Base Fill, weekly progress surveys were conducted by the Project Team.

Construction of the Base Fill element commenced in January 2014 and was completed in December 2014; the Select Fill was placed between January and July, 2015. Following the conduct of a post-fill hydrographic survey (and subsequent acceptance) by the USACE, the operation was transitioned to one of seagrass transplantation. A total of 17.1 acres of planform area was restored prior to the commencement of seagrass transplanting activities.

This presentation will review the construction sequencing, methods and successes (as well as challenges) associated with restoration of the site.

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RESTORING ALABAMA'S COAST

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Coastal Alabama is a vital part of the economics and beauty of the state. Many coastal areas are vital to marine and terrestrial wildlife that play a pivotal role in the overall health of the environment. These areas have been impacted by both natural and man-made disasters putting the ecosystem at risk along the Alabama Coast. A crucial portion of the overall health of the ecosystem is sediment supply from the various streams and rivers to Mobile Bay. Sediment delivery to the bay has increased due to watershed impacts associated with land development increased storm activity and intensity. Numerous watersheds surrounding the bay have been studied and recognized as problem areas for sediment supply.

The D'Olive Creek watershed has been identified as a watershed with increased sediment supply and drains part of the eastern shore of Mobile Bay, including parts of the cities of Spanish Fort and Daphne. The watershed is in transition from forested, agricultural, and residential land uses to residential and commercial development. The changes in land-use and impervious surfaces have impacted water quality and habitat in the watershed and Mobile Bay. Increased runoff has influenced erosion and stream channel degradation which has resulted in extensive sediment loads and destroyed habitat. Through the analysis of stability assessment and departure analysis, D'Olive Creek has been identified as an unstable creek that lacks the ability to access its floodplain. If nothing is done to restore or stabilize this reach of D'Olive Creek, it is expected that a large amount of material and time will be needed to create a floodplain at a lower elevation and reach a state of quasi-equilibrium as excessive sediment continues to be transported to Mobile Bay.

Using methods associated with natural channel restoration design, the design team has developed plans for restoring approximately 2700 linear feet of stream that drains directly to Mobile Bay. The streams ability to access its floodplain and withstand applied shear stress to the floodplain was also assessed. The purpose of the current design is to address the stability and departure of the creek and the accelerated bank erosion that has occurred along this reach of D'Olive Creek. Through 2-Dimensional hydraulic modeling, the design team evaluated the applied shear stress, velocity, and scour. The design proposes to restore and stabilize the channel through natural channel restoration and best engineering practices. This objective will be met through the design and construction of proper channel dimension, layout, and profile based on reference reach data and instream stabilizing structures. The design will also mitigate sediment deposition downstream through channel stabilization and native vegetation installation. With the successful implementation of the D'Olive Creek stream restoration plans, the design team hopes the project may be used as an example for addressing similar stream impairments within the Mobile Bay watershed.

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LONG TERM VEGETATION RESPONSE TO HYDROLOGIC RECOVERY IN ISOLATED CYPRESS DOMES OF WEST-CENTRAL FLORIDA

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Hydrology is the most important determinant of wetland type and processes. So much so, that hydrology or “getting the water right” normally guides wetland restoration planning. However, many restoration efforts fail to return wetland vegetation to its pre-impact communities because the restored hydrology is not necessarily appropriate for the re-establishment of the historic plant communities. An investigation into how wetland vegetative communities respond to hydrologic alteration was conducted at the J.B. Starkey Wilderness Park, in New Port Richie, Florida. As a municipal wellfield, Starkey Wilderness Park has a varied history of hydrologic alterations. Groundwater withdrawal for municipal water supplies to the Tampa Bay region began in the mid-1970’s and progressed at such a rate that by the early 1980’s wetlands within the park had been visibly altered. Pumping steadily increased to 11 million gallons per day until 2008. After 2008, alternate water supplies were secured and groundwater withdrawals were cut by 75%. As a result of these reductions, many wetlands have been able to hydrologically recover while others have not. As part of ongoing monitoring efforts detailed hydrologic and vegetation data has been collected in over 20 isolated cypress domes throughout the park. Using these detailed data sets, we compared wetland vegetation communities before and after pumping reductions were implemented in 2008 to assess responses to hydrologic recovery. All wetlands considered were isolated cypress swamps that were affected by a range of past pumping (and recovery) intensities. To assess vegetation responses to hydrologic restoration, prevalence index scores were calculated on an annual basis to track how hydrology affected overall understory community composition. Vegetation data from wetlands relatively unaffected by historical pumping were also used to determine reference community assemblages and to adjust for natural fluctuations associated with annual climatic variation. Restoration trajectories and indicator species were identified and prominent vegetative communities were aligned with specific environmental variables. The information collected here will inform about the capabilities and limitations, including time lags and function recovery, related to the hydrologic recovery of these wetlands. Results from this study can help natural resource managers develop reliable and science based restoration milestones, establish more appropriate restoration timelines, and accurately determine when a restoration project has reached completion.

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ACHIEVING DIVERSITY AND FUNCTION IN TALLGRASS PRAIRIE RESTORATION

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The restoration of former agricultural land to tallgrass prairie has become a common conservation tool throughout the tallgrass prairie region. Tallgrass prairie is both one of the most biodiverse and endangered ecosystems worldwide, much of it converted to agriculture. Prairie restoration can reverse this trend, providing habitat for a diversity of plant and animal species. The conversion of prairie and other ecosystems to agriculture has led to the reduction of many ecosystem functions, and the services they provide to humans. According to ecological theory, restoration of diverse communities may enhance functions and services, such as pollination, nutrient retention, and erosion control. However, achieving these aims is challenging, as a wide range of factors may influence outcomes, including management decisions and local site conditions. Exotic species invasions are also a major management issue. Here, we summarize our efforts to understand the variation and ecological processes underlying the restoration of native biodiversity, ecosystem functioning and services for prairies restored from former agricultural land in southwest Michigan.

Between 2011 and 2013, we sampled 29 prairie restorations in southwest Michigan, totaling 375 acres spread over 500 square miles. Each site was herbicided, then sown with native tallgrass prairie grasses and forbs between 2003 and 2008. We sampled restoration outcomes - plant community diversity and composition, and measures of ecosystem functioning and services. We also collected data on likely drivers of these outcomes – seed mix composition, management history, soil properties, land use history, and surrounding landscape composition. We addressed several important questions with these data. First, we asked how this range of potential drivers determine plant community assembly, in particular the establishment of sown species, exotic species invasions, and plant species diversity overall. Then, we explored links between established diversity and ecosystem functioning and services.

We found that seed mix composition and richness were the strongest drivers of established plant diversity and composition, and the establishment of sown species in particular. Sites sown with more species and a greater density of total forb seed had better establishment overall, leading to more diverse prairies. Diversity also appeared to decline over time. Establishment was variable among species, with the most commonly sown species (which dominate low diversity mixes) establishing reliably. Other species were limited by low seeding density, inappropriate matching of species to environmental conditions, or both. While seed mix composition was the strongest driver of sown species establishment, exotic species establishment appeared to be facilitated by a recent history of perennial (e.g., hay or pasture) vegetation, soil moisture availability, and infrequent prescribed fire.

Restored plant diversity generally did not support functions and services. In fact, decomposition rates and biomass stability were negatively correlated with established diversity. Floral resources for pollinators were enhanced by plant diversity, while other services were linked to other drivers. These results show that the right management decisions can establish diverse communities of sown species. They also show that, at least when restoring agricultural land to native prairie, local site conditions may be more important than species diversity in controlling ecosystem functioning and services.

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MULTI-SPECIES MANAGEMENT AND DECISION SUPPORT USING THE EVERGLADES FORECASTING (EVERFOR) APPLICATION

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The Florida Everglades is a large wetland ecosystem (28,000 km^2) of national importance. Over the last century, human intervention has significantly altered this once vast flowing wetland. Restoration of the Everglades to return the system to a more natural state is one of the largest ongoing restoration projects in the world. Restoration is expected to span decades and cost billions of dollars. A return to more natural hydrologic patterns is expected to lead to the recovery of ecological function and populations of species of national concern. Ecological models are used in the Everglades to help forecast potential ecological outcomes to proposed restoration projects; however, these models are not yet integrated and potential impacts of restoration to species and habitats are examined independently and not as a whole. Further, ecological metrics to measure restoration success are evaluated once at the end of each year, even though nearly real-time water level data are readily available.

To evaluate system function as a whole, we developed the Everglades Forecasting (EVERFOR) application to allow direct comparison of output among landscape, species, and community responses to hydrologic change. This spatially-explicit quantitative application allows decision makers to identify regional management actions that can benefit a suite of ecological communities, while explicitly quantifying the potential costs to others (e.g., endangered species, wading birds, prey fishes, seagrasses, and landscape responses). EVERFOR's integrated evaluation of ecological impacts from restoration allows for better-informed decisions that benefit the ecosystem as a whole and promote wiser investment of restoration dollars.

This project augments regional ecological modeling, which is designed to evaluate restoration scenarios 20 to 60 years into the future, with multi-species ecological modeling and decision tools that inform near real-time and near future operations in the transition to restoration as well as local restoration project implementations. With this tool, partner agencies develop ecological water management recommendations based on objective, spatial, and quantifiable information. This information is then communicated to the South Florida Water Management District to guide management of water operations.

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WADER DISTRIBUTION EVALUATION MODELING (WADEM) AS A GREATER EVERGLADES RESTORATION PERFORMANCE MEASURE

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Wader Distribution Evaluation Modeling (WADEM) was developed to predict how wading birds may respond to the changes in hydrology that will occur with Greater Everglades (GE) ecosystem restoration. It can predict Great Egret, White Ibis, and Wood Stork distributions over changing habitat conditions based on their selection of resources linked to hydrological variables. This suite of indicator species will provide a range of responses that can then be used to evaluate and inform long-term ecological restoration planning and assess its shorter-term success. WADEM model outputs have been validated with reproductive responses at multiple phases of breeding and are currently used in guiding water management operations and in the Central Everglades Planning Process (CEPP).

The original scope of WADEM was to implement a wading bird model that would be used to both assess and evaluate wading bird nesting effort metrics that are monitored annually, using both assessment (real-time) and evaluation (forecasted) hydrology. However, initial analyses suggest that the link between foraging conditions and annual nesting metrics is not predictable. The WADEM models are specifically linked to nesting effort and success so that *daily* changes in the indices themselves can indicate shifts in the timing and magnitude of nesting responses.

The goal of this project was to establish pre-CEPP reference conditions and variability using both the hydrology of the Natural System Regional Simulation Model (NSRSM) and the Everglades Depth Estimation Network (EDEN) periods of record (1965-2005 and 1991-2015, respectively) to guide development of a new wading bird foraging performance measure. To evaluate the effects of the modeled historical conditions (i.e., the NSRSM) on wading bird patch quality and patch abundance (i.e., WADEM outputs), we ran the WADEM models for each day of record across the NSRSM spatial domain. These estimates were then interpreted in the context of WADEM output from the EDEN period of record and referenced to CEPP restoration scenarios. These data will provide guidance to develop restoration targets and a performance measure for monitoring the foraging response to the implemented restoration projects.

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LOUISIANA'S COASTAL MASTER PLAN: PLANNING FOR AN UNCERTAIN FUTURE

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As coastal areas across the nation face increasing threats from flooding, land loss and sea level rise, there is a great need to advance long-term coastal planning and adaptation strategies. The Coastal Protection and Restoration Authority is charged with coordinating restoration and protection investments through the development and implementation of Louisiana's Comprehensive Master Plan for a Sustainable Coast (Plan). The first Plan was submitted to the Louisiana Legislature in 2007 and is mandated to be updated every five years. The plan's objectives are to reduce economic losses from flooding, promote sustainability by harnessing natural processes, provide habitats for commercial and recreation activities, sustain cultural heritage and promote a viable working coast. Two goals drive decision making about the appropriate suite of restoration and protection projects to include in the Plan: restore and maintain Louisiana's wetlands and provide flood protection (structural and nonstructural) for coastal Louisiana's citizens. As part of the decision making process, a wide range of additional metrics (e.g., cost-effectiveness, support of traditional fishing communities, ecosystem services) are used to evaluate the complex, competing needs of communities, industries, navigation and fisheries. Individual protection and restoration projects are ranked by how well they performed across the set of decision drivers and metrics, and high performing projects are then assembled into alternatives constrained by available funding and river resources (sediment and water). The planning process is grounded not only on extensive scientific analysis but also on interdisciplinary collaboration between scientists, engineers, planners, community advocates, and coastal stakeholders which creates the long-term dialogue needed for complex environmental planning decisions. It is through this collaboration that recommended alternatives are reviewed and modified to develop the final Plan.

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EVALUATION OF OPEN-GREEN SPACES IN KASTAMONU REGION IN TERMS OF ECOLOGICAL RESTORATION

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In rapidly growing urban areas, the natural structure of landscape is disrupted and there occur damaged areas with more human intervention. In this sense, open-green spaces inside the city become buffer areas in order for the compensation for disruptions in urban areas. Open-green areas become necessary in the solution of such problems as air pollution, water pollution and soil pollution, in balancing the increase in temperature, in creating the habitat for wildlife and in presenting recreational facilities for those living in the city. Therefore, urban open-green spaces and natural species used in these areas play an important role in the restoration of disruption in urban landscape.

Kastamonu region is located in the north of Turkey. Four sides of the city is surrounded by forests and 67.88 % (889,817.00 ha) of the city is forest area. Ilgaz Mountain National Park is in the south of the city and Kure Mountains National Park is in the northwest. Having hosted many civilizations and being an old residential area, Kastamonu region became the home of Gases in the 18th century BC and hosted Hittites, Phrygians, Kimmers, Lydians, Persians, Romans and Byzantines in time. It shelters works from these civilizations. The city, where there are traditional Turkish houses and incentive samples of recent Ottoman architecture, has been taken into the scope of urban sites. Despite all these features of the city, air pollution has become an important problem because of intensive and unplanned urbanization in the city center, two forest products institutions located in the northeast and southwest of the city and fossil fuels used in houses for heating purposes in winter months.

In this study, the difference in the use of open-green spaces in Kastamonu region between the years 1967 and 2015 is examined based on the zoning plan. The effects of differences in the city on natural and cultural values have been identified and those made and to be made in the renovation of the destruction in the city's natural and cultural structure have been tried to be determined. In this sense, plant species used in the open-green areas in the city and species in natural areas around the city are compared. According to the data, it has been identified that the amount of open-green areas in Kastamonu region has decreased depending on the increase in the population in time. When the species of plants used in the city are examined, it has been seen that natural plant species in the region have been preferred. Despite the decrease in the amount of open-green areas, it is considered that using natural species in the city is important in terms of reviving the old structure of the city again and decreasing the air pollution in the city correspondingly.

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DOWNSTREAM WATER QUALITY AS AN INDICATOR OF RESTORATION CONDITIONS AND ECOSYSTEM CHANGE FOR BISCAYNE BAY

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Upstream water use and water availability directly affect downstream water body conditions. In Biscayne Bay salinity is controlled by a series of canals that make up the southern part of the Central and South Florida (C&SF) Project which are under joint control by the United States Army Corps of Engineers (USACE) and the South Florida Water Management District (SFWMD). The Comprehensive Everglades Restoration Plan (CERP) has identified various changes in water management and the C&SF Project that are affecting, and will continue to affect, downstream waterbodies like Biscayne Bay. We have continuously collected downstream salinity, temperature, and depth at 15 minute intervals for twelve years and have a solid base to compare background conditions with changes due to operation from the CERP and from other watershed operations. The Integrated Biscayne Bay Ecosystem Assessment Monitoring (IBBEAM) project combines these parameters with invertebrates, mangrove fishes and benthic communities. We are able to look at different conditions affecting these communities for improvements or changes in the Bay and Biscayne National Park. It is important to look at water quality parameters to determine to relative benefits and deficits of changing conditions. Using this information we see that relatively small increases in discharge to the system during the dry season, particularly the early dry season has larger benefits than would be expected.

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MOVING TARGETS: CAN A HISTORIC NORTHERN EVERGLADES LANDSCAPE BE MANAGED IN AN ALTERED ENVIRONMENT?

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The A.R.M. Loxahatchee National Wildlife Refuge contains the northern-most remnant peat-forming wetlands of the Everglades watershed. Historically, these oligotrophic fens with seasonal patterns in sheetflow of surface water had fluctuating water depths that promoted spatial habitat heterogeneity as well as a suitable environment for the accumulation of soil organic matter (peat) over the past five millennia. Internal processes and external drivers led to the development of microtopographic patterning on an otherwise flat landscape, with alternating raised ridges and inundated sloughs as well as isolated emergent tree islands, produced primarily by feedbacks between vegetation and hydrology. Like many graminoid-dominated ecosystems, the Everglades landscape is also sculpted by wildfire. Variability in the flammability and response of habitats contributes to the maintenance of landscape heterogeneity and health of the Everglades.

However, anthropogenic alterations have dramatically compromised the once self-regulating Everglades wetlands. Land use change for agriculture and development brought with it water management for irrigation and flood prevention as well as nutrient pollution via runoff into canals that now encircle the Everglades as well as the Refuge. These alterations resulted in major shifts in the remnant wetlands, impacting floral and faunal habitat quality and distribution as well as ecosystem function. Soil oxidation in drained peatlands with reduced sheetflow enabled homogenization of the ridge-slough landscape and led to more severe wildfires similar to those recently occurring in drained peatlands of Indonesia. Loss of landscape heterogeneity and diminished habitat quality has cascading effects on plant and animal populations and can facilitate non-native species invasion, further compromising the ecology of the Refuge. Simultaneously, the climate has been changing, resulting in a warmer, drier climate than was present during the Everglades' inception. Therefore, the Everglades of yesterday may not be a realistic target for the Refuge we are trying to manage today.

Maintenance of landscape heterogeneity is critical for a functional Everglades, however the means to this end likely differ from those of the historic Everglades. Compounding concerns of water management and climate change make restoring historic hydrologic conditions unlikely; even if restored the water would flow over a much different landscape. Therefore, exploration of alternative mechanisms to restore or maintain habitat heterogeneity would be valuable for the mission of the Refuge. Similarly, a "pre-settlement" target for restoration and management is likely not maintainable under future scenarios. The challenges imposed by these novel conditions will likely require novel management practices, whose success may come at the expense of low-priority targets. Landscape patterning may be achieved by increasing water inputs, however not without lowered water quality that would likely lead to altered vegetation in that patterned landscape. Increased use of prescribed fire may aid in the control of invasive plants like Melaleuca but could lead to further landscape homogenization by favoring fire-adapted sawgrass communities. Targets for landscape management need to prioritize ecosystem components or services to develop practices promoting high-priority targets, particularly when they contradict a historic Everglades model.

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HOW THE "PALEO" RECORD CAN ASSIST WETLAND RESTORATION IN LIGHT OF CURRENT CLIMATE AND SEA LEVEL CHANGE

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Wetlands are vulnerable to current and predicted changes in sea level and hydroclimate. However, an examination of the geologic record shows that these abrupt changes are not unprecedented. Within relatively recent time, wetland communities in North America have been subject to rapid rates of sea level rise due to the collapse of the ice sheet over North America, abrupt cooling associated with the Younger Dryas (~12,900-11,400 years before present (yrBP)) and Little Ice Age (~400-200 yrBP), and sustained drought conditions during the Medieval Climate Anomaly (~1200-900 yrBP). Reconstructing the response of vegetation to these past events provides insight on how wetland plant communities respond to climate and sea level change.

We present paleoecological data spanning the last 14,000 years demonstrating how wetland communities have responded to past sea level rise and abrupt climate variability. We focus on wetland communities along the Southeastern and Gulf Coastal Plain, which include salt, forested tidal freshwater, and inland freshwater wetlands. The primary proxies used to document the response of these communities to past change are pollen, plant macrofossils, and carbon. The data that will be presented illustrate how wetland plant communities have responded not just to intervals of decadal change but intervals of change on the centennial scale. Understanding how wetland plant communities responded to past intervals of abrupt sea level rise and climate variability is critical for management and restoration of wetlands in light of current and future environmental change.

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INNOVATION FOR RESTORATION: THE C-43 WATER QUALITY TREATMENT AND TESTING PROJECT

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The Caloosahatchee River Estuary Total Maximum Daily Load, adopted by the State of Florida in 2009, requires a 23% reduction in total nitrogen (TN) loads. To date, there have been limited efforts to design treatment wetlands to optimize nitrogen removal from non-point runoff and surface waters to the low concentrations that may be needed to achieve a 23% reduction. This is especially true for dissolved organic nitrogen (DON), which accounts for approximately 80% of the TN present throughout the Caloosahatchee River and Estuarine system (Wetland Solutions, Inc., 20121). Through over a decade of successful operation of Stormwater Treatment Areas (STAs), the South Florida Water Management District (SFWMD) has attained extensive expertise in total phosphorus removal from non-point runoff using constructed wetland treatment systems. However, the mechanisms for TN removal via wetland treatment systems have not been demonstrated or optimized to the same extent.

The SFWMD, in partnership with Lee County, is investigating optimization of wetland-based strategies for removal of TN from Caloosahatchee River surface water through the C-43 Water Quality Treatment and Testing Project (C-43 WQTTP) demonstrations. In this study, special attention will be given to the net removal of DON, which is possibly the most recalcitrant form of nitrogen in the Caloosahatchee River. As a multiphase study, the first phase of demonstrations is twofold. Biologically available DON (BDON) was quantified through bioassays using laboratory incubations under different physical/chemical conditions of surface water collected along the river from December 2014 to October 2015 across seasons, and mesocosms will be employed to assess potential surface water nitrogen removal rates using different plant communities and hydrologic loading rates. Using the results of the Phase I demonstrations, a mass balance model of nitrogen processes will be developed to inform how nitrogen is stored in (both temporarily and permanently) and removed from the treatment systems. Collectively, this information will inform the Phase II demonstrations focused on scaling up the most effective mesocosm treatments.

The objective of the overall project is to demonstrate and implement cost-effective, wetland-based strategies for reducing loads of TN and other constituents, including phosphorus, to the Caloosahatchee River and its downstream estuary. Nutrient reduction strategies identified and tested through this project may be applicable to other South Florida river and estuarine systems.

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OVERVIEW OF THE CHESAPEAKE BAY WATERSHED AGREEMENT

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The Chesapeake Bay Program is a regional state-federal partnership convened in 1983 through the first Chesapeake Bay Agreement to restore and protect the Chesapeake Bay. The Program is led by an Executive Council, comprised of Governors of states within the watershed, the Mayor of the District of Columbia, the Chesapeake Bay Commission, and the Administrator of EPA representing the federal government. A series of Agreements beginning in 1983, have broadened the scope and strengthened the commitments. The most recent *Chesapeake Bay Watershed Agreement*, signed in 2014, brought in the headwater states as full members and was the first Agreement developed with adaptive management in mind.

Applying adaptive management with a geographic program the size of this partnership (covering 64,000 square miles, with hundreds of stakeholders and partners) is both necessary and complex. It is necessary to move forward immediately based on current knowledge while collecting information that helps expand that knowledge, driving implementation success. It is both scientifically and socially complex because of the large scale to which it applies and because employing adaptive management requires embracing flexibility to allow for course correction when evidence shows it is warranted.

This *Watershed Agreement* facilitates adaptive management within the partnership in several ways. First, it establishes a set of principles calling for the partnership to apply adaptive management. Second, it provides a vision, with 10 overarching goals containing 31 high-level, generally SMART outcomes (Specific, Measurable, Attainable, Realistic, and Timely). The agreement also requires development of Management Strategies to implement those outcomes, including 2-year workplans and a commitment to review the strategies at least every two years, when new workplans are developed.

The *Watershed Agreement* carries the signatures of Executive Council, signaling commitment to the vision and goals from the highest levels of the partnership – and changes will be made only at that level. For outcomes to be added, changed, or dropped, the next level of the organization, the Principals' Staff Committee must agree and must inform the Executive Council of those proposed actions; while Management Strategies and workplans can be updated and changed every 2 years, allowing for more facile changes to direction related to approaches and activities. These changes would be made through concurrence of subject matter experts on Goal Implementation Teams and the upper management of the partnership, the Management Board.

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BIOLOGICAL EFFECTS MONITORING TO IDENTIFY CONSEQUENCES OF EXPOSURE TO ENDOCRINE DISRUPTORS

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The effects of exposure to endocrine disruptors, particularly estrogenic compounds, have been documented in the Chesapeake Bay drainage and elsewhere. These effects include induction of vitellogenin, an egg yolk protein in male fishes, induction of testicular oocytes (intersex) and other gonadal abnormalities, behavioral changes and in some cases population effects. The co-occurrence of intersex and increased infectious disease, sometimes leading to fish kills, has also raised concerns about the effects of endocrine disruptors on the disease resistance. In order to manage ecosystem health it is necessary to identify the sources and pathways of exposure for these chemicals, indirect and direct effects, windows of sensitivity in sensitive species and efficacy of management practices. Sources of these chemicals include both point and nonpoint sources such as human wastes (wastewater treatment plant effluent, combined sewer overflows, use of biosolids as fertilizer), agricultural runoff (animal manure, pesticides) and urban/suburban runoff. Organisms are exposed to complex mixtures of chemicals that may be additive, synergistic or antagonistic. Concentrations in water can vary greatly seasonally and even weekly. Hence, measuring the presence of various chemicals in water or sediment often does not provide adequate information to understand the exposure of complex mixtures. Aquatic organisms are also exposed to a myriad of other stressors including climatic, water quality, habitat and infectious agents. Wild, resident fishes integrate these stressors over their life span and monitoring for adverse effects is advantageous in understanding the spectrum of effects and possible management of primary sources.

Biological effects monitoring at multiple sites within the Chesapeake watershed has included biological responses in wild fishes as well as in vitro cell-based assays for hormone activity. Fish biological responses include indicators at the organism (visible lesions, condition factor, gonadosomatic index), tissue and cellular (microscopic pathology, plasma hormone and vitellogenin concentrations) and molecular (gene expression) levels. These indicators also identify effects of both recent (acute) and not so recent (chronic, early life stage) exposures. The adverse effects monitoring together with hormone activity, chemical concentrations in water and sediment and land use/land cover data has added significantly to our knowledge of sources and effects and can be used to evaluate management practices.

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CAN WE OBTAIN RELIABLE DATA WHEN IMPLEMENTING ECOLOGICAL RESTORATION PROJECTS?

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Ecological restoration requires the collection of reliable data for determining the appropriateness of restoration techniques, evaluating the effectiveness of project activities against restoration goals, and building the necessary evidence to support management decisions. Often these data are collected as observations or estimates based on best professional judgment. Unlike a laboratory setting where rigorous quality assurance and quality control (QA/QC) procedures have been in place for decades, practitioners for ecological restoration projects do not have comprehensive guidance on how to ensure the reliability of data. To address this issue, U.S. EPA's Great Lakes National Program Office (GLNPO) has assembled the Interagency Ecological Restoration Quality Committee comprised of members from eight federal agencies and organizations, as well as consultants and practitioners. Committee members are developing guidance to provide tools and approaches to improve project efficacy and data use during planning, implementation, and assessment activities for ecological restoration projects.

This presentation describes attributes of reliable data and provides a framework for obtaining reliable data throughout every phase of an ecological restoration project, which is based on the guidance document currently under development. The presentation includes an analysis of project-level quality documentation for ecological restoration projects that have been funded through the Great Lakes Restoration Initiative and reviewed by GLNPO. The analysis identifies stages in the project lifecycle where more rigorous QA/QC procedures are needed and highlights how the guidance addresses these weaknesses.

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A SCIENTIFIC BASIS FOR RESTORING FISH SPAWNING HABITAT IN THE ST. CLAIR AND DETROIT RIVERS OF THE LAURENTIAN GREAT LAKES

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In the Great Lakes region, the St. Clair and Detroit Rivers historically served as some of the most important spawning grounds for fish such as lake sturgeon, walleye, lake whitefish and cisco. However, construction of commercial shipping channels removed or covered highly productive fish spawning areas, contributing to fish population declines. In 2001, a consortium of partners began working to mitigate for historical habitat losses by creating fish spawning reefs made of rock rubble placed on the river bottom. After establishing and studying seven reef restoration projects, a number of lessons have emerged about both the bio-physical and social aspects of habitat restoration planning and implementation.

This talk will focus on the human aspects of coordinating a diverse team, facilitating an effective adaptive management process, and engaging key stakeholders to achieve desired restoration outcomes. We will describe the roles within the restoration team and the internal and external factors that enabled the group to work together for more than twelve years without a formal agreement. Although a team with diverse expertise and affiliations has been invaluable, group coordination and decision making can be complicated and each stage of a project presents distinct challenges for collaboration. Over time, we have documented our adaptive management process and have identified strategies for each stage that will likely be applicable for other coastal management issues that require multi-organization collaborations, adaptive planning, and targeted outreach. Examples will be provided about how the restoration team has responded to hurdles and improved the collaborative process and specific techniques used to restore fish habitat.

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COASTAL HYPOXIA IN THE NORTHERN GULF OF MEXICO: THE BENEFITS OF LONG-TERM STUDY

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The activities of humans in the 19th, 20th and 21st centuries have resulted in many more areas of hypoxia than occurred historically and have aggravated conditions in areas that were already low in oxygen. The coastal ocean is an area of high primary and secondary productivity, but studies clearly linked declining estuarine water quality in the form of worsening hypoxia to declines of fish diversity, reduced estuarine habitat suitability, and declines in offshore fisheries. The biogeochemical cycling of nitrogen, phosphorus and carbon are altered in the more reduced environments. The causes of coastal hypoxia point to the need for nutrient reduction, but these issues are complicated in an overall treatment of human factors, including climate change.

The northern Gulf of Mexico affected by the discharge and flux of materials from the Mississippi River Basin is subject, at least since the 1950s, to an annual, perennial at this time, large area of bottom-water hypoxia. Hypoxic waters exclude demersal fishes from the areas with less than 2 mg/L dissolved oxygen concentration, resulting in reduced habitat suitability. The area of low oxygen water on the northern Louisiana continental shelf has increased over the years of its monitoring, since 1985. The size in July is directly related to the amount of nitrogen-nitrate discharged into the northern Gulf from the Mississippi River basin in May. Nitrate-N has tripled in the period 1950s to 1980s and has stabilized in the 21st century but with considerable variability from year to year.

The ability to register long term changes in a coastal ecosystem relies on curiosity, wisdom, long-term observations and experimentation which has benefited many, including the hypoxia research group of the northern Gulf of Mexico (LUMCON, LSU and collaborative scientists). This group has collected over three decades of data documenting the causes and dynamics of hypoxia along the continental shelf, as it is influenced by the Mississippi River Basin. These data have been instrumental in discussions with both scientific and non-scientific audiences on the impact of human-caused landscape change and utilization on water quality in these areas.

The monitoring of hypoxia on the Louisiana continental shelf has been conducted primarily through competitive research programs and is currently coming to closure as NOAA wants to take research-supported monitoring to the operational level. We have a consistent record of shelfwide mapping of dissolved oxygen dynamics and associated physio-biological parameters since 1985. This record continued through 2015, but it is not clear it will continue. The LUMCON/LSU group also has more frequent surveys on transects on a transect approximately 100 km from the Mississippi River Delta and off the Atchafalaya River Delta. Additional monitoring has been through deployed instrumentation at stations at 20-m water depth off Caminada Pass, Grand Isle, and 20-m off Terrebonne Bay. The only remaining working station is off Terrebonne Bay.

The different monitoring schemes give an integrated spatial and temporal scale with which to determine trends and changes related to Mississippi River materials flux, forecast, and mitigate nutrient excesses.

The hypoxia research group of the northern Gulf of Mexico (LUMCON, LSU and collaborative scientists) has collected over three decades of data documenting the causes and dynamics of hypoxia along the continental shelf, as it is influenced by the Mississippi River Basin. These data have been instrumental in discussions with both scientific and non-scientific audiences on the impact of human-caused landscape change and utilization on water quality in these areas.

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WATERVLIET DAMS REMOVAL: A CASE STUDY FOR MONITORING IN A COMPLEX NON-WADABLE RIVER

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The Great Lakes Restoration Initiative (GLRI) created important restoration opportunities throughout the Great Lakes Basin. Perhaps more importantly, GLRI invoked a new era of accountability predicated on demonstrated restoration success through effective monitoring as a funded project component. The availability of funding for monitoring restoration projects was previously limited and insufficient. Along with this new era of restoration funding and monitoring, comes the need to improve the reliability, validity, and quantitative power of restoration monitoring data. While the need for monitoring is great and the funding provision is long overdue, collection of poor quality or purely qualitative data is not much better than no monitoring. In this dam removal case study, we demonstrate the steps that were taken to increase the reliability of quantitative and qualitative monitoring data for drawing reliable conclusions about restoration outcomes.

The Watervliet Dams were located on the Paw Paw River, a major tributary of the St. Joseph River (Lake Michigan Basin). Both dams were completely removed in 2011. Three constructed riffles were used to stabilize the stream bed, while bankfull terraces were used to adjust cross-sectional dimensions and restore riparian habitat. In addition to restoring the main channel and fish passage, continuous flow was restored to 2,000 feet of formerly abandoned natural stream channel. Baseline monitoring was conducted in 2010 and 2011 prior to dam removal. Construction cost savings provided a unique opportunity to monitor the dam removal for two years after removal – 2012 and 2013. Monitoring included fish collections and marking, velocity measurements, macroinvertebrate collections, and morphological surveying.

Monitoring was executed through three core phases: planning, execution, and evaluation. Planning is a critical phase. Significant effort was spent with the project partners developing a project monitoring protocol. Goals and objectives were clearly defined. An extensive literature review was conducted to identify quantitative methods of data collection and analysis. Standard methods were used when available. Standard operating procedures (SOPs) were created and used to calibrate, inspect, and operate equipment; and record, validate, and analyze data. SOPs were then used to guide sampling efforts and maintain consistency throughout execution. Field procedures were audited by at least two workers checking preparedness and completeness at the beginning and end of sampling efforts. Data were evaluated to determine if they could reliably measure the end points. As necessary, additional planning was conducted to revise methods or endpoints.

The Paw Paw River is a medium-sized, non-wadable river. Abundant large woody debris, complex habitat structure, and limited access characterize the Paw Paw River. Despite the best laid plans, such environmental conditions present significant challenges. Methods must be properly selected to deal with them, but an adaptive approach to monitoring is also required. Unique and challenging environments will always make in-situ ecological monitoring of restoration projects more difficult and perhaps more uncertain under such circumstances. Maximizing the reliability, validity, and quantitative power of monitoring data should be the goal for monitoring efforts faced with such in-situ challenges.

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BENEFIT INDICATORS TO PROMOTE AND PRIORITIZE WETLANDS RESTORATION

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Ecological restoration of wetlands can reestablish ecosystem services that provide valuable social and environmental benefits. Explicitly characterizing these benefits can help managers garner support for restoration and better allocate scarce resources among potential restoration projects. Existing metrics for weighing the benefits of restoration have limitations. While metrics based on ecological functioning and expected ecosystem service production are useful, they neglect vital information for evaluating tradeoffs: who benefits from the resulting ecosystem services and by how much. At the other end of the spectrum, economic valuation studies monetize the value of wetlands, but such studies are often too resource intensive for the type of localized decisions that need to be made and it is not possible to monetize all benefits.

We present a rapid assessment approach that provides non-monetary metrics, using benefit indicators, to compare benefits of restoring different wetland sites. These benefit indicators are based on economic concepts and reflect the factors that contribute to economic value, including the extent of market (which determines the number of people who benefit), available substitutes, and preferences of those who benefit. We designed these benefit indicators to complement existing functional indicators, in order to provide a more complete picture of both supply and demand for potential restored ecosystem services.

We demonstrate the general approach to using non-monetary benefit indicators with an application to urban wetlands restoration sites in the Woonasquatucket Watershed in Rhode Island, USA. The specific benefit indicators used are transferable to similar urbanizing watersheds. With adjustments, the approach is transferable to other types of restoration and additional ecosystem services.

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HORSE CREEK ENHANCEMENT PLAN

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Mosaic's current approach to satisfy compensatory mitigation requirements include both onsite and offsite mitigation. Onsite mitigation is required pursuant to FDEP's Reclamation Rule 62c-16, requiring all wetland impacts be reclaimed at least acre for acre, type for type. Offsite mitigation projects focus on benefits at a watershed management level incorporating the Integrated Habitat network (IHN) and the Charlotte Harbor National Estuary Program Comprehensive Conservation and Management Plan (CHNEP CCMP) priority actions. This mitigation offsets wetland impacts by preserving and restoring wetlands outside the mine boundary, in addition to onsite mitigation, all within the same watershed. The offsite mitigation projects are constructed prior to mining activities, which reduces the temporal lag traditionally associated with onsite mitigation; involve large, ecologically significant parcels; incorporate rigorous scientific and technical analysis, planning and implementation; and require a significant investment of financial resources.

The Horse Creek Enhancement Project represents a landscape level restoration project in the Peace River Basin consisting of stream and habitat restoration within one of the more damaged sections of the Horse Creek riverine corridor. The property presents a unique set of opportunities to restore the aquatic and terrestrial habitats in a major stream corridor. Historically, the site consisted of an intact forested riparian floodplain. Over time, the site has been subject to extensive alterations resulting in a landscape dominated by improved pasture. Ditches were constructed and natural streams altered to facilitate drainage. The remaining onsite wetlands are disturbed, subject to altered hydroperiods and exhibit encroachment by exotic and nuisance species. For the approximate 5-mile length of Horse Creek that runs through the property, there are several areas where riparian corridor has been cleared right up to the bank, resulting in eroding banks.

The various components of the restoration plan include wetland re-establishment, wetland enhancement and preservation, upland enhancement and preservation, and forested floodplain restoration. The stream restoration component includes bank stabilization, in-stream habitat additions, restoring ditched streams that were historically natural streams to a more natural, meandering plan-form and riparian zone re-vegetation. The restoration of the terrestrial and aquatic habitats within the project area will allow for greater residence time and infiltration of water prior to discharge; thus, improving water quality downstream, will improve habitat support and connectivity, and will benefit a wide variety of both listed and non-listed wildlife species.

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ALLIGATORS, HYDROLOGY, AND AQUTIC FAUNA, OH MY! INTEGRATING ECOSYSTEM RESPONSES

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Alligators are one of the ecological indicators for the Comprehensive Everglades Restoration Plan (CERP) Monitoring and Assessment Plan (MAP), a system-wide monitoring and assessment program for evaluating CERP performance and ecosystem responses. Alligators are important in the Everglades food web as predator, prey, and protector, and are an ecological engineer, creating high (nests) and low (trails and alligator holes) topography within the marsh that is important for biological diversity and ecosystem function. A conceptual ecological model has been developed that describes linkages between alligators and ecosystem stressors such as water depth patterns and salinities, and other ecological attributes such as aquatic fauna and wading birds. Hypotheses have been developed that link responses of alligator relative abundance (alligators/km) and body condition to hydrologic conditions, salinity and prey abundance. In this talk we describe how we have used alligator monitoring data collected systematically across the Everglades since the early 2000s to examine status and trends, test and refine hypotheses about linkages between stressors, aquatic fauna, alligator responses, and provide information for ecosystem management and restoration.

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RESTORATION OF BIG MEADOW BOG AND RECOVERY OF THE ENDANGERED EASTERN MOUNTAIN AVENS

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Peatlands are complex and dynamic. They are home to a specialist community of animals and plants that function in a highly nutrient impoverished ecosystem. Intact, these ecosystems play a major biogeochemical role as they purify waters and can serve as a sink for atmospheric carbon dioxide. The 80 hectare Big Meadow Bog complex was ditched in 1958 in a failed agricultural enterprise that was abandoned shortly thereafter. Residents of the village of Westport, Brier Island, recall how before ditching, the bog's berries and waterfowl were a part of village life, but invasion of a dense undergrowth post-ditching has reduced access and community use dramatically. Conservation biologists recognize the lagg of Big Meadow Bog as the principal habitat of the globally imperiled species, eastern mountain avens (*Geum peckii*), which is currently in population decline.

As part of a broad collaboration between academia, NGO, private industry and government scientists, we are in the third year of pre-restoration data collection in preparation for physical restructuring of ditches and outflow channels that will return a more historic hydrology to the Big Meadow starting in 2016. In this paper we discuss preliminary efforts to understand the present condition of this unique bog ecosystem, primary issues that need to be addressed, restoration goals and plans for restoring historic function and rejuvenating populations of *Geum peckii* in coming years.

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NCER 2016 EFFECTS DIRECTED ANALYSIS OF ENDOCRINE DISRUPTING COMPOUNDS IN THE CHESAPEAKE BAY WATERSHED: AN IMPORTANT STEP ON THE ROAD TO MANAGING FISH HEALTH IN THE WATERSHED

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Unexpected die-offs, skin lesions, and intersex in smallmouth bass in the Chesapeake Bay Watershed may very well be due to exposure to endocrine disrupting chemicals (EDCs). Effects-directed analysis (EDA) is a technique utilized to uncover the identity of biologically-active chemicals such as EDCs from complex mixtures including natural waters or wastewaters. The response of a biological system known as a bioassay (cells or whole organisms generally) allows the detection of chemicals (such as EDCs) that cause a specific type of response. If chemically-induced endocrine disruption is suspected in a particular environment (i.e. male fish displaying intersex in the Potomac River), EDA can be extremely useful to discern if the endocrine disruption is indeed chemically-induced as well as identify the responsible EDCs. Additionally, EDA can also help rule out candidates that are not responsible for the observed biological activity or effect(s). Chemically-activated luciferase expression (CALUX) cell bioassays are common detection systems used to assess biological activity of different types of EDCs (i.e. androgens, estrogens, etc.) in the EDA process. The CALUX assays are generally more sensitive than many instrumental techniques (such as mass spectrometry), capable of detecting environmental concentrations of certain hormones and other commonly targeted EDCs in water. These assays when utilized for EDA also spare costly instrumental analysis, saving such chemical analyses until the biologically active EDCs have been separated from interfering or non-active agents. Here, we will present the development of an EDA process for determination of chemicals responsible for endocrine disruption in the Chesapeake Bay Watershed. Our proposed EDA framework is based on previous literature and the working parameters of the CALUX assays. Use of CALUX cell bioassays within the EDA framework allows clear and easy detection of certain EDCs, while detection of other chemicals offer more challenges. We are optimizing EDA procedures based on the CALUX cell bioassay strengths and limitations. Our efforts here to evaluate and develop EDA procedures designed specifically to identify EDCs responsible for ED in fish from the Chesapeake Bay Watershed will be further validated with in vivo models.

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HIGH TIDE ON MIAMI BEACH: A PEEK INTO THE FUTURE OF BISCAYNE BAY

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Abnormally hi-tide events (perigean springs tide or King Tides), which occur several times every year affecting coastal communities, allow the development of large scale intrusion/flooding experiments under up-scaled settings, useful to forecast water quality conditions under future higher sea levels. Monitoring these events is like opening a window into the future "normal" to explore the multitude of reactions and the complexity of seawater intruding aquifers and soils under a city, flooding the built environment and moving back into coastal and estuarine waters. We have sampled Biscayne Bay waters, flood waters on Miami Beach streets, as well as waters pumped back to Biscayne Bay before and during perigean spring tides since 2013. Our results indicate that the interaction between seawater and nutrient-metal-bacteria-rich soil waters under the city cause that receding and pumped waters returning to the bay to become nutrient and bacteria enriched, as we would expect for polluted stormwaters. Concentration levels score beyond the adopted criteria for the receiving waterbody. The relevant conclusion is that to avoid flooding by pumping water back to Biscayne Bay, seeking to increase city resilience is not enough and flood waters should be either treated before returning to the bay or deeply injected to avoid irreversible environmental damage, which, in turn, would spoil the tourist alluring waters of Biscayne Bay, while the associated economic activities.

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RAINWATER KILLIFISH IN NEARSHORE EPIFAUNAL COMMUNITIES OF SOUTHERN BISCAYNE BAY: INDICATOR OF ECOSYSTEM CHANGE FOR SOUTH FLORIDA RESTORATION ASSESSMENTS

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The rainwater killifish (Lucania parva) can be considered as a "stress specialist" given its tolerance to hypoxia, high temperature, high salinity and rapid salinity change. In Biscayne Bay it is one of the most numerically-dominant fishes and serves as important prey for several economically-valuable fishes, including largemouth bass, spotted seatrout, gray snapper, and great barracuda. Biscayne Bay, once an estuary that relied on significant freshwater input to maintain its ecosystem, has been transformed to a disturbed marine lagoon. It is affected by structural and operational changes in the South Florida Water Management District that have radically altered the temporal and spatial pattern of freshwater flow to the bay and its salinity patterns. New changes to freshwater flow and salinity patterns are expected with implementation of the Comprehensive Everglades Restoration Plan (CERP).

In this study, we used biotic and abiotic data collected between 2008 and 2015 in IBBEAM (Integrated Biscayne Bay Ecological Assessment and Monitoring) to relate rainwater killifish abundance to salinity. Quantile regression and temporal comparison of abundance and salinity change demonstrate the importance of rainwater killifish as an ecological indicator. Density and occurrence change as the quantity and delivery mode of freshwater changes. Our analyses provide a simple suite of ecological performance assessment tools to help evaluate CERP effects. As of the current state, freshwater flow into the bay has decreased and so has rainwater killifish abundance.

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DESIGNING FOR SUCCESS: LONG-TERM TRENDS OF CONSTRUCTED FRESHWATER WETLANDS IN HILLSBOROUGH COUNTY, FLORIDA

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Mitigation wetlands are ideal for studying long-term success of constructed systems because they address many of the well-known short-comings of ecosystem restoration. Unlike many non-mitigation projects, constructed mitigation wetlands have clearly defined goals, success criteria, and mandatory maintenance and monitoring periods to help ensure a desired stable state. This research examines how design variables such as wetland type, size, location, and planted vegetation community affect wetland structure and function following mitigation release.

Since 1987, over 1,200 compensatory freshwater wetlands have been permitted and constructed under the supervision of the Hillsborough County Environmental Protection Commission (EPC). From this database, a total of sixty-three (N=63) forested and herbaceous freshwater wetlands were surveyed to determine if constructed wetlands continue on their intended design trajectories through time or degrade to undesired conditions. Vegetation community structure, tree growth rates, uniform mitigation assessment method (UMAM) scores, functional wetland area and landscape development intensity (LDI) were assessed for both the project design and current state.

Preliminary results indicate that long-term success of constructed wetlands is affected by design factors such as size, location in the landscape, and wetland age. Total wetland area for the surveyed sites has decreased dramatically compared to their intended design. Results from this study may provide invaluable insight into wetland design and long-term successional trends of freshwater wetlands in urbanized watersheds.

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WAVE ATTENUATION BY VEGETATION: ROLE IN SEDIMENT TRAPPING AND RETENTION

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Wetland vegetation has long been considered a nature-based feature for reducing wave energy, storm surge and erosion. After Hurricane Katrina, engineers sought to further quantify the value of coastal wetlands for storm surge protection and coastal resiliency. Additionally, the value these ecosystems offer for trapping and retaining sediment has become of additional importance. While many studies have focused on the hydrodynamics of unidirectional flow through vegetation, knowledge gaps still exist in wave and wave-current conditions.

To study the role vegetation plays in reducing wave and turbulent energy, a 13.1 by 1.5 m section of idealized vegetation was constructed at the Coastal and Hydraulics Laboratory in Vicksburg, MS. The wave flume has a total length of 63 m and water depth of 31 cm at the test section. The maximum incident wave height generated was 16 cm with peak periods ranging from 1.5 to 4s. In addition to generating waves, the flume has a maximum flow capability of 50 L/s co-current or counter-current the direction of wave propagation. This study used three flow rates of 10.5, 24.6, and 44.5 L/s moving in the direction of wave propagation. The idealized vegetation was constructed of polyolefin tubing with a diameter of 6.35 mm and a length of 0.61 m. The vegetation density was 400 stems/m^2. The flume contains 16 wave measurement rods and seven acoustic Doppler velocimeters, ADV, set at 1/3 the water depth, both sampling at 25 Hz to monitor wave heights and kinetic energy.

Steady flow conditions showed a magnitude increase in the shear velocity between the non-vegetated and vegetated conditions. This increase in shear velocity is a result of the turbulence generation around the vegetation, increasing the flow friction. Wave attenuation by vegetation was quantified using the decay coefficient k_i. The maximum wave attenuation by vegetation was observed for a peak period of 1.5 s and yielded a k_i 0f 0.12 compared to 0.012 for no vegetation. This maximum k_i value corresponds to a wave height reduction of 77% over the 13.1 m. The ADVs measured a 93% reduction in the kinetic energy and 96% reduction in the shear velocity over 13.1 meters in the presence of vegetation. This reduction of energy would greatly reduce sediment transport and increase deposition. For the 24.5 L/s flow condition and a wave peak period of 1.5s, a kinetic energy reduction of 49% and a corresponding shear velocity reduction of 20% were observed compared to the non-vegetated control. With a wave attenuation coefficient of 0.12, no clear change was observed for wave dissipation with or without the added current. These types of wave attenuation and turbulence measurements are critical to sediment suspension and transport, which are important for long-term modeling, planning and management of wetlands.

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DEVELOPMENT OF A NEW METHODOLOGY FOR SETTING LACUSTRINE RESTORATION TARGETS BASED ON PHYTOPLANKTON COMMUNITY ASSEMBLAGES

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Setting valid water quality restoration targets is a challenge for many ecological restoration projects. It is often difficult to establish quantitatively the allowable degree of human impact for a given ecosystem. In the governmental sphere, targets should be ecologically valid and legally defensible.
The Florida Department of Environmental Protection has developed a new methodology to create restoration targets using the phytoplankton community diversity as an index. The new methodology supplements the department's existing tools, and it is expected to be a useful tool for future analyses of some lakes, where sufficient data are available and the approach is appropriate. Results from the pilot approach were used to set the restoration targets for a nutrient impaired waterbody located in the Lower St. Johns River Basin in Florida. Twelve years of biweekly phytoplankton community composition data collected by the St. Johns River Water Management District was used to evaluate the community structure in reference to changing nutrient concentrations. Community composition was assessed using a Shannon-Weaver index of diversity and multivariate analysis techniques. A nonparametric multidimensional scaling ordination of algal species presence/absence was performed and a two dimensional solution was selected as the best fit (stress = 0.2).

On a yearly basis, community diversity remained high when chlorophyll concentrations were below 15 µg/l, while community diversity decreased above this point. The water quality goal was set to achieve the condition of high phytoplankton diversity for the majority of the years with some room for natural exceedances driven by drought or other stochastic disturbances.

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THE ROLE OF EVIDENCE IN ADAPTIVE MANAGEMENT: EXAMPLES FROM THE MISSOURI RIVER AND COLUMBIA RIVER ESTUARY RESTORATION PROGRAMS

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A science-based adaptive management (AM) program relies upon processes that connect evidence on restoration action effectiveness to decision-making. The tools needed will vary depending on the type and degree of uncertainties relative to the decisions that must be made. In the habitat and ecosystem restoration programs on the Missouri and Columbia rivers, AM tools have been developed to address a range of challenges including hydrological variability, spatial and temporal heterogeneity in stressors and habitat quality, difficulty of detection of focal species during critical life stages, and the need to evaluate and integrate the cumulative effects of multiple restoration activities.

The Missouri River Recovery Program (MRRP) has been developing a new plan to adaptively manage the habitats and populations of three federally listed species: the piping plover (*Charadrius melodus*), the interior population of the least tern (*Sternula antillarum*), and the pallid sturgeon (*Scaphirhynchus albus*). An Effects Analysis (EA, as defined by Murphy and Weiland, 2011) was conducted in 2013-2014 to assess the effects of the Corps' operations on the Missouri River, as well as current and proposed management actions, to provide the basis for an integrated AM plan. For plovers and terns, the conceptual understanding of species-habitat interactions and the effects of management actions is relatively high and sufficient data exists for quantitative modeling. Variability in river flows and remaining uncertainties compel the creation of an AM program that can respond quickly to changing flows and habitat conditions while improving predictive capacity. Necessary tools include meaningful habitat and population targets, numerical model projections, decision support tools for facilitating and communicating responsive decisions, and specific decision criteria for action implementation.

For pallid sturgeon, a mechanistic link between documented recruitment failure and management actions on the river remains elusive. The AMP includes a defined process for resolving these critical uncertainties through a framework consisting of four levels of implementation—research, in-river testing of hypotheses, scaled implementation of select management actions, and full implementation—as well as the criteria and timelines for moving to higher levels of implementation. Crucial to the success of this framework is the research, monitoring, and assessment program and the development of quantitative models that will become more completely functional as new information is developed.

The Columbia Estuary Ecosystem Restoration Program (CEERP), designed to restore habitat for juvenile salmonids, shares some challenges in assessing site- and program-level restoration effectiveness with the MRRP. These include monitoring and evaluating the physical and biological effects of restoration in habitat subject to wide spatial and temporal variability in hydrology, assessing site-level benefits for individuals of mobile species using multiple locations, and synthesizing benefits across a range of salmonid stocks with different life history strategies. Tools include research, monitoring, and evaluation programs, indices to capture and tracks elements of the restoration program, data management, and lines-of-evidence approaches to synthesize and report on progress and improve future decisions.

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USING "EFFECTS ANALYSIS" TO BUILD SCIENCE-BASED ADAPTIVE MANAGEMENT ON THE MISSOURI RIVER

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The Missouri River Recovery Program (MRRP) has been developing a new plan to adaptively manage the habitats and populations of three federally listed species: the piping plover (*Charadrius melodus*), the interior population of the least tern (*Sternula antillarum*), and the pallid sturgeon (*Scaphirhynchus albus*). An Effects Analysis (EA, as defined by Murphy and Weiland, 2011) was conducted in 2013-2014 to assess the effects of the Corps' operations on the Missouri River, as well as current and proposed management actions for these species and their habitats to ensure the MRRP uses the best available scientific information. In 2014 the MRRP initiated development of an integrated Adaptive Management Plan (AMP) to address lingering uncertainties and improve future management decisions. The EA process produced several foundational components of the AMP, including conceptual models, information assessments, biological and management hypotheses, initial assessments of action effectiveness and predictive numerical models. By formalizing understanding of the uncertainties and challenges inherent for each species, the EA has helped identify the tools and approaches that would need to be developed for adaptive management to succeed. The EA has benefited from extensive review at each increment by the Missouri River Recovery Implementation Committee, the Missouri River Independent Science Advisory Panel, and scientists from multiple agencies and academia.

For plovers and terns, the conceptual understanding of species-habitat interactions and the effects of management actions is relatively high and sufficient data exists for quantitative modeling. Variability in river flows, however, in addition to remaining scientific uncertainties compel the creation of an AM program that can respond quickly to changing flows and habitat conditions while improving predictive capacity. Necessary AM tools include meaningful habitat and population targets, numerical model projections, decision support tools for facilitating and communicating responsive decisions across management levels and stakeholders, and specific decision criteria for action implementation.

For pallid sturgeon, a mechanistic link between documented recruitment failure and management actions on the river remains elusive. The AMP includes a defined process for resolving these critical uncertainties through a framework consisting of four levels of implementation—research, in-river testing of hypotheses, scaled implementation of select management actions, and full implementation—as well as the criteria and timelines for moving to higher levels of implementation. Crucial to the success of this framework is the research, monitoring, and assessment program and the development of quantitative models that will become more completely functional as new information is developed.

Progress and products for the EA and AMP were regularly shared with the Missouri River Recovery Implementation Committee, allowing stakeholders to engage and discuss the scientific findings and policy implications along with the agencies and researchers as the information was developed. The process has served as an example of how new information can be evaluated and incorporated into future adaptive management of a large ecosystem.

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RESTORATION OF SEASONALLY-FARMED EVERGLADES PRAIRIE WITHOUT REMOVAL OF DISTURBED SOIL.

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Everglades wetlands are characterized by large expanses of graminoid-dominated prairie and marsh that have woody vegetation only in small concentrations where topography and hydrology combine to protect these areas from the shaping forces of fire in the landscape. During the first half of the 20th Century, large swaths of short hydroperiod Everglades wetlands in southern Miami-Dade County were farmed seasonally (during the winter, or dry season) up until the mid-1950's. Over 4,000 acres of forested wetlands exist in areas outside Everglades National Park where seasonal farming was abandoned in the 1950's. The repeated addition of fertilizers to oligotrophic wetland soils has been shown to create a disturbed environment that facilitated colonization of woody species after farming was abandoned. These forested wetlands are currently often dominated by highly invasive species such as Brazilian pepper (*Schinus terebinthifolius*) and shoebutton ardisia (*Ardisia elliptica*), and have proven difficult and expensive to restore and to maintain free of invasive and nuisance species. More cost-effective techniques are needed to lower both initial restoration and long-term maintenance costs for such wetlands. In areas where removal of fertilizer-enriched soils is not feasible, soil disturbance appears to be a major factor in determining what species initially colonize a restoration site. Selective mulching to remove above-ground woody biomass, followed by a combination of herbicide treatment and mowing to prevent reestablishment of woody species and promote colonization by native graminoids, can result in rapid (within 2-3 years) restoration of short hydroperiod Everglades prairie that can subsequently be managed free of woody invasive plants through application of integrated land management practices including but not limited to prescribed fire. Initial and projected long-term costs for this process are substantially less than other restoration techniques, including restoration and maintenance of a native-dominated forested wetland community, or restoration and maintenance of graminoid prairie by clearing and grubbing forested wetlands then allowing natural recruitment to occur. This process is also considered more sustainable because the wetland hydroperiod in the restored area is nearly unchanged, minimizing effects on area ecological services.

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NOT YOUR FATHER'S TAX DITCH: ENHANCING DELAWARE'S DRAINAGE NETWORK THROUGH THE USE OF NATURAL CHANNEL DESIGN TECHNIQUES

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A tax ditch is a governmental subdivision of the State formed through Superior Court. Traditionally these systems were constructed to provide drainage benefit to lowing lying areas and agricultural fields. Delaware has over 230 Tax Ditch organizations responsible for managing over 2,000 miles of channel that deliver drainage to over one third of the State. However, after channelization many of these ditch systems were disconnected from their adjacent floodplains and forested wetlands. Tax Ditch Construction started in the late 1950's and peaked in the mid 1980's meaning that the majority of drainage infrastructure is 30-60 years old. In addition to age, the combination of channel construction techniques, hydrologic changes, and highly erodible soils have resulted in a substantial degradation of critical component of Delaware's infrastructure. Permanent rights-of-way established adjacent to the ditches provide access for maintenance practices that typically include annual mowing to control vegetative growth, riprap bank repairs, and ditch dip outs to maintain drainage.

The DNREC Drainage Program with assistance from interagency partners and Tax Ditch managers are working to improve Delaware's drainage. Utilizing natural channel design techniques not typically found in Tax Ditches, our partnership has begun to enhance floodplains, restore wetlands and habitat, and stabilize ditch banks using "green" techniques in lieu of riprap. Small projects have included use of compost and coir logs with live stakes for bank stabilization and two-stage channels with floodplain benches. Also, major stream restoration projects are transforming traditional Tax Ditches into natural systems by creating riffles, pools, and structures for grade control stabilization and habitat. These types of projects sustain essential drainage while helping to meet water quality goals by reducing pollutants including nitrogen, phosphorus, and suspended solids. This project will highlight several projects in the Chesapeake Bay Watershed that have used these techniques on both a small and large scale.

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MOLLUSK DEATH ASSEMBLAGES CAN RECORD FINE-SCALE SPATIAL VARIABILITY IN MARINE COMMUNITIES

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Mollusk shells can be used as historical indicators of various ecosystem characteristics, such as biodiversity and productivity. Paleontological data can contribute meaningfully to ecosystem restoration projects by providing baseline information for the pre-industrial state of modern ecosystems. Not only can paleontological data provide information about basic diversity measurements, but it can also provide information about the spatial variation in the faunal composition that may be present among and within different habitat types. We collected 61 bulk surficial sediment samples containing mollusk shells from 12 localities around San Salvador Island, the Bahamas, and used these samples to estimate the amount of spatial patchiness within and across shallow subtidal habitats. Multivariate analyses indicate that mollusk death assemblages exhibit a high level of habitat-specific patchiness, suggesting that spatial information resulting from environmental variability may be reliably recorded in shell death assemblages at relatively fine scales. To compare and contrast ecological patterns observed in modern habitats to those recorded in pre-industrial fossil record, small-scale environmental variability and the potential patchiness in species composition need to be evaluated. This San Salvador Island case study suggests that such fine-scale patchiness in species composition can be retrieved and quantified using the historical data provided by mollusk death assemblages.

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VALUING ECOSYSTEM SERVICES: THE US GEOLOGICAL SURVEY EXPERIENCE

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In October 2015, the White House Council on Environmental Quality, Office of Management and Budget, and Office of Science and Technology Policy directed U.S. Federal Agencies "to promote consideration of ecosystem services, where appropriate and practicable, in planning, investments, and regulatory contexts." Monetary and / or non-monetary valuation is a key element of implementing an ecosystem services framework. Ecosystem services valuation assessments often focus on in-place benefits resulting from resource or landscape preservation. An evaluation of restoration investments also requires use of an ecosystem services framework to effectively and comprehensively account for benefits and costs.

This presentation describes: (1) a conceptual framework employed by the USGS Science and Decisions Center to analyze restoration impacts using an ecosystem services approach; (2) valuation methods and practices; and (3) application of this framework to natural resource decision making. Valuation of ecosystem services will be discussed using recent and on-going USGS place-based research projects. Examples include the valuation of ecosystem services impacted by the restoration of sage-grouse habitat in the West, conserving water quality and floodplain functions in the Chesapeake Bay, and evaluating the effects of various management actions on ecosystem services in the Great Dismal Swamp National Wildlife Refuge.

Drawing on ecosystem services project experience, we will address the challenges and opportunities for identifying restoration impacts on baseline ecosystem structures and functions, translating those impacts into services that are of benefit to humans, describing various techniques for valuing services in monetary and / or non-monetary terms, and lastly, how this information can be used by Federal natural resource management decision makers. Specifically, the benefits of integrated bio-physical-economic approaches will be described. Discussion of ecosystem service valuation will include market-based, avoided cost, benefit-transfer, and group decision making as illustrated by focus groups and deliberative monetary valuation techniques. We will consider challenges resulting from lack of standardization. The presentation will conclude by offering observations on important bio-physical and valuation data gaps, and how these gaps can be addressed to evaluate restoration outcomes more effectively.

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RESTORING COASTAL ALABAMA: DIFFERENT APPROACHES FOR DIFFERENT NEEDS

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The use of coastal ecosystems by humans has resulted in widespread loss of ecologically important natural habitat, such as marshlands, seagrass beds and oyster reefs. These habitats provide many valuable services to humankind and, if continued to be destroyed, the development and exploitation of coastal systems by humans will be unsustainable. To help reverse this trend, we have been testing the cost-effectiveness of restoration methods based on the creation of subtidal reefs that can be used in a variety of coastal systems, ranging from moderate to intense levels of degradation. Reefs were expected to be colonized by oysters, which reduce wave energy and increase water clarity, in turn ameliorating conditions for seagrass growth, supporting sediment deposition, and marsh expansion. The reefs employed in our various projects range in shape, size and composition. In addition, the reefs have been deployed for different time-spans, from ca. 1.5 years in some projects to over 5 years in others. The impacts of these various reefs on shoreline stabilization appear to be disparate. Some of the locations continue to erode heavily, whereas in other locations the rate of erosion has been slowed by the reefs. We compare the performance of subtidal reefs with intertidal reefs closer to the shoreline, which seem to be more effective in reducing shoreline erosion. The effects of these reefs and recommendations for future deployments, such as dimensions of the reefs and candidate locations for best success, will be discussed.

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SMALL MAMMAL COMMUNITIES AS INDICATORS OF RESTORATON SUCCESS IN THE GREATER EVERGLADES

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A major aim of the Picayune Strand Restoration Project (PSRP) is to fill drainage canals to restore hydrologic pattern and function to the southwest portion of the Greater Everglades ecosystem. The presence and population health of species that depend on more natural hydrologic patterns can serve as indicators of hydrologic change and resulting ecosystem restoration. Returning Picayune Strand to a more natural hydrologic regime will not only increase habitat availability for important Everglades species but is also expected to restore connectivity within and between natural areas adjacent to the project areas such as Fakahatchee Strand State Preserve and Panther National Wildlife Refuge.

The goal of this study is to determine whether small mammal community composition has responded to restoration project implementation. Focal species are: Marsh rice rats (*Oryzomys palustris*), Hispid cotton rats (*Sigmodon hispidus*), and Cotton mice (*Peromyscus gossypinus*). As Picayune Strand experiences longer hydroperiods with restoration, wildlife communities and populations are expected to recover. Marsh rice rats, for example, are semi-aquatic rodents known to forage in marshes and therefore should expand into areas that become wetter with restoration.

Our study uses live-trapping to capture and mark small mammals in the PSRP footprint. We selected areas to trap small mammals within the major vegetative types within PSRP: cypress, pine, hardwood hammock, and wet prairie. We are trapping in 'restored' and 'not restored' areas of each habitat type to examine impacts of restoration progress. Areas considered 'restored' are within 1.4 km of Prairie Canal which was plugged in 2004. Areas considered 'not restored' are at least 8.5 km from Prairie Canal and are therefore located in areas that are heavily drained by existing canals. Traps are set in a 6 x 6 grid for 36 traps in each replicate across four trap nights. We use two grid replicates in each of the four habitat types and two restoration conditions (restored vs not restored) for 576 traps per trapping session.

Results from the first year (2014/2015) showed higher Cotton rat and Cotton mouse abundance in the 'restored' sites compared to the 'not restored' sites. Captures were made in all habitat types, but the majority were in cypress. More individuals were caught in 'restored' than 'not restored' habitats. The majority of Cotton mice were caught in wetter habitats during wet season, whereas Cotton rats were concentrated in drier habitats. Marsh rice rats were not captured in the first year, but several have been captured during the ongoing second year of the study (2015/2016) as restoration continues to progress.

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RESTORATION BENEFITS OBSERVED FROM THE BISCAYNE BAY COASTAL WETLANDS PROJECT

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The purpose of the Biscayne Bay Coastal Wetlands (BBCW) project is to contribute to the restoration of Biscayne Bay and adjacent coastal wetlands as part of a comprehensive plan for restoring the south Florida ecosystem. The project redistributes freshwater from existing point source canal discharges to coastal wetlands adjacent to Biscayne Bay providing for a more natural and historic overland flow to remnant tidal creeks. The project will improve the ecological function of saltwater wetlands and the nearshore bay environment by improving salinity conditions for fish and shellfish nursery habitat.

BBCW Phase 1 is composed of three components: Deering Estate, Cutler Wetlands and L-31E Flow Way. In advance of congressional authorization, the South Florida Water Management District (SFWMD) constructed the Deering Estate Flow Way and installed culverts for the L-31E Flow Way. By expediting the completion of these project features hydrologic environmental improvements and project benefits are already being realized.

Based on data collected during the last four years of ecological monitoring and a comparison of this to baseline data, the project is trending towards success. There is improved water quality to the bay as fresh water is redirected from canals to wetlands via the L-31E Culverts and the Deering Estate Flow-way. Additionally, point source fresh water discharges have been reduced. Monitoring results demonstrate a clear improvement of hydrologic conditions in response to Deering Estate pump station (S-700) operation. L-31E Temporary pilot pump dry season operations started on October 15, 2014. Based on data collected as part of the ecological monitoring, the project was successful and short-term hydrologic improvements are being realized in response to the L-31E Pilot Pump Test.

Vegetation within the vicinity of Deering Estate Flow-way is responding to improved hydrology demonstrated by die-off of upland vegetation, emergence of wetland species and expansion of sawgrass. Surface water salinity decreased to <1 in response to the pumping of fresh water from Deering Estate Flow-way Pump Station into the historic remnant wetlands in the vicinity of Cutler Creek. Groundwater salinity near the Deering Estate Flow-way also responded to the input of fresh water from S-700 into the historic remnant wetlands, salinity decreased to less than 10. Sawgrass mapping of 470 acres in the Miami Dade-County Preserve wetlands was performed in 2013 and 2015. During that period of time there was a 43 acre increase. During both semi-annual monitoring events in 2015 an increase in periphyton, various bird species, amphibians, invertebrates, and fish were observed. During this same period there was a decrease in invasive exotic plants species as well.

This presentation will focus on recent restoration benefits in the Biscayne Bay Coastal Wetland Project.

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HYPOXIA IN THE POST-PHASE I KISSIMMEE RIVER CHANNEL AND IMPLICATIONS FOR DISCHARGE MANAGEMENT

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As an indicator of water quality and the ecosystem's response to hydrologic and physical restoration, dissolved oxygen (DO) is one of the important performance measures being used to evaluate the success of the Kissimmee River Restoration Project (KRRP). DO concentrations have recovered significantly since the completion of Phase I construction in 2001. However, declines in DO concentration to hypoxic levels (<1 mg/L) continue to occur almost annually in sections of the Kissimmee River channel where flow was reestablished in 2001. Hypoxic conditions negatively affect the recovery of populations of native fish and other aquatic organisms in the restoration area where native communities are expected to reestablish. Hypoxic events are most pronounced and severe in the wet season, when temperatures are warm and in events where substantial rainfall is followed by increases in upstream discharge to the KRRP. The effects of direct rainfall over the river/floodplain are exacerbated by increases in discharge from upstream water control structures. Two potential mechanisms for these declines in DO to hypoxic levels are (1) inhibition of photosynthesis caused by flushing of photosynthetic aquatic organisms and greater attenuation of light with increased water depth and turbidity, and (2) influx of organic material from the floodplain and tributaries causing rapid increases in biochemical oxygen demand. Long-term (1997-2015) DO data from monitoring stations in the Kissimmee River channel are analyzed in relation to water operations and discussed in terms of potential water management strategies that may allow water managers to reduce the severity and/or duration of hypoxic events.

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APPLICATION OF NRDA TO LARGE SCALE RESTORATION IN TEXAS

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NOAA Restoration Center in Galveston, Texas has been actively involved in applying NRDA and other funds to large scale restoration projects in Texas. One successful example of large scale restoration is the Bahia Grande Restoration Project. Beginning in the late 1800's, the Bahia Grande area, a unique hypersaline lagoon, was recognized by early ornithologists (e.g., J.C. Merrill and G.B. Sennett) and naturalists for its abundant bird life. On August 2, 1939, J. Clark Salyer II, Chief of the Division of Wildlife Refuges, sent a 16-page report to Dr. Ira Gabrielson (first director of U.S. Fish and Wildlife Service), that identified Bahia Grande as a top priority for protection. Intervening years saw impacts from railroad, roads, and navigation channel developments with local old timers taking restoration of the hydrology into their own hands early on leading to various legal actions.

In 1999, the U.S. Fish and Wildlife acquired 21,762 acres surrounding the Bahia Grande and incorporating it into a unit of the Laguna Atascosa National Wildlife Refuge. A unique partnership based on incredible local interest formed the Bahia Grande Restoration Partnership, which includes over 65 partners, has worked to inundate the Bahia Grande wetlands to restore historic habitat and reduce the large dust storms which negatively impact nearby communities. Today, as a result of this work, the Bahia Grande again is flooded and serves as a hyper-saline wetland supporting shorebirds, wading birds, and one of the largest nesting colonies of gull-billed terns. This Partnership has been recognized in 2005 with DOI Cooperative Conservation Award, 2006 Coastal America Partnership Award, 2007 Gulf Guardian Award, and 2008 Texas Environmental Excellence Award.

This presentation will discuss the past and ongoing efforts to do successful restoration at such a large scale highlighting recent onsite restoration activities and the larger Bahia Grande Coastal Corridor Project (BGCC) that will help to complete a protected corridor linking the globally significant Laguna Madre region of the South Texas and Northern Mexico Gulf Coast. By acquiring approximately 6,000 acres of land using RESTORE Act funds, the project will add to a 105,000-acre corridor of conservation lands that includes the Laguna Atascosa National Wildlife Refuge (NWR), Boca Chica State Park and the Lower Rio Grande Valley NWR. This corridor also connects over 2 million acres of private ranchland located north of Laguna Atascosa NWR with the 1.3 million acre Rio Bravo Protected Area, managed by the Commission Nacional De Areas Naturales Protegidas (CONANP) in Mexico.

Key words: large scale restoration projects in Texas, Bahia Grande, Bahia Grande Restoration Partnership

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APPLICATION OF THE COASTAL DROUGHT INDEX TO SITES IN FLORIDA BAY AND THE GULF OF MEXICO

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Coastal droughts have a different dynamic from upland droughts, which are typically characterized by agricultural, hydrologic, meteorological, and (or) socioeconomic impacts. The location of the freshwater-saltwater interface in surface-water bodies is an important factor in the ecological and socioeconomic dynamics of coastal communities. Because of the uniqueness of drought impacts on coastal ecosystems, a Coastal Drought Index (CDI) was developed by using an approach similar to the Standardized Precipitation Index (SPI). Instead of using precipitation data, as with the SPI, the CDI utilizes salinity data. The CDI is a standardized probability index with zero indicating historical median salinity amount, and positive and negative values representing increasingly fresh and saline conditions, respectively. The CDI is computed for various time scales to capture short- and long-term conditions. Evaluation of the CDI indicates that the index can be used for different estuary types (for example: brackish, oliogohaline, or mesohaline), for regional comparison between estuaries, and as an index for wet conditions (high freshwater inflow) in addition to drought (saline) conditions.

The CDI characterizing 1- to 24-month duration salinity conditions was computed for five tributary sites in Florida Bay and for nine tributary sites in the Gulf of Mexico. Comparison of the CDIs using the same time intervals shows how the intensity of drought and freshwater conditions varies along the southwest Florida coast. Time-series plots showing the CDI index for all the computed time scales show how sites vary in response to short- and long-term conditions. To evaluate the effectiveness of the CDI as a prediction and adaptive management tool, there is a need to develop linkages between the CDI and coastal drought response variables. However, identifying potential coastal drought response datasets is challenging. Coastal drought is a relatively new concept and existing datasets may not have been collected or understood as “drought response” datasets. Potential coastal drought response datasets include tree growth and liter fall, harmful algal bloom frequency, *Vibrio* infection occurrence, sportfish populations, and shellfish harvesting data. The CDI computed for Florida Bay shows a strong visual correlation with the occurrence of harmful algal blooms along the coast. The presentation will describe the application of the CDI to sites along the Gulf of Mexico and Florida Bay.

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WATERSHED-SCALE AND LONG-TERM CONSIDERATIONS IN RESTORING LARGE WOOD TO RIVERINE ECOSYSTEMS

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Process-based restoration focuses on drivers of riverine dynamics. While this focus is generally important in restoration, it is particularly so in wood-oriented projects due to the relatively short lifespan of placed wood features and the high volumes of wood available to most US watersheds. Furthermore, rigorous consideration of background load, recruitment, transport, and deposition processes can reduce restoration costs, decrease risks of project failure, optimize biotic and ecological responses to projects, and protect infrastructure. Addressing these points requires assessment of basin-scale recruitment and supply issues, wood management at reservoirs and re-operations for wood recruitment and routing, effects of climate change, roles of stochastic flooding on pulsed collluvial and alluvial recruitment, planning and infrastructure design for large wood conveyance during peak flows, and large wood management and utilization in flood response.

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TREE ISLANDS AS PHYSICAL MODELS OF NUTRIENT SEQUESTRATION

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In the Everglades, tree islands are considered characteristic of the ecological "health" of the landscape. Phosphorus (P) levels in upland tree island soils are >100 times higher than P in adjacent marsh soils. Tree islands are hypothesized to be an active sink of P in the landscape contributing to the P balance of Everglades slough wetlands. Of primary concern is maintaining tree island soil P to prevent P enrichment of local marsh communities. Hydraulic and geochemical properties are key to understanding how the structure and function of tree islands can be maintained and restored and are critical parameters with which to monitor the "health" of tree islands. In this study, we compared the hydrogeochemical patterns at multiple temporal and spatial scales of four Everglades tree islands in the Water Conservation Areas 3A and 3B : wet, intact (3AS3 WCA-3A); wet, degraded (3A17-6 WCA-3A); dry, degraded (3BS10-WCA 3B) and wet-degraded (3BS2 WCA 3B). The objectives of this study are: 1) monitor and characterize spatial and temporal variability in diurnal ET patterns, 2) monitor and characterize temporal local and regional hydraulic patterns, and 3) characterize spatial and temporal hydro-chemical patterns in ions and nutrients among tree island plant communities and the adjacent deep water slough.

The daily and seasonal pattern of plant water use and water quality parameters including P and chloride concentrations in soil water, groundwater and surface water provide information about the "health" of tree islands. Results from this study to date have illustrated that "healthy" and degraded islands have characteristic patterns. Similarly, results produced three main findings that illustrate the mechanisms that lead to degradation of tree islands and how they can be restored: 1) healthy tree islands exhibit spatial and temporal variability in plant water uptake that is focused in the shallow soil profile, 2) evapo-transpiration (ET) that increases from wetter communities to drier communities within the tree island, and 3) evidence for actively accumulating ions, especially Cl, in soil water of the drier, High Head plant community. The extent and timing of regional hydrology, and its variability within Water Conservation compartments determines the tree island hydrogeochemical pattern and interrelationship between plant performance and soil mineral precipitation. Similarly, hydrology likely determines the balance between organic matter accumulation and decomposition of as peat soil.

Our results are also the basis of a distinct and robust model relating ion composition of tree island water and concentration of $TDPO_4$ for the wet, intact island. This model will prove useful when actions to restore the spatial and temporal pattern of regional hydrology are undertaken. The robustness of the model is complemented by evidence that links plant water uptake with tree island water sources. Thus, results from this study will help to refine performance measures for tree islands, provide information about their state of "health" and their potential for restoration.

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ENHANCEMENT OR JUST GOOD DESIGN? A COLLABORATIVE APPROACH TO RIVER AND WETLAND RESTORATION

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In the United Kingdom, the restoration of rivers and wetlands is often carried out as part of large-scale flood defence schemes, as an enhancement or added benefit. Frequently these elements of a scheme are the first casualties during the value engineering stages and where budget cuts are needed. However, recent changes to government funding for habitat restoration and creation in the UK have favoured a more integrated approach to large infrastructure and flood schemes where delivery of challenging habitat targets can be achieved.

The Exeter Flood Defence Scheme (Exeter FDS), which incorporates major upgrading of existing flood protection, is a good example of how well integrated design can work within the constraints of an urban environment. Incorporating new and restored wetland habitats has been a vital part of scheme design, promoted by the Environment Agency and supported by their project partners, including local councils. A model of habitat restoration, developed over many years by Environment Agency ecology and fisheries staff, accompanied by concept designs, was integrated into the initial Business Case Feasibility Report. Once funding was secured, a close-knit client-consultant team of river engineers, ecologists, fisheries experts, landscape architects and geomorphologists worked together to developed integrated designs that would deliver their primary purpose of protecting Exeter from flooding, whilst securing new areas of wetland and river habitat. Much of these habitat areas are necessary to mitigate for impacts across the whole scheme, but a fundamental part of the design philosophy was also to incorporate a multifunctional integrated design that met flood risk management, habitat restoration and wider environmental objectives, wherever possible.

Part of the Exeter scheme has now been completed. Phase 1 delivers flood risk management improvements to the City Centre and Historic Quayside areas of Exeter, Devon (south west of England). An existing 7 hectare (17 acre) flood relief channel has been transformed into a diverse wetland habitat whilst improving flood conveyance capacity. A meandering low-flow channel, scrapes (shallow ponds) and backwaters form a mosaic of wetland habitats, whilst modifications to an existing side spill inlet weir structure have provided two new fish passes. The siting and size of wetland features were carefully considered to enhance the use of existing hydrogeological features in the exposed channel floor.

Involvement of ecological expertise during the earliest stages of scheme development is crucial and inclusion of an experienced restoration ecologist as part of the design team is vital for successful delivery of valuable habitat. Development of partnerships is also critical to successful delivery and future maintenance of habitats. Exeter FDS has provided a model of how this can be done successfully in the UK, and other schemes are already in development using a similar approach (for example, a major Flood Alleviation Scheme in the historic city of Oxford). If the UK is to deliver it’s challenging habitat restoration and creation targets, we must ensure that these are fully integrated into flood risk management projects – simply put, it’s not enhancement, it’s just good design.

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MOLLUSK ASSEMBLAGES AS PROXY FOR WITHIN-HABITAT DIFFERENCES IN SEAGRASS BEDS

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Using the paleontological record to provide a historical perspective on present-day ecosystems is an emerging tool of ecological conservation and restoration efforts. Understanding how and when organisms and ecosystems responded to past environmental changes can help predict how they will respond to future changes. In this study, we develop a tool that will help determine how seagrass beds have changed throughout time along the Florida Gulf Coast using molluscan assemblages as a proxy for seagrass presence and characteristics. Because seagrasses do not fossilize well, it is difficult to examine their long-term responses to past environmental changes and develop informed forecasting models for how they might respond to future environmental change. It is therefore necessary to use indirect paleo-seagrass indicators, such as mollusks.

Sediment samples were collected from a suite of seagrass sites to describe patterns of mollusk abundance and distribution. These sites, distributed along the Florida Gulf Coast, have been monitored for water quality for 15 years and more recently for seagrass health parameters. Sites were chosen to capture a steep environmental gradient in nutrient concentrations, phosphorus in particular, with N:P ratios decreasing markedly northward. Modern mollusks were identified to species level and counted to obtain a diversity index. Species information such as trophic level and feeding guild were obtained from the literature.

One hundred and seven species of mollusks were found in the samples with the three most common species as follows: *Transenella* sp., *Cerithium muscarum*, and *Crepidula* sp.. Results indicate that molluscan death assemblages not only preserve ecosystem signals (already documented in the literature for mollusk assemblages from other regions) but can also preserve more subtle within-habitat differences within a region. Molluscan assemblages from the same river-influenced system group together and are less similar to assemblages from more distant systems. The controlling factor of system composition appears to be primary production, which is strongly correlated with dissolved phosphorous concentration. There is generally high fidelity of the death assemblages to living assemblages in these systems, suggesting that this region has remained stable over the recent centuries despite some anthropogenic stressors present in the area. The ecotype of the mollusk species – feeding guild and trophic level taken into consideration – also shows system-level differentiation, thus highlighting the potential for this proxy to be used in study areas other than the Florida Gulf Coast. This proxy has the potential to be used in deeper time studies to assess how seagrass beds have responded to historical environmental conditions and thus help us to develop effective conservation plans for seagrass ecosystems.

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AN APPLICATION OF THE NORTHERN EVERGLADES SIMULATION MODEL (NERSM) TO THE ST. LUCIE AND CALOOSAHATCHEE RIVER WATERSHEDS TO EVALUATE MEASURES THAT WILL IMPROVE HYDROLOGY AND WATER QUALITY WITHIN THE STUDY AREA

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As part of restoration efforts, the Northern Everglades Regional Simulation Model (NERSM) was used to evaluate a number of alternatives that addressed a variety of restoration goals. The NERSM is a link-node object-oriented numerical model that describes the hydrology in the Northern Everglades Area of Florida. The study area covers Lake Okeechobee, and both St. Lucie and Caloosahatchee River watersheds. Each alternative analyzed represented a unique combination of watershed storage and water quality projects needed to help improve the quality, timing and distribution of water in the system. Alternative 1 included current/ongoing federal and state watershed improvement projects; Alternative 2 had projects that primarily maximized water storage capacity; Alternative 3 focused on projects that maximized phosphorous and nitrogen load reductions; and Alternative 4 incorporated projects that combined both water storage capacity and nutrient load reductions. Based on a set of performance metrics, a modified Alternative 4 was identified as the alternative that best met both the environmental and legislative goals of the project.

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MIAMI HARBOR MITIGATIVE ARTIFICIAL REEF

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In 2015, the Port of Miami became the first port along the southeastern United States capable of accepting Post Panamax vessels. In order to accommodate the larger vessels, Miami Harbor was deepened to a maximum depth of 52 feet and the outer access channel was widened by 300 feet; these improvements resulted in direct impacts to approximately 7 acres of hardbottom. As mitigation, Great Lakes Dredge and Dock Company, LLC (GLDD) was contracted by the United States Army Corps of Engineers (USACE) to construct the largest natural limestone reef authorized by the State of Florida.

Tetra Tech, as a subcontractor to GLDD, would need to quarry, transport, and precisely place approximately 40,000 limestone boulders within 210 days. At odds with the high production schedule, each boulder was required to be a minimum of 3 feet in two dimensions and once placed in 45 feet of water, approximately 60% were required to lie at a height of 1.5 – 3.0 feet above the substrate.

In order to meet these requirements, Tetra Tech selected a limestone boulder gradation that allowed for high quarry production and proposed that reef acceptance be measured by high resolution multi-beam surveys as opposed to coarsely-spaced diver transects. Tetra Tech also proposed, and received acceptance for, a survey methodology based on historic agency acceptance of prior reef installations.

A total of 11.6 acres of limestone reef was constructed within the project timeline and has set a precedent for acceptance of future composite (high and low relief) reef installations. The procedures refined during the construction of Miami Harbor's mitigative reef will allow for the timely creation of large, natural limestone reefs that provide essential habitat for fish, corals, and other marine life for future projects.

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USING MULTI-DISCIPLINARY SCIENCE & ENGINEERING IN REGIONAL RESTORATION DESIGN & IMPLEMENTATION: THIRD HERRING BROOK RESTORATION CASE STUDY

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Ecological restoration projects attempt to return disturbed, dysfunctional human-affected ecosystems to a desirable state of "natural" functional ecology with a full complement of biological elements. However, our understanding of the ecological dysfunction and the "natural" restoration target is limited by our empirical, theoretical and predictive knowledge, and the analytical tools by which we gain this knowledge. Further, to design for and implement the desired ecological trajectory for restoration projects requires additional multi-disciplinary, site specific knowledge. Having the right team with the necessary skills and knowledge base (i.e., the "correct tools in the toolbox") are critical for project success. An effective project manager is required who can identify and weave together the needed disciplines of earth science, biology, ecology, bio-engineering and traditional engineering; as well as understand the level of design needed, i.e., when "less is more". Knowledge of the regulatory and social/public arena within which the project needs to occur is also critical. Once the project is implemented, adaptive management strategies are required to control and adjust as needed over months to years as dictated by the system. When performed on a regional scale, the need for this multidisciplinary approach only expands with the increased landscape.

A regional approach to ecological restoration in MA has included multiple dam removal projects providing significantly improved aquatic habitat conditions state-wide. One such collaborative project was the Third Herring Brook Restoration project with the removal of the Third Herring Pond dam. GZA provided engineering, ecological, and permitting services. The dam had impounded the waters of the brook for hundreds of years. By 2001, the dam and its condition had deteriorated to "Poor"; the earthen embankment with masonry walls was covered with trees and the inadequate sluiceway was crumbling. The pond was heavily silted-in and could no longer be used for recreation. River herring no longer utilized the brook. Working with the MA Division of Ecological Restoration (DER), the North South Rivers Watershed Association (NSRWA) and Mass Corporate Wetlands Partnership (MCWP), plans were developed to remove the existing sluiceway and restore the brook. Significant effort was expended in applying for the necessary permits. The team identified and brought together necessary evaluative and design technical skills, combined with agency support. Despite regulatory agency support, pond abutters stalled the project for a decade. In 2010, heavy flooding resulted in a partial dam breach. Abutters were forced to adjust to a new reality and the restoration of Herring Brook began again in earnest. Understanding of dam removal and stream restoration had also evolved during this delay. The project team made an affirmative effort to reach out to the abutters early in the revived process. The site and watershed was reanalyzed and design was modified. The evolved design included stream relocation to the breach location, only limited interventionist stream restoration (grading, bioengineering, geotextiles, planting, stream structures), with allowance for natural restoration (head cutting, stream channel carving, sediment sluicing, seed bed regeneration) along most of the stream reach within the pond basin. Grants were obtained to help offset project costs. All permits were re-issued in 2014 and the project was completed in three weeks. Rapid upstream channel formation occurred as predicted by design. Subsequent monitoring verified project success and guided the process for future dam removal projects. The project team's understanding of river restoration dynamics, allowed for applying a measured, but not excessive, amount of human intervention and physical construction, allowing natural fluvial processes and emergence of a stored seed bank within the sediments to continue the process of stream restoration.

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COUPLED VEGETATION COMPETITION AND GROUNDWATER SIMULATION MODEL TO STUDY EFFECTS OF SEA LEVEL RISE AND STORM SURGES ON COASTAL VEGETATION

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The potential future effects of sea level rise (SLR) and increased severity of storm surge overwash events on coastal vegetation are of great interest, as they threaten Everglades restoration. Low lying coastal areas islands are especially vulnerable to SLR and storm surge overwash events, which can have both acute and long-term effects on vegetation and on soil and groundwater salinities, resulting in loss or shift in coastal vegetation as one of the ecological impacts. This loss or shift of vegetation may be irreversible, hence affecting the biodiversity and posing risks of habitat loss critical to native species. To help predict, understand, and prepare for the consequences of these climate-related impacts on both the short-term dynamics of salinity in the soil and groundwater and the long-term effects on vegetation, the U.S. Geological Survey's spatially explicit model of vegetation community dynamics along coastal salinity gradients (MANHAM) is integrated into the USGS groundwater model (SUTRA) to create a coupled hydrology-salinity-vegetation model, MANTRA. MANTRA simulates the possible long-term effects of both gradual sea level rise and storm surge events on the ecotone between salinity tolerant (halophytic) and salinity intolerant vegetation, by simulating competition under changing groundwater salinity and other environmental conditions.

MANTRA simulations were applied to a coastal site in the Florida Everglades where a freshwater hardwood hammock may be vulnerable to transition to halophytic mangrove vegetation. Two storm surge scenarios were simulated. In one it was assumed that salinity overwash was accompanied by heavy damage to the hammock trees. In the other scenario only moderate damage to tree was assumed, but a relative drought of four years was imposed following the storm, thus limiting washing out of the salinity. In both cases a regime shift to mangroves followed the storm surge within a couple of decades. Storm surges with moderate or less damage and without extended droughts did not produce a regime shift. Another scenario without storm surges, but with steady sea level rise caused the hardwood hammock to be restricted to a narrow band after 150 years. It is envisaged that MANTRA would help in projecting the effects of overwash and climate change events on groundwater salinity as well as potential changes in vegetation composition. Further, potential countermeasures and strategies for ecosystem preservation can be further explored via MANTRA simulations.

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CHALLENGES OF COMPETING INTERESTS, LOGISTICS, AND PAYOFFS IN TWO DIFFERENT RESTORATION PROJECTS IN SOUTHWEST FLORIDA.

Nora Egan Demers
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Southwest Florida has been experiencing rapid population growth for several decades. Along with that development come intense habitat alterations including hydrological modifications and suppression of fire. I am working on two challenging habitat restoration projects, with the help of Service-learning students from Florida Gulf Coast University (FGCU). One project is restoration of a drainage district in a 2000-residence community in San Carlos Park, Lee County, FL. The second is to restore & enhance Gopher tortoise (*Gopherus polyphemus*) habitat at the Barefoot Beach Preserve, on the southern end of a barrier island in North Collier County, FL. Similar challenges exist with both projects, including, need for education of humans; balancing competing interests; funding; and logistics of working in a highly altered habitat surrounded by residences. During this presentation you will learn more about both projects and successes and challenges to date.

The mission of the San Carlos Park/Mulloch Creek Restoration Initiative is to restore, maintain and beautify the East Mulloch Drainage District (EMDD) in San Carlos Park. The community, in the greater Everglades, was developed with the ditch and drain mentality beginning in the 1960's. The District's boundaries cover 3,046 acres of land, and contain approximately 21 miles of canals, 20 retention ponds, and 9 drainage structures. The canals are generally overgrown and will require substantial rehabilitation to bring them up to original conditions. Cumulative impacts of homes with septic tanks, and residents using fertilizer, pesticides, and other chemicals has led to eutrophication, sedimentation, and, proliferation of invasive exotic plants brought on by the hydrological alterations necessary to dewater the area. The project began in 2006 with the creation of a "Florida Friendly" demonstration yard at the Drews House in the local community park. The major challenges include a non-*ad valorum* funding mechanism requiring an act of state government to increase, knowledge and awareness of the problem, access to the drainage district from homes on quarter-acre lots, and concern about stinging insects, and other non-human species inhabiting the community.

The mission of the Gophers@Barefoot project is to restore and enhance the habitat for Gopher tortoises at the Barefoot Beach Preserve. The small coastal strand habitat is located just south of multi-million dollar homes on a barrier Island. We accomplish our mission by simulating fire, conducting research, and preparing educational material and resources for beach visitors to understand and value the role of fire and Gopher tortoises in supporting a healthy ecosystem. Among the challenges there are inability to use control burn, concern about removing sea- grapes due to their protective nature during tropical storms, and competition for habitat between the Gopher tortoises and their food source and the visitors to the beach and their vehicles.

Of course, lack of funding and other resources hinder progress on both projects. To end on a good note, I've been successful in engaging dozens of University students that have learned more about these challenges. Collectively we have donated hours of service equivalent to over $100,000. During this presentation I will tell you more about these challenges, solutions underway, and solicit your advice on moving to the next step.

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ROLES OF CRITICAL UNCERTAINTIES RESEARCH IN LARGE-SCALE RESTORATION: EXAMPLES FROM THE COLUMBIA ESTUARY ECOSYSTEM RESTORATION PROGRAM

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Directed research into uncertainties is a critical element of successful adaptive management for large-scale ecosystem restoration. This study focused on aspects of restoration techniques that currently pose challenges for estuarine and tidal freshwater wetland restoration projects of the Columbia Estuary Ecosystem Restoration Program (CEERP) located on the 234-km lower river and estuary. The focus was on 1) topographic heterogeneity; 2) control of the invasive plant reed canarygrass (*Phalaris arundinaceae*); and 3) aspects of tidal channel network design to provide habitat connectivity for juvenile salmonids. Following outreach to practitioners to define challenges, and literature review, we collected and analyzed field data from 10 tidal wetlands on the lower Columbia River, Puget Sound, and Pacific Coast, and analyzed geographic information system data. Statistical analysis strongly suggested that soil moisture was negatively correlated with elevation in regard to the design of mounds (also called hummocks, peninsulas, or berms). Analysis of temperature was less conclusive, though it appeared to be positively correlated with elevation, and mound aspect appeared to be less important to temperature and moisture than hypothesized. Most available information about reed canarygrass control is from non-tidal environments, but key environmental controls are shade, nutrient availability, salinity, and elevation. Elevation is important at both the low and high ends of the spectrum: first through a feedback with the hydrologic regime (ensuring enough inundation to prevent growth), and secondly, at the high end, through providing less-frequently inundated substrate on which woody plants can become established and shade the grass. The analysis of channel network design focused on three metrics: the number of channel outlets, channel area, and channel perimeter. Linear regressions of these metrics as a function of wetland area by each of eight river reaches, distinguishing islands from mainland wetlands, produced very few good predictive models. We identified only five predictive models for specific combinations of reach, island or mainland position, and the response variable. In virtually all cases, the use of a common slope (i.e., for all reaches) in the model caused R^2 to drop below acceptable values, discouraging prospects for any single regression-model-based design tool using these parameters suitable for the entire lower river and estuary. The variability of channel network properties in the lower Columbia River and estuary both longitudinally (i.e., between river reaches) and laterally (i.e., between mainland and island wetlands) is substantial and in many cases statistically significant. Though a predictive model based only on channel network characteristics appears unlikely, the addition of inundation regime and plant community has the potential to strengthen a model-based approach to engineering design. The CEERP is using reporting, workshop, and internet formats to rapidly disseminate findings, including design and planning recommendations, to regional practitioners and managers of restoration.

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DALLAS FLOODWAY EXTENSION LOWER CHAIN OF WETLANDS AND GRASSLANDS: A CASE STUDY OF THE ADAPTIVE MANAGEMENT APPROACH IN ECOSYSTEM RESTORATION

Lynde L. Dodd *and Gary O. Dick*
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Working within an adaptive management (AM) framework for ecosystem restoration projects requires monitoring that includes the collection and analysis of quality biotic and abiotic data. These data must be legally defensible because of their use in the AM decision making process, especially in high profile aquatic ecosystem restoration projects authorized by the federal government, which are highly scrutinized by non-governmental organizations, stakeholders, or other entities. Quality assurance and quality control of the data are especially important as adaptive management strategies are employed. Consistency among data collection methodologies is paramount to ensure data comparability over the duration of the project. However, situations may arise in the field that challenge the ability to remain consistent in data collection methodologies. While these challenges may persist throughout the project, reliable data collection can be achieved.

In this presentation we will discuss AM approaches for ecosystem restoration elements of the Dallas Floodway Extension: Upper Chain of Wetlands and Grasslands. We will also explore the lessons learned that revolve around monitoring of a 10-year multi-purpose floodway project where highly dynamic site conditions call for prompt and decisive management action for corrective measures. Herbivory, water level and flow rate fluctuations, overbanking events, nuisance species and unintentional/intentional management activities by others sharing right-of-ways within the same project footprint are examples of unpredictable perturbations to a restoration project. All of these natural or anthropogenic interventions may alter the way in which monitoring data are collected and interpreted, and ultimately how AM strategies will be developed and subsequently implemented.

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MODELING LANDSCAPE SCALE PLANT COMMUNITY RESPONSE TO CLIMATE CHANGE AND HUMAN MANAGEMENT

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As a component of the modeling for the Louisiana Master Plan, we have developed a spatial explicit model of plant community dynamics for Louisiana's coastal wetland ecosystem. Our model takes a detailed, Gleasonian approach to modeling plant species. Each species is defined by the range of environmental conditions that promoted establishment and growth or result in senescence of each species. The expansion and senescence conditions for each species are based on how different species respond to different sets of environmental factors depending on their individual ecology. Establishment of new species is dependent on the dispersal probability, and the environmental conditions during establishment. Our model includes 40 plant species that represent the major community types present in Louisiana's wetlands including emergent herbaceous wetlands, forested wetlands, barrier islands, and submerged aquatic vegetation. We have applied this model to understanding how the Louisiana's coastal wetland plant communities may respond to management actions as well as the effects of sea level rise associated with global climate change. Louisiana's wetlands are subject to both local and global stresses. Sample outputs that show the effects of different restoration projects under variable future scenarios will be presented.

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POLICY, PLANNING, AND PERMITTING FOR TETHERED COASTAL, ESTUARINE, AND MARINE RESTORATION

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Restoration and enhancement projects are typically permitted on a project-by-project basis. Larger scale restoration planning may include multiple similar projects such as several small oyster reefs, or an eco-systemic approach that “tethers” the restoration of diverse habitats including high energy and estuarine beaches, salt marsh, oyster reefs, sea grass beds, and hard bottom. Restoration and enhancement strategies can include deploying artificial reefs for fisheries enhancement and direct restoration of marsh, reef, and beach areas. These approaches may occur over significant temporal and spatial scales and planning in the absence of regulatory certainty that all of the project components will eventually be permitted could compromise the integrity of the overall effort. In Florida, tourism, commercial and recreational fishing, and real estate development will be negatively affected if marine, estuarine and coastal habitats are not maintained restored and enhanced.

The current permitting scheme for marine, estuarine and coastal habitat restoration projects suffer from regulatory uncertainty, piecemeal project permit approval, and a lack of stakeholder participation. Planning at the scales necessary for successful restoration can involve resource and user group conflicts and multiple regulatory approvals at various levels of government. This poster examines current and potential mechanisms to facilitate large scale, long-term restoration across all or some of these ecosystems through “conceptual permitting.” Precedent for this sort of long-term scaled permitting can be found in Florida’s conceptual permitting framework often employed by ports and large-scale phased development projects to restoration policy. Other policy tools include regional sediment management programs, natural resource adaptation action areas, and regional waterway management for navigation improvements. An interdisciplinary group of researchers will propose a policy paradigm for conceptual restoration planning borrowing from these existing approaches such as Adaptation Action Areas, regional sediment management programs, regional general permits and port conceptual permits.

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SYSTEM-WIDE SCIENCE COORDINATION AND REPORTING

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REstoration COordination and VERification (RECOVER) provides essential support to the Comprehensive Everglades Restoration Plan (CERP) in meeting its goals and purposes. RECOVER does this by applying a system-wide perspective to the planning and implementation of the CERP. RECOVER is a multi-agency team of scientists, modelers, planners and resource specialists who organize and apply scientific and technical information in ways that are most effective in supporting the objectives of CERP. The RECOVER team conducts scientific and technical evaluations and assessments for improving CERP's ability to restore, preserve and protect the south Florida ecosystem while providing for the region's other water-related needs. RECOVER communicates and coordinates the results of these evaluations and assessments to managers, decision makers and the public.

The CERP Monitoring and Assessment Plan (MAP), is a system-wide monitoring and assessment program capable of evaluating CERP performance and system responses. The overarching goal of the MAP is to have a single, integrated, system-wide monitoring and assessment plan that is used and supported by all participating agencies and tribal governments as the means of tracking and measuring CERP performance. The MAP is organized by region and each region has a set of Conceptual Ecological Models (CEMs) that describe the ecological linkages between stressors and key attributes that serve as ecological indicators which are used to measure restoration success. The CEMs are used to formulate hypothesis clusters that describe not only what attributes are important, but also why changes occur. The CEMS are the framework for creating performance measures to measure the success of restoration and identify monitoring and research needs.

The CEMs have been used to establish hypothesis clusters that are assessed in the System Status Report (SSR). RECOVER produces the SSR every 5 years that assesses data garnered from MAP monitoring, CERP project-level monitoring, historical data and data from non-MAP sources. The SSR plays an important role within CERP; it is designed to assess and document the overall status of the ecosystem relative to system-level hypotheses, performance measures, and restoration goals. SSR key findings are intended to convey key scientific information to water managers, budget directors, decision-makers, and the public about the status of the Everglades ecosystem to support restoration and water management decisions. RECOVER uses the SSR to communicate the science behind the restoration by providing information for adaptive management (AM) and Congressional reports. RECOVER's assessment process used in the SSR synthesizes monitoring data and assesses the status of the South Florida ecosystem in order to determine how well CERP is meeting its goals and objectives (performance), and to address system-wide/regional hypotheses and reduce uncertainty.

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“WHY WOULD YOU EVER DREDGE ORGANIC SEDIMENT FROM AN ECOSYSTEM"

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The most common technologies currently used in the Ecosystem Restoration process in natural bodies of water that become polluted or begin to undergo *eutrophication* involve primarily some form of physical and or chemical treatment. These include use of chemical oxidizers, flocculants, activated carbon and zeolites and dredging. The primary drawback to physical/chemical treatments and dredging is their total disruption of all marine habitat and the associated costs related to the use of these methods.

In recent years “novel bioremediation technology” has been proven to be effective and far more economical in treating those systems. This unique bioremediation technology takes advantage of nature’s own processes for recycling of the basic elements of organic pollutants and organic sediments and its nutrient related materials back into the biosphere through what are known as the biogeochemical cycles. Bio-augmentation is used to accelerate these natural processes. It is the purposeful inoculation of a system with additional microorganisms that have been specifically selected for their metabolic processes and pathways that include the carbon and nitrogen cycles, combined with the novel ability to achieve denitrification (nitrate removal). This technology has been successfully applied in many natural and man-made water bodies to restore and improve water quality and break down organic bottom solids. We will review several project applications worldwide including a river in China, a retention pond in Malaysia, retention ponds in Jacksonville and Naples Florida in response to MS4 requirements and multiple lakes in the United States as well as a very nasty Swan Pond at the Jacksonville Zoo that show amazing results.

In these applications, substantial reductions in aqueous phase pollutants were observed including Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Total Nitrogen (TN), Nitrates & Nitrites and the near total elimination of Fecal Coliform. In addition, reductions of up to 80% and more of the organic bottom solids were observed without the need for dredging and its associated disposal of dredge spoil problems. This was accomplished in just 6 months. All this with no turbidity and no disruption to the marine habitat. Projects demonstrating the bioremediation of a wide range of organic matter to include hydrocarbons, Fats, Oils and Grease (FOG) have been very impressive.

In all cases where bioremediation has been successfully employed a cost savings of 65% or more over conventional technologies have been realized. It is estimated that one $8M Ecosystem Restoration Project in Florida could have been completed for less than $.5M using this technology in the same amount of time or less.

Importantly, because this is a completely natural, unaltered microbe, No permits are required from the COE or EPA to use these natural products. In Florida, an FDEP Environmental Resource Permit (ERP) is required. The FDEP has approved use of these microbes and placed a Notice in their Accepted Technologies Library.

Many 3rd Party Studies are available that demonstrate the reduction of organic pollutants and bottom sediment of as much as 1 to 3 feet during an 8-12 month period. CD’s of these studies will be available.

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US ARMY CORPS OF ENGINEERS PERSPECTIVE: OPPORTUNITIES AND CHALLENGES OF IMPLEMENTING COASTAL RESTORATION WORK-IN KIND AND CROSS-CREDITING LEGISLATION

Durund Elzey
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The purpose of this presentation is to provide the status of the Louisiana Coastal Area (LCA) Program and present the U.S. Army Corps of Engineers (USACE) perspective on the implications of cross-crediting, as authorized in WRRDA 2014, on advancing LCA projects to construction. LCA consists of 15 large, coastal Louisiana restoration projects. The State of Louisiana has initiated construction of certain LCA projects in advance of USACE receipt of Federal funding. Section 1019 of WRRDA 2014 amends section 7007 of the Water Resources Development Act of 2007 (WRDA 2007) to authorize credit, in accordance with section 221 of the Flood Control Act of 1970, for non-federal sponsor's (NFS) in-kind contributions for certain authorized projects. WRRDA 2014 also allows for the use of "excess credit" to meet a NFS's cost share requirement on other projects, and the State has identified LCA projects that it would be willing to use excess credit to cost share in the construction with USACE. USACE and the State have conducted extensive coordination on the development of the cross-crediting process to enable the State to receive in-kind credit to the maximum extent possible. This process could prove beneficial to other coastal restoration projects with cross-crediting authorization.

The presentation will present the status of LCA projects and provide USACE's perspective of opportunities and challenges of implementing cross-crediting provisions, and the issues and concerns that have arisen, resolutions sought, and lessons learned.

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RISK CONSIDERATIONS ASSOCIATED WITH PLACING WOOD IN STREAMS AND RIVERS

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The engineered placement of large wood (LWD) has been identified as an integral component of restoration strategies throughout North America. Historically, LWD and stable logjams were abundant in rivers and throughout watersheds. Within the past 100- to 200-years LWD has been removed from streams and rivers for a variety of reasons that include: increased channel flood capacity; improved channel navigability; improved fish passage; reduced debris loading on bridges and other instream structures; and improved safety to the general public. As a result, segments of the general public and recreational users have developed aesthetic perceptions that "clean" river channels are healthy and natural. Within the past 10- 20-years, the importance of LWD and stable logjams to geomorphic processes, habitat complexity and ultimately the health of aquatic ecosystems has become better understood. This has led to federal, state, local, tribal, and private citizens placing LWD in streams and rivers in the form of engineered logjams (ELJs) and LWD placements in an effort to restore channel processes and create habitat for the purpose of enhancing and restoring aquatic habitat, to recover many species protected as threatened or endangered under the U.S. Endangered Species Act (ESA).

While the placement of LWD is an important component of river restoration strategies, many of the rivers and streams have significant constraints such as civil and private infrastructure, private property ownership, and a host of recreational activities within the river corridors. These constraints are commonly damaged by natural fluvial processes and are at risk to flooding and erosion, resulting in significant public and private investments in river training structures and flood control projects. Current river management practices acknowledge that there are inherent risks associated with any rivers, and could negatively affect recreation opportunities, commerce, infrastructure and existing buildings within a floodplain. However since the European settlement started, large financial investments have been made in the United States to reduce flood risks and improve navigation through the removal of LWD, channel confinement, channel training, and flood control projects greatly simplifying aquatic habitat and disrupting natural fluvial processes.

In conducting a risk assessment related to LWD placements, it is essential to document the existing, inherent or background risks found within the stream or river you are working on. This is particularly important given that the assessment is intended to show whether or not the addition of LWD will introduce risks not found in the system or increase existing risks. During a risk assessment it is imperative to also consider that the failure to correctly restore wood in channels can also poses significant risks. This presentation will focus on key factors to consider in assessing risks related to the re-introducion LWD to streams and rivers from the perspective of flooding, erosion, and public safety.

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EVERGLADES RESTORATION: KEYS TO SUCCESS

Shannon Estenoz
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Everglades restoration is a collaborative, interagency, state/federal partnership to restore the greater Everglades ecosystem while providing for other water related needs of south Florida including flood protection and water supply for urban, agricultural and tribal areas. In 2000 Congress authorized the Comprehensive Everglades Restoration Plan (CERP), the largest component of Everglades restoration, comprised of 68 project elements. The central tenants of CERP and related restoration projects are to capture, store, clean and redistribute water within the 18,000 square mile Everglades ecosystem to meet restoration and other water management objectives. Everglades restoration is anticipated to unfold over more than three decades at a cost of nearly $20 billion.

The scale and complexity of Everglades restoration has required a high degree of cooperation and stakeholder engagement, and many lessons have been learned about both since CERP was authorized in 2000. In an effort to keep restoration moving under contracting fiscal conditions, innovative partnerships have been formed including the partnership between the National Park Service and the Florida Department of Transportation to construct the second phase of bridging across US Highway 41 to restore water flows to Everglades National Park. Furthermore, The South Florida Ecosystem Restoration Task Force (Task Force) has learned to use certain flexibilities Congress granted to it to convene stakeholders to build consensus even around the most complex restoration projects and programs. The success of Everglades restoration to date has had as much to do with innovation and effectiveness in the areas of governance, conflict resolution, stakeholder engagement, and intergovernmental administration as it has with sophistication in the areas of modeling, science and engineering.

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THE ECONOMIC VALUE OF ESTABLISHING FREEDOM SPACE FOR RIVERS

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Giving more space to rivers is increasingly considered as an alternative to hard and constraining engineering structures. The "freedom space" of rivers corresponds to zones that are either frequently flooded or actively eroding and includes riparian wetlands. Freedom space limits were mapped for three rivers in southern Quebec (Canada) as part of a pilot project to establish an approach applicable to other rivers.

The defined limits were subsequently used in a cost-benefit analysis to investigate the long-term societal value of such an approach. Within the analysis costs consist of loss or limitations to the right of farming and construction in the freedom space, whereas benefits are avoided costs for existing or future bank stabilization structures and avoided costs of flooding in agricultural areas. The economic value of ecosystem services provided by riparian wetlands and increased buffer zones within the freedom space were also included in the analysis.

Results show net present values ranging from CDN$0.7 to $3.7 million for the three rivers, with ratios of benefits over costs ranging between 1.5:1 and 4.8:1. Using a lower discount rate of 2%, which allows for the long-term ecosystem services to be taken into account markedly increases the benefits, resulting in ratios ranging between 2.3:1 and 7.1:1. River management based on freedom space for these three riversis thus beneficial for society over a 50-year period.

The presentation will outline the methods utilized and lessons learnt, in the hope that such an approach could be applied to other rivers, providing economic justification for ecosystem restoration based on establishing freedom space for rivers.

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SCIENCE AND ADAPTIVE MANAGEMENT AS TOOLS FOR JEOPARDY AVOIDANCE ON THE MISSOURI RIVER

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The Missouri River Recovery Program (MRRP) was established to implement requirements of a 2003 Biological Opinion (BiOp) and avoid jeopardizing three federally listed species [the piping plover (*Charadrius melodus*), the interior population of the least tern (*Sternula antillarum*), and the pallid sturgeon (*Scaphirhynchus albus*)] due to the US Army Corps of Engineers' (Corps) operation of the six mainstem reservoirs on the Missouri River and the Bank Stabilization and Navigation Program. The MRRP is undergoing a transformation arising from recommendations in 2011 by an Independent Science Advisory Panel (ISAP) and the Missouri River Recovery Implementation Committee (MRRIC), a roughly 70-member stakeholder group established by Congress.

An Effects Analysis (EA, as defined by Murphy and Weiland, 2011) conducted in 2013-2014 established the best available scientific information and provided the foundation for an integrated Adaptive Management Plan (AMP) to address lingering uncertainties and improve future management decisions. Key products of the EA that transition to the AMP include a suite of conceptual models, biological and management hypotheses, initial assessments of the effectiveness of alternative management actions and predictive numerical models. By formalizing understanding of the uncertainties and challenges inherent for each species, the EA has helped identify the tools and approaches needed for adaptive management to succeed. The EA and AMP have benefited from transparent development and extensive review by stakeholders (MRRIC), the ISAP, and scientists from multiple agencies and academia.

The AMP includes a defined process for resolving critical uncertainties through a framework consisting of four levels of implementation—research, in-river testing of hypotheses, scaled implementation of select management actions, and full implementation—as well as the decision criteria for moving to higher levels of implementation. Crucial to the success of this framework is the research, monitoring, and assessment program, the application of quantitative models to help forecast outcomes and test hypotheses, meaningful habitat and population targets, and decision support tools for facilitating and communicating responsive decisions across management levels and stakeholders. Development of a truly collaborative governance structure for the AMP – a commitment of the agencies and stakeholders - is challenging due to their respective organization and history, but trust has grown considerably through the process of the EA and AMP preparation.

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MERCURY SOURCE COMPLEXITY CHALLENGES THE MODALITIES OF MERCURY MANAGEMENT AND REGULATION IN THE SACRAMENTO-SAN JOAQUIN DELTA

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The San Francisco Bay-Delta Estuary (Estuary) is unique among the large estuaries in North America because it receives mercury (Hg) contamination from a variety of sources with varied speciation deposited throughout the watershed from erosion of upstream historic mining debris, natural geothermal springs and deposits, industry, and from atmospheric deposition. As elsewhere, the threat from Hg contamination is driven by the transformation of Hg by native bacteria into the more toxic and biologically available form, methylmercury (MeHg), in the wetlands and sediment both upstream and within the Estuary. However, little is known about how much of each Hg source is really available for Hg-methylation. To effectively manage this threat, a quantitative understanding of the relative contribution of the different Hg sources to MeHg formation and bioaccumulation is needed both within the Estuary and the upstream watersheds.

For the Sacramento-San Joaquin Delta (Delta), the freshwater portion of the Estuary, mass balance estimates of MeHg indicate that approximately 60% of the MeHg is delivered from tributary loads and 40% is produced within the Delta's legal boundary. Of the 60% delivered via tributary loading, the majority is bound tightly to mineral and organic sediment transported during storm flows, rendering it relatively unavailable for bioaccumulation. The 40% of MeHg produced within the Delta is primarily derived from the conversion of inorganic Hg deposited within the Delta's wetlands and bed sediment. Mass balance estimates for inorganic Hg indicate as much as 99% enters the Delta via tributary inputs, of which approximately 90% is adsorbed to suspended particles from tributary discharge and 10% is in the dissolved fraction likely derived from atmospheric deposition across the watershed. The remaining 1% of the Hg entering the Delta arrives through direct atmospheric deposition (wet and dry). The relative importance of these sources to MeHg production within the Delta is not linearly related to the mass inputs because atmospherically-derived Hg is believed to be more available to methylating microorganisms than sediment-bound Hg. Consequently, although atmospheric Hg deposition may contribute a relatively small portion of the total Hg loading to the Delta, it may contribute to a substantial portion of the MeHg produced within the Delta.

Drawing on a review of recent research findings and results from an in situ isotope dosing experiment performed in the Delta, we will discuss the relative contribution of the Hg sources to the Estuary and the challenges that complexity poses to its management and regulation. We also will present an explanation of an opportunity to exploit the differences in Hg phase availability toward managing the Hg threat through the application of simple, common technologies.

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SEAGRASS TRANSPLANTATION AT THE JULIA TUTTLE SEAGRASS MITIGATION SITE

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As part of the Miami Harbor Dredging Project's overall mitigation requirements, a seagrass mitigation site was created by filling in a +50 year-old borrow pit, located north of the Julia Tuttle Causeway in Miami, back to the same grade as the adjacent seagrass (*Syringodium filiforme*) habitat. This mitigation area is referred to as the Julia Tuttle Mitigation Site (JTMS) and covers a total area of 58,000 square meters (14.3 acres). One seagrass species, *S. filiforme,* was transplanted within the JTMS between August 10 and September 13, 2015. The source of donor material for the transplants was the relatively quiescent *S. filiform*e habitat that extended over several hundred acres adjacent to the JTMS. Two hundred and ninety, 10 × 10 m planting plots, or 29,000 square meters (7.2 acres) of planted plots, were established in a checkerboard pattern across the JTMS. Each plot was planted using the staple method on one meter centers with 100 bare root *S. filiforme* planting units (PU) at an average rate of 8.5 plots or 8,500 PU day^{-1}. Initial planting rates were low (4 plots day^{-1}) but later reached as many as 13 plots day^{-1}.

The transplanting process was organized around three, 4 to 8 person teams; one harvesting, one fabricating PU and one planting. The harvesting team used a 0.25 m^2 cutting device to sever *S. filiforme* rhizomes from harvesting points located along pre-defined transects. The distance between harvesting points was at least 2 m. Divers manually lifted plants from the sediment within the cutter by hand, shook out sediment and placed the plants in a dive bag which was submersed until utilization by the fabrication team. The fabrication team selected either vegetative propagules that had rhizome apicals that formed in the water column (aerial runners) or sediment rhizomes with an apical and associated short shoots that had been in the sediment. Over 118,000 apical-bearing rhizomes each with several short shoots were attached to landscape staples (average 4.1 apical-bearing rhizomes PU^{-1}) for a total of 29,000 PU which were inserted into the sediment by the scientific divers on the planting team.

Planting took place 34 days after final placement of fill. Although the surface sediments were only recently introduced into a marine environment, there was no apparent detriment to the PUs as rhizome extension and new shoot formation was noticeable within two weeks of planting and was continuing as of the most recent survey (October 2015). Volunteer recruitment by *S. filiforme* but also *Halodule wrightii* and *Halophila engelmannii* was observed within the JTMS. This volunteer recruitment may have been facilitated by the disposal of excess target and non-target plants (estimated to be over 90% of the harvested material) by the fabrication team, which was situated on the planting site. Colonization of the site by various species of macroalgae as well as *Cassiopeia* jellyfish was rapid and extensive.

On average, PU survival on the site was surveyed 30 days after planting. Despite locally intensive grazing by manatees, PU survival was 97.6%, substantially greater than the program requirement of 70% survival. A vast majority of the PU exhibited rhizome extension and new shoot formation. Barring any unforeseen disturbances, the project is on course to be one of the largest and most successful actively planted, commercial (seagrass mitigation) projects to date.

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DECISION ANALYTICAL TOOLS IN SUPPORT OF RESTORATION

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Decision support tools, do not make decisions. They do, however, facilitate communication when issues are multifaceted or collaborative. We argue that communication can be enhanced through the utilization of decision-analytical approaches applied to environmental restoration. Multi-criteria decision analysis (MCDA) is a well-formulated approach that has been used to facilitate effective decision making across a wide range of environmental management applications. Many of these MCDA exercises are staged with the specific goal to facilitate a normatively optimal solution for a decision problem faced by one or more stakeholder groups. Case experiences suggest that a shared understanding of the problem's structure is a necessary condition not only to develop a decision model, but also to engage in constructive dialogue on a problem and perspective taking across stakeholder groups. Once a decision model is developed, however, it can form the basis on which other analyses can be built. We will specifically address uncertainty analysis, value of information and scenario analysis. A set of projects demonstrating the data and resource needs as well as the various benefits of decision support tools will be presented; key considerations and future directions will be discussed.

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DELAWARE'S CHESAPEAKE BAY WATERSHED IMPLEMENTATION PLAN (WIP): IT'S NOT TOO LATE TO WIP IT, WIP IT GOOD!

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Since 2000, Delaware has participated with the Chesapeake Bay Program and has committed to achieving water quality goals to protect and improve the bay and tributary waters. In December 2010, EPA developed a Total Maximum Daily Load (TMDL) for nitrogen, phosphorus, and sediment that requires significant reductions in point and nonpoint source pollutant loadings from all jurisdictions within the Chesapeake Bay Watershed in order to achieve water quality standards.

In order to guide these efforts, EPA created an accountability framework to guide water quality restoration efforts in the Chesapeake Bay Watershed. This framework is composed of the Chesapeake Bay TMDL, Watershed Implementation Plan (WIP), two-year numeric and programmatic milestones, and monitoring progress. Delaware's Phase I WIP was finalized November 2010. Phase II was submitted in March 2012. The phase II WIP provided additional details about the partner organizations who will implement portions of the WIP, specifies when actions will occur, and identifies the resources necessary for success. Additionally, some of the implementation goals identified in the Phase I WIP have been pared down to a smaller, more localized scale, such as at the County level. Finally, the Phase II plan establishes implementation goals for 2017, which is when 60 percent of the necessary nitrogen, phosphorus, and sediment goals must be achieved.

The WIP details how load allocations will be achieved and maintained into the future. Numeric milestones detail reductions from pollutant reduction measures such as the Best Management Practices (BMPs) or Waste Water Treatment Plant (WWTP) upgrades. Programmatic Milestones identify the anticipated establishment or enhancement of the institutional means that support and enable implementation (e.g., funding, authorities, enhancing existing programs and resources, designing and establishing new programs, studies, etc.). This framework provides assurance that the Bay TMDL allocations will be achieved and maintained. Significant stakeholder involvement is essential to stay on track to meet EPA's rigorous requirements for achieving the Bay TMDL. Otherwise, EPA may impose several consequences, including developing Delaware's Phase III WIP for us, controlling or redirecting federal funding, and/or tightening permit requirements for wastewater treatment plants, municipal stormwater areas, and concentrated animal feeding operations in the agriculture sector. This presentation will provide an overview of the Chesapeake Bay framework and Delaware's continuous efforts for achieving ambitious goals to restore the Chesapeake Bay.

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LIGHT ATTENUATION IN ESTUARINE MANGROVE LAKES

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Quantifying the underwater availability of photosynthetically available radiation (PAR) is fundamental for determining the suitability of aquatic environments for submerged aquatic vegetation (SAV). SAV is often limited to water depths receiving >5-40% of surface PAR irradiance. Spatial and temporal distributions of underwater light availability often correlate with SAV abundance and community composition with large declines in SAV abundance associated with reduced light availability. Ecosystem resource managers may seek to restore SAV communities by increasing underwater light availability, but their actions are limited to indirect methods because light transmission cannot be directly controlled. SAV growth may be promoted by indirectly increasing light transmission by decreasing the concentrations of light-scattering and light-absorbing constituents in the water column. This strategy requires determination of the light extinction coefficient adjusted for solar elevation angle [K_t (adj)], and the quantification of partial light extinction coefficients for the water column constituents that contribute most to the light extinction rate. These determinations are the foci of the present study conducted at 42 sites in two sub-estuaries in the estuarine mangrove-surrounded lakes and bays located along and adjacent to the north shore of Florida Bay inside Everglades National Park.

The light extinction coefficient [K_t (adj)], turbidity, CDOM, and chl *a* were higher in the Alligator subestuary than in the McCormick subestuary. Site means of K_t (adj) ranged from 0.42 – 1.86 m^{-1} with a mean of 1.03 m^{-1} in the McCormick subestuary and from 1.20 – 3.17 m^{-1} with a mean of 2.15 m^{-1} in the Alligator subestuary. K_{CDOM} contributed the most to K_t in both subestuaries with 63% and 45% contributions to K_t in the McCormick and Alligator subestuaries. K_{turb} was the second largest contributor to K_t in both subestuaries with 31% and 41% contributions to K_t in the McCormick and Alligator subestuaries, respectively. K_{chl} contributed 3% and 12% to K_t in the McCormick and Alligator subestuaries, respectively. K_w contributed only 2-3% to K_t in both subestuaries.

The underwater light environment in the mangrove lakes is often unsuitable for submerged aquatic vegetation. 95% and 36% of the study sites experienced ≤40% and ≤5% of surface PAR light transmission to the bottom, respectively, at some time during the study period. Unfortunately, increasing light availability beyond these limits may not be possible in these sub-estuaries because the largest contributor to the observed high levels of underwater light attenuation is CDOM, a variable possibly insensitive to management control. In order to achieve light transmission to the benthos > 40% at 1-m depth, K_t must be < 0.92 m^{-1}. The mean partial light extinction coefficients for CDOM ranged from 0.72 m^{-1} in the McCormick sub-estuary to 1.05 m^{-1} in the Alligator sub-estuary; therefore, light limitation of SAV in the Alligator sub-estuary is expected be a persistent feature of the ecosystem. Though higher CDOM concentrations in the upstream mangrove-surrounded lakes and bays can account for greater light attenuation there relative to the more downstream and open estuaries of previous studies, the 20-fold difference between the determined CDOM specific light extinction coefficient for the study area (k_{CDOM} = 0.008 m^{-1}) and that previously determined for downstream Florida Bay (k_{CDOM} = 0.0004 m^{-1}, Kelble et al. 2005) indicates that upstream CDOM has a much greater light absorption density than CDOM in the lower estuary. These differences in the specific light absorption characteristics of CDOM suggest differing CDOM compositions between the upstream mangrove lakes and downstream Florida Bay.

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EFFECTS OF DURABLE SUBSTRATE ON ESTABLISHMENT OF OYSTER POPULATIONS, REEF ELEVATIONS, AND AQUATIC BIRD USE IN THE BIG BEND OF FLORIDA

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Offshore oyster reefs in the Big Bend coast of Florida have declined by 88% during the last 30yr, with the most likely mechanism being high mortality during episodic periods of reduced freshwater inflows to estuaries and high salinity regimes. Conversion to sandbar habitat and loss of elevation (cf 8 cm/yr) is common and appears to be nonreversible via natural processes once shell coverage is lost. We hypothesized that the addition of durable hard substrate could make reefs more resilient to periodic declines in freshwater flow. Here we report on a test of the inherent assumption that oyster recruitment on degraded reefs is limited in the short term by substrate availability. We added durable substrate in the form of limerock boulders and clam aquaculture bags filled with cultch and live oysters to eight paired treatment and control sites spaced along a highly degraded offshore reef chain. At sites with durable substrate, elevation on treatment reefs increased post-construction by an average of 16 cm. Mean oyster density on treatment sites increased by 2.65X on rock, 14.5X on clam bags and 9.2X overall compared with control sites. Clam bags contributed approximately 25% of the surface area on the reef, but accounted for 52% of the oysters overall. Densities on treatment sites were between 89 and 125 times those measured at a suite of other nearby reefs, and exceeded the 89th percentile of reported densities at natural and restored reefs in the Gulf of Mexico. Total bird use on restoration sites decreased by an average of 92% across species groups, with some species being found 56 times as often on the sandy control sites as on oyster enhanced sites. This suggests a potential tradeoff between restoring hard substrate for oyster restoration, and attracting aquatic birds. Bird surveys were performed before oyster populations were well established however, and it is unclear whether the same results would be obtained with a more mature restoration site. Oyster recruitment on these degraded reefs appears to be strongly driven by substrate limitation. In the short term, recruitment trajectories can be reversed in <18 months with addition of durable substrate, and longer term resilience is predicted through 1) persistence of settlement substrate between mortality events and 2) positive feedback of salinity with reef elevation and detention of nearshore freshwater.

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COMBINING PALEOECOLOGICAL, OBSERVATIONAL AND HIGH-FREQUENCY INFORMATION SOURCES TO IMPROVE PREDICTIONS OF ECOSYSTEM RESILIENCE

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Ecosystem changes occur on scales of minutes to millennia associated with local to global abiotic drivers and biotic interactions. Predicting future ecosystem states, a core objective in restoration ecology, is therefore dependent on understanding regulatory processes, and their interactions, across relevant timescales. The capacity of an ecosystem to respond to a particular perturbation, or its resilience to change, is largely dependent on past trajectories culminating from these interactions across temporal scales. This basic ecological concept is particularly relevant and challenging in regions with high temporal variance in driving variables. For example, subtropical regions like South Florida are exposed to millenial, multi-decadal, inter- and intra-annual climate drivers -- key regulators of wetland ecosystem processes. Predicting the impact of hydrologic restoration on systems with a variable underlying climatological template requires combining data from multiple sources across multiple time scales.

This presentation will illustrate two examples where long- and short-term sources of information have been combined to determine ecosystem resilience to perturbations. The first comes from the Everglades sawgrass-mangrove ecotone, where paleoecological, long-term observational and high-resolution sensor data have been the focus of collaborative research. Paleoecological data suggest that carbon accretion is controlled by climate drivers of the balance of ecosystem production and soil respiration. A reduction in organic matter accumulation is evident in regions susceptible to oxidation and increased salinity, in some areas resulting in peat collapse that will resist restorative efforts. Increased accretion occurs in areas receiving storm-delivered inorganic matter, conferring resilience to sea level rise by increasing soil elevation and nutrient supply, and improving prospects for freshwater restoration. High-resolution data from eddy covariance towers also suggest that long- and short-term effects of hydrologic restoration will depend on interactions with the existing climate regime.

We also studied temporal dynamics of resilience across timescales in the upper Everglades watershed at Archbold Biological Station. This region is the water tower for the central Everglades and is highly responsive to climate variability at all temporal scales. We used diatom-based paleoecological data, 30 years of monthly monitoring data and high-frequency sensor data to understand responsiveness of a deep sinkhole lake, Lake Annie, to climate fluctuations. We discovered that the key limnological features of this lake are regulated by the Atlantic Multidecadal Oscillation (AMO). This oscillatory climate driver controls water delivery into the upper watershed of the Everglades. The ability of the lake to respond to exceptional wet or dry years and storm events is regulated, in part, by the mode of the AMO. The paleolimnological record suggests this oscillatory driver has played a significant role in the long-term dynamics of the lake. It also implies that the southern Everglades may also be regulated, in part, by water delivery controlled by the AMO but masked by large-scale water diversion and regulation.

Predicting future states of these systems would not be possible without the confluence of data collected across several scales. Modelling efforts are now focused on incorporating temporal sources of variance in order to determine potential outcomes of hydrologic restoration at specific timescales and under distinct scenarios of underlying climate variability.

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A COMPARATIVE STUDY OF SUMMER GROWTH OF SPAT AND JUVENILE *CRASSOSTREA VIRGINICA* IN NEW YORK HARBOR AND IMPLICATIONS FOR URBAN OYSTER RESTORATION

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Oyster communities were originally among the most abundant bivalve populations that resided in the vast estuary system of New York Harbor. These organisms and their reefs have continued to provide a number of vital ecosystem services such as water filtration, habitat provision, and shoreline erosion prevention. However, anthropogenic activity over the course of the last four centuries has resulted in the degradation of this estuary ecosystem along with New York Harbor Eastern oyster (*Crassostrea virginica*) reefs. Habitat restoration initiatives relying on bioremediation via oyster reef installation present an exciting opportunity to return the harbor to the complex estuarine ecosystem it once was.

Estuary systems are complex and dynamic making it difficult to establish standardized practices for restoration projects. Therefore, oyster reef restoration initiatives would benefit from a greater understanding of localized habitat challenges. This paper attempts to overview the efforts regarding oyster restoration, specifically in New York Harbor. Furthermore, it provides insight into localized conditions through a study of oyster growth, water quality, and associated invertebrate communities at two relatively close New York Harbor areas throughout the summer growing season.

Three replicate cages containing settlement plates and groups of oyster spat on shell and juveniles were placed at Governors Island (GI) and in the East River at the Lower East Side Ecology Center (LES). Throughout Summer 2015 oysters and water quality were measured and invertebrate samples were collected. Growth was demonstrated to be highly variable among spat groups across all cages. Juvenile growth rates, invertebrate richness, and diversity all increased throughout the summer. These measurements were also consistently higher at the GI site (e.g. 1.43 mm/week verses 0.89 mm/week average oyster growth rates at GI and LES, respectively) indicating that the two sampling locations present different conditions that can influence community development.

These findings suggest that oyster reef restoration efforts should carefully consider localized water quality and environment when choosing locations for restoration projects. Furthermore, these results demonstrate the need for a more comprehensive understanding of localized water and sediment quality throughout the harbor.

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ARTHUR R. MARSHALL LOXAHATCHEE NATIONAL WILDLIFE REFUGE ANNUAL SCIENCE WORKSHOP: CHALLENGES AND SCIENCE NEEDS OF MANAGING AND CONSERVING HABITAT IN THE NORTHERN EVERGLADES

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The Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) is a nearly 145,000 acre oligotrophic wetland that is the northern-most remnant of the historic Everglades. As in much of the Everglades system, the landscape of the Refuge is a mosaic of vegetation communities, including tree islands, sawgrass ridges, sloughs, and emergent wet prairies. The distribution of the various vegetation communities/habitat types is driven by variance in local elevation and microtopography, as well as other wetland processes such as fluctuating water levels, water flow rates/direction, and fire. Historically, the variability in habitat types (vegetation communities) and water levels allowed a diverse suite of wildlife, with highly variable habitat requirements, to be simultaneously supported under a range of climatic conditions. However, massive efforts in the middle of the last century resulted in approximately one-half of the Everglades being drained and used for agriculture or urban development. The remaining Everglades were sectioned off and highly manipulated to provide flood control and water supply. As a result, the Refuge is completely encircled by a rim canal/levee system that requires constant management through water control structures located at strategic locations that connects the Refuge to the rest of the system, which is similarly configured and managed.

These system-wide manipulations and multi-use objectives (ecological, flood protection, water supply) present land managers with significant challenges to preserving and restoring the remaining Everglades, including the Refuge. Challenges include protecting the naturally soft-water habitat historically found in the Refuge from surface water enriched with minerals and nutrients, controlling invasive exotic species, and shifts in habitat types driven not only by water quality, but also altered hydrology and a lack of directional flow. The current configuration of the altered system does not allow for restoration of the original ecological dynamics that were once present throughout the Everglades and key to maintaining the characteristic mosaic of habitat types within the Refuge. Therefore, managers are forced to make decisions regarding tradeoffs between system features and characteristics in an effort to preserve the function of the system, rather than fully restore historic conditions.

Within the Refuge and throughout the Everglades system, an action to benefit one ecological component often has negative consequences for some other component. For example, due to an elevation gradient running north to south, providing adequate water levels to prevent expansion of woody species and allow access for treatment of exotic species in northern areas results in excessive flooding that can degrade tree islands and wet prairie habitats in southern, lower elevation areas. Therefore, it’s critical that land managers prioritize conservation goals/targets within the context of specified targets and feasibility. However significant knowledge gaps exist that impede developing specific targets and effective management strategies based on sound science. Science gaps, links between management actions and ecological outcomes, and priority targets will be discussed by the expert panel.

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ASSESSING IMPACTS OF AN ACTIVE WATER SCHEDULE ON VEGETATION AND MAMMAL COMMUNITIES IN HOLEY LAND WILDLIFE MANAGEMENT AREA

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The 35,350 acres of land that is Holey Land Wildlife Management Area (WMA) has been managed by the Florida Fish and Wildlife Conservation Commission (formerly the Game and Fresh Water Fish Commission) since 1968. Water management is coordinated with the South Florida Water Management District. As part of the restoration of the area, a pump station (G200A) in the northwest corner of Holey Land WMA began delivering water from the Miami Canal in 1991. In 2005, Hurricane Wilma damaged the G200A pump to where it was mostly non-functional until repairs were made in September 2014. These events provide a unique opportunity to examine the impacts of an active water schedule and to assess how water management activities affect both vegetation and wildlife communities in the Holey Land WMA. Mammal encounter rates were calculated from perimeter levee surveys over the last two decades. A small mammal survey was replicated and compared to surveys conducted between 1995 and 1997. Results of linear regression models show a drastic increase in cattail abundance during the period when the G200A pump was active and a decrease after its failure attributable to increased nutrient inputs. Mammal encounter rates showed a strong declining trend during the time period after the pump failure, but not for the entire time period analyzed. Active sampling for small mammals shows a decline in diversity along the Miami Canal since the mid 1990s but may be attributable to shifts in the spatial distribution of species as optimal habitat shifts in response to changes in hydrology.

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ESTIMATION OF PREDEVELOPMENT AND CURRENT HYDROLOGY FOR ECOLOGICAL RESTORATION OF A FLORIDA PINE FLATWOODS

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The 25,000 hectare JW Corbett Wildlife Management Area (WMA) contains one of the larger remaining portions of the pine flatwoods once prevalent E and NE of the Everglades. Historical accounts indicate that this mosaic of flatwoods and ponds/marshes was periodically covered by sheetflow, including regional inputs from the Allapattah Flats to the north. Sheetflow was not restricted to the large cypress strand present in western Corbett WMA; rather it flowed seasonally throughout much of the pine flatwoods. Drainage and development of the surrounding areas eliminated inputs from regional sheetflow, while drainage structures within Corbett WMA may also have had eco-hydrological effects.

We used real-time kinematic GPS to measure elevational transects through flatwoods, ponds and cypress and combined the relative elevation data with vegetation surveys and soil observations to estimate likely predevelopment hydrology as well as the degree of current deviation from predevelopment hydrology. Field measured elevations of a number of biomarkers, including apple snail *(Pomacea paludosa*) egg masses, adventitious roots, moss/lichen collars on cypress, water marks, patch edges of saw palmetto (*Serenoa repens*) and of surfaces of peat deposits supplemented our understanding of current hydrology. Twenty-six transects within seven landscape units were measured.

Quantification of the elevation differences between pond bottoms, hydric flatwoods and mesic flatwoods helps greatly to constrain estimates of the predevelopment hydrology. The discovery of deep (> 1m) deposits of peat soil in the centers of otherwise predominantly sand-bottomed ponds has also proven useful. Lowering of the peat surface below the elevation of the surrounding sand bottom, where found, indicates peat oxidation, in turn indicative of lowered average water elevations. We are combining the topographic, vegetative and soils field data with hydrologic simulations of regional surface and groundwater (S2DMM model) to refine our understanding of current and predevelopment hydrology. We are also using the modeling to evaluate several future water management scenarios, both within the Corbett WMA and in the adjacent urban areas. Scenario goals for the Corbett WMA are improved hydroperiods, increased hydrologic connectivity, protection of peat deposits, and improved timing of natural fires.

Improving hydroperiods will help restore native plant communities, minimize carbon loss, and is expected to decrease the need for intensive management activities such as herbicidal control of invasive exotic plants, roller chopping of saw palmetto and intensive fire management schedules.

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BINATIONAL RESTORATION EFFORTS TO REVIVE THE COLORADO RIVER DELTA

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The Colorado River is a lifeline for the western United States and northwestern Mexico. The river has an estimated annual economic impact of $1.4 trillion. It provides water to nearly 40 million people and irrigates over 5 million acres. Due to water diversions, little water now passes into the final stretch of the river in Mexico, and it rarely meets the sea despite historic deliveries of over 14.5 million acre feet per year. Anthropogenic water and land use have resulted in the loss of over 90% of the historic 2 million acres of delta wetland and riparian habitat. Much of the remaining riparian corridor has groundwater too deep for native trees to utilize to survive in this hyperarid climate. In portions of the river corridor where groundwater is shallow, soil and groundwater salinity are often too high for desired plants. Remaining vegetation is dominated non-native shrubs, which are better-adapted to these new conditions. Basin-wide drought during the early 2000s resulted in further stress and degradation of the remaining riparian corridor.

Despite dramatic hydrologic changes during the 20th century, episodic flows and pilot projects demonstrated that diverse ecosystem services of the Colorado River delta could be revived with relatively small amounts of water. Scaling up restoration projects and securing water for environmental purposes have proven to be politically challenging. Political will and public support have been fostered through cross-border partnerships, collaborative research and pilot projects, and local community engagement. Since 2002, hundreds of acres of riparian and marsh habitat have been created. Over 10,000 people from local community groups, universities, and government agencies have been engaged in these projects.

Binational partnerships between conservation organizations and government agencies have enabled implementation of innovative transboundary water policy, culminating in Minute 319 to the international water treaty between the US and Mexico. This agreement, signed in 2012, allocated water to the Delta for the first time in history, provided resources for additional on-the-ground restoration projects, and served as a large-scale experiment to inform scientists, managers, and decision-makers on the effective management of water for environmental purposes in the Delta. Efforts to secure long-term water dedications are ongoing. These flows will be required to sustain restoration areas and improve the condition of the overall riparian corridor. Continued ecological and hydrological monitoring is improving our understanding of the Colorado River delta, and models are being developed and refined to help manager determine how to most effectively allocate critical, yet increasingly scarce water resources.

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LOUISIANA'S COASTAL MASTER PLAN: MODELING IN A SYSTEMS CONTEXT

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The 2012 Coastal Master Plan was founded on state-of-the-art science and analysis, and the 2017 effort builds upon this further. The modeling process provides a deeper understanding of our coastal environment today, as well as the changes that are expected over the next 50 years. CPRA, The Water Institute of the Gulf, and a team of over 50 additional experts developed a Model Improvement Plan to guide refinements and advancement to the models that would be used for the 2017 Coastal Master Plan. Changes from the 2012 Coastal Master Plan models can be characterized into three broad categories: development of new process-based algorithms (e.g., sediment distribution), integration of landscape and ecosystem model codes into a single common framework (e.g., the Integrated Compartment Model), and increased resolution of model grids (e.g., eco-hydrology and risk assessment). In addition, a number of the habitat suitability indices used in 2012 were revised and others were developed for use in the 2017 modeling effort, and a dynamic fish and shellfish community model has been added for 2017. The models can be used to estimate the individual and cumulative effects of restoration and protection projects on the landscape. They are also used to examine possible impacts of climate change and future environmental scenarios (e.g., precipitation, eustatic sea level rise, subsidence, etc.) on the landscape and on the effectiveness of projects.

The development of Louisiana's 2017 Coastal Master Plan uses outputs from these coastal systems models and combines them in ways that help evaluate individual projects and groups of projects against the plan objectives. The modeling results are used in concert with project costs and assumptions about the availability of key resources, such as sediment, to identify the projects that best meet the State's need for a sustainable coastal landscape and communities that are resilient in the face of storm surge flooding. Model outputs are compared to the Future Without Action (FWOA) and restoration project effects are estimated using the models at 5-year intervals during the 50-year planning horizon. For protection projects, expected annual damages are estimated and compared to FWOA. The net amount of land maintained or created by a project is used as the key decision driver. 'Sustainability' is assessed by examining the trajectory of the land change curve at the end of the planning period, e.g., is the project continuing to result in a net increase in land area or are its effects diminishing over time. This is especially important considering the effects of eustatic sea-level rise are greater in later planning decades.

The final development of the 2017 Coastal Master Plan will include extensive stakeholder engagement as well as analysis of model results, but the models play a crucial role in providing an 'even playing field' for the evaluation of hundreds of restoration and protection options and ultimately guide billions of dollars of coastal investments.

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TAKING SOME POINTERS FROM EDEN: HOW ANALYZING THE PAST CAN HELP US ENVISION A MORE RESILIENT FUTURE

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The Sacramento San Joaquin Delta is a linchpin of California's water system, supplying over 23 million people and a million acres of agriculture with water. It's also the scene of extreme landscape transformation over the past 200 years resulting in a vast ecosystem conversion that has left many native species in crisis. The Delta is so altered that there are few to no remnants of the historical ecosystem left on the ground to study how the landscape supported ecological functions prior to European development. Less than 2 percent of the nearly 300,000 acre, freshwater wetland that occupied the region circa 1800 remains, making it the largest site of wetland loss in California. The modern, engineered landscape is not only heavily subsided and hydrologically altered, but its system of levees and infrastructure is static and brittle, making it vulnerable to perturbation from sea level rise, earthquakes, and major flow events.

Recent research has characterized the historical ecology of the Delta, allowing for the first time an analysis of landscape change, both in terms of physical and biological processes, from before significant alteration of natural systems to the present. This analysis reveals empirical measures that call into question common assumptions about causes of the current ecological crisis. It further highlights specific landscape elements and attributes of landscape processes that are pieces of the puzzle that need to be put back together in order to restore desired ecological functions and their resilience. While much has changed, by looking at current conditions in the region, we find that some areas retain key attributes of the original template of physical and biological processes, and we can identify particular opportunities to restore desired functions.

Carefully prioritized and linked together at the landscape scale, these opportunities add up to an ambitious, yet feasible, regional vision of ecosystem restoration that is a blueprint across this large area for the many diverse entities within the environmental restoration and stewardship community to work toward in common. This trajectory of the Delta is an extreme version of the story that has occurred countless times across our developed landscapes. The holistic approach we describe -- understanding long-term change in biological and physical processes to enable the identification of opportunities to restore desired ecological functions and resilience at a large spatial scale – is a useful framework for organizing synergistic restoration actions across large systems in general.

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THE EFFECTS OF SUPREME COURTS' DECISIONS ON ENVIRONMENTAL PROTECTION IN TURKEY

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Deformation on environment due mostly to human activities brings about destructive effects on all living beings. It has been recognized by the Constitution that everyone has the right to live in a healthy and stable environment, and that it is the duty of the state and citizens to develop the environment, to protect environmental health and to prevent environmental pollution. The Law of Environment has been enacted in order to protect the environment and natural resources, to prevent water, soil and air pollution and to guarantee the plant and animal species and natural historical wealth of the country. With the Environmental Impact Assessment Regulations, prepared on the basis of this law, it has been obliged to take reports from competent authorities in determining the positive and negative effects of projects on environment and in defining the measures to be taken in order to prevent or minimize the negative effects so as not to damage the environment. In legal regulations, however, there are some provisions to relax the limitations or to be exempt from the limitations in the legislation to protect the environment.

Legal regulations for the protection of the environment are frequently subject to annulments. It is quite burdensome, and even impossible in some cases, to restore the environment after it has been polluted and disrupted. For this reason, instead of environmental clean-up and renewing the disrupted environment, methods to prevent the negative effects on environment are sought after from the outset and the correct operational frame for the administration is defined by the courts. However, the grounds for annulment specified in court orders are ignored by the administration and provisions allowing activities that damage the environment are intended to be enforced again with the new regulations. The study examines both the decree of annulments by the Constitutional Court related to the legal regulations that can have negative effects especially on environment and the positive contributions of State Council's grounds for annulment through the determination of unlawfulness of general regulatory processes that are accepted by the executive body on the protection of the environment.

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STATE OF LOUISIANA'S PERSPECTIVE OF ADVANCING COASTAL RESTORATION USING WORK-IN KIND AND CROSS CREDITING LEGISLATION

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The severe degradation of Louisiana's coastal ecosystem and its impact to both the State of Louisiana and the Nation has been well described. For more than 30 years the State and Federal government, local communities and non-governmental organizations have developed and implemented projects in an effort to partially restore that ecosystem. Restoration experts and well as state, federal and community leaders have recognized that a more comprehensive large-scale approach to restoration planning and implementation is needed to achieve a sustainable Louisiana coastal ecosystem. Additionally, the catastrophic hurricanes of 2005 and 2008 (Katrina, Rita, Gustav and Ike) and the Deepwater Horizon Oil Spill have highlighted the need for a healthy resilient ecosystem for the good of the state and nation. The State of Louisiana has begun to change its approach to coastal ecosystem restoration and protection planning and implementation to include a comprehensive systems approach that has resulted in the implementation of several Louisiana Coastal Area (LCA) program projects.

The LCA program, authorized by Congress in the Water Resources Development Act of 2007, includes 15 near-term coastal Louisiana restoration projects. It was developed as a first step in this changed ecosystem restoration approach. The State of Louisiana will present its views on the need for coastal ecosystem restoration, the efforts of the State to implement LCA restoration projects, and collaboration between the Corps and the State to develop cross crediting processes to allow the State to realize credit for dollars expended and allow the Corps to implement LCA restoration projects in a budget limited environment. Additionally, we will discuss some of challenges from the local sponsor's perspective in accomplishing large scale ecosystem restoration as part of the LCA program.

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ASSESSING AND ENHANCING SALT MARSH RESILIENCY UNDER CLIMATE CHANGE FOR FLUVIAL VS. MARINE FED SYSTEMS

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This talk presents a paradigm shift for modeling the coastal dynamics of sea level rise (SLR), compares and contrasts a fluvial vs. marine fed system, and addresses how salt marshes may be enhanced and the benefits evaluated. To begin we must recognize that carbon emission scenarios directly influence climate change responses such as a rise in atmospheric temperature, which results in sea level change. This phenomenon further stimulates changes to coastal-related processes such as the shoreline, barrier islands, coastal dune systems, salt marsh productivity and migration, and land use land cover (LULC) change. We utilized SLR projections developed by Parris et al. (2012) for the year 2100 of low (0.2 m), intermediate-low (0.5 m), intermediate-high (1.2 m), and high (2.0). These projections were then linked to an individual carbon emission scenario; for example, the A2 carbon emission scenario corresponds to the high SLR scenario. This allows a comprehensive assessment and, for a given scenario, there is a specific state of the landscape and climate related processes (e.g., precipitation).

For the northern Gulf of Mexico, spanning MS, AL, and the FL panhandle, we have found that under future projections of SLR, coastal communities and ecosystems may experience land loss, altered habitats, and increased vulnerability to coastal storms and nuisance flooding. This results from nonlinear increases in tidal ranges, tidal velocities, surge heights, and inundation of present-day shorelines (Bilskie et al., 2014; Hagen and Bacopoulos, 2012; Passeri et al., 2015a-b). Long-term shoreline erosion rates are also expected to increase under future SLR, which may have detrimental consequences for barrier islands. In particular, coastal salt marshes struggle to keep pace with SLR and rely on sediment accumulation and availability of suitable uplands for migration (Hagen et al., 2013). Through seamless communication within a multi-model system and SLR scenarios that are always associated back to the carbon emission scenarios, we demonstrate how the resiliency of salt marshes can be enhanced.

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SOME CRITICAL LEGAL ASPECTS OF COASTAL CHANGE RESULTING FROM BOTH ANTHROPOGENIC AND NATURAL CAUSES

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When land at the seashore subsides by natural cause(s) sufficiently to remain covered by the sea even at low tide, ownership most likely reverts to the state. So should banks of inland rivers within the ebb-and-flow of the tide. However, if the subsidence is due to artificial causes, in some states a private owner may still retain ownership of some water bottoms. Thus, given the current concerns about Relative Sea Level rise, climate change, "Blue Carbon," and so on, both ownership of shore and near-shore acreage and its long term utility in any of several conservation/restoration/mitigation scenarios are important topics . . . and not just for proponents, customers, planners, and regulators of all types of projects in coastal areas. For example, especially in states with budget deficits, areas far from the shoreline will likely see acquisition of mineral rights/revenues as a very attractive way of filling state treasuries. Inside the mitigation and restoration industries - - and particularly when some projects require either conservation easements and/or when mitigation banking instruments require perpetual commitments - - site selection is perhaps the most important aspect in coastal regions.

Moreover, since coastal change is unlikely to require new law, properly dealing with the effects of coastal change will require more than just a good understanding of present law. Instead, the challenge is more likely to be facing up to coastal law as it already is. Virtually all of the major cases concerning coastal issues arising around the nation in recent years - - such as beach front lot owners objecting to beach restoration projects - - were all resolved by applying existing law. Many of these laws are not just based upon Roman laws going back over 2,000 years; some are almost word-for-word copies of them. Unfortunately, not all players in coastal and riverine-based industries appear well versed in the basic principles of land change in coastal and near-coastal areas. Worse, there may not be a sufficient appreciation of the geological factors independently driving coastal changes. Law as an institution has never attempted to "control nature" per se but it most assuredly attempts to specify and control who gains and who loses when new land forms at the beach or when existing land disappears beneath the waves. Since law can only help illuminate the choices and assign the risks to various parties, geology - - not law - - is more likely to be the key to future decisions about longevity and site selection on a coast. For example, the average rate of actual sea level rise in the Gulf Coast is only about 2 mm/year. The other 7 mm/year of "rise" in Louisiana is actually the land supporting those two tide gauges subsiding. As to practical responses to geological drivers such as faulting, moving the project to the up thrown block is likely the best option. Project proponents should routinely perform geo-hazard investigations as part of site selection. If 3-D seismic is not available (or is too costly), other tools can be used, such as literature searches, historic maps, or Natural Source Electromagnetism (NSEM; lightning strike data). Review and approval agencies, such as the Corps of Engineers for Section 404 activities, should require much higher financial guarantees for all proposed restoration or mitigation sites lacking a geo-hazard investigation, especially ones on a coast.

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MULBERRY PHOSPHATE TRUSTEES ACHIEVE OYSTER REEF RESTORATION IN HILLSBOROUGH BAY, FLORIDA

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The Mulberry Phosphates (MPI) phosphogypsum stack breached at the phosphoric acid and fertilizer production facility in Mulberry, Polk County, Florida on December 7, 1997. About 50-56 million gallons of acidic process water flowed through the breach into Skinned Sapling Creek and the Alafia River, lowering the ambient pH in the freshwater and estuarine tributaries for several days. The National Oceanic and Atmospheric Administration (NOAA) determined that the effluent caused a fish kill in the Alafia River, damaged shoreline and some riparian vegetation in areas of Polk County, and caused losses of palustrine and estuarine resource services.

In 2000, NOAA and the Florida Department of Environmental Protection formed a Restoration Council ("Trustees") with representation from the Environmental Protection Commission of Hillsborough County. The Trustees developed a Final Damage Assessment and Restoration Plan/Environmental Assessment that identified restoration alternatives to compensate for the various injuries and losses of natural resources resulting from the spill. Oyster reef creation was a selected alternative for restoring biomass of fish, crabs, and shrimp in estuarine waters. The Trustees tested several approaches to mitigate functional oyster loss in the Alafia River and Hillsborough Bay estuary. A Final Estuarine Restoration Implementation Plan issued in 2000 identified two dredged spoil material disposal islands in Hillsborough Bay as appropriate locations for the oyster reef restoration. Intertidal areas on the eastern shoreline of Spoil Island 2D were selected as the project site. Settlement monies administered through NOAA funded the project design and implementation. The Trustees selected the Tetra Tech team in May 2013 to provide engineering, environmental, geotechnical, permitting, and implementation services.

A fundamental goal of the Trustees was to provide functional habitat in the region that could compensate for lost resource functions resulting from the breach. The Tetra Tech team designed the project and obtained permits for the maximum intertidal oyster reef area possible given the technical and financial limitations. The reefs were designed to avoid seagrass and mangrove communities within the project area, remain stable under 25-year wave conditions, and use limestone as a substrate. Limestone had been demonstrated in the project's study phase to be readily colonized by oysters and other estuarine beneficial organisms. The project budget allowed for the acquisition and placement of approximately 1,200 cubic yards (CY) of limestone material within two of 14 permitted reef segments.

The Project was permitted for 28,350 square feet (0.65 acre) of reef substrate. The base plan provided for 12,975 square feet (0.29 acre). The Trustees estimated the available budget would fund the installation of only two (1,200 cubic yards total) of 14 permitted reef segments. During reef installation, less rock per linear foot than designed was necessary to achieve the design reef footprint, and the team adaptively added three more reef segments than anticipated without exceeding the 1,200-cubic-yard limit of rock volume. With the addition of the three reef segments, the total reef area was 21,470 square feet (0.49 acre) or 76% of the permitted reef area. The project was implemented over 45 days between April 20 and June 24, 2015. A Trustee inspection on June 25, 2015 documented macroalgal and diverse invertebrate colonization of the newly installed reefs.

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DEVELOPMENT OF A SEAGRASS NURSERY FOR RESTORATION OF SEAGRASS IN THE INDIAN RIVER LAGOON

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Catastrophic loss of seagrass occurred in the Indian River Lagoon (IRL), Florida, due to two consecutive years (2011-2012) of unprecedented phytoplankton "super blooms". Shading resulted in widespread loss of seagrass, with up to 100% loss at many sites in the northern IRL; lagoon-wide approximately 60% (47,000 acres) was lost. Two years later, some sites began to recover, but large areas of the Lagoon showed no recovery, despite seemingly adequate water quality for growth.

The lack of seagrass recovery in IRL could be due to the lack of available recruits, vegetative fragments (shoots, roots, and/or rhizomes), or if other environmental factors are limiting recovery. A seagrass restoration feasibility study was conducted in partnership with the St. Johns River Water Management District. Experimental plantings of seagrass (shoal grass, *Halodule wrightii*) were made in 2013 and 2014 in experimental plots at four sites to determine if seagrass recruitment might be limiting recovery. At each recipient site, transplants were made in unprotected plots (without enclosure) and protected plots (within enclosures) due to potentials impacts of grazers. Results of the test transplants suggested that, in the absence of grazing pressure, the environmental conditions present at three of the four sites are favorable for seagrass recovery. These observations support the hypothesis that the lack of natural recruitment and recovery is lack of available recruits (vegetative fragments and seeds) rather than environmental factors.

Whether or not restoration in large, denuded areas of the IRL, can be accelerated by vegetative planting is still an open question. The next step in considering seagrass restoration is a pilot-scale test, drawing on what was learned in the experimental plots. In order to provide a supply of sustainable donor material, we have launched a project to develop the initial infrastructure and technical capabilities to successfully cultivate and transplant seagrass as part of a collaborative effort to restore seagrass in the IRL. Our initial effort focuses on *Halodule wrightii* in a closed-system, land-based tank system at FAU Harbor Branch. Our innovative nursery approach to seagrass restoration and creation could play a significant role in the re-establishment of seagrass habitat, one of the most valuable communities in the marine environment, and improve the management of this vital IRL resource.

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DECISION SUPPORT FRAMEWORK FOR RESTORING LANDSCAPE CONNECTIVITY AND ENHANCING RESILIENCE AS PART OF GULF COAST ECOSYSTEM RESTORATION

David Hanson
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In 2009, The University of Alabama and HansonRM began a Congressionally requested study, Sustaining Alabama's Gulf Coast Fishery Resources – A Risk-based Integrated Environmental, Economic, and Social Resource Decision Management Framework, in response to the long-term degradation of fisheries, as well as coastal habitat and infrastructure. The initial objective was to develop a decision support framework to evaluate technical, social, and economic goals and interactions for a sustainable fishery in an area undergoing economic expansion and vulnerable to impacts from hurricanes and tropical storms. Following the Deepwater Horizon Spill, the project was realigned to address the goals and recommended actions in the long-term ecosystem restoration strategy for the Gulf. This presentation summarizes the role landscape connectivity plays in enhancing community resilience as well as meeting other ecosystem restoration objectives.

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TRACKING MARINE TURTLES THROUGHOUT THE SEASCAPE REVEALS CONNECTIONS AMONG US PARKS AND PROTECTED AREAS

Kristen M. Hart
U.S. Geological Survey, Wetland and Aquatic Research Center, Davie, FL, USA

The use of innovative satellite- and GPS- tracking technology has allowed the wildlife community to track animals across landscapes to reveal previously unknown animal migration patterns and habitat-use patterns of a wide variety of avian, land, and marine species. Such location-based scientific data has become essential for guiding conservation policy-making through informed management.

Long-lived marine turtles have complex life cycles, often utilizing spatially separate breeding and foraging grounds that may be located hundreds to thousands of kilometers apart. Extensive use of innovative satellite- and GPS-telemetry of turtles tagged primarily on nesting beaches has shown pathways used by individuals to transit from important breeding areas to foraging sites where they obtain resources critical for survival. Locations of migratory corridors have also emerged, revealing key high-use zones in the marine environment.

In recent years, tracking of marine turtles that nest in U.S. National Parks and protected areas has been a priority for understanding the spatial habitat use patterns of these imperiled species. Real-time online tracking has illuminated connections among parks that were previously unknown, as well as species-specific use of common foraging areas. This presentation will feature turtles tracked in south Florida's Everglades and Dry Tortugas National Parks and other sites in the Gulf of Mexico and Caribbean. Highlights of links between nesting beaches and foraging grounds will show key corridors and high-use areas that are necessary for sustaining populations and essential for population recovery.

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THE SCIENCE OF STRATEGIC COMMUNICATION AND ITS UTILITY IN NATURAL RESOURCE MANAGEMENT

Matthew C. Harwell
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The field of Strategic Communication involves a focused effort to identify, develop, and present multiple types of communication media on a given subject. A Strategic Communication program recognizes the limitations of the most common communication models (primarily “one size fits all” and “presenting everything and letting the audience decide what is important”) and specifically focuses on building a communication framework that is composed of three interlinked pillars:
Message – Identifying the right content for a given audience and a vehicle
Audience – Identify the right target group for a given message and vehicle
Vehicle – Identifying the right types of media for a given message and audience

In addition to serving as an organizational framework, the physical structure of a Strategic Communication plan also can serve as a way to show an audience where they, the message, and vehicle fit into the larger picture (i.e., “*you are here*”).

This presentation will explore the process of designing a Strategic Communication plan and examine some examples of its utility in natural resources management, ecosystem restoration, adaptive management and structured decision making. Ideally, a strategic communication matrix can be utilized to identify and access the materials of interest for any given activity (i.e., avoids the need to recreate materials or use the wrong materials for the wrong audience). Challenges in implementation will also be explored.

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GULF COAST ECOSYSTEM RESTORATION COUNCIL: HOLISTIC RESTORATION APPROACHED WATERSHED BY WATERSHED

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The Gulf of Mexico region is vital to our nation and economy. The region has also experienced the loss of critical habitats and catastrophic events including major hurricanes and the Deepwater Horizon oil spill (DHOS). The DHOS led to passage of the RESTORE Act (Act) in 2012, which dedicates 80 percent of Clean Water Act (CWA) civil penalties from the DHOS to the Gulf Coast Restoration Trust Fund (Trust Fund). The Act also created the Gulf Coast Ecosystem Restoration Council (Council) comprised of the Governors of the five Gulf States and Cabinet-level officials from six federal agencies. The Council is administering a portion of the Trust Fund "to undertake projects and programs, using the best available science, which…restore and protect the natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, coastal wetlands, and economy of the Gulf Coast…without regard to geographic location".

With current and future DHOS CWA fines overseen by the Council potentially totaling over $3 Billion, the Council has tremendous responsibilities including writing and updating a Comprehensive Plan and developing a Funded Priorities List (FPL; i.e., list of projects and programs the Council intends to fund) at a minimum of every five years. The Council must also comply with all applicable federal environmental laws, executive orders and policies in accomplishing its mission. There are numerous challenges, but also benefits, to having diverse membership on the Council. Challenges include developing consensus among eleven different entities regarding plans, projects, and an overall approach to holistic Gulf restoration—no small feat given the size of the Gulf. Benefits include diverse membership that bring abundant capacities to the table to accomplish the Council mission. For example, with major federal regulatory agencies among its members, the Council is well-positioned to ensure that its regulatory compliance actions are both robust and efficient.

The Council published the Initial Comprehensive Plan in August of 2013 and the Initial FPL was finalized in December of 2015 totaling approximately $156.6 Million in activities such as hydrologic and water quality restoration, land conservation, and planning for large-scale restoration projects. Council members collaborated to build an FPL that responds to Gulf ecological needs by focusing on activities that address stressors in ten key watersheds and estuaries across the Gulf in order to concentrate and leverage available funds in high priority locations. If all proposed FPL activities are fully implemented, this FPL leverages approximately $1.27 Billion in other Gulf restoration investments. This FPL also includes foundational Gulf-wide investments in science, monitoring, and planning tools to support science-based decision-making. The Council members also collaborated effectively to identify ways to expedite the regulatory review to implement a range of restoration and protection activities, including conservation of valuable habitat, plugging abandoned oil and gas wells, and water quality enhancement measures. In some cases, federal members were able to use existing environmental compliance documentation to expedite approval of projects sponsored by state members. The Council also ensured that these regulatory efficiencies did not come at the expense of transparency and public engagement.

The Council has been very successful in getting the Initial FPL finalized by working together in a collaborative manner. In addition, by taking a watershed-by-watershed strategy, holistic Gulf restoration can be approached at a practical and manageable scale. See www.RestoreTheGulf.gov.

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USE OF DECISION FRAMEWORK TO FORMULATE THE CHESAPEAKE AGREEMENT AND MANAGEMENT STRATEGIES

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The Chesapeake Bay Program is attempting to manage a very large, very complex ecosystem to achieve the best attainable sustained benefits for inhabitants of the system. While the program arguably has some of the most extensive technical information and tools available for this task, it is still operating with a great deal of uncertainty. Both the long-term trajectory of the system and the effectiveness of many management strategies are largely unknown. As a consequence, pursuit of program goals must be undertaken with a focus on learning while doing.

The fact that the program is being undertaken with hundreds of millions of dollars in public funding, means neither large scale experimentation nor simple trial and error approaches are acceptable. The program must be transparent and accountable, with an identifiable rationale for all its actions, and a defensible strategy for confronting inherent uncertainties.

The solution has been adoption of a structured approach to definition of program objectives, development of management strategies, and analysis of outcomes. The purpose is to make explicit both the initial understanding of the system and the expected response to management interventions. Carefully planned and implemented monitoring of interventions and responses then enables iterative improvement of both the knowledge base and management strategies.

The approach is codified in the Chesapeake Bay Program Decision Framework. Outlined as a seven step process, the framework is essentially a formalized approach to adaptive management that seeks to facilitate purposeful analysis of program actions and increase certainty in strategy implementation. The framework is also a means of moving toward true ecosystem-based management from a starting point of less than perfect understanding of the system and is applicable for any large, complex ecosystem.

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VEGETATION COLONIZATION THRESHOLDS AND MARSH PLATFORM EXPANSION DYNAMICS AT A TIDAL FRESHWATER RESTORATION SITE IN THE SACRAMENTO-SAN JOAQUIN DELTA, CALIFORNIA, USA

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Understanding plant colonization and expansion dynamics is an essential component in the development of sustainable wetland restoration plans. The Sacramento-San Joaquin Bay Delta is the largest deltaic wetland habitat complex on the western coast of the United States. As has occurred with many coastal ecosystems, the Sacramento-San Joaquin Delta has been extensively altered, with more than 95% of the Delta wetlands drained and leveed for agricultural use. Currently, there is great interest in restoring tidal wetland habitats in this region. The intentional breaching of agricultural levees in the Delta has been proposed as restoration technique to restore tidal hydrology and facilitate re-establishment of freshwater tidal wetlands.

Our study site, Liberty Island, was leveed in the 1920s for farming. However, in 1997 a high river discharge event caused the levees to permanently fail. The area has since been undergoing a gradual succession to tidal *Schoenoplectus* spp. freshwater marsh (commonly referred to as tules), with *Schoenoplectus californicus* typically dominating the lower intertidal areas. *Schoenoplectus acutus* and *Typha latifolia* are also present at this site.

Our studies were initiated in 2010 and have focused on understanding the factors that influence vegetation establishment, vegetation expansion rates, and development of the freshwater tule marsh platform. Our approach had multiple components, including: 1) seed bank assay, 2) field transplant study of *S. californicus, S. acutus, and Typha latifolia*, 3) field transect study spanning from tule marsh platforms to adjacent unvegetated mud flats, and 4) investigation of *Schoenoplectus californicus* marsh edge lateral expansion rates at numerous locations. The seed bank at the site displayed a greater species richness of viable seeds than is currently present in the emergent wetland plant community, suggesting that environmental conditions limit the successful germination and persistence of many of these species. Transplant establishment success was greater with adult transplants than rhizomes, likely because of greater flooding stress tolerance in adults. Further, although all three species assessed were able to establish, *S. californicus* displayed the highest transplant survivorship and rapidly became the dominant species, exhibiting high rates of vegetative expansion. The transect study revealed interesting differences between locations at Liberty Island that displayed a range of soil conditions, marsh platform and marsh edge elevations, as well as variable rates of lateral expansion. Vegetation lateral expansion rates were significantly less along marsh edges that were lower in elevation and flooded approximately 100% of the time compared to marsh edges that were flooded less than 94% of the time. Previous site history, in combination with current hydrologic and exposure gradients, appear to be exerting considerable modulation of the plant community dynamics. Our findings illustrate the importance of recognizing multiple factors and dynamic interactions between the plant community and the abiotic environment when considering restoration thresholds.

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CHANGING COURSE: THE STUDIO MISI-ZIIBI TEAM PROPOSAL: THE NEW MISI-ZIIBI LIVING DELTA: AN ECO 3D APPROACH TO A SELF-ORGANIZING SUSTAINABLE DELTA

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Acknowledging that the Mississippi River Delta will continue to evolve over the next 100 years, the new MISI-ZIIBI LIVING DELTA for the 22nd century – a healthy, productive and resilient delta - relies on a synergistic and leveraged combination of delta building, the working delta, and delta living. This new Delta will be more sustainable and smaller in area through using the natural forces of the Mississippi River, but will have faster vertical accretion rates than earlier deltas, which keeps pace with current and future rates of global sea-level rise. The vision for the new Delta will be achieved through ECO 3D [dredge + dump, dredge-siphon, divert] – in which the bounded Mississippi River will be fragmented into a network of constructed distributaries, using sediment diversions, in order to feed the wetlands with the necessary sediment for delta building. Although the diversions will be constructed and managed, the delta formation in the receiving basins is self-organizing and naturally formed.

In addition, we propose to shorten the Mississippi River and construct a new navigation entry point further upstream with a new distributary node near West Point à la Hache for a better and more sustainable navigation channel. The realigned and shortened river provides more efficient methods to use the sediment loads and increase safety and navigation reliability, and lower flood levels along the Mississippi River in this area. Ensuring that the navigation and marine economy continues to expand the river will be dredged to 50ft deep, the existing ports and Port Fourchon expanded, existing navigable inland water bodies maintained, and a new port constructed in the new Bird's Foot. As a result there is a maximum integration of navigation, flood control and restoration.

We propose over time a gradual transition of industry and communities into more protected and resilient communities in order to assure long-term sustainability of the areas with the highest population density and economic productivity. The concept of DELTA LIVING is about embracing the ideology and cultural aspect of communities by enabling a means to continue to live with the Delta in new ways, and accommodating a regional growth strategy of safe, strong, and distinctive communities. Overall, the MISI-ZIIBI LIVING DELTA uses constructed and natural ecological landscapes to provide for both the safe and sustainable inhabitance of the Delta region while encouraging a vibrant, growing and sustainable economy that thrives in light of unpredictable and long-term changes.

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THE IMPACT OF EUTROPHIC ESTUARINE SEDIMENTS ON BENTHIC INFAUNAL DIVERSITY IN THE INDIAN RIVER LAGOON

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There are many indices of an eutrophic estuarine ecosystem including Fine-Grained Organic-Rich Sediments (FGORS). This study examines a range of FGOR sediments while analyzing the richness and diversity of benthic infauna found within. Sediments were collected monthly using a Petite Ponar grab at 16 locations (n=3 for each location) and sifted using a 500 micron sieve from May 2015 to the present. Another sample from each location was used for sediment characterization. Metazoa were counted and identified via stereomicroscopy. A total of 76 species have been observed. Major taxa and representative species (highest observed density ±1SE) include annelids (e.g., *Diopatra sp.,* $2.9\text{x}10^3 \pm 1.05\text{x}10^3$ m^{-2} in September), molluscs (e.g., *Acteocina canaliculata,* $3.9\text{x}10^3 \pm 1.5\text{x}10^3$ m^{-2} in October), and arthropods (e.g., *Peratocytheridea setipunctata*, $3.3\text{x}10^3 \pm 2.07\text{x}10^3$ m^{-2} in September). The Shannon-Wiener Diversity Index for infaunal communities ranged from 0 to 2.3 with 12 species in the most diverse sample. Possible correlations between biodiversity and abundances and FGORS conditions (water content, % organics, and silts/clay content) are being investigated. It is hypothesized that, as FGORS' organic content increases, biodiversity and richness of metazoan infauna decreases. Understanding anthropogenic impacts can lead to better management and restoration processes.

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DOES WHAT WE KNOW ABOUT BIODIVERSITY HAVE A PLACE IN ECOSYSTEM RESTORATION PLANNING?

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The diversity of wildlife species has often been considered a good indicator of detectable change in the environment. In 1934, Everglades National Park (EVER) became the first park to have its biodiversity recognized in its enabling legislation. Tracking biodiversity is key to the NPS and EVER mission of "preserving the… diversity, abundance and ecological integrity of its unique flora and fauna." The question is "Can measures of biodiversity add value to the current suite of indicators for Everglades ecosystem restoration efforts?"

Species lists updated by this project were provided to provide the South Florida and Caribbean Inventory and Monitoring Network to update NPSpecies, an on-line database that contains lists of species for all national parks. A second goal was to identify the preferred habitat associations for the native and non-native species and distribute them within 17 distinct physiographic regions. This study estimated that there are 344 bird species (308 native and 21 non-native), 43 mammal species (33 native and 10 non-native), 372 fish species (360 native and 12 non-native), 78 reptile species (42 native and 26 non-native), and 19 amphibians species (16 native and 3 non-native). By the time of this presentation, the number of non-native fish and reptile species will already be underestimated.
This presentation will address what we know about biodiversity of EVER wildlife emphasizing how this information can contribute to ecosystem restoration planning. Factors that may impact biodiversity such as changes in regional hydrology, sea level rise, and the establishment of non-native species are also discussed.

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REDUCING NONPOINT SOURCE POLLUTION THROUGH EFFECTIVE DITCH MANAGEMENT

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Artificial drainage through manmade ditches or channelized streams is a common practice to allow for agricultural production of poorly drained soils on the Delmarva Peninsula. Over time, ditches accumulate sediment and vegetation that impedes drainage of water from adjacent fields. Removal of these accumulated sediments (i.e., dip out) is necessary to restore ditch functionality. Current management of the removed material (i.e., spoil) typically involves spreading and incorporating the sediments in adjacent agricultural fields. However, the potential for dissolved losses of P from spoil following this practice is unknown.

Spoil incorporation by chisel plow was simulated in a laboratory incubation study that was designed to characterize and predict the potential for dissolved phosphorus (P) transport from spoil amended fields over a 30 day period. Representative field soils and corresponding spoil samples were collected from seven ditch dip out locations throughout Delaware and mixed at three field soil (F) to spoil (S) ratios (1F:5S, 3F:3S, and 5F:1S). The field soil to spoil ratios selected simulated a spoil spread depth of 15 cm or less prior to incorporation. Samples from each mixture were subsampled at 2 and 30 days and analyzed for water extractable P (WEP) and Mehlich 3 P, Al, and Fe.

Initial characterization of the field soils indicated WEP concentrations (4-27 mg kg^{-1}) were at least four times higher than WEP concentrations in the corresponding spoil samples (0.2-3 mg kg^{-1}). At most sites, Mehlich 3 P concentrations (57-463 mg kg^{-1}) and Mehlich 3 PSR values (0.07-0.31) of the field soils were at least double those observed in the corresponding spoil samples. Incorporation of spoil material decreased Mehlich 3 P and WEP concentrations; incorporating spoil at a ratio of 5S:1F resulted in the greatest reductions in WEP and Mehlich 3 P concentrations.

Amending a smaller area of soil adjacent to a ditch with a high spoil to soil ratio may reduce the risk of dissolved P losses from adjacent agricultural fields, while minimizing the area of cropland affected by ditch maintenance. Developing a method to determine the most effective spoil spreading depth to reduce WEP and soil test P concentrations at ditch sites planned for dip out can help to improve ditch management and water quality throughout Delmarva.

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RESTORATION AND MONITORING TECHNIQUES IN THE MIDDLE RIO GRANDE

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The U.S. Army Corps of Engineers in collaboration with the Middle Rio Grande Conservancy District, City of Albuquerque, Pueblo of Sandia and Village of Corrales developed ecosystem restoration concepts and educational and recreational enhancements for the bosque (riparian woodland) as part of the Middle Rio Grande Restoration Project which began construction in 2011. Collaboration with tribal partners, non-federal sponsors, and local stakeholders occurred throughout the planning and implementation process.

The goal of the project is to develop a framework to restore the bosque into a more functional and sustainable ecosystem, as well as increase the diversity and quality of wildlife habitat. Another key focus is to reduce wildfire hazards through the removal of the metal jetty jacks, debris, dead wood and treatment of non-native vegetation (salt cedar (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia)*, Tree of Heaven (*Ailanthus altissima)*and Siberian elm (*Ulmus pumila*)).

At the same time, the project promotes enhanced recreational and educational opportunities for local citizens and visitors to the region. Restoration features include reconnecting the river and floodplain through the construction of bank terraces and high flow channels. Construction of willow swales and revegetation with native species are project components. The project incorporates trail amendments, viewing blinds, canoe access, picnic tables and benches in locations that allow public use while protecting areas for wildlife.

Planning, implementation and post-construction has been adaptively managed based upon changes in flow and invasive species over the study and implementation period. How these changes were managed, and the design modified, will be discussed.

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UNDERSTANDING MERCURY SOURCES TO THE GREAT LAKES USING STABLE ISOTOPES: CRITICAL INFORMATION FOR RESTORATION PLANNERS

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The North American Laurentian Great Lakes are the world's largest freshwater ecosystem and are used extensively to support commerce in the United States and Canada. With this use however, significant stress has been placed on this ecosystem as there have been numerous examples of contamination, invasive species, and loss of shoreline habitat. In 2010, the United States Environmental Protection Agency initiated the Great Lakes Restoration Initiative (GLRI) to help address some of the most pressing issue, including the issue of widespread fish consumption advisories due to mercury (Hg). Despite problem recognition, studies on Hg sources, cycling and fate in the Great Lakes are sparse, with only consistent fish monitoring since the 1960s. The initiation of GLRI provided a new opportunity to expand Hg research in the Great Lakes, including the emerging use of Hg stable isotopes to examine source apportionment, cycling, and spatial and temporal trends.

Natural stable isotopes ratios have long been used to trace environmental processes, however, the technique has only recently been applied to understand Hg dynamics. The complex analytical instrumentation necessary to achieve high resolution separation of naturally-occurring Hg isotopic patterns is available, albeit costs are relatively high (approaching $1M). Instruments are capable of detecting both mass dependent fractionation (MDF) and mass independent fractionation (MIF) of Hg isotopes in nature. Hg-MDF (e.g., δ^{202}Hg) occurs as a result of chemical, physical and biological processes. Odd-MIF signatures (e.g., Δ^{199}Hg) result from specific pathways, such as photochemical reduction. Even-MIF signatures (e.g., Δ^{200}Hg) are hypothesized to be formed only in the atmosphere by Hg photochemical oxidation process. Hg isotope distributions can for example, provide a three dimensional tracer (δ^{202}Hg-Δ^{199}Hg-Δ^{200}Hg) to address many long-standing questions in Hg research including: 1) identification of specific sources of Hg; 2) understanding complex biogeochemical pathways for Hg; and, 3) determining reactivity of specific Hg sources.

Our research in the Great Lakes has initially focused on sediments and fish, solid phase end members that allow us to address the importance of specific sources for bioaccumulation. Our initial studies suggest that atmospherically-derived Hg may be a more important source of Hg bioaccumulated by fish than legacy Hg derived from point-source contamination and deposited in bottom sediments. From a management standpoint, these observations can influence mitigation and restoration approaches when contaminant sources to biota are considered. Our observations form further research questions which include better delineation of regional atmospheric signals and an improved understanding of reactivity and methyl-Hg dynamics during bioaccumulation.

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NEAR REAL-TIME AVAILABILITY OF THE NORTH AMERICAN MULTI-MODEL ENSEMBLE: AN INTRODUCTION

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The North American Multi-Model Ensemble (NMME) System for Intra-Seasonal to Inter-Annual (ISI) prediction is a collaborative experimental multi-model climate forecasting system. NMME consists of global, coupled climate models from a range of North American forecasting centers, including University of Miami (RSMAS), NOAA, NASA, and more. NMME is an operational climate forecasting system that is currently used as guidance for NOAA Climate Prediction Center (CPC) forecasts. Currently available are global and regional North American predictions of sea surface temperatures, precipitation, and surface temperatures at various lead times. Both monthly and seasonal time-scales are represented at lead times up to 7 months, and included are graphical forecasts and real-time or hindcast prediction data. More information on NMME is in Kirtman et al. 2014 (BAMS).

NMME is intended to meet research needs in the academic community, but also to provide decision support for climate information users. Additionally, data is available for users who wish to use hindcasts or real-time forecasts as boundary conditions for a given model. Shown here is an introduction to NMME prediction data, including available graphical forecasts and data availability. We also introduce predictions and data from the Community Climate System Model version 4.0 (CCSM4), available in the most recent phase of the NMME project.

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EYE-OPENING OUTCOMES THROUGH THE POWER OF MODELING IN THE HOLLY POND WATERSHED

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On behalf of the Connecticut Department of Energy and Environmental Protection (DEEP), the Louis Berger Group is engaged in the restoration of Holly Pond and Lower Noroton River in Stamford and Darien Connecticut. Holly Pond is a shallow estuarine embayment at the mouth of the Noroton River with a tidal dam at its downstream end. At the opposite end of Holly Pond, a large shoal has formed at the mouth of the River that is exposed above the water level at low tide. The large sediment shoal is believed to be contaminated, which may present an exposure pathway to ecological receptors.

This project involves three primary components; Restoration of the Shoal Area, Bank Stabilization, and Watershed Management Practices. The first includes updated bathymetry and sediment characterization of the shoal along with an alternatives analysis of measures to avoid wildlife exposure to the contamination. Alternatives include dredging of the shoal to a depth where sediments are no longer exposed at low tide, the creation of a tidal marsh at the location of the shoal, and the creation of a living shoreline using the shoal sediment to restore marsh habitat along the seawall. To identify and mitigate the sediment that contribute to the shoal, the project includes an alternatives analysis for corrective actions to address eroding streambanks of the Noroton River through soil bioengineering practices. Finally, the project includes an alternatives analysis with detailed proposed projects and cost estimates for managing peak streamflow discharge and sediment volumes, through enhanced groundwater recharge or retention, on a watershed scale, to reduce channel adjustments and sediment deposition downstream.

In order to evaluate alternatives for the thirteen square mile watershed, the Noroton streambanks, and the Holly Pond shoal, Louis Berger created a watershed wide model. The modeling effort is critical to evaluate project alternatives and inform the design of practical and effective sustainable solutions to the shoaling issues. A conjunction of models were used; a watershed model that provided inputs into the in-stream model, and the in-stream hydraulic and sediment impact analysis model

The modeling results served surprising outcomes revealing information about the Holly Pond Shoal and sediment transport through the watershed. Out of the total 12.7 square miles of the watershed, a subbasin of merely 3 square miles over 5 miles north of Holly Pond contributes about 80% of the sediment load per day to the estuarine embayment. The 3 miles of the river that contain highly eroded streambanks only contribute about 12% total sediment per day. Furthermore, the model shows all 4500 tons per day sediment out is silt. Because the shoal is made of larger grain sizes, gravel mostly, the watershed sediment yield is not contributing to the shoal. Contrary to the expected, the sediment shoal is in equilibrium. In agreement with that statement, the 100-year storm event only allowed velocities of 4.7 feet per second to outlet into Holly Pond from the Noroton River, not allowing enough push for grain sizes larger than fines. In this presentation we will discuss the problem solving through complex modeling that sets this ecological restoration project apart from the rest.

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EFFECTIVENESS OF A CHANNEL HABITAT RECONNECTION IN TIDAL FRESHWATER OF THE COLUMBIA RIVER: SANDY RIVER DELTA

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We evaluated the effectiveness of a restoration action completed in 2013 to remove an earthen dam and rechannelize the Sandy River delta in tidal freshwater of the Columbia River (rkm 190). The working hypotheses were that the restoration action would 1) increase access for juvenile salmon to shallow water habitats in the SRD; 2) reduce non-native fish populations; and 3) increase flow and channel cross-sectional area. The statistical design was a before-after-control-impact (BACI) design that entailed two pairs of impact/control sampling sites. Pre-restoration (before) data were collected during 2007 through 2012. Post-restoration (after) data were collected during 2015. Post-restoration sampling is scheduled to be completed in early 2016. Visual observations revealed a dramatic change in the physical environment; where once was a backwater slough is now a free-flowing tidal river. Preliminary data indicated changes to the fish community as well. Final results of the evaluation will be available in spring 2016.

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DEFINING EVERGLADES RESTORATION TARGETS: USING OUR KNOWLEDGE OF THE PAST TO CREATE A SUSTAINABLE FUTURE

Robert Johnson, *Dave Rudnick, and Jed Redwine*
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The Everglades watershed covers an area of nearly 11,000 miles^2 (2.8 million hectare) extending from the central Florida peninsula to the Florida Keys. A century of development and drainage has allowed south Florida's population to grow to over seven million, but reduced the spatial extent of this internationally significant wetland ecosystem by more than half. While the degradation of the Everglades has attracted great attention, little of the original landscape remains, making it difficult to establish targets to restore the critical structure and function of this ecosystem. Understanding the original linkages between pre-drainage hydrology and ecology of this ecosystem is key to restoring the greater Everglades, and assuring the long-term sustainability of south Florida.

Recent studies of the paleo-ecology of the Everglades have improved our understanding of the original characteristics of the pre-drainage Everglades. We have learned that this original ecosystem was more resilient to disturbances because of its large spatial scale, more persistent water flows, its complex mosaic of inter-connected habitats, and its high biodiversity.

This information is being used to establish specific restoration targets that incorporate natural variability, with the goal of recovering the key components of the original ecosystem's structure and function. We can use this information to predict how the ecosystem will likely respond to unexpected disturbances. This information will also allow us to develop more proactive approaches in our responses to climate change, to promote improved resilience in this human dominated ecosystem.

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HOW MUCH RESTORATION & WHERE? - USING STRUCTURED DECISION MAKING TO TURN LANDSCAPE PRIORITIES INTO EFFICIENT ADAPTATION STRATEGIES IN THE OZARKS

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Regional conservation partnerships are an important component of the effort to conserve biodiversity in the face of landscape and climate change because these threats operate beyond the reach or resources of any one organization. However, regional conservation planning is hampered by multiple sources of uncertainty regarding the degree, rate, nature and spatial patterning of landscape changes, as well uncertainty in how population processes will interact with those changes to produce observed species responses. Further, regional planning is hampered by the inherent social and ecological complexities surrounding local conservation decisions. The recent development of dynamic landscape population viability models and the growing use of structured decision making provide regional planners with an opportunity to overcome these limitations. Dynamic landscape population viability models provide the foundation to link local habitat actions and landscape patterns to regional population viability as well as a means to understand impacts of landscape and climate change on population viability. Structured decision making provides a formal framework for assessing tradeoffs among the multiple, often competing, objectives of conservation actions. We applied these techniques to a regional planning effort for the Ozark Highlands region of Arkansas, Missouri, and Oklahoma. The planning team – composed of State, Federal, and NGO staff – had already produced a system for ranking small watersheds (avg. approx. 1,000 ac) within the Ozarks based on current landscape conditions and habitat restoration potential, but did not have a mechanism for considering potential future changes in the process of setting priorities. Working with the team we identified restoration objectives for forested habitat systems and a set of alternative approaches for selecting portfolios of watersheds for restoration. The team also selected a suite of wildlife species to model whose predicted viability would serve as performance metrics for the various restoration portfolios. Viability models were developed based on demographic information in the literature and verified against trend data when available. Restoration portfolios were built by developing a GIS program to select watersheds based on the team's ranks and identified selection approaches (e.g. build out from existing public lands, avoid urbanizing areas). The program selects watersheds until objectives for all habitat systems are met. Preliminary results indicate that viability measures for a species vary among portfolio options, which allows selection of the "best" alternative for a species. Results are also indicating that viability varies among species within a portfolio, which allows assessment of tradeoffs among competing objectives (e.g. mature forest vs. early-succession species). Further, the results are providing feedback to planners on the relationship between the spatial arrangement of restoration efforts (Where) and the restoration objectives (How much). When complete later in 2016, this study will provide a dynamic decision support system capable of evaluating restoration planning options and objectives before decisions are made.

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RESTORED OYSTER REEFS ENHANCE ESTUARINE ECOSYSTEM SERVICES

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Oyster reefs provide myriad ecosystem services, including water quality improvement, fisheries and other faunal support, shoreline protection from storm surge, and economic productivity; however, their role in directing flow during non-storm conditions has been largely neglected. In regions where oyster reefs form linear structures parallel to the coast and across the path of estuarine streams and rivers, they likely alter near-shore mixing by acting as fresh water “dams”. We hypothesize that these reefs have the potential to detain large volumes of fresh water and influence salinity over extensive areas, thus providing a “keystone” ecosystem service by supporting multiple estuarine functions that rely on the maintenance of estuarine (i.e., brackish) conditions in the near-shore environment. Importantly, in regions where shore-parallel reefs have been degraded, this service is likely lost or reduced, potentially initiating a positive feedback loop whereby reef loss results in decreased freshwater detention and higher salinities, which in turn drives increased marine predation, high oyster mortality, and eventual reef collapse.

In this work, we investigated the effects of shore-parallel reefs on near-shore salinity using field data and hydrodynamic modeling in a degraded reef complex in the Suwannee Sound (Florida, USA). Results suggest that freshwater detention by oyster reefs plays an important role in modulating salinities not only in the oysters’ local environment, but over extensive estuarine areas as a function of reef morphology. Field data confirmed the presence of strong salinity differences between landward and seaward sides of a degraded reef in the Suwannee Sound over very short distances (<100 m) and over both short (tidal) and long (seasonal) time scales, with long-term mean salinity differences >30%. Numerical results expand experimental findings by illustrating how oyster reefs affect the lateral and offshore extent of freshwater mixing. In general, the effect of simulated reefs were most pronounced when they were highest, without gaps, and when discharge was low (i.e., during droughts). Taken together, these results elucidate a poorly documented ecosystem service provided by oyster reefs; provide an estimate of the magnitude and spatial extent of this service; and offer quantitative information to guide future oyster reef restoration.

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DEMONSTRATING OYSTER REEF BREAKWATERS AND OTHER LIVING SHORELINE TECHNIQUES IN THE DELAWARE ESTUARY AS PART OF A TIDAL MARSH RESILIENCE PROGRAM

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In 2013, The Nature Conservancy received a grant from the U.S. Fish and Wildlife Service to implement a project to construct a living shoreline at The Nature Conservancy's Gandy's Beach Preserve in Cumberland County, New Jersey. The project will implement and test an innovative technique of creating a nearshore oyster breakwater to attenuate waves while providing unique oyster habitat for economically and ecologically important fish and crabs. There is a need for innovative techniques to create resilient habitats and communities in the face of sea level rise and coastal storms as a critical strategy for conservation organizations and agencies across the Mid-Atlantic. Coastal habitat loss and conversion has reduced the buffering ability of tidal marshes and beaches to upland habitats and coastal human communities from storms and future sea level rise impacts. The poster will discuss the oyster breakwater project at Gandy's Beach, New Jersey. The poster will also present information on the project's identification and need, engineered design, monitoring, and preliminary results on pilot living shoreline installations in 2015. An additional goal of the project is to determine the feasibility of implementing this living shoreline technique at other strategic locations across the Delaware Estuary. A discussion on how the project fits into a larger tidal marsh resilience strategy for The Nature Conservancy in New Jersey that includes living shorelines, tidal marsh platform restoration through the beneficial use of dredge material, and land acquisition to allow for future marsh transgression due to sea level rise.

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EVALUATING HABITAT RESTORATION IN THE ST. CLAIR-DETROIT RIVER SYSTEM USING EGG DEPOSITION ON SPAWNING REEFS AND LARVAL DRIFT OF NATIVE FISHES

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Early and mid- twentieth century pollution, channelization, dredging, and development in the St. Clair-Detroit River System (SCDRS), a bi-national connecting channel between Lake Huron and Lake Erie, reduced water quality and decreased the availability of natural spawning substrate for fishes. Coinciding with habitat losses were declines in populations of several species of native fish including lake sturgeon (*Acipenser fulvescens*) and lake whitefish (*Coregonus clupeaformis*). Historically, the entire system provided a vast stretch of spawning and nursery habitat for both of these fish as well as other native species. In 1987, declines in fish populations and vital habitat, among other water quality issues, resulted in a Great Lakes Area of Concern designation with Beneficial Use Impairments for portions of both rivers. Eventual improvements to water quality provided opportunities for habitat and population restoration. Recently, artificial spawning reefs have been constructed and were monitored through a collaborative multi-agency partnership. These reefs were constructed throughout the St. Clair River (Port Huron, Hart's Light, Point aux Chenes, and Middle Channel Reef) and the Detroit River (East Belle Isle, Northeast Belle Isle, Belle Isle, Fort Wayne, Fighting Island, Fighting Island Expansion, Grassy Island, and Sugar Reef). This poster will focus on pre and post-assessment of these artificial spawning reefs and which species utilized these areas. Biological monitoring such as this will aide in evaluating the success of habitat restoration within the SCDRS and determine the need for other long term monitoring programs for future projects.

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MONITORING THE AQUATIC ENVIRONMENT OF A BI-NATIONAL CONNECTING CHANNEL (ST. CLAIR-DETROIT RIVER SYSTEM)

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Rivers are inherently dynamic with their hydrology and morphology, but complexity also exists with the composition of the species contained within these systems. This is especially true with connecting channels of Laurentian Great Lakes as fish species move from one system to another highlighting their importance relative to other neighboring aquatic systems. Understanding the seasonal and interannual biotic and abiotic changes of these systems from one year to the next, or even through perturbations, can be especially challenging due to the spatial and temporal scale at which these changes and any restoration practices occur. Providing regular sampling of species within connecting channels can be revealing about not only the biota of the system, but also the overall complexity of the system contained within it. Sampling that occurs simultaneously with restoration efforts can yield important short-term measures of performance that serves as feedback mechanism for adaptive management and helps build long-term data series.

The St. Clair-Detroit River System (SCDRS) is a bi-national connecting channel which runs between Michigan, USA, and Ontario, Canada connecting the Upper and Lower Great Lakes. The St. Clair River flows from Lake Huron into Lake St. Clair and then into the Detroit River and ultimately Lake Erie, providing a vast stretch of spawning and nursery habitat for numerous species of fishes. Historically, dredging for shipping and contaminants from industry altered both the morphology and water quality of the rivers. A subsequent decline in fish utilizing the system occurred due to this degradation. Both Lake Whitefish (*Coregonus clupeiformis*) and Lake Sturgeon (*Acipenser fulvescens*) along with numerous other species declined coinciding with water quality and habitat impairments. Both the St. Clair River and Detroit River were designated as Area of Concerns in 1987 due to severe degradation. Recently however, collaboration between various state and federal agencies has promoted the creation of spawning reefs and shoreline habitats to remediate these perturbations. Restorations activities are designed in an adaptive management framework that relies on intensive monitoring evaluate performance.

Initial phases of monitoring have yielded numerous data for pre and post construction of the spawning reefs. A wide array of other monitoring includes monitoring of water velocity, substrate assessments, zooplankton surveys, sport fishery creel and diary program, lithophilic egg spawner collections, adult fish sampling through trawls, gillnets, and setlines, juvenile fish sampling through shoreline seining, and larval fish sampling. The presentation will focus on post-assessment monitoring biological monitoring of the reefs, and inclusion of other biological and physical parameters that will aide in evaluating the performance of the habitat restoration within the SCDRS and establishing a long term monitoring program for continued evaluation of the connection channel’s ecology.

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DRIVERS OF CHANGE IN NUTRIENT INPUTS TO THE CHESAPEAKE BAY WATERSHED: 1950-2012

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Chesapeake Bay is a eutrophic estuary with periodic hypoxia and anoxia, algal blooms, diminished submerged aquatic vegetation, and degraded stocks of marine life. Temporal and spatial patterns of degradation have been linked to increases in nitrogen and phosphorus fluxes to Chesapeake Bay. Efforts to restore the estuary rely on reducing these fluxes through a variety of management strategies (particularly agricultural "best management practices" or BMPs) implemented across its watershed. The Chesapeake Bay Program partnership has worked with natural resource agencies, agricultural agencies and local planners to support BMP implementation under a voluntary framework since 1985. In 2010, an EPA Total Maximum Daily Load was established, which assigned mandatory reductions in nutrient fluxes to the estuary from across the Chesapeake Bay watershed. The ability to meet these goals hinges largely on the implementation of BMPs within the agricultural sector.

An understanding of changes in nutrient inputs, agricultural practices, and implementation of BMPs across the watershed is an essential first step in the effort to explain their effects on nutrient fluxes. To meet this need, we compared long-term patterns of anthropogenically-derived nitrogen and phosphorus inputs to reported BMP implementation, changes in agricultural land use, and changes in agricultural practices over time across sub-basins of the Chesapeake Bay watershed. We focused primarily on inputs from the agricultural sector, which is responsible for the majority of nutrient loads to the estuary. Long-term temporal shifts in agricultural practices (such as livestock populations, crop acres, and manure and fertilizer application) and land use change were shown to affect observed changes in nutrient inputs from 1950 through 2012. The relation between spatial and temporal changes in nutrient inputs and the spatial patterns of BMP implementation from 1985 (when BMP reporting began) through 2012 provides insights into existing management strategies and can inform future decision-making. These findings will be evaluated in conjunction with estimates of temporal trends in nutrient fluxes measured at USGS streamflow gages throughout the Chesapeake Bay watershed, with the goal of attributing changes in nutrient fluxes among the suite of nutrient sources and practices examined.

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RESTORATION TARGETS FOR JUVENILE SPORTFISH IN FLORIDA BAY

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Everglades estuaries are critical nursery habitat for a number of commercial and recreational fishery species. This ecosystem function was highlighted in the total system conceptual ecological model used for Everglades restoration planning. Moreover, recreational fishing is a big economic input for south Florida, with Everglades saltwater anglers accounting for over $883.6 million in total economic output and 8,896 full time equivalent jobs. Because of this economically and ecologically important role as nursery habitat, Everglades restoration needs to be able to assess, evaluate, and predict the impact of proposed restoration projects on the quality of nursery habitat in downstream estuaries. Florida Bay is a critical estuarine nursery habitat downstream of the Everglades and is starved for freshwater resulting in severe hypersalinity (>70 psu), seagrass die-offs, and degradation of nursery habitat.

As part of the Comprehensive Everglades Restoration Plan's (CERP) REstoration, COordination, and VERification Monitoring and Assessment Program (RECOVER/MAP), we have been systematically monitoring juvenile sportfish in Florida Bay since 2004. This sampling is focused on quantifying the juvenile population of spotted seatrout, *Cynoscion nebulosus*; an established indicator of estuarine fish habitat quality. One of the goals of this monitoring project was to develop restoration targets for the CERP. The first step in this process was to quantify the relationship of juvenile *C. nebulosus* capture rates with environmental parameters, such as temperature, salinity, and seagrass. Quantifying these relationships led to the development of a habitat suitability model based on the frequency of occurrence of juvenile spotted seatrout.

This habitat suitability model for juvenile *C. nebulosus* is used in conjunction with paleoecological salinity records and a natural system model to estimate the quality of nursery habitat, if the hydrology of the Everglades had never been altered. These results are used to develop quantitative, dynamic restoration targets for juvenile sportfish habitat in Florida Bay, which CERP should strive to achieve. In addition to setting targets, we will demonstrate how the habitat suitability model was used to evaluate different alternative restoration plans proposed for the Central Everglades Planning Project, the next step in CERP. Lastly, we will show how Everglades Restoration projects already implemented are affecting the environment of Florida Bay and how the juvenile sportfish restoration target can be applied to assess the effect of restoration on estuarine nursery habitat.

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BACTERIAL LEVELS AT RECREATIONAL BEACHES INFLUENCED BY OUTFLOWS FROM FLORIDA BAY AND THE CALOOSAHATCHEE AND ST. LUCIE RIVERS

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This work evaluates water quality at beaches that receive outflows from Florida Bay and the Caloosahatchee and St. Lucie Rivers in terms of fecal indicator bacteria (FIBs, specifically enterococci). FIBs are bacteria such as enterococci and *Escherichia coli* that are present in fecal material and used by the U.S. Environmental Protection Agency as indicators of fecal pollution in water. While beaches are measured throughout the state as part of the Florida Department of Health's Florida Healthy Beaches program, how outflows may affect FIB levels at nearby recreational beaches remains unknown. Work by our colleague, Feng et al. indicates that many natural factors affect the FIB levels at recreational beaches. Here, we add the outflows from the Everglades, specifically Florida Bay and the Caloosahatchee and St. Lucie Rivers, to the coastal zone and evaluate the FIB levels.

Our objective was to evaluate the spatial distribution of FIBs at beaches downstream from these areas of outflow. This represents the Everglades watershed, which here is defined as the area drained by the St. Lucie and Caloosahatchee Rivers as well as Florida Bay. Our four case study sites include these three areas, plus the Loxahatchee River, which is included as a control. Florida Bay and the Florida Keys are located at the southern extent of the Florida Everglades, receiving inputs from the C-111 canal. Beaches near the Caloosahatchee and St. Lucie Rivers receive flows from Lake Okeechobee, which is a highly managed component of the Everglades system. The Loxahatchee River watershed, just south of the St. Lucie River watershed is located in the eastern central Everglades, without influences from Lake Okeechobee discharges.

The beaches evaluated were located within 2,000 feet of the corresponding river/estuary outlets. Location was shown to have an effect on FIB exceedences. FIB data collected from beaches in the Florida Keys showed a significant decrease in enterococci between the year 2000 and 2011. Both the geometric mean (the number used by the EPA in their water quality analyses) and the percent exceedence started out high and began to decrease by 2011. In 2012, both increase. Percent exceedences represent the percentage of samples that exceeded the Florida Healthy Beaches program single-sample threshold of 104 colony forming units (CFU). In our study, more than 5% exceedences was the cutoff point for "good" water quality. Elevated enterococci levels were observed at bay beaches closest to the Caloosahatchee River (Cape Coral Yacht Club 3.5% exceedence) and the St. Lucie River (Roosevelt Bridge 10.4%.) Beaches closest to the Loxahatchee River (Dubois 8.6%) and Florida Bay (John Pennekamp, 4.4% exceedence) demonstrated similar results.

We hypothesize that these river outputs, which represent outflows from Lake Okeechobee plus additional contributing areas downstream of the lake, impact local water quality and ultimately FIB levels. The FIB may come directly from these rivers or from nutrients in the rivers that may contribute towards the survival of the FIB. Future work will focus on the relationship between these nutrients and FIBs.

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RESTORING THE FEDERALLY ENDANGERED HIGGINS EYE PEARLYMUSSEL (*LAMPSILIS HIGGINSII*) IN THE UPPER MISSISSIPPI RIVER – PROPAGATION AND REINTRODUCTION

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Native freshwater mussels (Unionidae) are one of the most globally imperiled faunal groups with many North American species either extinct or endangered. Restoring endangered mussel species populations via propagation and reintroduction into areas where previously extirpated has become an important conservation measure. Since 2000, a variety of conservation measures have been used by the U.S. Army Corps of Engineers in collaboration with the interagency Upper Mississippi River (UMR) Mussel Coordination Team (MCT) to protect the federally endangered Higgins eye pearlymussel (*Lampsilis higginsii*). One such measure is the establishment of new and viable Higgins eye populations in areas protected from heavy zebra mussel (*Dreissena polymorpha*) infestations within its historic range where the species has been extirpated. The goal of the project is to establish at least five new viable populations with a ten year of implementation phase at a minimum of ten sites followed by twenty years of monitoring and augmentation (if required).

Reintroduction activities have included; 1) evaluation and selection of relocation/reintroduction sites; 2) genetics studies; 3) propagation via glochidia-inoculated fish released into the wild or used for cage culture in the wild; 4) relocating naturally propagated adults and artificially propagated juveniles; and 5) monitoring of existing and potential newly established populations. Ten reintroduction sites in the UMR and its tributaries were selected based on criteria including the species historic range, risk of zebra mussel invasion, existing native mussel community, presence of suitable host fish, and water quality. Over a ten year implementation phase, propagation efforts involved the use of nearly 400 donor females of two genetically-unique strains. Reintroduction to date include; nearly 500 adult Higgins eye relocated from waters heavily infested with zebra mussels to areas with low threat of zebra mussel infestation; over 44,000 sub-adult Higgins eye propagated in closed-bottom cages and placed in the wild; and an estimated 4.5 million juveniles transformed and introduced to the wild from free-released fish or from fish in open-bottom cages.

Initial monitoring efforts have suggested reintroduction efforts have been successful at most sites. Relocated Higgins eye adults and sub-adults reared in captivity and placed in the wild are surviving and there is evidence those individuals are reproducing as females are routinely gravid and new recruits have been observed at and near reintroduction sites. Higgins eye have been successfully reintroduced into areas where fish inoculated with glochidia have been free released or held in open bottom cages as individuals have been discovered where the species was locally extirpated, indicating that glochidia on free-released, inoculated fish have successfully transformed and survived at the sites. In addition, at these sites there also has been evidence of reproduction of introduced individuals as females have been observed gravid and evidence of new recruits has been observed at the sites. Monitoring is planned to continue to determine if reintroduced Higgins eye populations are viable and self-sustaining long term.

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GETTING TO ADJUST: ADAPTIVE MANAGEMENT AND DECISION MAKING ON THE PLATTE RIVER

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Adaptive management and a unique governance structure are at the center of attempts to bridge the gap between science and decision making in a large-scale species recovery program on the central Platte River in Nebraska. The Platte River Recovery Implementation Program (Program) began in 2007 as a joint effort between the states of Colorado, Wyoming, and Nebraska; the U.S. Department of the Interior; waters users; and conservation groups to address water use and endangered species needs in this semi-arid river basin. The Program manages land and water resources in central Nebraska to address habitat loss while preserving existing water uses. Uncertainties related to the response of target species to Program management actions are addressed through the application of adaptive management, in this case defined as a rigorous approach for designing and implementing management actions to maximize learning about critical uncertainties that affect decisions while simultaneously striving to meet multiple management objectives. The Program's Adaptive Management Plan provides the structure for organizing and implementing management actions such as flow releases and sediment augmentation to test priority hypotheses and answer overarching questions related to river form and function and species responses. After nearly nine years of implementation, a collaborative governance structure that includes stakeholders and clear lines of decision making and communication have the Platte River Program poised to successfully complete one full loop of the six-step adaptive management cycle and actually adjust in response to accumulated learning.

Headwaters Corporation provides the Executive Director and staff for the Platte River Program. Executive Director Jerry Kenny will discuss the tools being used on the Platte to deliver useful science to decision makers and help the process of making management decisions. Dr. Kenny will discuss the use of adaptive management and structured decision making, communication devices, and the collaborative nature of the Program's governance structure in the process of taking learning on the ground and making it part of the Program's decision making process.

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APPLICATION OF THE REGIONAL SIMULATION MODEL TO THE EVERGLADES AND LOWER EAST COAST FOR THE MODIFIED WATER DELIVERIES AND C-111 SOUTH DADE PROJECTS

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America's Everglades once covered almost 11,000 square miles of South Florida where water flowed down the Kissimmee River into Lake Okeechobee, then south through the vast Everglades to Florida Bay. By restoring the Everglades through one of the largest environmental restoration project in USA, long-expected benefits from the Everglades restoration efforts are finally reaching Everglades National Park (ENP). As the implementation of the Modified Water Deliveries (MWD) and C111 South Dade projects, begun in 1992, are now in the process of being finalized, planning for a set of significant changes to the operation of the local water management infrastructure that controls the flow of water into ENP is underway. This effort will design the Combined Operational Plan (COP) for the system associated with the MWD and C-111 South Dade projects and will rely in part on modeling tools to help predict and evaluate a range of potential options.

The Regional Simulation Model for the Everglades and Lower East Coast (RSMGL), a hydrologic model developed and implemented by South Florida Water Management District, is planned to be used to evaluate regional project benefits. RSMGL, an implementation of the Regional Simulation Model (RSM; SFWMD, 2005a and 2005b) provides a tool to simulate the natural hydrology and the water management operations of several important basins in south Florida. The RSM is a robust and complex regional scale modeling tool that utilizes an implicit, finite-volume, distributed, and integrated surface-water and ground-water framework. This modeling tool simulates one-dimensional canal/stream flow and two-dimensional overland and groundwater flow using physically-based numerical formulations with a variable triangular mesh. The RSMGL model has the capability to evaluate potential operational alternatives to address issues in south Florida's regional system. The RSMGL is one of three hydrologic models that is being implemented and refined so that it could be applied for the development and the evaluation of COP alternatives. These models will leverage each other's strengths and pass information in the form of boundary conditions to assist with project evaluation at a variety of spatial and temporal scale.

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SUBMERGED AQUATIC VEGETATION RESTORATION IN FLORIDA SPRING SYSTEMS

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Dense submerged aquatic vegetation (SAV) communities are the foundation of Florida spring ecosystems by maintaining water quality and providing habitat for fish and wildlife. Many spring systems have experienced substantial changes to their ecological drivers over the past century including nitrogen enrichment, riparian development, nuisance vegetation expansion, manatee population growth, recreational use, and sea-level rise. These changes tend to favor a plant community shift from SAV to filamentous algae dominance that is associated with an overall degradation of the ecosystem. A pilot restoration project was initiated in 2014 for the Crystal River/Kings Bay spring system to test a variety of innovative techniques to address these plant community shifts and their drivers. This project is addressing key drivers that inhibit the re-establishment of SAV by deploying temporary herbivory exclusion barriers and managing filamentous algae and other nuisance species. Eelgrass (*Vallisneria americana*) is the primary focus of this restoration effort because it was historically a dominant SAV species in this system and has the ability to persist in a wide range of conditions. An experimental eelgrass "sod" was cultured offsite and transplanted into three quarter-acre plots within Crystal River/Kings Bay in the fall of 2015. Early results show that the eelgrass is persisting and beginning to expand in some areas. Filamentous algae, hydrilla (*Hydrilla verticillata*), and southern naiad (*Najas guadalupensis*) are also beginning to colonize these areas and are being managed to promote eelgrass colonization. Monitoring is ongoing to assess the SAV community and to evaluate any changes to water quality, sediment characteristics, and invertebrate communities as a result of SAV restoration. In the spring of 2017 the exclusion barriers will be removed to determine if the newly established SAV community can persist under ambient conditions. If this restoration project is successful, then the goal is to apply this approach to additional areas within Crystal River/Kings Bay and other spring systems in the region.

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CASE STUDIES OF ONGOING NRCS WETLAND RESTORATION PROJECTS IN FLORIDA

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Taylor Engineering has partnered with the United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) to assist design and permitting of wetland restorations funded through the Agricultural Conservation Easement Program-Wetland Reserve Easements (ACEP-WRE) program. The basic design philosophy is to develop a hydrologic condition that recreates pre-development wetlands to the extent possible, identify the minimum number of gravity structures to allow an effective restoration and to develop the minimum external berm elevations to protect offsite properties from flooding. The property owner retains “compatible use rights” to the property which the design includes insofar as possible. Two of the projects in development are used to compare the different restoration approaches on agricultural sites with different degrees of land alteration. The Bubba Mills site at the western boundary of the Everglades Marsh slough province in Hendry County includes sugarcane fields and unimproved pasture with wetlands in roughly equal amounts. The Lonesome Island site in Highlands County consists wholly of bedded citrus groves with no remnant native wetland assemblages.

In general, engineering design on both sites and will include earthmoving to enhance and rehabilitate external / edge berms; remove internal structures and abandon wells, remove existing discharge structures, fill internal ditches, and remove internal berms. Construction of simple, robust water outflow structures; and creation or enhancement of access roads completes the primary construction components. Practical considerations include construction costs, post-construction management costs and labor effort, and avoidance of impact to off-site hydrology, and protection of cultural and historic resources during construction.

Selected restoration flooding characteristics for Bubba Mills was based on protecting remnant, undisturbed live oak (*Quercus virginiana*) hammocks and a property owner’s cabin. One land owner has identified access roads perpendicular to flow patterns that require sufficient structures to ensure effective east-west flow. Within in the easement, two separate properties along SFMWD L-2 canal resulted in a design including a discharge structure within each property. This conceptual restoration design has been approved and engineering design is ongoing. Construction should occur in 2017.
The Lonesome Island site, four hydrologically independent areas linked by common canals, is the first bedded citrus grove NRCS has selected for restoration. Major conceptual issues influencing the design process: the necessary degree of bed levelling, a significant restoration cost, and the large amount of earthmoving necessary to create external dikes around a large portion of some of the parcels; the type and extent of vegetation management necessary to ensure that desirable wetland communities, nowhere in evidence on the site, will develop after 30 years of herbicide treatment to suppress vegetation; and the landowner desire to create high quality duck habitat, a compatible use of the site.

The project will include an experimental component of leaving some bedded landscape and areas raised and lowered from existing elevations to enhance specific community types. The Lonesome Island conceptual restoration designs are still under development and hydrologic modeling is underway.

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EVALUATING ECOSYSTEM GOODS AND SERVICES IN NATIONAL FOREST PLANNING: BALANCING RIGOR AND EFFICACY

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The USDA Forest Service manages 193 million acres of forest and grassland in 44 states, providing to the public with a variety of ecosystem services including water, recreation opportunities, and other forest-related benefits. National forest management includes: (1) forest planning, which develops broad, long-term objectives for individual forests; and (2) project-level planning and implementation, which involves developing and executing specific management activities on the ground (e.g. harvesting, thinning to reduce wildfires, and habitat restoration). Additionally, the National Environmental Policy Act (NEPA) of 1970 requires managers to assess the environmental effects of any ground-disturbing project proposed, and to include the public in decision making processes. Ecosystem services concepts were formally incorporated into national forest management under a new forest planning rule in 2012, requiring forest planners to address ecosystem services as they prepare national forest plans. By extension, forest managers may consider ecosystem services outcomes as they conduct project-level assessments. The Forest Service's new planning rule intends to make public participatory processes more open and meaningful by describing a more comprehensive set of forest benefits accruing from management activities, so that the process of managing national forests is more transparent and less contentious.

The new ecosystem services requirements potentially influence three primary aspects of forest planning: (1) initial assessments to identify key ecosystem services affected by forest plans, (2) incorporation of ecosystem services evaluations into forest plans and (NEPA) analyses; and (3) monitoring of ecosystem services outcomes resulting from plans. Additionally, ecosystem services evaluations can facilitate tradeoff analysis to support forest management decision-making. The 2012 planning rule provides substantial discretion to forest managers in how they might implement ecosystem services assessments and analysis. However, the shift toward an ecosystem services approach also involves methodological and institutional challenges. Managers seek guidance concerning how to evaluate ecosystem services using methods that are both cost-effective and useful for addressing management questions in ways that the public can understand.

We outline the challenges in evaluating ecosystem services to support national forest planning, and what they imply about the types of analyses that are likely possible given national forest staffing and planning timelines. We propose a method for identifying and evaluating key ecosystem services during the initial assessment phase of forest planning, with a focus on ease of implementation, transparency, accessibility to the public, and consistency with economic principles. The approach seeks to highlight key relationships between ecosystem services and beneficiaries, as well as linkages between forest benefits and social, cultural, and economic conditions. We see the approach as a necessary compromise between analytical rigor and efficacy, and providing a basis for ecosystem services evaluations required of latter planning phases. Our presentation is intended to promote discussion about how best to address ecosystem services in public land management and other federal natural resource policy contexts.

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MASONVILLE COVE MITIGATION DESIGN AND CONSTRUCTION

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The Maryland Port Administration (MPA) is completing the major environmental mitigation components required by construction of the Masonville Dredged Material Containment Facility (DMCF). The DMCF project consisted of filling about 130 acres of waters of the Patapsco River, which is a major tributary to the Chesapeake Bay. The mitigation is a comprehensive package of in-water and upland projects totaling over $20 million. The majority of mitigation is located adjacent to the DMCF in 90 acres of open water and 50 acres of upland that comprise Masonville Cove. The projects serve to enhance existing habitat, remediate contamination, and provide opportunities for community-based environmental education to promote stewardship of the Bay waters for local citizens. The completed in-water mitigation projects include 5 acres of tidal wetland creation, 2 acres of tidal wetland enhancement, 6 acres of non-tidal wetland creation, 90 acres of sand placement in water for substrate improvement, placement of 2,000 concrete reef balls, and 2 acres of concrete rubble for reef creation. Adjacent upland remediation and terrestrial habitat enhancement projects included capping 30 of the 50 acres with 2 feet of clean soil and planting the total 50 acres with native trees, shrubs, and non-woody vegetation. A noteworthy feature of the project was the construction of a net-zero energy environmental education center using renewable solar and geo-thermal technology. Implementation of the mitigation package required integration of the remedial activities with the habitat enhancements and coordination with stakeholders and community members. This paper presents details of the many project designs and construction methodology used to build the projects. Completed projects are presented, along with lessons learned.

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PALEOECOLOGICAL PERSPECTIVE ON ECOLOGICAL RESILIENCE: THE YOUNGEST FOSSIL RECORD AS A HISTORICAL ARCHIVE OF ECOSYSTEMS

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To fully assess ecosystem resilience, we need to develop a historical perspective on long-term stability and volatility of communities. Multiple studies of the last two decades indicate that the most recent fossil record (i.e., surficial death assemblages and shallow cores) represents a viable source of such long-term historical data. Those studies suggest that paleoecological data can be of direct relevance to ecosystem conservation and restoration efforts by providing quantifiable data that offer us a multi-centennial to multi-millennial perspective on ecosystem dynamics. Two critical assumptions underlie this novel approach: (1) fidelity – paleoecological data record faithfully ecological signals; and (2) chronological control – the time span and spatiotemporal resolution of those records can be estimated reliably.

Over recent decades, data fidelity has been tested directly by comparing living communities and their sympatric death assemblages. These death assemblages consist primarily of skeletal remains of organisms with high potential for fossilization such as mollusks, corals, mammals, diatoms, or foraminifera. The outcomes of those tests indicate that death assemblages represent high quality record of alpha diversity, beta diversity, faunal composition, and community gradients. There is thus emerging evidence that paleoecological data can provide a valid proxy for biological communities.
Thanks to rapid advances in geochemical techniques, it is now possible to date large numbers of individual specimens of mollusk shells, echinoid tests, and other skeletal remains. Numerous dating projects have been conducted over the last decades, with particular focus on mollusks. These studies consistently suggest that death assemblages provide time-averaged records spanning multiple centuries or millennia. They, thus provide a long-term proxy for past ecosystems extending back far into pre-industrial times.

Thanks to the high fidelity of death assemblages and the rapidly emerging understanding of their temporal nature, it is increasingly viable to use paleoecology for assessing past states of ecosystems and evaluating community responses to both pre-industrial and post-industrial environmental changes. Paleoecological data derived from the most recent fossil record can provide an important historical perspective on the long-term stability and resilience of ecosystems.

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MONITORING AND DATA MANAGEMENT TO INFORM CONSERVATION IN THE DELAWARE RIVER WATERSHED INITIATIVE

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The Delaware River Watershed Initiative involves collaboration among professionals from different disciplines to protect aquatic ecosystems throughout the Delaware River Basin and the Kirkwood-Cohansey Aquifer. The projects encompass a combination of place-based restoration land preservation, and engagement, and watershed-wide policy. We identified eight "clusters" of subwatersheds, constituting approximately 25 percent of the total Delaware Basin, where analysis has shown that investment in water quality could deliver significant returns. A key component of the program is to monitor waterways potentially affected by restoration and preservation actions and to analyze these watersheds on multiple scales. Monitoring plans are executed primarily by professional researchers, but include partnerships with citizen and stakeholder groups as well. The result is a flexible but comprehensive and consistent approach to monitoring. Unique approaches have been applied to involve diverse stakeholder groups, identify sampling sites and to measure water quality changes in the short- and long-term. An open source, relational, georeferenced database has been developed for projects details and monitoring data. This database will facilitate collaborative research and project inventory for partners in the Initiative and beyond.

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WETLAND RESTORATION UNDER THE AGRICULTURAL CONSERVATION EASEMENT PROGRAM IN FLORIDA

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The Natural Resources Conservation Service (NRCS) conducts wetland restoration in Florida under the Agricultural Conservation Easement Program-Wetland Reserve Easements (ACEP-WRE), as part of the 2014 Farm Bill. ACEP-WRE is a voluntary program in which eligible landowners can enroll their property in either 30 year agreements or perpetual easements to restore wetlands on agricultural land. The program, formerly Wetlands Reserve Program (WRP), originated in the 1990 Farm Bill and was piloted in nine states. The 1995 farm bill made the program available to private landowners, Indian tribes and state and local governments throughout the country for the purpose of restoring wetland habitat. The 2002 Farm Bill and all subsequent farm bills have limited program eligibility to only private landowners and Indian tribes. Eligible land must be former wetlands that have been drained or altered by agricultural use and no longer have the desired wetland functions.

The first WRP easements in Florida were enrolled in 1998 in partnership with St. Johns River Water Management District. Florida NRCS enrolled a handful of easements each of the following years through 2007 on mostly private land converted to improved pasture for livestock grazing. The increased funding levels in the 2007 farm bill coincided with the real estate decline and allowed for a “perfect storm” in which 85,000 acres in permanent easements on large ranches and fallow cropland were enrolled in a five-year period. The majority of easements enrolled in the last few years have been on citrus land due to the effects greening has had on the industry. Florida now has over 178,000 acres in restoration agreements and permanent easements on land formally used for pasture, sod, crop and citrus production. Restoration activities have been completed on approximately 111,000 acres with the remaining acres currently in some stage of planning, design, permitting or construction.

The easement restoration process involves detailed surveying, ecological assessments, hydrologic modeling, engineering designs, permitting and construction activities. Various land uses and levels of manipulation provide numerous design and ecological challenges to ensure properties can be restored without causing any negative onsite or offsite impacts. Semi improved pasture on large ranches is typically far less complicated with a much quicker ecological response time than more heavily manipulated small parcels of bedded citrus land. Typical restoration practices include water control structures, dikes, land smoothing and plugging ditches, along with invasive species control, native species planting, brush management and prescribed burning. There is also a significant effort in monitoring, management, and maintenance of restored easements with controlling invasive species being the largest challenge. Florida NRCS has engaged several consulting companies and partner agencies such as the US Fish and Wildlife Service, the Army Corp of Engineers and the Florida Fish and Wildlife Commission to assist with this enormous restoration effort.

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RESTORATION STRATEGIES FOR SUBMERGED AQUATIC VEGETATION ON SITES HIGH IN SEDIMENT ORGANIC MATTER

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In recent decades populations of native submerged aquatic vegetation (SAV) have declined in Florida spring runs due to sharp increases in benthic filamentous algae and a suite of other anthropogenic changes. Though managers are attempting to revegetate many degraded spring runs, sediments in these sites are often highly reduced due to high sediment organic matter content and thick mats of benthic algae. In these reduced conditions, phytotoxic compounds such as hydrogen sulfide can potentially hinder plant establishment and growth.

In this study we compared three different methods for planting eelgrass (*Vallisneria americana*) in a formerly vegetated section of a Florida spring run: seed broadcasting, ramet planting, and sod installation. For each planting method, we established plots in organic sediments covered in benthic algae, in mineral sediments free of benthic algae, and in sediments where benthic algae and organic matter had been recently removed via hand dredging (n=3). To determine which management approach was best for reestablishing eelgrass, we monitored sediment redox potential and plant growth for four months. Preliminary results show that biomass in both ramet and sod plots had increased after one month in both the mineral sediment treatments and in treatments where benthic algae was removed. Conversely, many ramets planted in benthic algae/organic treatments have senesced after only a few weeks. When planting eelgrass in sites high in organic matter, managers can increase planting success by first dredging and/or removing benthic algae from sediments. In sites where this is not possible, installation of eelgrass sod with an established root system may act as a viable planting alternative.

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NATURAL RESOURCE ADAPTATION ACTION AREAS: A PLANNING FRAMEWORK FOR RESTORATION

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Sea level rise (SLR) is a growing threat to coastal communities in Florida and around the world. One response local municipalities can take to address the ecological and economic challenges of SLR is to incorporate adaptation strategies into city planning and policies. However, most of these efforts have occurred in large cities, with a strong focus on the built environment. Coastal rural municipalities often have fewer resources to develop adaptation plans, and differ from their urban counterparts in two critical ways: they contain less infrastructure and the local economy is usually more dependent on natural resources. With these important differences in mind, we have developed a SLR adaptation plan for Yankeetown, Florida, a small coastal community on the Gulf Coast in Levy County.

In 2013, Yankeetown received a grant from the Florida Department of Economic Opportunity (FDEO) to amend its comprehensive plan to include a Natural Resource Adaptation Action Area (NRAAA; an area vulnerable to SLR impacts and subject to coastal flooding) through science-based planning and nature-based economic development. In collaboration with Yankeetown, we identified a 17-acre NRAAA and developed a corresponding SLR Adaptation Action Plan outlining restoration and adaptation methods for increasing ecological community resilience to environmental change in the face of SLR. The Plan includes 1) a Science Plan summarizing existing conditions within the NRAAA and providing specific long-term SLR adaptation strategies, and 2) a Municipal Business Plan, focused on nature- and education-based tourism opportunities, aimed at increasing town revenue for supporting SLR adaptation recommendations. Our recommendations are organized into three broad planning strategy categories outlined by FDEO: protection, accommodation, and retreat. We recommend protecting the NRAAA against SLR by promoting natural structural barriers (e.g., oyster reefs and living shorelines) through restoration and preservation. Likewise, restoring and preserving naturally submerged habitats adapted to tidal flooding (e.g., seagrass beds and salt marsh) accommodate increased flooding conditions resulting from SLR. Lastly, we recommend retreat of development by maintaining a buffer for habitat migration, allowing ecological communities to migrate landward as a means of minimizing net habitat loss. These recommendations not only benefit ecological communities and stabilize the physical landscape, they create opportunities for multiple restoration projects to occur in the NRAAA, all with shared objectives, and can also easily be expanded for large-scale, regional restoration and enhancement efforts.

Yankeetown is currently considering adopting the Adaptation Action Plan into its local government comprehensive plan. Integrating science into the local government planning process and building economic resilience by promoting a sustainable, natural resource-based local economy is a new and unique approach for addressing SLR impacts in coastal communities. The development of this work in Yankeetown serves as a pilot for other rural coastal municipalities facing the many challenges of a changing climate.

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CHOOSE YOUR WEAPON: COMPARING INVASIVE REMOVAL METHODS IN AN URBAN WATERSHED

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The Hunnicutt Creek Restoration Project is an ongoing effort started in 2013 with the goal of re-establishing the natural functions and conditions of a degraded watershed located on Clemson University's campus. Monitoring and removal of invasive species, primarily Chinese Privet, Silverthorn, and Nandina, within the upper reaches of the watershed is one of the main goals toward restoring a natural and more aesthetically pleasing system. We established thirty 5x5 meter plots, using the Carolina Vegetative Survey protocol, to measure the effectiveness of various removal techniques. We used four treatment methods to remove invasive species: chemical, mechanical, mechanical and chemical, and prescribed grazing. A variety of herbicides and mechanical removal techniques were used based on plant size. Mechanical and chemical treatments combined both techniques by removing plants and then applying herbicides to cut stems. Prescribed grazing consisted of 40 goats contained in an area for 40 days. Five plots were randomly assigned to each of these treatments in addition to five control plots. With 5 plots selected as reference sites to establish a target long-term restoration goal and for comparison with treatment plots. Preliminary results indicate that the chemical and mechanical treatment is the most effective at reducing cover and stem count of invasive species. The goats were effective in opening up the landscape but were not selective in their grazing. In addition to our efforts of analyzing one year of collected CVS from the monitored plots, we are increasing our removal efforts with a volunteer force using the mechanical and chemical treatment. Further restoration efforts are being made with the propagation of desired native species for eventual introduction into watershed.

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NYC SALT MARSH ASSESSMENT FOR RESTORATION AND RESILIENCY PLANNING: STRATEGIES FOR IDENTIFYING AND PRIORITIZING RESTORATION NEEDS AND OPPORTUNITIES

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Today, New York City (NYC) has about 4,000 acres of intertidal salt marsh, representing less than 20 % of the historical extent of this ecosystem in the Hudson River Estuary region. These remaining marshlands are highly vulnerable to further loss during this century due to sea level rise (SLR) and other stressors. In order to improve the long term viability of these marshes, and to prioritize restoration, the NYC Department of Parks & Recreation's (NYCDPR) Natural Resources Group (NRG) is conducting an EPA funded project in partnership with the Natural Areas Conservancy (NAC) and The Nature Conservancy (TNC) that evaluates the current condition and vulnerability of NYC wetlands to a variety of factors and prioritizes marshes and their adjacent uplands for restoration. Through field and desktop analyses NRG, NAC, and TNC evaluated current marsh condition, vulnerability to SLR, and opportunities for protection, restoration and potential inland migration for salt marsh complexes across NYC.

At the 25 largest fringe salt marshes across the city, ecological condition data was collected using a rapid assessment method focusing on vegetation and soil parameters. Changes in vegetated marsh area and marsh loss at these sites was determined by comparing current marsh area on the ground and in the field to 1974 tidal regulatory maps and aerial photos. Future marsh inundation projections at these sites were developed using Sea Level Affecting Marshes Model (SLAMM) for NYC developed by Warren Pinnacle. The field data, landscape parameters and other data sources were used to develop condition and vulnerability indices for each marsh. Opportunities for restoration at the marshes were identified, as well, both in the field and through an analysis of likely future inundation based on SLAMM. Several restoration strategies were identified to optimize adjacent future inland migration, restore lost marsh and improve the longterm viability of the existing salt marsh footprint. These included identifying parcels of land adjacent to the marshes for acquisition by NYC Parks to facilitate marsh migration, identifying impervious areas that impede migration, prioritizing sites in need of increased elevation, and prioritizing sites to restore, or build out, in the water ward direction where marsh has recently eroded or converted to mudflat. Our analysis and findings are being used develop salt marsh restoration and management priorities, to identify potential wetland mitigation sites, and to inform local waterfront planning initiatives, as well as state and federal coastal resiliency programs.

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URBAN SALT MARSH RESTORATION OVER TWO DECADES IN NYC: ASSESSMENT STRATEGIES AND PRELIMINARY RESULTS

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Since 1990, tens of millions of dollars have been invested in the restoration of hundreds of acres of salt marshes across New York City. However, there has never been a city-wide assessment to examine the condition of these varied restoration sites and whether they have been successful in restoring salt marsh structure and function in NYC. We believe such an assessment is essential in the context of continued wetland loss and need for restoration of these systems in NYC. The objective of our study is to quantify ecological conditions and functions in restored marshes of varying types and ages in order to: (1) compare restoration sites to one another and to existing salt marshes; (2) assess whether there is a need to develop salt marsh restoration design guidelines to account for sea level rise and climate change; (3) review and refine restoration monitoring guidelines. We developed a protocol to quantify the functions of habitat, through measurements of vegetation percent cover, stem heights, aboveground plant biomass, and fauna counts, and Marsh Structural Stability through belowground biomass sampling, soil characterization, and a desktop analysis of change in marsh area since restoration. A simplified protocol only examining percent cover and fauna was applied to 16 restored sites across the city in June and July 2015. A more intensive protocol that included biomass collection and soil cores was applied to 8 restored sites and 6 reference sites in August and September 2015. The findings from this sampling will be analyzed and compared across restored sites and with natural sites to determine statistical differences. The goal of this project is to use this information to help inform future salt marsh restoration monitoring and design.

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USING NATIVE COTTONWOOD TO IMPROVE WATER QUALITY IN URBAN STREAMS

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As a part of a larger study to rehabilitate an urban riparian area along an agricultural drainage canal that flows into the Rio Grande at the city of Sunland Park, NM, cottonwood (*Populus fremontii ssp. Fremontii*) trees were planted and monitored in a test-site. Nine cottonwood cuttings were planted in each of the six 40 ft x 40 ft test plots, during the growing season of 2014. All plots were enclosed by six inch tall earthen borders. Of the six plots, three plots were amended with a three inch layer of clinoptilolite zeolite mixed with native sandy soil. Two additional plots with and without amendment were also created as a control. To study cottonwood's ability to improve water quality, each plot was to be flooded with four inches water from the canal. Once this water infiltrated into the soil, it would be collected via buried drainage pipes and tested. Due to time constraints, this flooding test was not carried out. It was hypothesized that the use of low water consuming and established native riparian vegetation along with zeolite amended soil, would improve water quality in nearby urban drains through filtration and phytoremediation of contaminants. Baseline data on soil texture and chemistry, depth to groundwater, plant growth and survival were collected during the summer of 2015. Preliminary data on both soils show that the cation exchange capacity (CEC) of soil saturated paste (1:1 ratio of soil:distilled water) ranged from 10.4 to 14.8 cmol/kg. The sodium adsorption ratio (SAR) for the plots ranged from 3.19 to 8.68. Electrical conductivity of soil saturated paste (ratio of soil:distilled water of 1:5) ranged from 348 μS/cm to 702 μS/cm. This type of soil can be classified as "normal" salt-affected soils (EC of saturated paste < 4000μS/cm and SAR <13) and is expected to sustain cottonwood trees. This study is in progress and long-term data collection is anticipated including chemistry of leachate in the drainage pipes from the plots and assessment of cottonwood for use in phytoremediation.

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ZEN AND THE ART OF ECOSYSTEM RESTORATION: ASSESSING PRECISION AND ACCURACY IN THE LAB AND FIELD

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Quality assurance and quality control (QA/QC) are well established practices in the analytical laboratory. There are many steps along the sampling, sample preparation, and instrumental analysis pathway where QA/QC samples and checks can be inserted to quantify and minimize the overall uncertainty in the final number. A common misconception among ecosystem restoration practitioners is that rigorous QA/QC measures cannot be applied to field measurements or observations. In Robert Pirsig's classic novel "Zen and the Art of Motorcycle Maintenance" he explores two definitions of quality, one classical and one romantic. Laboratory QA/QC conforms largely to the classical definition while field QA/QC is often romanticized. Rather than gathering quantifiable QA/QC data during field monitoring activities, ecosystem restoration practitioners may go by a "gut-feeling" that the measurements are "good". This presentation explores the similarities and differences in QA/QC procedures that are commonly in place in laboratory analyses and can and should be implemented in field measurements associated with assessing the success of ecosystem restoration projects. We focus primarily on precision and accuracy as metrics of data quality. Although the concepts for assessing precision and accuracy of ecorestoration field data are conceptually the same as laboratory data, the manner in which these data quality attributes are assessed is different. The sample plot can be likened to an analytical laboratory sample while the field crew is comparable to a laboratory instrument that requires initial and re-calibration, with results obtained by experts at the same plot treated as laboratory calibration standards.

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ASSESSING THE IMPACTS OF ENDOCRINE DISRUPTING COMPOUNDS ON FISH POPULATION DYNAMICS: A CASE STUDY OF SMALLMOUTH BASS IN PENNSYLVANIA, USA

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Quantifying the population-level effects of endocrine disrupting compounds (EDCs) is essential for understanding the risk of EDCs to aquatic and terrestrial organisms and for helping to inform land and water management decisions. Using the smallmouth bass in Pennsylvania as an example, we explored the impacts of EDCs on fish populations through a model simulation. This study focused on seven of the major rivers that support smallmouth bass recreational fisheries in Pennsylvania. Populations in several of these rivers have shown signs of intersex and disease and have declined in abundance, which has raised concern about the potential effects of EDCs in Pennsylvania and in the Chesapeake Bay watershed in general. Using age-length data, catch-per-effort data and young-of-year data from fishery independent surveys, we conducted an integrated analysis that incorporated the Von Bertlanffy growth model, the Ricker spawner-recuritment model, and the fishing processes into the catch-at-length analysis framework. We applied the Bayesian approach to estimate growth, natural mortality and recruitment parameters. We assumed river-specific parameters to account for spatial variation in life history traits and fishing activities. We examined the correlation between key life history parameters and the EDC related factors such as the percentage of agriculture land and the number of potential EDC sources within each river drainage area. Using the developed model, we conducted a simulation to evaluate the response of fish populations under scenarios in which individual growth, mortality and reproduction were impaired due to exposure to EDCs. We aimed to provide a modeling framework to investigate the impacts of chemical pollutants such as EDCs on fish and wildlife at population level.

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RESTORING AND ENHANCING LIFE HISTORY HABITATS THROUGH LARGE AREA PERMITTING

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Habitat restoration and enhancement projects are often localized and site specific, yet many animals expected to benefit from such projects are mobile members of populations with broader geographic ranges. Gag grouper (*Mycteroperca microlepis*) is an example of an economically important reef fish that has a spatially stage-structured life history, with ontogenetic habitat shifts from seagrass nursery habitat, through shallow-shelf juvenile habitats of variable quality, to spawning aggregations along the shelf-edge break. The Steinhatchee Fisheries Management Area (SFMA) is a federally permitted large area (~100 sq. mi.) in the northeastern Gulf of Mexico that has been enhanced to alleviate a suspected bottleneck in the gag population due to density-dependent growth and mortality of juveniles. Given its scale, the SFMA took 15 years to implement, from conception through construction; evaluation studies are now underway. Steps taken over that period illustrate the stakeholder, regulatory and resource management cooperation that is inherent in the policy paradigm proposed by this session.

Conception of the SFMA occurred in spring 1997 when a coastal business leader sought help to develop artificial reefs for economic development. Gestation of the SFMA occurred through a series of discussions about ecological processes affecting sustainable reef fish fisheries and the efficacy of artificial reefs as fisheries management tools. The resulting objective for the SFMA was to alleviate the suspected life history bottleneck for gag, and thereby serve the sustainability of the coastal economy.

The SFMA concept was then shared with key staff of the Florida Fish and Wildlife Conservation Commission's (FWC) Division of Marine Fisheries Management, who organized an October 1997 interagency meeting with the Florida Department of Community Affairs, Coastal Zone Management Program and the Chief of the Atlantic Permits Branch of the US Army Corps of Engineers (USACOE). That meeting was followed by a June 1998 meeting of the same parties, plus representatives of the NOAA National Ocean Survey, the US Coast Guard and the Florida Department of Environmental Protection.

Public workshops were organized through the Taylor County Cooperative Extension Office to address citizen concerns and build public support. Presentations to the Regional Planning Council and elected representatives helped to solidify local support.

Pre-application meetings with the USACOE were held in 2000 and 2002, with the permit application submitted on 14 June 2002. The permit was issued 23 December 2004 and renewed in 2009 and 2014.

Construction contracts from the FWC Artificial Reef Program funded 40 evaluation reefs in 2005 (Phase I) and 500 conservation reefs in 2011-2012 (Phase II), plus 14 fishing reefs in a designated zone. Multi-year research grants from NOAA Fisheries are funding the SFMA evaluation.

Clearly, early acceptance of the conceptual plan was crucial for permitting and implementing the SFMA.

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CHANGING THE RESILIENCE PARADIGM: BEYOND RISK MANAGEMENT TO ADDRESS COMPLEXITIES OF LARGE INTEGRATED SYSTEMS

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In the face of uncertainty, there is growing recognition of the short-comings of risk analysis and conventional risk management approaches for environmental management. Risk management is often focus on hardening components of the system that have high probability of failure, often without any consideration of how fast critical functionality of the system can be regained. Realization of the inability to predict threats resulted in significant interest in resilience-based management which is focused on the ability of a system to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events. Resilience thus uses strategies of adaptation and mitigation to augment traditional risk management. Resilience can be planned for, built, and managed even if the nature of the expected adverse impacts or system vulnerabilities are not fully understood. However, resilience management is a new discipline and there is a great deal of confusion on similarities and differences in risk and resilience, especially as it applies to critical infrastructure and environment. This presentation will focus on the needs for resilience-based management and ways in which environmental practitioners can operationalize resilience. Methods and tools that are able to reconcile conflicting information, as well as the complex context of the decision making environment will be discussed.

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REINTEGRATING NATURE IN A DENSE URBAN ENVIRONMENT: RESTORATION OF WALLER CREEK

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Waller Creek is a highly urbanized stream in downtown Austin, Texas that has experienced severe flooding, channel erosion, and degraded water quality. The intense wet-weather flows in the creek will be controlled through the construction of a large tunnel, which will reroute stormwater beneath downtown Austin and deliver excess flows to the receiving waterbody, Lady Bird Lake. Upon completion, the Waller Creek Tunnel will remove approximately 28-acres of downtown land from the 100-year floodplain creating a new hydrologic condition for the creek and a unique opportunity for urban revitalization and ecological restoration of the Waller Creek Corridor.

Waller Creek is negatively impacted by dense urbanization, a degraded drainage network, slope failures, and an aged, disconnected trail system. The ability to control flooding in the Waller Creek Corridor has allowed project partners to realize the large-scale restoration potential for this delicate urban ecosystem. In cooperation with the City of Austin and the Waller Creek Conservancy, the restoration of Waller Creek is being planned by an integrated team of landscape architects, hydrologists, engineers, scientists, and ecologists. An important part of the project has been working with the City, the Conservancy, and regional planners to develop a common understanding of the goals for development of the Creek corridor, including human use opportunities, water quality, aesthetics, ecological restoration, and habitat creation.

LimnoTech's primary role in this multi-phase project is to analyze the creek hydrology and hydraulics under existing and post-tunnel conditions. Restoration of Waller Creek has been guided by the philosophy of the Stream Functions Pyramid, where the biological, physicochemical, and geomorphological functions depend on the hydrology and hydraulics of the ecosystem. We are using hydrologic and hydraulic models (HEC-HMS and HEC-RAS, respectively) of the creek system to evaluate the effects of varying flow regimes on water surface levels and stresses under the full range of flow conditions to inform channel design and habitat creation. An adapted geomorphology responding to these changed hydrologic conditions requires a fundamental alteration of channel section and plan that varies significantly by reach, requiring combinations of hard and soft channel modifications that coordinate with the planned human use of the restored waterway and restoration goals. This presentation will provide an overview of the project, discuss restoration goals, and highlight model results used to inform the ongoing ecological restoration of Waller Creek.

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ESTUARINE FISH AND SUBMERGED AQUATIC VEGETATION RESPONSE FROM THE C-111 SPREADER CANAL WESTERN PROJECT

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The C-111 Spreader Canal Western Project (C-111 SCWP) was completed in January 2012 and began functioning in May of that year. The project was designed to ameliorate the problem of ground water seepage from Taylor Slough to the C-111 canal. The goal of this project was to increase freshwater flow through Taylor Slough to Florida Bay by reducing losses to the canal system with the express purpose of promoting more natural physical conditions in northeastern Florida Bay. The intended outcome was to create more favorable ecological conditions down stream that would result in increased submerged aquatic vegetation (SAV) and higher prey base fish production that favor successful nesting of colonial water birds in northeastern Florida Bay. Our ecological monitoring program has been systematically collecting hydrologic, SAV and prey base fish data in the mangrove zone north of Florida Bay since 1996. The mangrove fringe is critical foraging habitat for myriad piscivorous predators. This monitoring program was designed specifically to examine the ecological responses to water management practices that influence freshwater flow through the C-111 and Taylor Slough. We predicted that if the project performed as models indicated, the ecological response would be an increase in overall SAV, a change in fish community structure and a gradual increase in fish biomass. Our approach to analyzing the ecological affects of the C-111SCWP was to compare our data from any given hydrologic year following completion of the C-111 SCWP to a previous year that had similar rainfall patterns and antecedent conditions but was not subject to the influences of the C-111 SCWP. For the first two hydrologic years (June-May) post project (2012-13 and 2013-14) the C-111 SCWP appeared to result in hydrological and ecological responses in the mangrove zone that fit our predicted outcomes. Both of these years had cumulative rainfall patterns that were proximal to the median values in several parameters compared to our period of record, i.e., we considered these rainfall years to be "typical." In the last year (2014-2015), the rainfall analyses indicated it was a "drought" year compared to our period of record. Although the C-111 SCWP pump structures slightly exceeded the output of the two "typical" years, flows through Taylor Slough did not increase compared to a similar "drought" rainfall year prior to the C-111 SCWP. Hydrological and ecological data indicated no change over baseline despite the high outputs of the C-111 SCWP structures. These results lead to the conclusion that Taylor Slough remains primarily a rainfall driven watershed with little hydrologic influence from the greater Everglades watershed. When rainfall conditions are "typical", the C-111 SCWP appeared to perform well in redistributing water between the C-111 and Taylor Slough, however, in drought years, the lack of connectivity with the greater Everglades rendered the project ineffective. Our preliminary conclusion is that the C-111 SCWP appears to have benefits in correcting timing and distribution issues with the C-111/Taylor Slough basin but falls well short in correcting quantity issues, a condition we expect to continue until restoration efforts re-establish the natural hydrologic connection between Shark River Slough and Taylor Slough across the Rocky Glades.

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PIGMENT-BASED CHEMOTAXONOMY: A RELATIVELY EASY AND ECONOMICAL METHOD FOR MICROALGAL COMMUNITY ASSESMENT AND ADAPTIVE MANAGEMENT

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Pigment-based chemotaxonomy utilizes a taxon-specific marker pigment to calculate (viz. estimate) the amount of chlorophyll-a contributed by that taxon (Division, Class) to the total community chlorophyll-a. The percentage of taxon-specific chlorophyll-a then equates to the percentage of that taxon in the microalgal community. The molar or weight ratio of each marker pigment to chlorophyll-a varies amongst the various taxa and does require a certain amount of ground trothing to account for physicochemical variables such as temperature, light (photon flux density and spectral dispersion), nutrient stress, and the-like.

Our studies of phytoplankton, periphyton and epiphytes in Lake Okeechobee, the Everglades and Florida Bay have shown that, due the presence of senescent and dead microalgae as well as resuspended sedimentary material, this methodology works much better with fresher materials. That is, especially in the case of periphyton and epiphytes, artificial substrates (mimics) which can also be time-course monitored work the best. The reason for this is that, during senescence and death related biochemistries, certain pigments and their taxa, such as fucoxanthin / diatoms-chrysophytes and peridinin / peridinin-type dinoflagellates, are preferentially lost relative to the more stable carotenols and their source taxa (zeaxanthin / cyanobacteria; alloxanthin / cryptophytes; lutein / chlorophytes). Periphytometers (glass slides) and “epiphytometers”, such as subaquatic vegetation blade mimics and artificial emergent (bulrush etc.) plant stalks (viz. “sweater” style epiphytes) allow monitoring the recruitment selectivity of microalgae without significant interference from senescent / dead materials. Using marker pigments for nitrogen-fixing (diazotrophic) cyanobacteria, the impact of phosphorus pollution, lowering the Redfield Ratio and selecting for those taxa, can easily be discerned.

As samples are routinely collected for total chlorophyll (-a) determinations, the extension of sample extraction to high performance liquid chromatography (HPLC), which is amenable to autosampling, easily returns the data required to enter into simple Excel based simultaneous linear equations (SLE) and/or more complex algorithms such as CHEMTAX or the Bayesian Community Estimator (BSE).

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ECOLOGICAL AND HYDROLOGICAL RESPONSE OF FLORIDA BAY TO THE C-111 SPREADER CANAL WESTERN PROJECT

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Drainage and diversion of water from the Everglades watershed during the 20th century has reduced flow to the Florida Bay estuary by about half. This has resulted in lower water levels and drier conditions in the southern marshes and higher salinity in the estuary. The resulting ecological impacts in Florida Bay are the periodic decimation of the seagrass community, sporadic algal blooms, shifts in community structure and reduced faunal abundance. The implementation of the C-111 Spreader Canal restoration project in 2012 and adaptive management of the water supply is designed to restore greater freshwater flows to Florida Bay through Taylor Slough by reducing seepage to the east of the main flow way, thus retaining water in the central slough that delivers freshwater to Florida Bay. A multi-scale, multi-disciplinary science and monitoring program is tracking the effects and potential benefits of the restoration, including water levels and flows, salinity distribution, nutrient fate, transport through the wetland and loading to Florida Bay, and vegetation and faunal responses in the marsh and in the bay.

Long-term ecological datasets from the period prior to and following implementation of the C111 project are compared to determine trends and potential ecological responses. Spatial mapping of Florida Bay indicates that the distribution of increased water flow and reduced salinity appears to have responded to the project with a shift from east to west toward Taylor Slough. Ecological responses occur on a longer timescale but some indications are positive. A particular target for restoration is the freshwater requirement needed to reduce seagrass loss and promote species diversity. *Ruppia maritima*, a critical ecosystem component providing food, shelter and habitat in the ecotone has persisted and expanded when freshwater discharge has increased. The *Ruppia* seedbank is shown as instrumental in allowing the species to quickly recover after a period of poor conditions. Forage fish important in the food complexes of larger fish species and wading birds have increased in areas that show improved SAV habitat and reduced salinity.

A twenty year dataset on the nearshore Florida Bay seagrass community shows recovery from a catastrophic loss of *Thalassia* caused by drought in 1987 until a regional drought in 2015 was again likely responsible for an episode of seagrass die-off that is ongoing. However, the antecedent condition of the bay, prior to the 2015 drought, may have been aided by increased fresh inputs, creating more normal estuarine salinity levels, variation patterns and attenuated salinity extremes that promote a diverse seagrass community more typical of historic norms. This pre-conditioning may have better positioned the bay for a more resilient response to the 2015 drought, which could allow a more rapid recovery of the seagrass community.

The potential transport of additional nutrients to the bay with increased flow and their enrichment effect on epiphyte and phytoplanktonic communities is of concern and is the focus of ongoing monitoring and research. A new study of the mechanisms triggering algal blooms in the coastal ecotone indicates that increased freshwater flow may not increase the nitrogen forms that promote blooms and that freshwater flow by dilution may reduce the potential for algal growth.

Significant positive patterns in water level, nutrients, phytoplankton and seagrass have been observed, although the contribution of natural climatic variability versus project effects remains to be parsed through continuing data collection. Overall, the trend is in the desired direction, notwithstanding the die-off event, and the hydrologic setting has been established for continued ecological improvement.

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LEARNINGS FROM IMPLEMENTATION OF A COMPREHENSIVE MONITORING PROGRAM IN THE SOUTH RIVER

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Mercury was used in the manufacturing process at a facility in Waynesboro, Virginia between 1929 and 1950, resulting in its release and migration into surface water, sediments, soils, and biota of the South River. Monitoring plans have been developed to quantitatively evaluate remedy effectiveness within the framework of adaptive management.

A secondary objective of the bank stabilization remedy is the maintenance or improvement in functions and services provided by the river ecosystem. Remedial actions are being considered in terms of their anticipated effects on habitat, wildlife populations and river use by humans.

The broad objectives and the planned phased implementation are being assessed in an adaptive management framework. A comprehensive monitoring plan has been implemented, with consideration of the data needed to reduce the uncertainty in projecting the effects of remedial and restoration actions.   The adaptive management approach utilizes formal decision-analytical tools, which allow integration and visualization of the outputs of data inputs, risk and mercury cycling models. The South River Program demonstrates that the adaptive management framework is a valuable tool that incorporates monitoring data, collected throughout an integrated remediation/restoration effort, to shape restoration objectives by increasing the certainty of projected outcomes from future actions.

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ACTIVE MARSH IMPROVEMENT: A DECADE OF REHABILITATING CATTAIL IMPACTED AREAS

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For the past decade our restoration efforts focused on accelerating recovery of cattail (*Typha domingensis* Pers.) impacted areas in WCA-2A of the Everglades. Our early experimentation involved a spray-then-burn method using Glyphosate and Imazapyr. This initially resulted in vast submersed aquatic vegetation/open-water marshes of *Chara* spp. within 2 years, provided multiple year cattail control but a similar recovery period for desirable emergent/submersed vegetation. These plots were located along a hydrologic and nutrient gradient. This gradient, along with a switch in 2011 to using Imazamox, an herbicide that more selectively controls cattail, were key factors that influenced the amount and spatial extent of cattail reinvasion in all our experimental plots. A decade since implementation, some experimental plots have evolved into either wet prairie or mixed broadleaf marsh; some required no maintenance, whilst others needed bi-annual treatment to maintain a competitive advantage against cattail. Key factors influencing succession over time were the persistence of seedbank and the switch to Imazamox.

We found Imazamox to be an ideal herbicide as it reduced cattail to 20% of its original presence after two years, while minimizing damage to desirable vegetation, and maintaining the ridge and slough spatial structure. Additionally within two years, previously outcompeted slough was re-established such that 4 years post initial treatment slough vegetation was prominent in once historic expanses. Few studies have assessed Imazamox efficacy in such dense cattail areas therefore we conducted a complementary study to assess the minimal amount of Imazamox required to provide effective cattail control and reduce residual chemical while restoring impacted ridges and sloughs on the leading edge of the cattail front. According to the manufacturer, aquatic applications of Imazamox for cattail control are recommended from 32 to 64 fl. oz. per acre. We determined an application of 32 fluid ounces per acre reduced cattail cover by an average of 69% (±33%) and 27% (±47%) at a 24 oz. rate, yet without treatment, cattail cover increased on average 64% (±77%) during the same time period.

In addition, we are refining our treatment strategy, specifically the timing of Imazamox application; comparing the implementation of prescription burning before herbicide application to the spray-then-burn method. It is thought this may provide better coverage of herbicide on cattail and result in greater spatial control. In the future, we plan to use best active marsh improvement strategies to recover and link ridge and slough habitat with tree Islands to provide a network of productive wildlife habitat.

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ALIGNING PROGRAMS AND POLICIES TO FACILITATE PRIORITY PROJECT IMPLEMENTATION: A LOCAL SPONSOR'S PERSPECTIVE

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The State of Louisiana has suffered the loss of approximately 1880 square miles over the last 80 years, and is at risk of losing another 1700 square miles over the next 50 years if bold action is not taken. In order to confront this challenge head on, the State of Louisiana has initiated construction of certain LCA projects in advance of U.S. Army Corps of Engineers (USACE) receipt of Federal funding. WRRDA 2014 authorizes credit for non-federal sponsor's (NFS) in-kind contributions for certain authorized projects, and allows for the use of "excess credit" to meet a NFS's cost share requirement on other projects and implementation of these authorized projects when federal funds are not available. Morganza to the Gulf Risk Reduction Project is one such project where the NFS has initiated 300 million dollars of construction prior to receiving federal money. This provision allows priority projects to proceed at an accelerated pace, and while allowing the maximum benefit of every dollar spent on restoration and protection efforts planning and implementation.

Because over 75% of Louisiana's coastal area is privately owned, working with landowners to implement coastal protection, restoration and conservation projects is crucial to a successful restoration program at any scale. However, interpretation of current policies with regard to fee-title acquisition and restrictive easement policies have been impediments to project implementation, and often conflict with community, state needs and priorities.

The Terrebonne Levee and Conservation District and the citizens of the project area have taxed themselves twice in the last fifteen years in anticipation of paying its cost share for this massive project. In order to fast track its construction the local sponsor has taken on the role of implementing agency for this project. The Morganza to the Gulf Project while mostly a flood protection project has many elements that work in conjunction with massive restoration efforts. While there is much work left to complete this civil work project, several environmental structures and miles of levees and flood gates have been completed since 2009. The five-year outlook for this project includes construction of a lock complex and other restoration features totaling 700 million dollars.

This presentation will discuss the efforts of the Terrebonne Levee and Conservation District through its partnership with Coastal Protection and Restoration Authority of Louisiana, the value of leveraged funding available through the partnerships; the benefits of locally led implementation of these projects and areas where streamlining features of the work can expedite implementation and reduce project costs. It will also focus on aligning state and federal objectives for restoration and mitigation to achieve positive results in implementing the states coastal master plan and achieving maximum benefits with Restore Act funding. More importantly this presentation will focus on reducing restrictions on servitudes and land rights to be consistent with state law and restoration goals.

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COUPLING PALEOECOLOGICAL DATA AND MODEL-PRODUCED HYDROLOGY TO ESTIMATE CIRCA 1900 CE CONDITIONS IN FRESHWATER MARSHES AND MARL PRAIRIES WITHIN EVERGLADES NATIONAL PARK (ENP)

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Paleoecological data from three sediment cores collected by the USGS from freshwater marshes and marl prairies in ENP were interpreted and coupled with model-produced data to estimate the pre-drainage hydrologic regime (stage and flow) in the Everglades within ENP. Each sediment core was located relatively close to an existing ENP stage monitoring station. The proximity of the stations facilitated the use of statistical and numeric models coupled with the paleoecological pollen data to produce time series simulations of the pre-drainage water levels in a Shark River Slough marsh, a marl prairie community east of Shark River Slough, and a marl prairie community east of Taylor Slough.

Multiple-variable Linear Regression (MLR) stage models were developed to combine the output from from the South Florida Water Management Model Natural System Model (SFWMM NSM 4.6.2) with the freshwater wetland paleoecological data to estimate the 1900 CE stage throughout the ENP freshwater wetlands and flow in Shark River and Taylor Sloughs. Down-core pollen assemblages were used to estimate the approximately 1900 CE seasonal average water depth. The SFWMM NSM 4.6.2 output data were adjusted to correspond to the results of the USGS freshwater wetland paleoecological analyses. This procedure converts the average paleo-based stage information into an estimate of the daily stage variability in the freshwater marsh and provides an estimate of the water flow required to achieve it. The paleo-based stage conditions produced by the MLR stage models were used with existing salinity models to simulate the resulting pre-drainage salinity conditions throughout Florida Bay and the mangrove rivers of the ENP Gulf coast. This procedure is a modification of methodologies developed for estuarine-based paleoecological data collected from Florida Bay (Marshall et al., 2009).

The model outputs were compared with observed freshwater wetland hydrology data, observed Florida Bay/Gulf coast salinity data, and estimated pre-drainage conditions (1900 CE; stage, flow, salinity) from the published estuarine paleo-based simulations of Florida Bay. Results indicate that average pre-drainage water levels in the marshes and prairies were about 0.15 m higher and hydroperiods were about two times longer. Paleo-based freshwater delivered to the wetlands was estimated to be 2-3 times greater than the current flow. In Florida Bay, simulated paleo-based salinity was about 5-20 psu less on average compared to modern data, depending on location.

The results of the freshwater wetland analyses are consistent with the published results of the estuarine paleo-based simulations of pre-drainage hydrology and salinity conditions. The results of these analyses add important information to the existing knowledge base regarding the Everglades pre-drainage freshwater hydrology (stage and flow) and estuarine salinity. Combined, the results of the Florida Bay, Gulf coast, and freshwater wetlands paleoecological/modeling investigations act like a 'three-legged stool' with the independent outputs providing corroborating, supporting, or correcting information on the pre-drainage hydrology and salinity conditions in the closely-coupled Everglades coastal system.

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CORAL RELOCATION AND ADVANCED COMPENSATORY MITIGATION

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As described in the 2004 federally approved Miami Harbor Environmental Impact Statement, direct impacts to reef communities were imminent as a result of proposed dredging activities associated with the deepening and widening of the existing federal entrance channel to Miami Harbor. Primary mitigation to offset habitat loss of the protected reef communities was mandated under Florida state law and prescribed by the Florida Department of Environmental Protection (FDEP). In addition to the primary mitigation requirements, in 2011, the National Fisheries Service's Protected Resource Division issued a Biological Opinion stating that staghorn coral (*Acropora cervicornis*), a listed coral species under the Endangered Species Act, would also likely be adversely affected as a result of the project, and special measures would be necessary to reduce impacts to known colonies within the project area.

Mitigation for lost resources was required in the form of artificial reef construction, relocation of hard corals (non-acroporid) within the outer reef (3rd reef) dredge footprint, relocation of potentially affected staghorn corals (*A. cervicornis*) from the middle reef (2nd reef), and post-relocation monitoring of reattached and natural (native) coral colonies for 5 years. The National Marine Fisheries Service also required fragmentation of the relocated imperiled staghorn corals and transfer of the fragments to an authorized coral nursery in southeast Florida to help achieve recovery goals of the species. As an add-on to the prescribed mitigation efforts, and in recognition of the risk of potential unintended impacts often noted during construction projects occurring in close proximity to coral reef habitat, advanced compensatory mitigation was conducted by the dredging contractor. The approach was simple; salvage additional benthic resources that were within the project footprint but exempt from the transplantation requirements due to their location or faunal group.

Consistent with the FDEP permit conditions, all hard coral colonies >10 cm diameter and located within the direct impact area of the third reef were relocated during December 2013 and January 2014 in approximately equal proportions to natural hardbottom and the newly constructed artificial reef. *A. cervicornis* colonies previously identified within 100 ft of the channel edge along the second reef were located, and a 5-cm fragment was collected from each colony and transferred to the University of Miami's permitted *in-situ* coral nursery. The remaining intact colonies were then relocated to natural reefs to the north and south of the project footprint, outside the anticipated area of influence. Advanced compensatory mitigation encompassed the relocation of hard corals, octocorals, and barrel sponges (*Xestospongia muta*) from within the channel, along the channel walls, and from the 3rd reef dredging footprint. A portion of all relocated specimens, both primary and compensatory mitigation, were tagged, and a 30-day monitoring survey was performed showing only partial mortality of the relocated *A. cervicornis*, non-acroporid hard corals, octocorals, and barrel sponges.

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REAL-TIME EVALUATION TOOLS: CAPE SABLE SEASIDE SPARROW HABITAT VIEWER AND TREE ISLAND INUNDATION MONITORING

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The Everglades Depth Estimation Network (EDEN) is an integrated network of real-time water-level gages, computer models, and web-accessible applications that generate daily water-level and water-depth maps and derived hydrologic data for the freshwater part of the Everglades for the period 1991 to current (2016). This quality-assured data source allows for the development of specialized real-time online visualization, statistical, and data analysis tools for use by scientists and resource managers working in the Greater Everglades. The presentation will describe the development of two real-time evaluation applications.

An application was developed to use EDEN water surfaces to evaluate water depths in Cape Sable Seaside Sparrow (CSSS, *Ammodramus maritima mirabilis*) habitats on a real-time basis. The endangered CSSS, one of eight remaining subspecies of seaside sparrow, once ranged throughout freshwater and brackish marsh habitats in southern Florida. The sparrows build their nests less than six inches above the ground in mixed marl prairies. To increase nesting success, these short-hydroperiod prairies must remain mostly dry during the nesting season (March through July). An animated viewer shows flooded areas, calculates the percent dry area, and the consecutive dry days by subpopulation domain. Wildlife-resource scientists and managers can use this EDEN application to assess impacts on nesting success and develop management strategies for the future.

An application was developed that allows real-time evaluation of Everglades Restoration Transition Plan (ERTP) water levels at tree islands by using EDEN data to monitor and compare current water levels with the water levels that occurred during the previous Interim Operational Plan (IOP). The application monitors water-level at 106 gages and 394 tree islands. Daily median water levels during the ERTP period are plotted with daily water-level percentiles computed for the IOP period. An email notification option informs subscribers when current water levels reach specified elevations at one or more gages or tree islands. An alert can also be triggered for a gage when the water-level elevation equals or exceeds the 90th percentile for the IOP period or for tree islands when the water level equals or exceeds the maximum ground elevation. The application provides interested parties an online resource for monitoring potential Central and South Florida Project water-level effects on tree islands in the Everglades.

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ECOLOGICAL CONSIDERATIONS ASSOCIATED WITH LARGE WOOD IN STREAMS AND RIVERS

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Large wood is a natural feature of most lotic ecosystems and exerts a major control on many of the physical attributes of streams; its lack is often attributed as the cause of species declines and alternation of physical conditions in streams. As a result, restoration of large wood is a frequently employed stream restoration strategy usually with the aim of enhancing fish species of management interest. The variable record of the success of wood restoration to achieve biological goals over time argues for consideration of the ecological role of wood, factors controlling the wood budget in the stream and the ecological functions that will be addressed through restoration.

The function of large wood in streams varies regionally and reflects local geology, climate and bio-geography. Though regional differences are important, three broad roles in streams can be identified: 1) formation of meso- and micro- habitat features, 2) control of channel structure and form, and 3) support of organisms that contribute to the trophic structure of streams. Wood interacts with stream hydrology and geomorphology to create meso-habitats (pools, riffles, etc.), provide hydraulic refugia and feeding stations for fish, and create predator refugia as well as habitat for ambush predators. Wood creates bars and cut-banks and traps bed load to aggrade the channel. Large wood provides substrate for bio-films and a community of invertebrates that form the prey base for many fish species. Allochthonous plant material from riparian forests is trapped by wood structures and, in streams with anadromous salmonids, the carcasses of spent spawners as well. This allows organic matter to be processed locally by an array of organisms that support the aquatic food web and species of management concern. Engineered wood structures are an interim solution to the loss of wood in stream channels but the fundamental linkage between riparian forests and large wood must be retained to achieve long-term benefits.

The effectiveness of wood restoration is controlled by a suite of physical and biological factors that collectively determine the potential of a stream to support species and functions of interest. Large wood is part of a hierarchy of biological and physical factors that control habitat formation and maintenance in streams. Restoration projects should be evaluated in the context of a limiting factors analysis to ensure that large wood restoration will achieve management objectives.

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INTEGRATING ECOSYSTEM RESTORATION AND FLOOD RISK MANAGEMENT ALONG THE SOUTH SAN FRANCISCO BAY SHORELINE

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The South San Francisco Bay Shoreline Study is a congressionally authorized study by the U.S. Army Corps of Engineers together with the Santa Clara Valley Water District and the California State Coastal Conservancy to identify and recommend flood risk management and ecosystem restoration projects along South San Francisco Bay. The partnership has completed the first interim feasibility study, which recommends a project that includes construction of an engineered levee to reduce flood risk to Silicon Valley's residents and infrastructure and tidal wetland restoration of former salt production ponds. The ecosystem restoration features will also reduce long-term flood risk in the face of future sea level rise. Technical and policy challenges encountered during the 11-year study process include: addressing tradeoffs between flood risk management, ecosystem restoration, and public access; planning under a range of potential sea level change scenarios; conflicting habitat needs of resident and target species; and managing evolving expectations and requirements in a multi-agency planning partnership.

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WEB TOOLS TO SUPPORT THE UPCOMING EVERVIEW LITE VISUALIZATION PLATFORM

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The EverVIEW Data Viewer desktop application from the Joint Ecosystem Modeling (JEM) community has fulfilled a need for natural resource managers and decision-makers to visualize and interact with complex modeling outputs for the past several years. While the desktop application is able to leverage the resources of a user's computer to provide rich interaction, some users also have a need for a more flexible platform that allows them to quickly visualize modeling data regardless of the computer they are using and without having to transfer modeling data each time. To that end, JEM is developing a lightweight web visualization platform called "EverVIEW Lite" with some of the key features that EverVIEW Data Viewer users are already familiar with, such as spatio-temporal inspection of modeling data and side-by-side comparisons, paired with data management and services needed for a web application platform.

Several tools and services are required to support the data modeling library for EverVIEW Lite. In addition to hosting reference modeling data, such as from Louisiana's 2012 Coastal Master Plan, users will log in to the Data Server Application to manage files and use the Upload Portal to add new modeling data within their quota. The Upload Portal application uses technology that supports pausing and resuming uploads, as well as automatically retrying individual parts of a file upload that may have failed due to network disruptions. The Upload Portal also uses the NetCDF Conventions Checker application to ensure that uploaded data adheres to a basic set of metadata conventions so that it can be properly visualized.

Also supporting the data modeling library is a THREDDS Data Server (TDS) that service-enables data access to hosted files using Open Geospatial Consortium Web Mapping Services layers. Paired with TDS is the NetCDF Tools application that updates datasets with additional, readily-accessible metadata and provides metadata services that EverVIEW Lite needs — but that TDS does not provide — such as minimum and maximum layer values and timestamps, via the JavaScript Object Notation format. Another service, the EverVIEW Lite Data Harvester, is responsible for mirroring external data catalogs that JEM users commonly access, such as the USGS Everglades Depth Estimation Network water surfaces and depths, to increase data availability and throughput to the EverVIEW Lite mapping front end.

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ESTABLISHING INTERIM GOALS AS TOOLS FOR ASSESSING RESTORATION SUCCESS FOR THE COMPREHENSIVE EVERGLADES RESTORATION PLAN

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Programmatic regulations for the Comprehensive Everglades Restoration Plan (CERP) (33 CFR Part 385) state that "interim goals" shall provide a quantitative basis for evaluating the restoration success of the Plan during CERP's implementation period, and will reflect incremental accomplishments of expected performance, as reported in five year increments. Lessons learned from other large-scale restoration programs (e.g., Chesapeake Bay, Puget Sound) on the use of interim goals, the selection of indicators, and adoption of an adaptive management framework are informative and essential to successful watershed restoration. Sustainability of these large-scale programs requires a significant public investment over many years; setting goals and tracking progress are means to ensure accountability for this public investment.

Interim Goals provide a means of tracking restoration performance of the CERP, as well as a basis for reporting on the progress made towards restoration of the South Florida ecosystem, and for periodically evaluating the accuracy of predictions of system responses to the effects of the Plan. Interim goals are restoration oriented and have particular interest to resource agencies and public stakeholders wanting to chart the progress of the program.

The REstoration COordination and VERification (RECOVER) program of CERP provided technical recommendations for the establishment of Interim Goals in 2005; a formal Interim Goals agreement was signed in early 2007. The original set of goal statements from the RECOVER team was largely qualitative, due to lack of well-developed tools with which to predict ecologic responses to CERP implementation. Scientific information gained over the past 10 years through implementation of the monitoring and assessment program (MAP) and ecological modeling tools has caused RECOVER to relook at their 2005 technical report with an eye towards a quantitative update of the initial indicators and recommendations.

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MISSISSIPPI RIVER DELTA MANAGEMENT STUDY: ANALYSIS AND EVALUATION OF PROPOSED LAND BUILDING STRATEGIES

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Sediment diversions on the lower Mississippi River were proposed as a large scale restoration tool in Louisiana's 2012 Coastal Master Plan by the State of Louisiana Coastal Protection and Restoration Authority. The primary goal of the proposed sediment diversions was to create new wetlands and replenish existing areas that were deteriorating as a result of many causes, including hydrological disconnection from the river. In addition to delivering sediment to the receiving basin intended to sustain and build new wetlands, some proposed sediment diversions could discharge a high volume (75,000 cubic feet per second of peak Mississippi River flow) of nutrient-rich fresh water into existing wetlands and bays. The overall goal of the analysis presented here is to improve our understanding of morphodynamic response of the large receiving basins and the ecosystem effects of discharge of freshwater and nutrients. The analysis includes performing an extensive field data collection campaign, and setting up a numerical model capable of simulating: (1) morphological evolution processes resulting from sediment deposition into wetland areas, and (2) salinity and nutrient-related effects to the wetland vegetation, soil, and the estuarine open water conditions of Breton Sound and Barataria Bay estuaries. While the model has been developed to support the immediate need of understanding the effects of sediment diversions, it can also be used to explore changes in the estuary solely due to change in future conditions, e g., subsidence or sea-level rise, the interactive effects of diversions with other restoration techniques, e.g. marsh creation using dredged material, and/or other restoration projects that influence the extent of wetlands within the estuary or estuarine hydrology and mixing.

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HYDROLOGIC REMEDIATION TO REVIVE STRESSED FRESHWATER SPECIES IN TIDAL SWAMPS

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Freshwater supply is becoming a key conservation issue for coastal freshwater wetlands, because freshwater is becoming more limited due to increased anthropogenic water usage and climate-induced drought. In Big Thicket National Preserve (BTNP, TX), salinity levels of tidal swamps rose in 2011−12 because of excessive water extraction and drought, so that freshwater tree species began to die. Our observations led to successful funding for a new project to track groundwater salinity levels in tidal freshwater swamps across the Gulf of Mexico (USGS and UF). Earlier research during the hydrological remediation effort to push oil offshore during the Deepwater Horizon Incident in Jean Lafitte National Historical Park and Preserve (JLNHP&P; LA) demonstrated that freshwater could ameliorate salinity and biogeochemical stresses for trees. Tree production increased in JLNHP&P after four months of hydrological remediation in 2010 versus other years (2007−12). Similarly, tree health increased dramatically after two months of hydrologic remediation in a study of *Eucalyptus* forests along the Murray River (Australia). Also in JLNHP&P, elevation increased from 2011–14, and this phenomenon constituted a regime shift as tested using pairwise regression. By 2015, the elevation in these swamps began to decline. Both studies suggest that hydrologic remediation could be a useful engineering tool to improve environments in impaired freshwater tidal forests. Even short−term releases of freshwater can benefit the health of freshwater species in tidal coastal forests, so that these water management tools may help managers to offset future conservation problems due to climate change and/or water extraction.

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FEDERAL INVESTMENT IN THE CALIFORNIA BAY-DELTA: OPPORTUNITIES AND CHALLENGES

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The California Sacramento-San Joaquin Rivers Delta (Delta) is part of the largest estuary on the West Coast of the United States; is home to hundreds of species of fish, birds, mammals and reptiles; and is considered an ecosystem of national significance. Agricultural land irrigated by Delta water contributes billions of dollars in production for the Nation. Two deep water ports in the Delta serve as important marine terminals for dry bulk cargo vessels transporting agricultural products through the Delta's deep draft navigation channels to world markets. Delta levees protect thousands of acres of orchards, farms, and vineyards as well as critical infrastructure including state and interstate highways, major rail lines, natural gas fields, gas and fuel pipelines, water conveyance infrastructure, drinking water pipelines, and numerous towns, businesses and homes.

The Delta is a web of channels and reclaimed islands at the confluence of the Sacramento, San Joaquin, Cosumnes, Mokelumne, and Calaveras Rivers. Forty percent of California's land area is contained within the watersheds of these rivers. The Delta covers about 738,000 acres and is interlaced with hundreds of miles of waterways. Much of the land is below sea level and protected by a network of 1,100 miles of levees which have been constructed over the past 150 years to manage the flow of water through the Delta. The land behind the levees is predominantly agricultural (corn, wheat, vineyards, cattle) and waterways provide recreational outlets for nearby urban areas and essential habitat for fish and wildlife, including Federally listed species under the Endangered Species Act. The Delta is also the largest single source of California's water supply, providing 25 million Californians with drinking water and irrigating millions of acres of farmland in the Central Valley. In addition, more than 500,000 people live within the Delta and rely upon it for water, recreation, and livelihood. The majority of that population is in the greater Sacramento and Stockton areas, though there are communities within the Delta. Several Delta towns, known as "legacy communities," are listed in the national registry of historic places.

Despite the obvious opportunities with the extensive infrastructure within and reliance upon the Delta, as well as the national status and importance of the ecosystem, Federal investment in flood risk management and ecosystem restoration comes with a variety of challenges. The overlapping purposes of the existing infrastructure (e.g., levees originally built for reclamation of swamplands that now function as water supply conveyance infrastructure and flood risk reduction features) mean that multiple Federal, State, and local agencies have their own objectives to consider when developing a vision for a future Delta. Sometimes these objectives are consistent among agencies, but more typically they are compatible at best, and conflicting at worst. Even within agencies, these multiple purposes for key infrastructure complicate planning and subsequent Federal investment. Traditional agency roles and responsibilities can limit and complicate planning; however, a myriad of opportunities exist for agencies to collaborate, determine where synergies exist, and build reasonable, logical recommendations for Federal investment as the vision for a future Delta continues to evolve.

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IMPROVING SOIL HEALTH ONE GRAIN AT A TIME: INNOVATIVE CROPLAND METHODS TO INCREASE AND TRACK COVER CROPS

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As Chesapeake Bay jurisdictions come closer to the 2017 Midpoint Assessment, Delaware is working harder than ever towards reaching the established nutrient and sediment loads outlined in the states Watershed Implementation Plan (WIP) for meeting the Total Maximum Daily Load (TMDL) or pollution diet. As the easily attainable best management practices (BMPs) are implemented and given nutrient reduction credits, Delaware must seek innovative ways to implement additional BMPs, as well as track practices that are not currently able to be accounted for. One practice that Delaware relies heavily on to reach these goals is the implementation of cover crops.

As an example of efforts to increase practice adoption, the Sussex County Conservation District recently purchased an air seeder to help farmers in the early establishment of cover crops. The technology of the Miller Nitro with a 90 ft. boom equipped with a specialized seed box allows the farmer to plant cover crops while their cash crop is still in the field. The air seeder drops seed below the canopy allowing for better seed to soil contact and more even seed distribution. By planting early, the cover crop benefits from the longer growing degree days during the summer, therefore getting a better established crop to improve water quality and soil health. A pilot program was created enrolling more than 20 interested farmers which began planting in late July and will run through early October. The pilot included a $60 per acre incentive for using the air seeder. There was no fee for using the air seeder but the farmer was responsible for purchasing and loading the seed as well as the fuel. The District partnered on this project with Buckeye Soil Solutions of Ada, Ohio who modified the Miller Nitro with the specialized seed box and distribution system which they built. Southern States Cooperative in Dagsboro, DE also partnered on this project by providing an operator for the air seeder. The goal was 4,000 acres in the first year, which should be surpassed once everything is planted. The additional cover crop acres will help Delaware's farmers get increased nutrient load reductions in the Chesapeake Bay Watershed Model.

Delaware has also taken additional steps to account for practices that were previously thought of as unable to be tracked. In 2014, Delaware's Department of Natural Resources and Environmental Control's (DNREC) Watershed Assessment and Management Section developed a cropland roadside transect survey for obtaining tillage types, crop residue, and cover crop data across the state. Through interagency cooperation, a team was assembled with members from DNREC, University of Delaware Cooperative Extension, Delaware Department of Agriculture, Natural Resources Conservation Service, Farm Service Agency, and County Conservation Districts. The purpose of the survey is threefold: (1) to provide information that can be used by individual soil and water conservation districts and others in establishing priorities for conservation programs, (2) to evaluate progress achieved in reaching county, statewide, and watershed wide goals, and (3) to provide accurate data on the adoption of cover crops and conservation tillage systems. Data collected is verified by the Conservation Technology Information Center and submitted to the Chesapeake Bay Program, making this statistically accurate survey an ideal tool for conducting watershed assessments as well as measuring progress for locally led conservation.

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APPLICATION OF THE NORTHERN PALM BEACH COUNTY VERSION OF THE LOWER EAST COAST SUBREGIONAL HYDROLOGIC MODEL (LECSR-NP) TO DETERMINE INTERIM RESTORATION BENEFITS FOR THE NORTHWEST FORK OF THE LOXAHATCHEE RIVER

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The Loxahatchee River watershed is located along the east coast of Florida within northern Palm Beach and southern Martin counties. The Northwest Fork of the Loxahatchee River is a federally designated National Wild and Scenic River. Although the watershed includes a number of large and relatively intact natural areas that are publically owned, the predevelopment watershed and tributaries covered an area much larger than it does today. Over several decades, adverse alterations to the Loxahatchee River watershed included the opening of Jupiter Inlet, construction of primary drainage features, such as the Central and South Florida Project's C-18 Canal, and construction of secondary and tertiary canal systems, altering drainage patterns and lowering groundwater levels. Construction of a substantial roadway network further reduced the hydrologic connectivity of natural areas to the River. These alterations have reduced significantly the dry season flows to the Northwest Fork and resulted in saltwater intrusion into freshwater riverine and upper tidal reaches.

State of Florida 'Minimum Flows and Levels' (MFL) criteria were adopted to prevent significant harm of the water resource from further withdrawals. Since the minimum flow was frequently not being realized, a recovery strategy was incorporated for the development of a restoration plan for the River. The Northwest Fork of the Loxahatchee River and its watershed is also the focus of the Loxahatchee River Watershed Restoration Project (LRWRP) of the federal Comprehensive Everglades Restoration Plan (CERP) and is a component of the South Florida Water Management District (SFWMD), Florida Department of Environmental Protection (FDEP) and United States Environmental Protection Agency's Restoration Strategies Regional Water Quality Plan. The Restoration Strategies plan for the Loxahatchee River was initiated to identify a replacement water storage facility for a reservoir that was previously a component of CERP and is now a component of Restoration Strategies. The State's Restoration Strategies goals for the Northwest Fork of the Loxahatchee River focus on meeting the MFL criteria and partial river restoration, while CERP's goals focus on providing restoration flows to the river and hydrologic improvements within the watershed.

The Northern Palm Beach County Version of the Lower East Coast Subregional Hydrologic Model (LECSR-NP) is the primary hydrologic model applied for both Restoration Strategies and CERP for the Loxahatchee River goals. LECSR-NP is a MODFLOW-based model that utilizes several add-on packages to simulate wetland systems and canals, water deliveries (or diversions) and water restrictions, in addition to groundwater flow. Model applications assisted in identifying the replacement project and determining interim benefits to the river and its watershed. CERP model applications were updated with state modeling assumptions to focus on meeting MFLs and improving dry season flows to the River without degradation to other natural areas. Model applications were formulated for existing (or without project) and several future (or with project) conditions to evaluate the relative performance of the applications. Model results were applied to evaluation criteria for state goals. A summary of the model applications, evaluation criteria, comparison of the applications and how the model has been adapted for state and federal goals is presented.

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PLANNING, IMPLEMENTATION, AND ADAPTIVE MANAGMENT FOR RESTORATION OF FORMER AGRICULTURAL LANDS AT PERICO PRESERVE IN COASTAL SOUTHWEST FLORIDA

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As continued urbanization and the threat of sea-level rise to coastal areas increase, the acquisition of undeveloped coastal properties for preservation and protection of ecologically valuable estuarine wetland habitats has become common in southwest Florida. Upland portions of these acquisitions for preservation provide opportunities for restoration of native coastal upland habitats, which have become rare in the region due to historical land uses and continued urbanization of coastal areas.
The upland habitats on these coastal properties are often in poor ecological condition due to disruptive historical land uses, typically row crop agriculture. Historical and adjacent land uses have resulted in the upland portions of many coastal properties being dominated for decades by nuisance and exotic vegetation. The repeated soil disturbance and the subsequent establishment of highly competitive nuisance and exotic vegetation has largely extirpated desirable native flora and fauna from upland areas of these sites. These areas are most often isolated from larger contiguous areas of natural upland habitats, which further increases the difficulty of restoration due to a lack of natural recruitment of desirable native species from adjacent sources.

At a 176-Acre coastal acquisition property called Perico Preserve, Manatee County began restoring ecological functions to low quality upland areas in 2007. The ecological enhancements to 56 acres of low quality uplands of the site were specifically planned so that future management, necessary to maintain ecological improvements, would be feasibly sustainable by Manatee County land managers. Careful planning, well executed implementation, and attentive habitat establishment period adaptive management have resulted in the successful early establishment of a variety of habitat types on the once low quality upland areas. This project included restoration of a highly diverse groundcover stratum to restore plant diversity in areas of the site that, prior to disturbance by humans, consisted of pine flatwoods and oak scrub. This was achieved through a combination of direct seeding and out plantings of nursery grown material. Other upland areas became sites for creation of freshwater wetlands, saltmarsh habitats, and approximately 12 acres of created seagrass habitat.

The planning, implementation and early establishment period management methods used on the Perico Preserve project have shown early signs of success. The methods applied and lessons learned during the Perico Preserve project have resulted in desirable project outcomes which are applicable to many coastal preservation property acquisitions that contain low quality upland areas.

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LARGE SCALE AND LONG TERM: THE ROLE OF SCIENCE AND COLLABORATION IN LARGE ECOSYSTEM RESTORATION PROJECTS

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The South Bay Salt Pond Restoration Project (www.southbayrestoration.org) is the largest tidal wetland restoration project on the West Coast of the United States. When complete, the project will restore and enhance 15,100 acres of former industrial salt ponds to a rich mosaic of tidal wetlands and other habitats.

San Francisco Bay has lost an estimated 85 percent of its historic wetlands due to fill or other alterations since the 19th century. This dramatic loss of tidal marsh caused populations of estuarine fish and wildlife to dwindle. It has also decreased water quality and increased local flood risks. Restoration of the South Bay's former salt ponds provides an opportunity to begin to reverse these trends, by improving the health of San Francisco Bay for both people and wildlife for years to come.

A broad coalition of agencies, scientists, conservation groups, and members of the public developed a 50-year visionary plan for balancing multiple objectives of habitat restoration, public recreation, and flood protection in the highly urbanized setting of San Francisco Bay. As with many large scale and long term coastal and estuarine restoration projects, this project faces similar obstacles from competing interests, diverse stakeholders, shifting demographics, and now more urgently - a changing climate. This presentation will examine the use of regional planning documents, an extensive stakeholder process, interagency collaboration, and an adaptive management framework to achieve significant success so far in its first decade.

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MEASURING CHANGES IN NUTRIENT AND SEDIMENT LOAD IN THE CHESAPEAKE BAY WATERSHED

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The Chesapeake Bay is the Nation's largest estuary and one of the most ecologically productive estuaries in the world. Transport of excess nitrogen (that is, total nitrogen), phosphorus (that is, total phosphorus), and suspended sediment from the Chesapeake Bay watershed has had a detrimental effect on the habitat available to the living resources throughout the bay. In 2010, the U.S. Environmental Protection Agency mandated the development of a total maximum daily load (TMDL) for the bay watershed as part of continued effort to reduce nitrogen, phosphorus, and suspended-sediment loads delivered to the bay with an expected improvement in bay habitat as measured by increases in water clarity, the extent of submerged aquatic vegetation, and dissolved oxygen concentration. The Chesapeake Bay Program (CBP), comprised of federal, state, and local governments, academic institutions, and non-profit organizations has agreed to implement sixty-percent of the nutrient and sediment reduction strategies required to meet the bay TMDL by 2017 and all strategies by 2025. The single most-asked question from the CBP is whether nitrogen, phosphorus, and suspended-sediment loads in the bay's streams and rivers are responding to these implemented nutrient and sediment reduction strategies?

The U.S. Geological Survey (USGS), as a partner of the CBP, is responsible for determining the extent to which nitrogen, phosphorus, and suspended-sediment loads are changing as a result of implemented reduction strategies. This is accomplished by analyzing water-quality observations from the 117-station CBP Nontidal Monitoring Network (NTN) to estimate nitrogen, phosphorus, and suspended-sediment annual loads and trends using Weighted Regressions on Time, Discharge, and Season (WRTDS). The resulting trends in nitrogen, phosphorus, and sediment loads are flow normalized to account for the year-to-year variation in river discharge; thus, the remaining trend is a result of changing sources, delays associated with storage or transport of historical inputs, and/or implemented reduction strategies. Nitrogen, phosphorus, and suspended-sediment loads are showing measurable improvement at many locations across the bay watershed from 2005 to 2014. Trends in nitrogen loads are improving at 44 of 81 (54 percent) NTN stations analyzed. The average reduction in nitrogen load, for these 44 NTN stations, is 1.0 pound per acre or 12 percent. Trends in phosphorus loads are improving at 41 of 60 (68 percent) NTN stations analyzed. The average reduction in phosphorus load, for these 41 NTN stations, is 0.17 pounds per acre or 27 percent. Trends in suspended-sediment loads are improving at 29 of 59 (49 percent) NTN stations analyzed. The average reduction in suspended-sediment load, for these 29 NTN stations, is 225 pounds per acre or 29 percent.

The investment made by the CBP in establishing and maintaining the NTN and the innovative load and trend approach developed and applied by the USGS has resulted in an unprecedented network of trend results for nitrogen, phosphorus, and suspended-sediment loads. This trend in load information is critical for measuring progress made by the CBP towards achieving the nitrogen, phosphorus, and suspended-sediment load-reduction goals specified within the bay TMDL.

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SCIENCE-BASED STRATEGIES FOR EXPERIMENTAL FLOODING IN GRAND CANYON

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The completion of Glen Canyon Dam in 1963 dramatically altered the hydro-geomorphology of the Colorado River in Grand Canyon National Park. Annual discharge variability diminished because of reduced peak flows and higher baseflows, and Lake Powell trapped the entire sediment load delivered from the upper Colorado River basin. As a result, sediment deficit conditions developed downstream from the dam and fine sediment deposits were eroded from the river corridor, primarily from eddy sandbars. These eddy sandbars and associated fine sediment deposits on channel margins are vital as a recreational resource for river runners and hikers and as the physical template for the riparian ecosystem and aquatic backwater habitats. The first controlled flood released from Glen Canyon Dam in spring 1996 demonstrated the potential for rehabilitation of geomorphic processes within the riverine ecosystem downstream from the dam. Fine sediment – primarily sand – stored on the channel bed was redistributed to higher elevations in eddy sandbars and along channel margins. But the results also showed that new sandbars often eroded during the subsequent six to twelve months of above-average annual releases associated with proposed new dam operations. Additional controlled floods, also referred to as High Flow Experiments (HFEs), conducted in fall 2004 and spring 2008 supported the hypothesis that floods timed to follow tributary sediment inputs within weeks would increase their effectiveness by maintaining higher suspended sand concentrations in depositional settings.

Monitoring of fine sediment budgets through repeat surveys and a combination of conventional and acoustic suspended sediment measurements during these first controlled floods suggested that repeated, appropriately timed floods might be used to rebuild sandbars without likely exacerbating the long-term sediment deficit. As a result, in 2012 the Department of Interior implemented a new "HFE protocol" that calls for controlled flood releases based on sediment enrichment computed using a combined modeling-measurement approach to estimate sediment budgets. The Paria River is the primary fine-sediment source downstream from the dam, and cumulative sand inputs are computed throughout summer/fall and winter tributary flooding seasons on an event-basis and used as a trigger for HFEs. As the sediment input seasons progress, Bureau of Reclamation engineers iteratively model sand transport under different dam operation and flood scenarios to determine the optimal controlled flood to balance sandbar building, and sand export relative to recent tributary sand inputs. Controlled floods as part of the new protocol were implemented in 2012, 2013 and 2014. Monitoring of flood response showed that each controlled flood rebuilt eddy sandbars, thus increasing their average size. Yet sandbar response to HFEs can be highly variable between eddies over the 400 km long management-study area. Uncertainties regarding future water and sediment delivery scenarios require that the HFE protocol be adaptable to variable boundary conditions. Through the incorporation of transparent and timely monitoring, combined with inter-agency modeling and scenario development, scientists and resource managers have developed a science-based experimental sandbar rehabilitation strategy that is both flexible and coupled to detailed accounting of hydro-geomorphic processes.

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PRACTICAL FIRST STEPS IN UNDERSTANDING AND MEASURING CHANGES IN COASTAL RESILIENCE: THE DOI HURRICANE SANDY RESPONSE PROGRAM

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Hurricane Sandy made landfall in the Northeastern US on Oct. 29, 2012, wreaking havoc on communities in 12 states and the District of Columbia. In the aftermath of that destruction, the Department of the Interior (DOI) funded 162 restoration, mitigation, and science projects to develop and implement best practices for enhancing coastal resilience to sea level rise, storm surge, and wave erosion for both ecosystems and coastal infrastructure (e.g. communities, and commercial and public installations). To assess the benefits of these projects, DOI needed a way to measure changes in resilience, thresholds of stress beyond which measurable changes in ecological and infrastructure condition can occur, and the likelihood that those thresholds will be exceeded in the future. Meanwhile, a vigorous debate has developed from the local to the international scale on how resilience should be defined (i.e. is it a system trait, a process, or an outcome?), and therefore what we need to measure to test our attempts at improving resilience over time. Through a combination of DOI, inter-agency, and contracted expert analysis by socio-economists and scientists, a suite of core resilience measurements are being developed as practical first steps to test resilience-improvement strategies. These pilot measurements will provide an early assessment of the effect on resilience of the DOI projects, while also informing the ongoing global discussion on how resilience strategies should be understood and applied. Using established, peer-reviewed concepts as an assessment framework, such as "causal chains" for linking resilience with societal benefits through changes in biophysical processes and conditions, "planetary boundaries" of principal environmental stressors affecting global ecological balance, and "social foundations" necessary to sustain and enhance human health and dignity, the DOI's Hurricane Sandy Response Program is taking some important first steps to measure the utility of mitigation, restoration, and enhanced science understanding for improving resilience in coastal regions. The conceptual model, progress updates, and lessons learned in those first steps will be presented.

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CREATING RESILIENCY IN URBAN STREAMS: RESTORATION AND FLOODPLAIN RECONNECTION

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Floodplain reconnection and green infrastructure are evolving resiliency tools. While mostly focused on reducing flood risk and improving water quality by storing or conveying water within the floodplain, these tools create broad, often unaccounted for environmental and economic benefits.

To be successful, reconnection must be incorporated into flood planning efforts to support the natural and beneficial functions of riparian and aquatic ecosystems as well as improve flood conveyance and storage and sustain geomorphic stability during future flood events.

This presentation will explore the concept of incorporating floodplain reconnection in stream restoration and floodplain management. Discussion will focus on the concept of resiliency as it relates to stream restoration and reconnecting a channel to its floodplain. In addition, the presentation will describe the challenges and opportunities for floodplain reconnection.

The idea of resiliency – pivoting from trying to prevent natural disturbances to naturally managing disturbances – fits under an emerging trend in stream restoration: floodplain reconnection. This resiliency tool seeks to manage floods by storing and conveying water on floodplains, either through new flood bypasses or setting back embankments and levees. It also allows floods to pass more slowly, reducing damage to bridges, levees and other infrastructure. Other underappreciated benefits associated with floodplain reconnection include improving water supply through increased groundwater recharge, improved water quality, and infrastructure protection.

The presentation will also discuss the importance of watershed coalitions and partnerships in creating floodplain resiliency. Watershed collations are a driving force in forming a collaborative and focused process that develops long-range plans to restore rivers.

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THE NEED FOR SCALABLE, ROBUST TOOLS AND BENEFIT INDICATORS, AND CURRENT TOOL AVAILABILITY

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The Corps of Engineers is exploring the potential for using Ecosystem Goods and Services (EGS) assessment across all mission areas to illustrate the value of Corps Civil Works projects, particularly restoration projects, in ways that are more meaningful to the public than the habitat metrics currently employed. Concurrent with this effort is a "Smart Planning" initiative, which promotes a streamlined decision process making use of best available science, managing risk, and avoiding investments in data that don't change decisions. Corps projects can range in scale from watershed studies to project-level alternatives analyses and NEPA documentation. Finally, Corps policies restrict the use of certain economic methods, necessitating that some EGS benefit indicators be non-monetary, while still addressing social preferences more than current ecological indicators do. These constraints dictate a need for scalable, robust tools and benefit indicators that comply with current policies.

We investigated EGS assessment tools that were previously developed by universities, public, or private entities, in order to assess the utility and sufficiency of these tools in evaluating EGS in Corps projects. Seventy-three assessment tools, models, and data sets were screened using criteria derived from Corps needs and interests: relevance, transparency, transferability, sensitivity, and scientific and technical quality. Twenty-three tools were found to meet the screening criteria and to provide metrics for which the Corps did not already have approved tools. These tools were compiled into a searchable catalogue, which provides key information on each tool: technical specifications, ecosystems addressed, EGS addressed, costs, training, data requirements, inputs and outputs.

A synthesis of the readily available tools indicates that few address all EGS of potential Corps interest. In addition, many employ methods that are inconsistent with Corps economics and planning guidelines. However, many tools address specific EGS or specific steps of an EGS assessment (i.e., ecosystem production functions) and could be used in combination to address a wider suite of benefits than is typically addressed during alternatives analysis. In addition, our research identified key areas of need that are not met by existing tools. Development of new tools is underway, leveraging work already completed in a GIS map server to deliver simple spatial queries of multiple data sets without need of specialized GIS programs. Of particular interest is the development of non-monetized non-use benefit indicators that incorporate economic principles of scarcity and non-linear demand responses.

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CHANGING COURSE DESIGN COMPETITION: THE BAIRD TEAM SOLUTION – A DELTA FOR ALL

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The Changing Course Design competition was initiated to evaluate options for re-positioning the mouth of the Mississippi River and/or modifying the management of the Lower Mississippi River to support the 2017 Master Plan for the Louisiana coast. This paper will present the findings of one of the selected competitors: the Baird Team and their "Delta for All" approach.

A key to success in the future management of the lower Mississippi River is the development of an integrated and holistic approach to management. Such an approach would recognize the need to harness the full land/wetland building and restorative potential of the river at the same time as improving flood protection and navigation.

Fundamentally, the Baird solution recognized the underlying geomorphic challenges of the Delta: it receives three to four times less sediment from the Mississippi River than it did historically and sea level is rising two to three times faster than it did historically and is predicted to rise much faster in the future. The result will be a smaller delta in the future. The approach seeks to harness as close to 100% of the land building potential of the river to make the smaller future delta as large as possible. This compares to the 2012 State Master Plan which would harness approximately 50% of the land-building potential. The approach also recognizes that the further inland new distributary mouths and associated sub-deltas are located, the greater the delta building potential.

The approach builds with the river by creating and managing new river distributaries that are opened and closed every 50 years or so, to build new sub-deltas within a defined sustainable delta footprint. By placing the last outlet somewhere in the vicinity of English Turn, the lower Mississippi River would become a tidal channel. These two simple concepts of harnessing 100% of the river and placing the last outlet near English Turn result in immediate and significant benefits for flood protection and navigation. Through the elements of the approach, the level of flood protection for New Orleans and surrounding areas would be increased from a 1/100 year to approximately 1/1000 year level. By making the lower river a tidal channel, costly future maintenance dredging for a 50 ft navigation channel would be mostly eliminated and expansion of navigation and shipping facilities would be possible.

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RESTORING ECOSYSTEM FUNCTION IN THE P-ENRICHED EVERGLADES: CREATING AN ALTERNATE REGIME

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Four decades of elevated phosphorus (P) loads to the historically oligotrophic Everglades has resulted in a regime shift from the ridge (*Cladium jamaicense* Crantz)-and-slough landscape to large areal expanses of cattail (*Typha domingensis* Pers.). To accelerate the recovery of P-impacted areas, restoration requires not only a reduction in the external P concentrations and loads, but also management activities that reduce the internal resilience and resistance inherent to the cattail regime. The cattail habitat improvement project (CHIP) is a large-scale *in situ* study comprised of 15 6.25 ha plots to test the ability to rehabilitate cattail areas by creating an alternative submerged aquatic vegetation (SAV) regime.

Using a combination of herbicides and fire, open areas were created in enriched and moderately enriched areas of the northern Everglades (Water Conservation Area-2A) in July 2006. The two primary objectives were to assess whether creating openings in dense cattail areas will sufficiently alter trophic dynamics such that wildlife diversity and abundance could be increased and, determine to what extent the ecological functions of these created open areas compared to those of the natural Everglades. Within weeks to months there was strong evidence of altered ecological function within the open plots relative to controls with; 1) increased dissolved oxygen concentrations, 2) increased microbial activity and associated decomposition, 3) extensive SAV, principally *Chara* cover, and 4) increased fish abundance. Direct evidence of connections between altered nutrient cycling and foodweb dynamics were assessed using stoichiometric relationships. Stoichiometric relationships indicated that the quality, quantity, and diversity of primary consumers were greater in open plots relative to controls. In addition, because the active management strategy removed dense emergent macrophytes the higher quality prey were more readily accessible for consumption by wading birds. A principal concern of the project was active management could exacerbate P issues in this already enriched landscape. During the first four years, floc P levels were elevated in open versus control plots, more recently, P concentrations have decreased and indicate P is being stored differently in potentially a less available form. Nine years since project initiation, it appears that with minimal effort and cost, the ecological benefits of this altered regime could be sustained in the long-term

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ALTERNATIVE TREATMENT TECHNOLOGIES EVALUATION

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The South Florida Water Management District (District) is continuing to seek ways to reduce runoff from agricultural areas and cattle ranch operations in an effort to improve regional water quality in Lake Okeechobee, the Caloosahatchee and St. Lucie estuaries, and water moving south via the Everglades Stormwater Treatment Areas. To address a number of inquiries from vendors about the suitability of their products for water quality treatment, the District created a structured process to evaluate these technologies- the New Alternative Technology Assessment (NATA) Program. The NATA Program provided interested vendors the opportunity to demonstrate the efficacy of potential treatment technologies for reducing phosphorus (P) and/or nitrogen (N) concentrations in waters discharged from farms and urban tributaries. A number of technologies were evaluated initially in 2010 and 2011. Potential technologies were vetted through a selection process based on criteria designed to provide a rapid and equitable method for the initial screening of novel nutrient removal technologies that might warrant further investigation by the District. Selected technologies were evaluated further, using District facilities or farm lands, and using the District's laboratory facility for analytical testing. All other direct and indirect costs associated with conducting NATA projects were borne by each vendor. In addition, the District evaluated a number of other technologies brought to its attention through avenues other than the NATA RFP process.

All the technologies evaluated through the NATA program demonstrated the potential to reduce TP concentrations in surface waters to some degree, and many of them reduced TN levels as well. However, these studies were only initial assessments of treatment efficacy and considerable follow-on work would be needed to generate the data needed to conduct a feasibility analysis for a full scale treatment system using any particular technology. In addition, the scope of the NATA program was limited to those vendors who approached the District and consequently, the technologies evaluated represent only a small subsample of all available water treatment technologies. Although there are no current plans to conduct additional laboratory or field tests, the District remains interested in potential water treatment technologies, and a scientific review team continues to vet new products and processes on an as-needed basis.

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THE ROLE OF SULFUR IN METHYLMERCURY CONTAMINATION

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Sulfur, in its many chemical forms, plays a key role in the production, bioaccumulation, and impacts of methylmercury. In wetlands sulfate stimulates microbial sulfate reduction, often the dominant process converting inorganic mercury (Hg^{2+}) to methylmercury (MeHg). Both inorganic and MeHg readily bond to reduced sulfur species like sulfide, and with organic sulfur compounds, and this can alter the solubility and transport of mercury species. In organisms (including people), MeHg readily binds with sulfur containing amino acids, facilitating bioaccumulation in protein and active transport into vital organs, including the brain.

Our work has focused on the role of sulfur as a major control on the complex biogeochemistry of MeHg production in the Florida Everglades. While sulfate stimulates the microbial production of MeHg from Hg^{2+}, this stimulation is opposed by the inhibitory effects of sulfide (the major endproduct of sulfate reduction) on MeHg production. The exact mechanism of sulfide inhibition of MeHg production is still unclear, but involves inhibition of Hg^{2+} transport across bacterial cell membranes to the cells interior where methylation occurs. Sulfate stimulation and sulfide inhibition of MeHg production results in bell-shaped nonlinear relationships between sulfate concentration and MeHg production and a distinct maximum in MeHg production. Most MeHg production occurs in anoxic wetland soils/sediments, and the chemical nature of the substrate and amount of dissolved organic matter can influence sulfide inhibition of MeHg production. For example, soils with high organic matter or metal contents may modulate the inhibitory impacts of sulfide on methylation by removing sulfide from solution through reaction and formation of soil organic sulfur or metal sulfides. Dissolved organic sulfur species form by the reaction of sulfide with dissolved organic matter can complex Hg^{2+} and affect transport across cell membranes and methylation.

This complex biogeochemistry makes the prediction of MeHg production under changing environmental conditions a challenge to researchers. A predictive methodology for evaluating how changing conditions impact MeHg production would be an important tool for ecosystem managers and health officials to use in managing the threat MeHg contamination poses. We first developed a conceptual model relating MeHg production to sulfate loading, DOM, and soil composition. This conceptual model was then used in the development of a mathematical model that relates how changes in sulfate loading affect MeHg production in the ecosystem. This model is currently being used to examine how sulfate loading to the ecosystem could be used as a mitigation strategy to control MeHg production and levels of MeHg in Everglades biota. The presentation will discuss details of this modeling effort, as well as a general overview of how sulfur geochemistry impacts MeHg contamination in wetlands.

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ECOLOGICAL VALUATION OF ALTERNATIVES AND ASSESSMENT OF MITIGATION REQUIREMENTS – U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT'S HURRICANE SANDY COASTAL RECOVERY PLANNING

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In January 2015, the U.S. Army Corps of Engineers released the North Atlantic Coast Comprehensive Study which incorporated the consideration of natural and nature-based features [NNBFs] (e.g., barrier islands, wetlands, oyster beds) in hurricane recovery and resilience planning based upon the additional services (e.g., erosion control, flood reduction, wave attenuation) they provide to the coastal landscape. In October 2015, the Office of Management and Budget released a formal memorandum that directed federal agencies to develop and institutionalize policies to "promote consideration of ecosystem services, where appropriate and practicable, in planning, investments, and regulatory contexts". As part of the U.S. Army Corps of Engineers, New York District's Hurricane Sandy Coastal Recovery Mission, a unique approach was developed by the Project Delivery Team to consider the benefits and/or impacts in terms of ecological services while evaluating different planning alternatives that would provide coastal storm risk management (CSRM) to an impacted study area and the surrounding communities. This was accomplished by pairing an existing ecosystem functional assessment tool with a site-specific Habitat Equivalency Analysis (HEA). The HEA was enhanced by using a quantitative decision analysis method for habitat scaling based on the importance to key ecological resources. This unique approach provided a means to comprehensively evaluate the benefits or losses of ecological services across a range of identified habitat types of which may not have equal value or service to the impacted ecosystem. In turn, the tool provided an ecologically holistic evaluation of the benefits for incorporation of NNBFs as well as impacts associated with the overall CSRM alternatives. Finally, the tool facilitated scientific, as well as economic informed decisions for selection of specific compensatory mitigation projects to offset impacts associated with CSRM alternatives. The developed methodologies will be presented as an approach which effectively evaluated and promoted ecosystem services within the context of a large federal planning project.

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COMPUTING WATER-LEVEL GRADIENT VECTORS TO ASSESS SYSTEM CHANGES IN SHEET FLOW AND DIRECTION

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Water-level gradient vectors characterize the magnitude of water-level elevation differences and the general direction of sheet flow. The magnitude of gradient vectors represent the “steepness” of the water-level slope and can be used as a surrogate for velocity. Changes in water-level slope may be due to changes in flow, flow resistance, and landscape structure including topography and vegetation (type and density). Analyzing water-level gradient vectors over time can be used for evaluating system responses to water management and restoration practices, precipitation, and landscape structure.

Everglades Depth Estimation Network (EDEN) daily water-level surfaces were used to generate daily water-level gradient vectors for areas within Everglades National Park (ENP) and Water Conservation Area 3B (WCA3B) for the period 1991 to the present. Rose diagrams of the water-level gradient vectors computed for specific EDEN grid cells for these areas, averaged over various timescales, reveal how water-level gradients changed over time and space. Regions that were analyzed include areas near Shark River and Taylor Sloughs in ENP, and the Decomp Physical Model in WCA3B. Water-level gradient vectors can be used to study changes in flow direction and magnitude resulting from restoration activities, operation of water control structures, or changes in hydrology.

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RECOVER: PROVIDING SOUND SCIENCE TO DRIVE DECISION MAKING IN THE COMPREHENSIVE EVERGLADES RESTORATION PROGRAM

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The Comprehensive Everglades Restoration Plan (CERP) was authorized with specific requirements under the Water Resources Development Act of 2000 (US Congress 2000). These requirements described in the Programmatic Regulations (DOD 2003) that a science oversight group and an adaptive management framework be developed to guide CERP implementation. The framers charged the REstoration, COordination, and VERification (RECOVER) program with convening the RECOVER Leadership Group (RLG), a body of ten agencies and two tribes. The RLG organizes many scientists and represents a wide variety of interests, agencies, not for profits and universities. Teams were established to develop a system-wide monitoring plan, an adaptive management program that would build from other monitoring activities in the region, and to report on progress toward meeting interim goals and interim targets every five years. Fifteen years after the authorization of CERP, RECOVER continues work to maintain the integrity of the science program as authorized in the Water Resources Development Act of 2000 and its ability to inform management in ways that are key to optimizing the success of this large, complicated, and long-term restoration program.

April Nudo Patterson will share the complexities of communicating science; including the timing, collaboration among diverse team membership, and budget determinations that assist in communicating the many facets of the ecosystem's responses. Such information is needed for management interaction with resource management agencies, planning determinations for new projects, and maintaining a stream of communication about the investment in monitoring, modeling, and planning tools. April Nudo Patterson will share how RECOVER is making significant progress through the Programmatic Adaptive Management Plan in categorizing the risks associated with scientific uncertainties and communicating the management actions necessary to achieve restoration success. These evaluations of risk and uncertainty aid in prioritizing research and applied science monitoring and modeling investments useful for determining the management decisions needed that the science community helps inform to project managers, program managers, and other decision makers.

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EVERGLADES SPATIALLY-EXPLICIT HYDROLOGICAL NEAR-TERM FORECASTS FOR ECOLOGICAL MODELING

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The restoration and integrity of ecological systems in the Everglades is largely driven by water flows, depths, distributions, and quality. Water management has been the primary tool available for landscape resource management. Hydrologic modeling helps to steer decisions for long-term restoration alternatives and regulation schedules constrained with South Florida Water Management District position analysis sway near-term water management operations. Position analyses project near-term water stage based on current trends and forecasts of climatic influences. The position analyses currently in use are non-spatial; they forecast a range of probable water stages at a location or as an average for an area. The spatial distribution of water stage is necessary, however, if species and community connectivity and landscape response to immediate and near-term water management decisions is to be understood.

We have developed a spatially-continuous forecasting approach to create daily, 400 m resolution simulations of near-term futures for water stage and depth over a period of up to a year beyond current conditions. Regional water management operations are spatially modeled with SFWMD Regional Simulation Model hydrologic scenarios. Best fit near-future conditions are constrained and adjusted to National Oceanic and Atmospheric Administration and North American Multi-Model Ensemble precipitation forecasts. Monte Carlo simulations bound uncertainty around the central tendency of the projections. Uncertainty is quantified as Everglades Depth Estimation Network past water stage variances and variability in past rates of change under similar climatic conditions. The near-term hydrologic forecasts link ecological models in an objective, spatially-explicit decision framework that ranks species and landscape responses.

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ENDOCRINE DISRUPTING COMPOUNDS IN THE CHESAPEAKE BAY WATERSHED – WHERE ARE WE GOING? WHERE SHOULD WE GO?

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USGS scientists from across the country are tasked with establishing a national framework to evaluate endocrine disrupting compounds (EDCs) and their effects of fish. This framework was applied directly to ongoing efforts as part of the USGS Chesapeake Bay research on fish health. Fish health issues include increased incidence of infectious disease and parasite infestations, feminization of male fish, signs of endocrine disruption, reduced reproductive success and recruitment, and liver and skin tumors. Identifying and quantifying the sources, fate, transport, and distribution of EDCs throughout the Chesapeake Bay Watershed is a necessary first step in assessing exposure to fish. Chemical data are being collected and compiled from strategically selected stream sites in the Chesapeake Bay Watershed to: 1) address the multiple factors affecting fish health by focusing on the complex interactions of pathogens/parasites, land use and chemical exposure and 2) define sources, pathways and timing of chemical exposure to various life stages for chemicals identified as causing potential effects on fish health.

Water and bed sediment are being collected and analyzed for over 200 potential EDCs (including hormones, pesticides, personal care products, and legacy pollutants) and bioassays for biological activity such as estrogenicity. Initial sampling is focused on routine data collection from from six sites in the Chesapeake Bay watershed that reflect a wide range of agricultural land use conditions, during both baseflow and stormflow conditions. Sampling in later years will include assessments of urban areas. Chemical and bioassay sampling is coordinated with companion biologic assessments (including histopathology, plasma vitellogeninin, intersex and other measurements) in order to assess exposure of fish to chemical contaminants at different times during the year and during different flow conditions. In addition, chemical data are being compiled from existing sources (including previous studies of EDCs and pesticides) in order to expand the geographic and temporal coverage of chemical and biologic analysis.

Results from this study will be used to help understand sources and exposure pathways of EDCs to fish, and to develop management strategies to improve fish health in the Chesapeake Bay watershed. New and historic chemical data, together with biological data collected at the same sites, will be used in ongoing modelling and risk assessment efforts that will enable the findings to be extrapolated to other areas in the watershed. The approaches developed in the Chesapeake Bay watershed to assess the occurrence and exposure of EDCs to fish can be used as a case study in addressing this issue in other areas of the nation.

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PROVIDING SCIENCE TO SUPPORT DECISION MAKING FOR THE CHESAPEAKE ECOSYSTEM

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The Chesapeake Bay Program (CBP) partners apply adaptive management through a decision framework to continuously assess progress and reduce uncertainty toward addressing the 31 outcomes in the Chesapeake Bay Watershed Agreement. Science supports the CBP decision framework, which includes these components: (1) articulating program goals, (2) describing factors influencing goal attainment, (3) assessing current management efforts and gaps, (4) developing a management strategy, (5) developing a monitoring program, (6) assessing performance, and (7) adaptively managing. The management strategies for the Chesapeake Agreement will be evaluated every two years, so there are opportunities to adapt approaches as new science is brought forward to reduce uncertainty. Approaches to use science in the CBP decision framework include:

- Articulating Program Goals: Existing understanding of ecosystem conditions were used to help develop science-based goals and outcomes for the Bay Agreement.
- Factors influencing ability to meet goal: Scientific understanding was used to identify key natural and human factors that could affect the ability of management approaches to attain the desired outcomes.
- Assessing Current Efforts and Gaps: As part of this effort, science providers collaborated to identity research gaps and approaches to address the gaps.
- Developing management strategies: Science was reviewed to help assess the effectiveness of previous management actions and policies. For some outcomes, modeling was conducted to simulate potential effects of different management strategies and the associated degree of uncertainty. The potential effects of climate change are also being considered in each of the management strategies.
- Develop monitoring program: Indicators are being developed for each outcome and supporting monitoring is being identified. Expanding monitoring to address the needs of the 31 Chesapeake outcomes is one of the biggest challenges for science providers.
- Assess performance: Monitoring results and scientific understanding is being used to assess if the ecosystem is responding as expected to management efforts. Relating ecosystem response to management actions is difficult due the influence and interaction of multiple environmental and human factors.
- Manage adaptively: Scientists interact with decision makers to understand the implications of monitoring results and performance assessments so management strategies can be adapted.

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WATER QUALITY AND *E. COLI* MONITORING FOR A GULF OF MEXICO COMMUNITY'S RESTORATION DECISION MAKERS

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The Turkey Creek Community in Gulfport, Mississippi, is a historically African American community that predates the City of Gulfport. Over the years the community has been annexed into Gulfport and what was once largely neighborhoods, forest and riparian floodplain has changed dramatically, especially considering hardened surfaces, an international airport and commercial development along highway 49. Turkey Creek itself is a tidally influenced stream that can have increasing salinity and mixed fresh and estuarine fish species as it flows downstream into Bayou Bernard. The creek has historic problems related to elevated bacterial levels (*Fecal Coliform TMDL for Turkey Creek* revised January 2015).

The Turkey Creek watershed includes the neighborhoods of Turkey Creek and North Gulfport. These two neighborhoods completed *the community's plan for the Turkey Creek and North Gulfport Neighborhoods* in August 2011. In that plan, there was a specific desire to "identify and mitigate all pollution sources for both Turkey Creek and Bayou Bernard, and establish regular monitoring to ensure water quality." Turkey Creek is still actively fished and used for recreation by members and visitors of the community. Citizens and leadership in the community wanted increased monitoring data on which to make decisions, determine sources of pollution and seek solutions to those sources.

To answer this call for increased monitoring data, especially for quality assured water quality data and *E. coli* levels in the stream, a partnership was formed that includes the organizations listed above. Partners complete weekly monitoring of the stream at three sites that have historical data sets and at one additional site near the 8th grade school so students who live and/or go to school in the watershed can participate in the monitoring. The IDEXX method is used to quantify *E. coli* concentrations using the most probable number and data sondes are used to collect water quality parameters. The monitoring data is then presented on a regular basis to the Turkey Creek Steering Committee so decision makers can work cooperatively to use the data to target solutions for any issues found. Some duplicate samples where high levels of *E. coli* have been found are having DNA source tracking conducted to provide an even greater level of specificity on which the Steering Committee can make decisions. Additionally, Turkey Creek has been targeted by several partners for significant restoration efforts in the near term and in future years.

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HABITAT REHABILITATION AND ENHANCEMENT PROJECTS AND THE MODELS USED TO JUSTIFY THEM FOR THE UPPER MISSISSIPPI RIVER RESTORATION PROGRAM, POOLS 1 THROUGH 10

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Since 1986, the U.S. Army Corps of Engineers (Corps) has been responsible for administering the Upper Mississippi River Restoration Program (UMRR), which has implemented innovative and effective Habitat Rehabilitation and Enhancement Projects (HREPs) to ensure that the Upper Mississippi River System remains a nationally significant ecosystem. The Corps has led a strong partnership of other federal and state agencies and has, to date, constructed 55 HREPs resulting in direct improvements to 100,000 acres of fish and wildlife habitat in the floodplain of the river. Annual appropriations since the program was initiated has ranged from a low of $16.5 million to a high of $33.2 million. Projects are distributed throughout the Upper Mississippi River using a wide range of construction techniques and approaches that manage natural river processes to provide benefits to the river at the system, reach, pool, and local scales.

The St. Paul District (MVP) is one of three Corps districts involved in the UMRR with jurisdiction over Pools 1 through 10 and associated tributaries such as the Minnesota River. MVP has constructed 27 HREPs and is in various planning phases for 9 more. HREPs have ranged from $80,000 for a small scale drawdown to over $20 million for large complex projects involving island construction. Other HREP features that have been constructed include water level management systems, shoreline protection, aeration structures, closing structures, and backwater dredging. Rock riffles, tree plantings, loafing structures, and emergent wetlands are included opportunistically within the HREPs. Pool-wide drawdowns have also been implemented, but require intense coordination and advanced planning to accommodate the interests of navigation and other special interest groups.

As part of a rigorous Corps' planning process, MVP applies models to quantify ecosystem outputs used in cost benefit analyses that helps determine the best combination of features for the least cost. Outputs are based on the U.S. Fish and Wildlife Services' Habitat Evaluation Procedure (HEP) and associated habitat suitability index (HSI) models that drive the computations. HEP uses a 2-dimensional approach and compares with- and without-project conditions to quantify net gains in terms of habitat units, typically for a single species. A wide representation of HSI models are available, however, they may not reflect the unique conditions and associated biological communities of the river within MVP's boundaries. In response, MVP has developed its own HSI models which include bluegill overwintering (*Lepomis macrochirus*) and migratory waterfowl. There are advantages and disadvantages of this approach within the context of balancing detail and uncertainty in the predictions of ecosystem restoration program outcomes. Based on the experiences of MVP and the UMRR partnership, there is strong interest in expanding this approach to address these uncertainties.

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STRATEGIES FOR FACILITATING COLLABORATION BETWEEN SCIENTISTS AND DECISION-MAKERS AND CO-PRODUCING ACTIONABLE SCIENCE

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Scientists and managers receive different types of training and often work separately from one another, yet achieving ecosystem management goals often requires that managers and scientists work together. Collaboration between scientists and decision-makers is key to success in an adaptive management approach, since adaptive management involves linking science and monitoring to decision making. Actionable science – science that can be used to make decisions and take action – can most reliably be produced when scientists and decision-makers work together. In this session, panelists will discuss tools, techniques, processes, and governance structures to facilitate communication and collaboration between, and co-production of actionable science by, scientists and managers.

Meridian Institute works with parties from diverse backgrounds and perspectives to design collaborative processes to solve complex problems, make informed decisions, and implement solutions that improve lives, the economy, and the environment. Jennifer Pratt Miles will discuss challenges and solutions to facilitating communication and collaboration between scientists and managers, using examples from the Everglades, Middle Rio Grande, the Collaborative Adaptive Management Network, and the Advisory Committee on Climate Change and Natural Resource Science. Ms. Pratt Miles will describe how convening assessments, meeting design, visual tools, field visits, and creating explicit processes for collaboration and decision-making can help decision-makers and scientists communicate and work together more effectively, which in turn can lead to improved ecosystem restoration and management. In addition, Ms. Pratt Miles will share guiding principles and recommended practices for co-producing actionable science from a "How-to-Guide" authored by members of the Advisory Committee on Climate Change and Natural Resource Science.

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DECIPHERING BETWEEN PROJECT-RELATED AND REGIONAL IMPACTS TO CORAL REEF COMMUNITIES NEAR THE MIAMI HARBOR DREDGING PROJECT - THE SCIENCE BEHIND THE STORY

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Miami Harbor is the largest dredging project to be conducted in the region during the past decade. Specifically, Miami Harbor is the first of four eastern seaboard ports to be deepened to accommodate larger post-Panamax vessels. In total, five different dredges removed more than five million cubic yards of rock, limestone and sand. Construction began in late 2013 and was completed in the summer of 2015.

Dramatic statements by project opponents were made about the effects of the dredging in Miami, specifically regarding sedimentation impacts to offshore resources. These statements, based on a paucity of scientific data and one-off site visits garnered significant media attention. However, results from both long-term compliance and post-construction biological monitoring showed that project impacts were mostly local and ephemeral. Coral mortality related to the project, while present, was minimal. Moreover, the greatest impacts associated with coral mortality were directly attributed to a catastrophic, coral bleaching/disease outbreak. High sea-surface temperatures contributed to a significant region-wide coral bleaching event that started in August 2014, with a second, subsequent bleaching event occurring in 2015. After the 2014 bleaching event, the monitoring program specifically designed for the Miami Harbor project noted a white-plague coral disease outbreak spreading throughout the project area, initiating in the vicinity of the southern control sites. White-plague disease was widespread across all hardbottom, middle reef, and outer reef stations accounting for >85 percent of the total hard coral mortality at these sites. No differences were seen in the levels of disease-related mortality between the near-project compliance and far-field control sites. These results confirmed a regional-scale disease outbreak as opposed to one driven by project activities. Region-wide monitoring by members of the project team has detected impacts of the disease from southern Biscayne National Park in the south to Breaker's Reef in Palm Beach County to the north; a spread of over 130 km in less than one year. The disease outbreak affected at least 13 coral species. The most heavily impacted corals were *Meandrina meandrites* and *Dichocoenia stokesi*, showing losses $\geq$ 97% region-wide. This outbreak of white-plague disease in southeast Florida is arguably the most lethal coral disease ever recorded on a contemporary coral reef system.

The regular monitoring of tagged corals at control and near project sites provided the detailed information needed to assign the correct cause of mortality to corals in the project area as opposed to the undocumented assertions of project opponents who conducted one-off surveys. The actual monitoring results from the project emphasize the requirement for implementing scientifically-based, not ideologically-based management of natural systems to best understand and protect our fragile coral resources.

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DECIPHERING PATTERNS OF CORAL HEALTH AND MORTALITY USING A REPEATED MEASURES MONITORING PROTOCOL – LESSONS FROM MIAMI HARBOR

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Repeated measures designs are based on resampling replicates (e.g. sites) over time. The repeated measures design tests for interactions of time with treatment. In such designs, environmental impacts are determined by the variability of time trends among sites. Thus, the repeated measurement of experimental units over time is now central to many environmental impact investigations. In the case of dredging impacts on corals, there may be a number of possible outcomes resulting from repeated measures sampling. In one case, the cumulative effects of chronic sedimentation (press impacts) may not be expressed until well after the commencement of the dredging operations. In this case we would expect to see coral health decline with time. In a second scenario, impacts due to sedimentation may occur over a short period of time (pulsed impacts). In this second scenario we would expect to see differences among the corals diminish as time passes. In a third case, other natural stressors may be acting simultaneously or synergistically causing coral health to be affected by sources other than dredge operations. Due to the variety of responses that can be expected, the effects are best observed in the interaction between time and treatment. A key point in all three cases is that many impacts may not be detected by monitoring if the response variable (coral) is measured at only a single point in time or the temporal intervals are too widely spaced to distinguish between the various causes. Thus, a closely spaced repeated measure design reduces the chances of drawing invalid conclusions leading from the logical fallacy that correlation does not imply causation.

As part of the FDEP permit conditions for the Miami Harbor expansion project, some 643 scleractinian corals (including 286 controls) were tagged for repeated monitoring at 26 sites. *In situ* coral-condition data were collected by scientific divers for all tagged colonies. Still photographs of each of the corals were also taken. A monitoring "event" was triggered anytime the active dredge operations were within 750 m of a site during any given week. Between October 19, 2013 and July 13, 2015 each tagged coral, was monitored and photographed up to 50 times (events) depending upon site. In the laboratory, *in situ* coral condition data were compared with corresponding still photographs for cross-verification and validation. Combining these data with other collected abiotic metrics (sediment, SST, etc.) allowed us to differentiate between chronic and acute stressors, natural and anthropogenic. We were specifically able to calculate the prevalence of corals impacted by sedimentation, predation, competition, coral bleaching, and disease. Most importantly, in cases where corals had died, we were able to discern the exact cause of mortality by carefully evaluating the sequence of events recorded (and photographed) prior to their death. Our results indicate that sedimentation impacts diminished in time, indicative of a pulsed impact. The greatest source of coral mortality was associated with a regional coral disease outbreak and not local dredging operations.

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CONTROLS ON GROUNDWATER DISCHARGE IN TAYLOR SLOUGH/C-111 BASIN OF EVERGLADES NATIONAL PARK

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Groundwater discharge in the southern, coastal Everglades is brackish, enriched in phosphorus and influences both surface water chemistry and ecosystem metabolism. Despite its occurrence, the hydrologic drivers of the groundwater discharge have yet to be defined. The objective of this investigation was to determine the relationship between hydrologic drivers and groundwater discharge along the coastal Everglades region of Taylor Slough/C-111 Basin. The timing of groundwater discharge was determined from groundwater well clusters (one deep, 6-9m; and one shallow, <4 m) at 2 sites: TS3 and TS6. Site TS3 is the more upstream site located about 7 km inland of the coastline, while TS6 is located about 2 km inland. Potential drivers of groundwater discharge include precipitation, evapotranspiration, upstream surface water and canal water levels, upstream water management flows, and downstream coastal surface water levels. Cross-correlation and spatial analyses were performed between the timing of groundwater discharge and the potential hydrologic drivers. The effects of groundwater discharge on surface water chemistry was also investigated.

Strong seasonality was observed in all of the potential hydrologic drivers, with precipitation, evapotranspiration, water levels, and surface water flows greater in the wet season as compared to the dry season. The potential for groundwater discharge occurred year-round, but there was greater discharge in the wet season. Water levels in the upstream portion of Taylor Slough/C-111 Basin were found to be the most likely control on groundwater discharge: higher upstream freshwater levels create a greater hydrologic potential for groundwater discharge near the coastline. Groundwater discharge also correlated positively with surface water flow, most likely because both were controlled by upstream freshwater levels. During the wet season when groundwater discharge was higher, the overlying surface water chemistry remained fresh with low concentrations of phosphorus. Higher salinity and phosphorus values occurred in the dry season, when surface water levels were low and flow direction was reversed with seawater from Florida Bay flowing inland.

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EVAPOTRANSPIRATION EFFECTS ON THE ACCUMULATION OF CARBONATE MINERALS IN RECREATED EVERGLADES' TREE ISLANDS

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Hydrologic management in South Florida over the past century deteriorated the interior-Everglades landscape, originally consisting of ridges, sloughs, and tree islands. Tree islands act as phosphorus sinks contributing to the oligotrophy of the Everglades ecosystem. Thus, understanding the mechanisms of tree-island formation and maintenance is important for preserving the remaining tree islands and maintaining an adequate functioning of the ecosystem. In the southern Everglades, archaeological excavations revealed a CaCO3 layer within the peaty soils of 20 tree islands. The original environmental conditions and the depositional and cementation processes under which these sediments formed have not been fully determined.

The interior-Everglades landscape features are present at the Loxahatchee Impoundment Landscape Assessment (LILA) facility, located at the Arthur R. Loxahatchee National Wildlife Refuge, in Boynton Beach, Florida. This facility contains created tree islands of different geologic characteristics and has the capacity of managing the hydrologic conditions, providing a unique opportunity for conducting long-term monitoring of the hydrogeochemical and hydrogeological conditions across a recreated Everglades landscape. In order to assess carbonate-mineral accumulation in the soils of the tree islands at LILA, we integrated groundwater and surface-water levels and chemistry from a network of wells across the landscape. In addition, we analyzed soil cores obtained from the center of the tree islands at LILA.

Long-term monitoring of the hydrogeochemical and hydrodynamic conditions at LILA showed that seasonal evapotranspiration produces a water-table depression beneath the center of the tree islands, transporting and concentrating ions and nutrients. In addition, geochemical modeling of the water-chemistry data showed that the groundwater in the center of the tree islands remains supersaturated with respect to calcite ($CaCO_3$) year-round, suggesting a potential for $CaCO_3$ to precipitate in the tree island soils. These results are also supported by carbon analyses on soil cores showing a horizon of increased total carbon (TC) and total inorganic carbon (TIC) content right above the lowest groundwater level. More detailed analyses of soil structure and chemistry, including X-ray diffractions and smear-slide analyses are still necessary to understand the physicochemical mechanisms responsible for the encountered soil horizons with elevated TC and TIC content. Finally, studying biogeochemical processes that may lead to tree island stability under managed hydrologic conditions can provide a useful tool for tree island restoration.

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THE FACTORS NEEDED TO CREATE AND SUSTAIN A ROBUST REGIONAL ECOLOGICAL RESTORATION INITIATIVE

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To restore aquatic ecosystems at a meaningful scale there needs to be a well-defined support system to bolster an ambitious ecosystem restoration initiative. The following components are essential to advance a regional restoration initiative; community support, public/private investment, scientific and academic research, education and outreach, a flexible regulatory environment, experienced engineering firms, and a steady source of funding. A structural support network that includes these components needs to be in place for projects to be implemented consistently and constantly. Furthermore, a clearly-communicated and common understanding of what defines ecological restoration is essential. An agreement that restoration projects by definition should; be self-sustaining, not rely on excessive engineering, alleviate ecosystem stressors, and address problem sources, not symptoms, is ideal.

To varying degrees Massachusetts has built these support networks over the past two decades. How to foster these support systems is not formulaic, rather it is a product of social as well as environmental factors such as land-use, mores, historical events, geography and land ethics. For purposes of this abstract, we have identified three main focus areas that strongly influence “a restoration culture”; community support, public/private investment and an experienced engineering community.

Community Support: Given that restoration directly impacts local communities, grassroots groups are often the most effective project leaders. Massachusetts watershed associations have a long history of involving citizens in protecting and restoring their natural resources via education, monitoring and partnership-building. Strong watershed associations have the ability to forge partnerships, educate and engage local citizens, and overcome community fears. Motivated by the need to restore streamflow, connectivity and fish populations, local watershed groups across the state are embarking on campaigns to restore rivers through dam removal and water demand management.

Public/Private Investment: Massachusetts may be the only state to have a government program exclusively dedicated to ecological restoration. The MA Division of Ecological Restoration (DER) in the Dept. of Fish and Game was created to initiate holistic-based ecosystem restoration and is not driven by traditional wildlife habitat management. DER staff provides seed money, project management and technical support to community-based groups. As a state agency, DER facilitates permitting and develops polices and guidelines that support the discipline. DER fosters a strong connection to the private sector by working with private landowners and corporations. Corporate support is facilitated through the MA Corporate Wetland Restoration Partnership.

Experienced Engineering: Multi-disciplinary firms that weave together earth science, biology and ecology to inform bio- and traditional engineering are best suited to design and oversee restoration projects. Knowing the level of design required and the regulatory and social arena within which the project occurs is critical. A multitude of competitive firms with deep experience with adaptive management and tolerance for unpredictability can help apply cost-effective solutions to a disciple where resources are inherently limited.

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IDENTIFYING PLANT INVASION HOTSPOTS TO PRIORITIZE RESTORATION IN A MULTIPLE USE FOREST

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The spread of exotic invasive plant species is major issue in multiple use forests throughout the United States. In the Clemson Experimental Forest, a multiple use forest consisting of 17,500 acres was established in the 1930's to restore agricultural lands in the South Carolina Piedmont region. In the forest, invasive plant species are commonly found near trailheads and alongside roads and trails. However, the ecological mechanisms that explain these patterns of invasion are not well understood. We conducted two studies to determine if anthropogenic activity on trails and roads resulted in increasing the spread of these invasive species. The first study consisted of identifying plant species and canopy cover at 0, 5, 10, 25, and 50 meters from the road; then measured 0, 2, 4, and 12 meters from the trail. Our results indicate that exotic invasive species decreased in cover from 15% to 9% with increasing distance from trails and 24% to 10% with increasing distance from roads. This relationship between invasive plant species and roads and trails – which was strongest for Japanese stiltgrass (*Microstegium vimineum*) – suggests that trail users influence their dispersal and/or establishment.

In order to research the patterns of Japanese stiltgrass invasion further, we conducted an experimental addition study to determine which trail users' disturbance (hikers, bikers and horseback riders) might be contributing to its establishment. In November of 2015, we established four randomized 2 x 1 meter plots with five replications of each plot creating a total of twenty plots. Then we disturbed each plot by hiking, biking and riding a horse through each plot. An additional set of control plots was left undisturbed. Next, we planted 1,000 Japanese stiltgrass seeds in each plot. In the spring of 2016, we will return to see if establishment patterns differ between treatments.

By shedding light on the patterns and drivers of plant invasions in multiple use forests, this research will help land managers predict where invasive species are most likely to establish. This will facilitate early detection and rapid response activities, thereby reducing impacts caused by these species and minimizing the need for costly restoration efforts.

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A NEW ERA IN ECOSYSTEM RESTORATION - PUBLIC-PRIVATE-PARTNERSHIPS (P3S)

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Nationally, nearly all publically funded ecosystem restoration projects are performed on public lands. That's because it's is far easier and much quicker to restore public lands, and it avoids the potential negative public perceptions that could occur if tax dollars were invested in privately held lands.

This has been a good model, but the time has come to reconsider that single-minded focus for a number of reasons. To start with, the availability of public land is limited. More than 81% of the property in Florida is privately held, so potential sites for habitat restoration sites are becoming tougher to find.

As we move into the future, we must develop habitat restoration endeavors that are ecologically driven. In other words, the identification of potential habitat restoration sites should be based upon ecological needs, not whether there's a publically owned parcel available. This is not to say that the many restored sites are not good projects, because they all provide notable site improvements and educational benefits.

But the next wave of habitat restoration must demand that sites be prioritized based primarily upon ecological needs of the region, such as restoring low-salinity stretches of a tidal river, focusing on habitats that were disproportionally lost, or targeting areas that have little or no critical habitat remaining. Only after this exercise is completed should jurisdictional boundaries be considered. The birds, fish, and animals don't recognize these artificial boundaries, neither should resource managers!

Of course we recognize that developing the partnerships necessary to restore private property with public funds is not easy. These Public/Private/Partnerships (P3s) inherently have a series of real and perceived issues that must be addressed before they can be undertaken. For example:

- Who will be responsible for ongoing maintenance?
- What kind of public access will be allowed?
- How will private land owners be prevented from developing the land at a later date?

An agreement to ensure that restored areas will remain natural and continue to provide ecological benefits to the region may be the most critical issue. A binding legal instrument must be forged and documented so future decision makers cannot undo restoration efforts funded by the public. This Conservation Easement (CE) is a legal document which severely restricts the future land use of the parcel. It is imperative that these CEs are held by an entity that can track and enforce the provisions of the CE such as state agencies who have the legal authority to ensure that the investment of public funds continues to provide benefits to taxpayers.

This paper highlights a successful example of such an agreement at the Newman Branch Creek Ecosystem Restoration project in Apollo Beach, Florida. This P3, between the Tampa Electric Company (TECO) was funded by the Gulf of Mexico Foundation, and resulted in an award winning project which ultimately, over many phases, resulted in the enhancement or creation of over 100 acres of coastal ecotones. For resource managers, P3s open the door to implement critical habitats where they are most needed and effective. Thus, P3s represent a possible new ERA for habitat restoration projects!

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SEAGRASS MONITORING AT TWO DIFFERENT SITES FOR THE MIAMI HARBOR PHASE III FEDERAL CHANNEL EXPANSION PROJECT

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The Miami Harbor Phase III Federal Channel Expansion Project was designed to widen and deepen the outer entrance channel to the Port of Miami to increase access by larger vessels, including post-Panamax vessels. To accommodate these larger ships, the outer entrance channel was widened at the outer reef and deepened to -52 (±1) feet Mean Lower Low Water (MLLW) (-15.6 ± 0.3 m). The project was permitted through the Florida Department of Environmental Protection (FDEP), under Permit No. 0305721-001-BI (issued on May 22, 2012). Permit conditions provide a number of protective measures to ensure the preservation of natural resources, such as hardbottom, reef, and seagrass communities, including methods of environmental monitoring required before, during, and after dredging activities.

Two seagrass survey areas were followed before, during, and after the Miami Harbor Phase III project. The two survey areas were 1) Fisherman's Channel and Meloy Channel, adjacent to portions of the dredging operation and; 2) the Julia Tuttle Seagrass Mitigation site, a seagrass area adjacent to the seagrass mitigation site. Although both areas are located within northern Biscayne Bay, their local environmental conditions were different in terms of tidal flow and depth. As a result, the two seagrass communities were quite different. By comparing and contrasting these differences, we documented that seagrass communities persist through a wide variation of environmental conditions. Temporary construction activities, such as Miami Harbor Phase III, when done using Best Management Practices had no measureable effect on these seagrass communities.

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PLANNING FOR LARGE-SCALE COASTAL RESTORATION: DEVELOPMENT OF THE FLORIDA STATE EXPENDITURE PLAN

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The 2010 Deepwater Horizon oil spill was an ecological and economic disaster for the Gulf of Mexico and the myriad of stakeholders who depend on the Gulf for their livelihood. In 2010 Congress passed the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economy of the Gulf Coast Act (RESTORE Act) that provides a mechanism to hold the responsible parties financially accountable for restoring the Gulf in the wake of the oil spill. The RESTORE Act was signed into law in 2012, and in July 2015 a tentative settlement was reached with BP, the primary responsible party. The passage of the federal RESTORE Act established an unprecedented funding source and a unique opportunity for Gulf Coast states and local governments to implement coastal zone projects over the next two decades that address five strategic goals:

- Restore and Conserve Habitat;
- Restore Water Quality;
- Replenish and Protect Living Coastal and Marine Resources;
- Enhance Community Resilience; and
- Restore and Revitalize the Gulf Economy

Among the five affected states, Florida is unique with regard to the large geographic extent of its coastline and the associated diversity of ecosystems and affected communities. In Florida, implementation of the Act will be different than the other four Gulf coast state as it has developed the Gulf Consortium, an organization composed of an elected official from each of Florida's 23 Gulf Coast counties, and six Governor-appointed representatives, working under a Memorandum of Agreement (MOA) with the State of Florida. Pursuant to this MOA the Gulf Consortium is responsible for the development of the Florida State Expenditure Plan which will specify the projects, programs and activities to be implemented using the approximate $300 million generated by the Spill Impact Component of the RESTORE Act.

This presentation will provide an overview of the RESTORE Act, with a specific focus on the Spill Impact Component of the Act, and how that component will be uniquely executed in Florida through the development of the Florida State Expenditure Plan by the Gulf Consortium. The types of projects, programs and activities proposed for funding under the Spill Impact Component will be reviewed, and the process for developing and implementing the Florida State Expenditure Plan with such a large group of stakeholders will be summarized.

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INVASIVE SPECIES MANAGEMENT IN THE NORTHERN EVERGLADES

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Invasive species are directly implicated in the loss of native species, biodiversity, ecosystem functioning, and ecosystem services in the Florida Everglades. As both drivers and stressors of ecosystems, invasive species can alter ecosystem patterns and processes on both small and large scales and may result in unexpected successional trajectories as Everglades restoration proceeds. As with other regions of the Florida Everglades, the A.R.M. Loxahatchee National Wildlife Refuge (Refuge) is particularly vulnerable to the proliferation of two highly invasive species, melaleuca (Melaleuca quinquenervia) and Old World climbing fern (Lygodium microphyllum). The aggressive spread of melaleuca, a fast growing Australian tree, can lead to the conversion of open marsh habitat to dense single species melaleuca forests. This habitat conversion significantly changes species composition and structure, reduces carrying capacity of important wildlife species, and alters necessary ecosystem processes such as fire. Old World climbing fern is a vining fern that aggressively invades bayhead tree islands in the Refuge. Once established, Old World Climbing fern forms dense rachis mats over the ground and tree canopy, drastically reducing the abundance of native vegetation. These dense mats also increase the likelihood of intense, destructive fires in tree island canopies. Together, melaleuca and Old World climbing fern present significant threats to the unique plant communities and ecosystem functions and services of the Refuge.

Given the significant threats presented by these two species, resource managers consider their removal to be critical to the successful preservation and restoration of the Refuge. However, highly invasive nonindigenous species are rarely eradicated once they are well established on the landscape. Since eradication of these species is no longer feasible, natural resource managers must adopt strategies aimed at long-term suppression of the invaders to mitigate impacts to the greatest extent feasible. Management of well-established invasive species in the Refuge presents many challenges. First, melaleuca and Old World climbing fern appear to act as drivers of ecosystem change as opposed to “passengers” responding to system alterations. For these species, efforts aimed at restoring environmental conditions to pre-disturbance states will have limited influence on the system’s resistance to invasion. Long-term active management using direct control tools such as herbicides and biological control agents may be the only viable approach to controlling these species. Second, active management of invasive species generates its own unique disturbance regime, which may lead to unintended consequences. For example, efforts to remove a dominant invasive plant with non-selective herbicides can result in direct impacts to remnant species of the native community. The removal of a dominant invasive species can also result in novel successional trajectories that diverge from restoration targets. Third, invasive species management strategies and logistical considerations must be carefully planned in concert with other Refuge restoration activities to take advantage of potential synergistic effects or to avoid conflicts. For instance, prescribed burning shortly after herbicide applications can dramatically reduce herbicide efficacy while post-fire herbicide applications are often found to be more effective.

It is clear that ecosystems resulting from restoration will contain new species assemblages and biotic interactions relative to their predisturbance state, and these new biotic components and interactions are certain to include invasive non-indigenous species. It is also evident that a long-term commitment to management of highly invasive species, which produce deleterious alterations to critical ecosystem functions and processes, is necessary if the goals of Refuge restoration are to be achieved. Thus, natural resource managers should implement invasive species management using a whole-system approach such that resources are directed toward priority invasive species in the context of restoration goals while carefully minimizing adverse impacts of the management activities themselves.

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DESIGNING THE EVERGLADES HEADWATERS NATIONAL WILDLIFE REFUGE FOR HABITAT NEEDS CONSIDERING URBANIZATION ENCROACHMENT

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The Everglades Headwaters National Wildlife Refuge (EHNWR) and Conservation Area, when completed, will serve to protect the upland habitats and wetlands of Lake Okeechobee and Everglades watersheds. The location of the new refuge in Central Florida will allow species adaptation from climate change impacts, and provide improved water quality for water flowing southward to the Everglades and habitat for many species of concern (e.g., Florida panther, Florida grasshopper sparrow, Everglades snail kite). "Reserve design" for the EHNWR's objectives involves many ecological, social, and political factors to successfully identify parcels of land for protection. For example, land acquisition choices for a large protected area are difficult because it typically takes many years to gather the funds to purchase all necessary parcels of land, and initial land acquisition planning could be complicated by future conditions such as projected climate and urbanization changes across the landscape.

To meet the reserve design needs of the EHNWR, including the protection of five target habitats (dry prairie, pine flatwoods, scrub/sand hill, wet prairie/marsh, forested wetlands), we used the conservation planning software Marxan to allocate the targets among two "zones" representing different methods of protection: fee-simple purchase (up to 50,000 acres), and conservation easement agreements (up to 100,000 acres). We used projections from urban growth models to represent dynamic loss of habitat due to urbanization. These projections provided an indicator of how climate change could affect the study area by examining how urbanization associated with people moving inland from the coast ("coastal retreat") might affect the availability of parcels for inclusion in the reserve design. We ran Marxan scenarios excluding parcels forecasted for development, and compared the resulting reserve designs with those obtained without urbanization to examine: 1) reserve costs, 2) number of real estate transactions, and 3) ability to meet targets. We found that the cost of reserves increased substantially under urbanization, and some habitat targets could not be met in those scenarios.

To add further realism to finding a reserve design solution, we developed a dynamic-heuristic model that simulates reserve site selection on an annual basis, and considers uncertainty associated with annual budgets and the probability that a parcel is lost to development from year to year. Initial tests show that this new heuristic could have wide applicability in large-scale reserve design.

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MODELING TO ASSESS THE INFLUENCE OF WATER WITHDRAWALS ON SPATIAL DISTRIBUTIONS AND ABUNDANCE OF ESTUARINE SPECIES IN CHARLOTTE HARBOR, FLORIDA

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In order to set minimum flows and levels associated with planned water withdrawals from the Lower Peace River, the Southwest Florida Water Management District (SWFWMD) is sponsoring research to assess the influence of changes in salinity and temperature patterns on selected fish and invertebrate species in Charlotte Harbor, Florida.

In order to create an ecological baseline, habitat mapping has been conducted using environmental data (temperature, salinity, dissolved oxygen, depth, and bottom type). Catch rates (CPUEs) have been computed using Fisheries-Independent Monitoring (FIM) data collected from 1996-2013 by the Florida Fish and Wildlife Conservation Commission (FWC).

A statistically rigorous habitat suitability model (HSM) was developed by FWC, using generalized additive models (GAMs), and applied to assess the spatial distributions and relative abundances of six fish and invertebrate species. All species chosen have affinities for low salinities found in the Lower Peace River. Using geographic information systems (GIS), the models allow the spatial quantification of relative population numbers for each species life-stage in relation to environmental conditions. Predicted habitat suitability maps were created from the FIM data depicting the spatial distributions and relative abundances of juvenile and adult life-stages by season. These represent long-term HSM conditions by species across years.

The next phase of the study involves running “what-if” scenarios. Circulation modeling is being conducted to predict seasonal temperature and seasonal salinity patterns associated with: a) baseline flow conditions, and b) water withdrawal conditions. Habitat grids created from the temperature and salinity data will be used with HSM to assess the potential impacts of 20% water withdrawals on each species life-stage by season.

Rainfall is generally low during the winter (January-March) and spring (April-June) and higher in the summer (July-September) and fall (October-November). Using the HSM analyses, the influence of water withdrawals during each season will be determined. The HSM analyses can help SWFWMD managers make decisions concerning minimum flows and levels that conserve the estuarine ecosystem, while providing water to Florida residents.

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THE EVERGLADES NATIONAL PARK AND BIG CYPRESS NATIONAL PRESERVE VEGETATION MAPPING PROJECT

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The Everglades National Park (EVER) and Big Cypress National Preserve (BICY) vegetation mapping project is a cooperative effort between the South Florida Water Management District, the United States Army Corps of Engineers, and the National Park Service. This project employs a grid-based mapping approach as opposed to the traditional vector-based methodologies. Photo-interpretation is performed by superimposing a 50 m x 50 m grid network over stereoscopic color-infrared aerial imagery on a digital photogrammetric workstation. Photo-interpreters identify the dominant vegetation community in each cell based on community specific spectral signatures and extensive ground-truth data. The community in each cell is classified using a hierarchical classification system. This project is expected to produce a highly accurate and spatially complete vegetation map with over 80% accuracy. In addition, this project will provide essential baseline information needed to detect and document changes in the spatial extent, pattern, and proportion of plant communities within EVER and BICY as they respond to hydrological modifications due to restoration efforts and/or climate change related impacts. Additional ancillary products generated from this mapping project include a landscape level network of spatially specific vegetation data that includes species level relative abundance and georeferenced photographic documentation. The first map deliverable is expected in spring 2016, with subsequent deliverables ready each year thereafter. Project completion is expected in September 2019.

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USING MULTICRITERIA DECISION ANALYSIS TO EXPLORE MANAGEMENT OPTIONS IN THE GRAND CANYON

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In January 2016, the Bureau of Reclamation and the National Park Service published a Draft Environmental Impact Statement concerning the long-term management of water releases from Glen Canyon Dam and associated management activities. In developing this long-term experimental and management plan, the lead agencies used two formal decision analysis methods, multicriteria decision analysis and the expected value of information, to evaluate alternative strategies against the resource goals and to evaluate the influence of uncertainty.

The Colorado River ecosystem between Glen Canyon Dam and Lake Mead, comprising Glen, Marble, and Grand Canyons, is important to many stakeholders, including: American Indian Tribes, whose creation stories begin there; citizens of the seven western Colorado River Basin states, who rely on the river for water and electricity; visitors from around the world, who raft, hike, camp, and fish in the extraordinary wilderness; and environmental advocates, who seek to conserve the species and ecosystems of this unique place. The two lead agencies, in partnership with subject-matter experts and in consultation with cooperating agencies, developed 18 performance metrics associated with 8 resource goals, as quantitative measures against which to evaluate 7 management alternatives. Stakeholder agencies were invited to participate in a swing-weighting exercise to understand their range of perspectives. The results of the swing-weighting exercise were combined with the evaluation of the alternatives to complete a multicriteria decision analysis. The alternatives differed across performance metrics, producing unavoidable tradeoffs. When the performance of each alternative was weighted across performance metrics, three alternatives (B, D, and G) were top-ranked depending on the set of weights proposed. Alternative D was identified as the preferred alternative in the Draft Environmental Impact Statement.

The effects of uncertainty on the ranking of alternatives were evaluated through calculation of the value of information. Surprisingly, these rankings were not sensitive to the critical uncertainties that were evaluated; that is, the choice of a preferred alternative was sensitive to the value-based judgment about how to place relative weight on the resource goals but was not sensitive to the uncertainties in the system dynamics that were evaluated in this analysis.

This work provides an example of how to use formal decision analysis methods in the context of an Environmental Impact Statement to integrate value judgments and scientific evidence in the evaluation of natural resource management alternatives.

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REGIONALLY INTEGRATED, SUSTAINABLE, AND RESILIENT DEVELOPMENT OF NATIONALLY SIGNIFICANT WATER RESOURCES ON THE TEXAS COAST

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Coastal Texas is experiencing rapid infrastructure development, with new technological trends in oil and gas sector production, refining, and transportation. This translates into elevated demand for the network of deep draft navigation channels and Gulf Intracoastal Waterway on the Texas coast, and improved flood risk management. USACE, Galveston District, is addressing this growth under its Civil Works and Regulatory Program authorities. Shared visioning of non-Federal sponsors and stakeholders coast wide inform mutually held objectives of a vibrant economy, resilient community, and healthy ecosystem. Ecosystem restoration features associated with newly authorized navigation channel improvement projects for construction, as well as beneficial use of channel maintenance materials, include a broad spectrum of emergent wetlands, bird islands, and barrier shoreline nourishment. Two new Mega-Studies being advanced, the Houston Ship Channel 45 ft Expansion and Improvement Study, and the Coastal Texas Protection and Restoration Study, offer significant opportunities to increase the ecosystem restoration and management value proposition through extended beneficial use of dredged materials and integration of natural and nature based features in a multiple lines of flood defense context. Cutting edge science and technologies are being applied at pilot demonstration scale as a strategic enabler to priority objectives management. Realization of Ecosystem Goods and Services output synergies, derived at a regional scale across business lines of the district's project portfolio, will serve as an international exemplar for regionally integrated, sustainable, and resilient coastal resources management on America's Energy Coast.

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COMPREHENSIVE AQUATIC SYSTEMS MODEL (CASM) FOR EVALUATING COASTAL RESTORATION PROJECTS IN COASTAL LOUISIANA (PART II)

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Comprehensive aquatic systems models (CASMs) developed to represent the estuarine food web in Barataria Basin, Breton Sound, and Pontchartrain Basin were calibrated to daily species biomass data under existing conditions (1995-2010) and then used to evaluate the responses to proposed large-scale Mississippi River diversions for key species. We calibrated the model using a combination of the PEST software and ad hoc adjustments to match basin-wide biomass predictions to biomass data collected by Louisiana Department of Wildlife and Fisheries and the NOAA National Marine Fisheries Service. Plots of predicted seasonal biomass by polygon versus the mean seasonal temperature, salinity, primary production, proportion of marsh vegetation, consumption rate, and predation mortality were used to verify that spatial distribution patterns were realistic for each population and to understand the environmental and food web factors driving the distribution pattern. The DELFT-3D model was used to simulate restoration alternatives accounting for different river diversion locations and operational plans (intermediate versus high flow). Daily temperature, salinity, and Chl a generated at the DELFT nodes, and maps of marsh vegetation and open water generated by the LA-VEG module within DELFT at 1 km2 resolution, were averaged for the 49 CASM polygons. The CASMs for each of the three basins were run over 5 to 50 years with the simulated environmental inputs for each alternative. The relative changes in key species biomasses (e.g., brown shrimp, blue crab, red drum, gulf menhaden) over time for the entire system and within the thee coastal basins were evaluated by comparing the predicted seasonal and annual biomass results from each diversion alternative to a future-without-project scenario with no river diversions. Species responses were primarily driven by primary production and bottom-up effects on the food web, although the factors driving biomass were more complex for the larger predatory estuarine species with varied diets and wide-ranging salinity and habitat preferences.

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DEVELOPMENT OF COMPREHENSIVE AQUATIC SYSTEMS MODELS (CASMS) FOR COASTAL LOUISIANA (PART I)

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Three comprehensive aquatic systems models were developed for Barataria Basin, Breton Sound, and Pontchartrain Basin in the Mississippi delta region to predict changes in species biomass in response to proposed river diversions designed to build land and reduce salinity. The three CASMs used the same underlying food web made up of 34 taxa including phytoplankton, periphyton, zooplankton, benthic infauna, Caridean shrimp, brown and white shrimp, blue crab, oysters, bay anchovy, gulf menhaden, largemouth bass, red drum and spotted seatrout. Many species were split into two or three life stages that were simulated separately and linked through growth and reproduction. Bioenergetics-based equations were used to simulate daily biomass change for each consumer population. Daily temperature, salinity, chlorophyll, and marsh vegetation data from the Louisiana Master Plan models from 1995 to 2010 were used to drive each CASM. Phytoplankton and periphyton biomass were estimated from the simulated chlorophyll data. Simulated temperature data were used to seasonally modify consumption. Salinity and structural habitat (i.e., marsh vegetation) were used to adjust daily growth according to habitat modifying functions that were determined for each species and life stage. The CASM was run in 49 polygons across the three basins to predict the distribution of each population across the model domain, and the results of each polygon were combined by basin to produce three biomass estimates. Basin-wide biomass was calibrated to biomass estimates from Louisiana Department of Wildlife and Fisheries and National Oceanic and Atmospheric Association sampling programs. The CASM approach predicts biomass based on bottom-up processes (hydrology, water quality affecting prey growth and distribution). The CASMs also use a daily time step, which is critical for evaluating the effects of short term management actions (e.g. seasonal or pulsed operations the river diversions).

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RECENT HYDROLOGICALLY-DRIVEN VEGETATION SUCCESSION IN SHARK RIVER SLOUGH, THE SOUTHERN COMPARTMENT OF THE EVERGLADES RIDGE AND SLOUGH LANDSCAPE

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In the Everglades, where plant communities are primarily arranged along a hydrologic gradient, the ridge and slough (R&S) landscape, a mosaic of sloughs, sawgrass ridges, and tree islands, comprises plant communities representing different stages of vegetation succession. With temporal changes in hydrologic regime, a change in species composition may affect vegetation successional processes and cause a shift in boundaries between vegetation communities present in ridge, slough and tree island landscapes. However, the direction and magnitude of such a change are determined by the extent of hydrologic alterations, with prolonged and extreme wet events even resulting in loss of upland woody vegetation. Persistent drying conditions initiate an opposite trend, toward an expansion of sawgrass, and the dominance of trees over herbaceous plants.

We studied ridge and slough vegetation communities system-wide and broadly assessed the existing conditions of the R&S landscape in the Everglades. We then specifically examined the interaction between hydrology and vegetation over a 13-year period, between 1999/2000 and 2013 within the ridge-slough portion of marl prairie-slough gradient and seasonally flooded portions of tree islands in Shark River Slough. In the ridge-slough marsh, vegetation was sampled 4 times during that period, while vegetation along tree island transects and in permanent plots was sampled twice, once near the beginning of the period, and again in 2011 or 2012. Using a suite of multivariate techniques, including trajectory analysis, we examined the direction of vegetation change over time by quantifying the displacement of sites in relation to the hydrologic gradient in ordination space.

In the Everglades, substantial portions of the ridge-slough landscape are severely degraded. In Shark River Slough, drier conditions of the last decade or so have caused an apparent increase in spikerush and sawgrass cover at the expense of open water sloughs in the ridge-slough portion of marl-prairie-slough gradient. Moreover, within the complex tree island landforms, we have noted an expansion of woody plants across the full suite of communities, i.e., within the Bayhead Forest, Bayhead Swamp, and Sawgrass Tail portions of the islands. In prolonged dry conditions, the progression towards sawgrass, and ultimately the establishment and growth of trees in the peat environment drives successional processes towards the expansion of tree islands in the ridge and slough landscape. This study has implications for how the ridge and slough landscapes are managed in the Everglades.

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LOUISIANA'S COASTAL MASTER PLAN: REDUCING FLOOD RISK AND INCREASING COMMUNITY RESILIENCE

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Coastal Louisiana faces one of the highest land loss rates in the world, which puts our homes, businesses, communities, and national energy and transportation infrastructure at risk. As part of the 2017 Coastal Master Plan, the Coastal Protection and Restoration Authority is responding to this crisis by developing the Flood Risk and Resilience Program which will support communities' ability to reduce flood risk and adapt in the face of an uncertain future. CPRA's Flood Risk and Resilience Program is unique in geographic size, its focus on risk reduction over a 50-year time period, and its extensive engagement with a diverse group of stakeholders. The program is based on a combination of technical, programmatic, and outreach efforts that integrate federal and state best practices. The effort also recognizes the local context of coastal communities and parishes who have previously implemented mitigation measures in order to support locally-appropriate solutions. The Master Plan analysis combines structural and nonstructural protection options to determine the best strategy to reduce risk across coastal Louisiana. The resulting data can be used by the state, parishes, and residents to better identify structures targeted for mitigation by providing information about groups of structures at highest risk, cost-effective mitigation options, and project benefits. Project recommendations are also further refined based on areas of low to moderate income populations and severe repetitive loss properties. Nonstructural projects will need to be implemented in partnership with other state agencies, coastal parishes, and property owners. Program development includes the creation of a state-led grant program to implement nonstructural projects. It will encourage a streamlined and efficient methodology for distributing funds to projects that are the most effective at reducing coastal flood risk. With this information, CPRA and other state partners can make the most beneficial and effective flood risk reduction investments across the coast.

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HOW DOES DPM HELP MOVE EVERGLADES RESTORATION FORWARD?

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Once a continuous wetland conveying water from Lake Okeechobee to Florida Bay, the Everglades landscape has been partitioned by 1000 miles of canals and levees that have drained most areas and impounded others. Most importantly, these activities halted the primary mechanism – sheetflow and sediment transport – which once maintained the corrugated ridge-and-slough patterning and topography. Modeling and small-scale field studies suggest predrainage water velocities of 2-3 cm s^{-1} entrained and redistributed the Everglades' sediments from sloughs to ridges. While levee removal is essential to restoring sheetflow to the system, the canals adjacent to them pose the potential to inhibit sediment transport and introduce high-nutrient sediments to downstream wetlands. The Decomp Physical Model (DPM) is a landscape-scale experiment (15-km^2) quantifying benefits of sheetflow and canal-backfilling on Everglades ridge-and-slough wetlands. To evaluate sheetflow and backfill hypotheses, the DPM uses 10 gated culverts on the L 67A levee to provide sheetflow into the "pocket" between the L-67A and L-67C levees. Other features include three 1,000-foot canal backfill treatments and 3,000-feet of removal of the L-67C levee. The DPM uses a "before-after-control-impact" (BACI) design, consisting of field monitoring under no flow (baseline) and high flow (impact) conditions. High flow events have been completed in the Fall of 2013, 2014 and 2015. An additional spatial design was implemented to quantify existing gradients in sediment characteristics and the overall spatial footprint of sheetflow generated by the culverts. Sediment movement was quantified using several methods: horizontal and vertical traps for transport and accumulation (respectively); release and capture of a synthetic and paramagnetic tracer hydraulically matched to Everglades sediment; molecular biomarker analyses of standing and advected sediments; and traditional sampling of water column particulates coupled with water velocity monitoring.

In two flow events, horizontal traps indicated sediment transport in sloughs increased 5- to 20-fold under high flow, while ridge transport increased subtly. Initial pulses of water (within hours of opening the culverts) generated disproportionately greater suspended sediments and sediment transport than steady-state flows. Synthetic sediment tracers confirmed that sediments moved through sloughs under high flow and settled in ridges. Sediment traps, sediment biomarker analyses, and acoustic Doppler velocimeters (ADVs) deployed showed that high flows and sediment transport were limited to within 500-m of the culverts. In the canal, sediment traps showed that partially and completely backfilled treatments exhibited a shift to mineral-dominated sediments with lower Phosphorus content (reflecting fill material). Under high flow, the open (non-backfilled) canal treatment exhibited the greatest sediment accumulation and downstream transport of sediments. These preliminary DPM findings have important implications for Everglades restoration. First, given the limited spatial extent of high flows and the tendency for flow to go in the "wrong" direction (east instead of south), active management approaches are likely needed. For example, vegetation management to hydrologically re-connect and expand remnant sloughs will likely maximize the effectiveness of culverts and levee gaps in achieving sheetflow and sediment redistribution over larger areas, and in the historic direction. The extent to which active management is needed and implemented requires further study. Second, operating culverts to include multiple "pulse events" may also enhance sediment transport. Third, canal backfilling appears helpful in in preventing eutrophication of downstream marshes by reducing mobilization of high-nutrient sediments. However, this phenomenon also requires additional monitoring. Vegetation regrowth in canal treatments is ongoing, reflecting a disturbed system that may not resemble the structure or nutrient cycling attributes of the final, steady state condition.

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RESTORING LARGE LANDSCAPES TO BENEFIT NATIONAL PARKS

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During this centennial year of the U.S. National Park Service (NPS), there is much to celebrate. Science and stewardship have prominent roles in park management—far more than at any time in our agency's history. In addition, there is widespread recognition that the mission of the NPS to safeguard our shared natural heritage extends beyond the boundaries of any particular park unit. At the same time, the diversity of native species and the natural processes with which they are intertwined face unprecedented challenges. Without innovation and concerted action, we risk losing key parts of this heritage—the species richness, role and function, and beauty a biodiverse landscape brings. National parks and other protected areas have long served as critical preserves for biodiversity and natural resources; however, they have often been managed in isolation from surrounding areas. Scientific consensus now clearly demonstrates that land managers must plan for extensively connected ecosystems across broad landscapes and that management at this scale is necessary to ensure both restoration and persistence of ecosystems and their component species. The NPS is committed to applying this approach in its operations and management, and to actively engage with other agencies, organizations, and partners in ways that benefit biodiversity conservation across the landscape. Numerous U.S. laws, policies, and programs from local to national scales implicitly or explicitly support the conservation of biological diversity, and embrace more coordinated approaches to resource conservation. While these mechanisms have led to important investments in conservation and natural resource protection, it is critical that increased coordination, integration, and landscape-scale creativity will be necessary to ensure long-term persistence of biodiversity and associated ecosystem services. In many instances, this landscape-scale approach will also require targeted investments in restoration, to re-establish connectivity and ensure continued ecosystem integrity. The NPS stands ready to engage in and help lead such efforts, and recognizes that the ability of our agency to accomplish its mission will depend on this perspective. In taking this approach, the NPS hopes to cultivate a support network—a community of practice—among NPS employees, park neighbors, stakeholders, and partners at national and international levels, with a common goal of natural heritage conservation and stewardship in the 21st century.

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GASEOUS CARBON EMISSIONS (METHANE AND CARBON DIOXIDE) FROM WETLAND SOILS IN A RE-CREATED EVERGLADES LANDSCAPE

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Reducing the rates of greenhouse gas (GHG) emissions is critical in combatting global climate change. Carbon dioxide (CO2) and methane (CH4) are the two most important carbon-based GHGs, for their atmospheric warming potential. Wetlands such as the Florida Everglades play major roles in the global carbon cycle, as varying hydrologic conditions affect the production rates of these two GHGs. Although wetlands are widely known for their capacity as carbon sinks, flood patterns (including timing, frequency, amplitude, duration, etc.) may cause differential production rates for CO2 and CH4, affecting the balance of GHG potential. While CH4 is generally produced at lower rates compared to CO2, CH4 represents a relatively more "potent" GHG, and can have a disproportionately greater impact in terms of atmospheric warming. As one of the world's largest wetlands, the Everglades represents a key component to both the carbon cycle and the water regime of South Florida. Historically, this unique system was formed and sustained by the steady flow of water south of Lake Okeechobee. Over the past century, however, increased anthropogenic activities have altered the amount and flow of water in the region. Since the late 1800's, South Florida has undergone a series of hydrologic modifications that have reduced the Everglades to about half of its original spatial extent, and its function as a wetland has been severely impacted. In response, the Comprehensive Everglades Restoration Program (CERP) has sought to increase water inputs to many areas to restore historical flow. To provide a better understanding of the mechanisms by which an Everglades landscape can be restored and sustained, the Loxahatchee Impoundment Landscape Assessment (LILA) serves as a large-scale physical model within the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Boynton Beach, Florida, USA). Here, scientists are able to test and monitor methods of restoring the condition and function of an Everglades wetland. This particular study measured CO2 and CH4 concentrations in pore-water, from soils across varying elevations at LILA, where water levels were controlled to reflect natural flood patterns. While lower elevations experienced longer flooding and produced more CH4, higher elevations conversely produced more CO2. Since CH4 has a relatively high global warming potential, CO2 production would need to be 70 times greater than that of CH4, to balance the GHG output. The average ratio of CO2:CH4 across all elevations was 22.0 (mol:mol), indicating that prolonged flooding may increase the overall global warming potential of these areas, without considering carbon sequestration by photosynthesis. Future restoration and water management within wetlands should therefore consider GHG production potential, as an important aspect of carbon balancing under global climate change.

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BALANCING LIFE SAFETY WITH ECOLOGICAL HEALTH AND ECONOMIC SUSTAINABILITY: CHALLENGING THE STATUS QUO IN THE SACRAMENTO RIVER VALLEY AND DELTA

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The Sacramento River Flood Control Project (SRFCP), located in California along the Sacramento River and a number of its tributaries, from Shasta Dam to its confluence with the San Joaquin River in the Sacramento-San Joaquin Delta, is undergoing a general reevaluation by the US Army Corps of Engineers together with the Central Valley Flood Protection Board.

The existing project is a levee system that was designed and built in the early 1900's following engineering and design standards of that time. The levees were constructed close to the river to increase velocities which would flush out hydraulic mining debris that caused widespread deposition and disruption of economic uses of the river. In the mid 1900's reservoirs with dedicated flood storage were constructed on the major tributaries of the levee system to reduce peak flows. The combination of levees and flood storage resulted in a substantial reduction in the probability of flooding in the Sacramento Valley.

As a result of the levee improvements, important ecosystem processes directly associated with riverine systems such as channel migration, meander cutoffs, and wetland habitats were severely reduced by near-channel levees, bank revetment, and water diversions. Reservoirs on the system reduced the size of peak flows released to the leveed system. However, this lengthened lower flows and further altered the river's natural geomorphic processes. Consequently, significant habitats and native species populations continue to decline.

In addition, it is now recognized through use of more modern engineering analysis and collection of additional historical data that flood risk in the Sacramento Valley may be higher than previously thought. The high velocities that flushed out mining debris are eroding the levees. There is greater understanding of through- and under-seepage as geotechnical modes of levee failure. Also, analysis of more than a century of recorded flood flows has revised the probability calculations of exceeding the system's design capacity. Since the SRFCP was completed in the 1950s, only localized improvements have been made. Over this same period, many areas have seen substantial urban development. This urbanization has dramatically increased the consequences of levee failure in these areas.

A number of alternatives integrating a combination of ecosystem restoration and flood risk management measures will be evaluated. Proposed measures include widening existing bypasses, modifying existing weirs, optimizing weir operations, constructing setback levees, developing floodplain management plans, restoring riverine aquatic and riparian habitat, removing barriers to fish passage, and restoring natural geomorphic processes.

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CHANGING HYDROLOGIC CONDITIONS IN THE MISSISSIPPI RIVER BASIN: IMPLICATIONS FOR RESTORATION AND ECOLOGICAL PROCESSES

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Many parts of the Mississippi River Basin are experiencing different hydrologic conditions than they did 100 years ago as a result of changes in magnitude of hydrologic inputs and withdrawals. These changes can be attributed to factors such as altered amounts and timing (seasonality) of precipitation, changes in rainfall-runoff relations due to altered land use over vast portions of the basin, and anthropogenic disturbances to streams and river systems. All of these issues are important to those agencies responsible for flood protection, river and watershed management and habitat protection.

Data from thousands of NOAA daily-precipitation gages, and all USGS flow data in the basin were used. Level III ecoregions had been previously shown to be a good differentiator of regional hydrologic conditions. However, because of the need to account for changing hydrologic conditions within drainage basins, basin boundaries (HUC-4) were also used to subdivide the data. The data used in this study cover about a 100-year period.

Results show that in general, most of the Mississippi River Basin is receiving more rainfall than it did 100 years ago. Precipitation has also generally shifted temporally such that winter precipitation has significantly decreased in many areas while spring and autumn precipitation has generally increased. This indicates that winter snowpacks have decreased, leading to smaller spring discharges. Even within regions of increased precipitation, water yields have decreased significantly, particularly in the western part of the basin and particularly in spring. Parts of the western basin are experiencing 25 to more than 50% less discharge per unit area than they did 100 years ago. The anthropogenic influence on water yield, including the construction of thousands of dams, evaporation from large reservoirs and irrigation appears to be large over vast areas, with values of water yield per unit precipitation also decreasing between 25 to more than 50% throughout much of this area.

Areas with pronounced increases (25 to > 50%) in water yield include a north-south slice of the central United States bounded on the west by the eastern parts of the Dakotas, Nebraska, Kansas and Oklahoma and on the east by Lake Michigan, Illinois and the lower Mississippi Valley. This increase in water yield can be partly attributed to increases in precipitation (5-25%), but also to improved drainage conditions. These increases will result in changes to channel geometry, causing increased erosion and heighted sediment loads and nutrient transport. Ultimately, these changes will impact and degrade surface-water quality and aquatic habit. With hydrology being a primary driver of stream processes, by providing a better understanding of the how changes in hydrology result in changes to in-stream processes, loadings and aquatic habitat, we can adapt how we design restoration projects to maintain stable systems and reduce species vulnerability associated with those changes.

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COASTAL WETLAND RESTORATION TO ENHANCE FISHERIES PRODUCTION AND FLOOD RESILIENCE: THE VICTORIA POND ECO-HYDROLOGY PROJECT, THE BAHAMAS

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Since 2009, researcher and local residents have worked to restore mangrove wetlands associated with Victoria Pond in the center of historic George Town, Great Exuma. Lake Victoria (aka “the Pond”) has suffered from a lack of coordinated management and poor coastal development practices; Victoria Pond was polluted and had been altered by roads, filling of wetlands and development for over 200 years. The Victoria Pond wetlands project was designated as UNSECO’s Eco-hydrology Site for the insular Caribbean in 2012. The restoration project has three components: a.) removal of trash and fill in original wetlands, b.) re-construction of wetlands through culverts, rock revetments and mangrove planting, and c.) routine monitoring of water quality and fauna biodiversity, especially fisheries target species.

Six years after the initiation of the Victoria Pond Clean-up and Restoration Project, the coastal wetlands show some signs of improvements. Monitoring of water quality and marine fauna showed continuing degradation around George Town, particularly after major storms and rain events. Quarterly monitoring of the water quality and wetlands has resulted in a shift of project emphasis on using restored wetlands as tools to mitigate flood risk and to protect near shore water quality. The wetland restoration has launched an island-wide assessment of wetlands and coastal resources for better coastal zone management, especially looking at wetland resilience in disaster and flooding events.

The Victoria Pond restoration project aimed to eliminate the very real public health threat of rats, mosquitoes, and leaching of raw sewage into protected wetlands and waterways. The overall vision for the Victoria Pond restoration project is to demonstrate that a highly-altered coastal wetland can be restored and can regain ecological function. The project is designed to show the value of a protected wetland and coastal environment within a populated settlement; demonstrating that people can live alongside mangroves and their associated wildlife. The goals are: 1.) To establish a local mangrove preserve that includes the Pond, an appropriate coastal buffer zone, channels, and associated embayment and ponds that will function as an ecological unit; 2.) To complete the necessary clean-up, excavation, and restoration needed to restore natural drainage and tidal flow through the wetland preserve system; ultimately, the cleanup of Victoria Pond will improve the coastal water quality of adjacent Elizabeth Harbour; 3.) To delineate the preserve area with markers and signage and restore native plant communities to the coastal zone of Victoria Pond; 4.) To develop long-term community outreach and coastal stewardship programs to help maintain and finance the management of the Victoria Pond mangrove preserve and 5.) To document measurable improvements in coastal water quality and near-shore fish habitat in the George Town environs.

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IMPLEMENTING LOW-CRESTED ARTIFICIAL OYSTER REEF BREAKWATERS INTO RESTORATION PRACTICE

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The northern Gulf of Mexico is home to numerous coastal restoration and shoreline protection projects exploring and incorporating nature-based coastal infrastructure (oyster reefs, marshes, etc.) over more common, traditionally engineered infrastructure solutions (seawalls, bulkheads, revetments, etc.). One way nature-based coastal infrastructure is currently being incorporated into restoration practices and projects is through the use of nearshore, low-crested, artificial, oyster reef breakwater structures. Artificial oyster reef breakwater structures attempt to serve dual purposes of affording shoreline protection by attenuating wave energy and providing habitat and ecosystem values that exceed that of "hard" armored shoreline stabilization solutions.

However, nearshore, low-crested, artificial, oyster reef breakwater structures are not well understood coastal infrastructure technologies. Designs (placement, material composition, and geometric properties, etc.) vary greatly. Additionally, coasts and shorelines are very unique systems with ranging and variable features, composition, and nearshore hydrodynamics, even when compared to nearby or adjacent sites. As a result of these differing and fluctuating characteristics the functionalities and capabilities of nearshore, low-crested, artificial, oyster reef breakwater structures are largely unknown. This presents a considerable challenge to the widespread implementation of these nature-based coastal infrastructure technologies in coastal restoration practice.

This presentation will consider and review factors hindering the widespread adoption of nearshore, low-crested, artificial, oyster reef breakwater structures in engineered coastal restoration projects. Discussion will emphasize research and engineering techniques that should be implemented into restoration practices which are adopting nearshore, low-crested, artificial, oyster reef breakwaters. Additionally, discussion will highlight remaining needs and shortcomings that are limiting the widespread use of nearshore, low-crested, artificial, oyster reef breakwater structures in coastal restoration practice.

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REDUCING LABILE PHOSPHORUS IN AGRICULTURAL DRAINAGE CANAL SEDIMENTS BY CONTROLLING FLOATING AQUATIC VEGETATION IN THE EVERGLADES AGRICULTURAL AREA

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A significant portion of phosphorus (P) loads exiting the Everglades Agricultural Area (EAA) basin in south Florida is in organic particulate forms from canal sediments during farm drainage events. This study was initiated to investigate the role of controlling floating aquatic vegetation (FAV), such as water lettuce (*Pistia stratiotes*), on the formation of denser inorganic sediments and recalcitrant P forms on eight farms. It is hypothesized with FAV removal, more light penetrates the water column, potentially allowing for the co-precipitation of P with calcium and magnesium into less labile minerals and reducing the accumulation of labile organic P in sediments. With FAV removal, more oxygen is present, possibly increasing redox potential and P-sorption. This change in redox potential can increase the capacity of iron and aluminum (Fe-Al) minerals to sorb P into more recalcitrant forms. Phosphorus fractionation was used to measure labile and recalcitrant P pools in eight farm canal sediments at the 0-2.5 cm depth in the EAA. Treatment canals implement aggressive FAV control, while control canals operate under normal management practices. The generation of denser inorganic mineral P may reduce P transport out of farm canals and reduce P loads into the downstream Everglades ecosystem. On all farms, residue and Ca-Mg-bound P pools have the highest concentration, and labile P has the lowest. There are no significant changes found between P pools over sampling periods so far. In addition, x-ray diffraction (XRD) analysis was used to assess the spatial and temporal change in mineral composition of canal sediment. In the future, sediments exported with drainage water will be subject to P-fractionation analysis to assess the speciation of P exported during pumping events.

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IMPROVING LAKE OKEECHOBEE ECOLOGY

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The construction of the Herbert Hoover Dike around Lake Okeechobee coupled with the expansion of agricultural development in the watershed and the competing uses of the lake for water supply and flood control significantly altered the lake's physical state by increasing the frequency, amplitude, and rate of change in lake levels and by accelerating the rate of eutrophication, resulting in elevated dissolved and particulate nutrient concentrations and the accumulation of a deep organic sediment layer in much of the pelagic zone. Concomitant ecological impacts have included, among others, the extensive replacement of important native emergent plant species by a variety of exotic-invasive species, an increase in cyanobacterial blooms, periodic die-offs of the submerged aquatic plant community and its associated epiphyton, and shifts in the benthic macroinvertebrate community toward pollution tolerant species.

Since returning the lake to its pre-anthropogenically altered state is infeasible, restoration goals must focus on improving lake ecology while still maintaining the lake's critical societal and economic functions for south Florida. Currently, three major tools are being employed to this end: 1) managing lake levels in a way that incorporates an understanding of the hydroperiod requirements of the lake's littoral and nearshore zones 2) active vegetation management to control invasive-exotic species and support preferred native species, and 3) nutrient source control in the lake's watershed. This talk discusses these approaches and uses information from Lake Okeechobee long term monitoring data sets to highlight progress and challenges in achieving an ecologically healthier and more stable lake.

Anthropogenic changes to Lake Okeechobee have contributed to undesirable ecological changes. Returning the lake to its pre-anthropogenically altered state is infeasible and restoration goals must focus on improving lake ecology while still maintaining the lake's critical societal and economic functions for south Florida; utilizing the tools of managing lake levels, active vegetation management and nutrient source control. Lake Okeechobee long term monitoring data sets highlight progress and challenges of this approach.

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CHANGING COURSE - THE MOFFATT & NICHOL TEAM SOLUTION- THE GIVING DELTA -A "SYSTEMS APPROACH" TO A CONSOLIDATED AND SUSTAINABLE LOWER MISSISSIPPI RIVER DELTA

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In response to the Changing Course Design Competition a bold, innovative "systems approach" to link the specific needs of the region's ecosystem, economy and community is proposed. "The Giving Delta" plan empowers the Mississippi River's seasonal natural flood pulse to maximized sediment capture in order to build and maintain wetlands, mitigate the effects of climate change and subsidence, and to slow the inevitable marine transgression of the Delta. Sediment capture is optimized by a series of sediment retention strategies and passive sediment diversion structures, as well as establishing a new deep draft navigation channel connected to the Barataria Bay shoreline littoral zone 40 miles north of the current channel. This paradigm shift from "flood control" to "controlled floods", connects the River's natural flood pulse to the coastal landscape. Using hydraulic residence time in the basin as a design and operational criteria for these controlled and passive structures, balances estuarine recovery and system response tolerance in order to determine the magnitude of the peak flows possible without intolerable salinity suppression in the receiving basins. Seasonal salinity gradients can be established that enable the diversion program to operate in harmony with and promote regional fisheries. On an annual basis, fisheries, communities and ecosystems will adapt to seasonally changing conditions. This plan is not designed to completely rebuild the wetlands that have been lost over the last century. Instead, the design encourages wetland adaptation to accelerated sea level rise in the coastal basins. With this plan, the basin ecologies would "self-organize" in parallel to the human settlement's natural ability to adapt and change to this long-term vision, as a new, consolidated and sustainable Delta emerges. By establishing a framework of implementation over 100 years, incremental adaptation minimizes individual uncertainty and costs within each human generation.

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BUILDING COASTAL RESILIENCE IN THE GULF OF MEXICO: DECISION SUPPORT TOOLS FOR ASSESSING THE COSTS AND EFFECTIVENESS OF ECOSYSTEM RESTORATION

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The power of decision support tools lies in their ability to bring disparate stakeholders groups together to visualize, explore, and facilitate a greater understanding of risks and opportunities. Not only do these tools give planners and managers the power to make more informed decisions, but they give modelers a more intuitive way to communicate their data and analyses to decision makers, which can help make a more compelling case for project funding or policy changes. Through tool demonstrations and success stories, this session will provide an overview of a suite of applications (apps) within The Nature Conservancy's (TNC) Coastal Resilience online decision support system. Attendees will learn how others have used these apps to support stakeholder engagement and adaptive management at various scales.

In the Gulf of Mexico, TNC partnered with the reinsurance company Swiss Re to develop the Economics of Coastal Adaptation (ECA) app which evaluates the cost effectiveness of eight different nature-based and artificial risk reduction solutions across the region. The ECA app serves as a mechanism to improve understanding about the drivers of coastal risk and helps to inform planning and investments for large-scale restoration and conservation efforts to reduce that risk. Cost-benefit assessments like these that incorporate natural defenses are relevant for insurers, lenders, and agencies seeking to avert billions of dollars of damages for millions of people.

We will also provide examples from Old Saybrook, Connecticut, where the Future Habitat app was used to inform communities about where marsh advancement will likely occur under various future sea levels. In California, the Department of Defense at Naval Base Ventura County used several Coastal Resilience tools to evaluate assets that might be at risk with expected sea level rise. Using the insight gained, the Department of Defense partnered with TNC to create a progressive retreat plan for the base that will emphasize nature-based solutions to not only accommodate increasing coastal hazards, but also supports the base's mission and policies.

These innovative decision support tools promote collaboration and arm managers and planners with the information they need to implement more effective adaptation solutions. This session will encourage attendees to envision how decision support tools can inform their own adaptive management planning processes and ultimately give them the power to turn concept into action.

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ENGINEERING CONSIDERATIONS FOR PLACING WOOD IN STREAMS AND RIVERS

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In many regions large wood offers cost benefits relative to quarried stone for river channel stabilization and habitat projects, but it requires expertise in project management and design to produce desirable outcomes. Design of wood placements is a challenging class of river engineering problems due to the buoyancy and decay of wood. No less challenging, however, are more fundamental issues associated with determining whether or not wood placements are appropriate for a given site or project. Since wood is often mobile and bound to decay unless it is continuously wet, wood placements should usually be viewed as temporary aids to allow recovery of a natural regime that includes creation of islands and other relatively stable surfaces in the stream corridor, colonization of the islands by trees, growth of trees to maturity and natural recruitment of wood to the aquatic system. Since wood breaks and decays, the efficacy of wood structures depends in large measure about the presence of and their ability to trap background wood load. Thus engineering for wood placement must be based on prior geomorphic and ecological assessments. Project managers should be able to identify pre-project habitat deficiencies and explain how wood placement will form and maintain desired habitat features. A long-term vision for the treated reach that places it within the landscape context and clearly defines future wood sources, sinks and transport and the interaction of these processes with fluvial processes and with the built environment is essential.

Fluvial systems that are candidates for large wood placements are usually more or less degraded, and often bordered or crossed by infrastructure that presents constraints on large wood projects. At present, selection of the types of wood structures and their placement within a given reach is primarily a matter of professional judgment, but future work will likely rely more on multi-dimensional numerical models. Design of wood structures to produce outcomes with acceptable risk profiles often requires careful analysis of forces (buoyancy, lift, drag, friction, gravity) imposed on the structure and selection and design of restraints such as ballast, pilings, burial, or anchors. Design equations are readily available, but coefficients and constants must often be selected based on judgment and experience. Furthermore, considerable uncertainty arises when attempting to predict the near field depth, velocity and scour that produce the design condition. Recent work in the western U.S. has emphasized using vertical logs driven into the bed as piles for restraints, but many methods have been used.

Engineering considerations include project implementation and construction. Placing wood in stream corridors so that net environmental impact is maximized requires care to avoid disturbing riparian zones, channel banks and beds and associated biota. Since wood projects involve amphibious work, transporting large wood (logging operations) and work with heavy equipment, safety issues are demanding and complex. Finally, implementation should include provision for at least qualitative monitoring and adaptive management.

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MODELING THE PROBABILITY OF ALLIGATOR NEST-SIGHTING TO EVALUATE AND ANTICIPATE EFFECTS OF WATER-MANAGEMENT DECISIONS ON THE EVERGLADES ECOSYSTEM

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Spatial and temporal hydrological fluctuations affect the abundance, distribution, and health of all animal species in the Everglades. As the Modified Water Deliveries Project and the Comprehensive Everglades Restoration Plan unfold and the hydrology changes, models that can evaluate and anticipate effects of water-management decisions are needed. Since the American alligator is the top predator in the ecosystem, preying on animals of all sizes at its different life stages, its abundance and health serve as indicator of the overall system health.

The Alligator Production Suitability Index (APSI) is the most recent version of a progression of deterministic alligator habitat suitability models. The major input requirement for the model includes daily continuous surfaces of water depth over the modeling time period, habitat, locations and height of tree islands, locations of alligator holes, and, optionally, salinity for coastal regions. Advantages of this model are that it produces an annual index at a spatial resolution of 400 m^2 and is based on expert observations and investigations of alligator behavior, body condition, and nesting in the field. Disadvantages are that with a deterministic model there is no quantification of the uncertainty in model output, and because the index is not measurable, it is difficult to validate.

In this project we build a statistical model of the probability of a nest-sighting as a function of causal factors. Logistic regression is used to avoid the challenges of zero-inflated data on a 400 m^2 grid-cell resolution. We use the data and a variety of statistical techniques to validate and/or update the functional forms used in the APSI as well as the choice of variables to remain in the final model. We account for spatial correlation and use statistical model-validation procedures. Since this model allows new data to be added each year, it can be used to evaluate the most recent effects of water-management decisions and to project future effects under hypothetical hydrological scenarios.

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ECOSYSTEM RESTORATION AND THE US ARMY CORPS OF ENGINEERS: WHAT DOES THE FUTURE HOLD?

Mindy Simmons
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The nature of the Army Corps of Engineers' Aquatic Ecosystem Restoration program is changing…have you wondered how your projects and programs can be more competitive in this new environment? How are studies and projects selected for implementation? The Corps of Engineers has recently spent $300-400 million annually on aquatic ecosystem restoration. Large, regional programs, such as the Everglades, Upper Mississippi River Restoration, and salmon recovery efforts in the Pacific Northwest have comprised a significant portion of this amount, and when combined with several smaller projects and programs throughout the nation, have produced significant results.

It has become increasingly challenging to fund ecosystem restoration work, particularly in the absence of Congressional earmarks. Learn about the criteria that the Corps uses to prioritize projects; how these criteria are used by the Corps, the Army, and the Office of Management and Budget (OMB); and about the process used allocate limited funds to ecosystem restoration projects, particularly when they are competing against projects that provide benefits to navigation or reduce the risk of flood damage. Learn and ask questions about how you can influence the decision makers in this process. Further, how can we change these criteria to better describe the benefits of potential projects to make them more competitive and relevant to the general public/American taxpayer?

So, what does the future hold? The Corps of Engineers has unique abilities to work with a wide array of partners to manage rivers and coastal systems at a large scale. We have no doubt had significant impacts on the environment as we fulfill our various missions. In the future, how can we leverage these same abilities to restore ecosystems (perhaps undoing past damage we have caused); to smartly and efficiently manage resources, such as dredged material or riverine sediment, to create sustainable, resilient watersheds and communities in collaboration with our partners? Together, better describing the benefits of our projects and programs to the nation will be integral to our success.

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CHEMICAL AND CANINE ANALYSIS AS COMPLIMENTARY TECHNIQUES FOR THE IDENTIFICATION OF ACTIVE ODORS IN AN INVASIVE PATHOGEN, *RAFFAELEA LAURICOLA*

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Raffaelea lauricola is an invasive fungus that was brought into the country in the early 2000s and is currently devastating both commercial avocado groves and essential ecosystems in the Southeast United States. It leads to the fatal laurel wilt disease among members of the Lauraceae family, killing trees with six weeks. The fungus is spread by the beetle (*Xyleborus glabratus*), which bores into a host tree and farms the fungus as food. The host tree responds by systematically shutting down its respiratory system, which eventually kills the tree by also halting the spread of nutrients. Detection canines are currently the only method for early detection of infected trees. Early detection is necessary for the protection of surrounding trees. It is essential that an environmentally safe, long lasting, reproducible training aid be created for use by these canines to make the training aids more easily accessible for handlers and to reduce the risk of accidentally spreading the fungus. First, canine trials were performed to determine the canines' accuracy when presented with controlled odor mimic permeation systems (COMPS) made from infected avocado tree samples, uninfected avocado tree samples, and *R. lauricola* cultures separately. Canines alerted to fungal odors present in the infected avocado tree samples and the cultures with a positive predictive value of 98.3%. This supports the assumption that training aids can be made to mimic the odor of infected avocado tree samples.

In order to identify the odor of infected avocado tree samples, the current research used solid phase microextraction-gas chromatography-mass spectrometry (SPME-GC-MS). Twenty-eight compounds were thus identified; however, most of these compounds are not commercially available. To achieve the goal of a reproducible and easily accessible training aid, actual VOCs from infected avocado tree samples were collected from the headspace of the samples and separated using a gas chromatography column. Separated fractions of the chromatograph were collected on cotton gauze and presented to the detection canines in a series of trials. Results from the trials were used to select a fraction of odor that the canines alert to, called the active odors for *R. lauricola*. This fraction will be used to create a training aid that is safe, long lasting, and reproducible. Using this method, a new method of odor identification was created for future use in rapid detection of invasive and harmful species.

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THE ROLE OF LILA (LOXAHATCHEE IMPOUNDMENT LANDSCAPE ASSESSMENT) IN EVERGLADES RESTORATION

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There is broad agreement that enough is known about the Everglades ecosystem to move ahead with the Comprehensive Everglades Restoration Plan (CERP) but that key uncertainties must be reduced as it progresses. The restoration of the Everglades relies on an adaptive assessment framework that evaluates progress based on performance measures with quantitative targets. The Loxahatchee Impoundment Landscape Assessment (LILA) physical model is a tool to interpret the complex patterns that come from monitoring biological performance measures in the natural system. LILA involved sculpting the physical features of the Everglades landscape from two existing impoundments and then manipulating water depths and flow rates to induce a response by (1) wildlife, (2) tree islands, and (3) ridge and slough communities. LILA links hydrology (flow, seasonal water level fluctuations) with these three CERP high priority features of the greater Everglades ecosystem. As such, LILA is a physical model for hydrologic regimes proposed under CERP but yet to be implemented on a broad scale. From a scientific perspective, LILA acts as a bridge between the results of small-scale microcosm experiments and large-scale ecosystem monitoring. From a restoration and management perspective, the strength of LILA is that the certainty of data interpretation is high because hydrology and other critical processes are controlled and replicated.

LILA is a working 80-acre model of the Everglades ecosystem on the grounds of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (ARMLNWR). Since 2003, this model has been helping scientists from around the world learn more about restoring the Everglades, as well as inform decision-makers, stakeholders and the general public on restoration science. LILA operations include basic maintenance of a 30,000 gpm electric pump and its control system, levee and water control structures and several small outbuildings. The research conducted at LILA is supported by the Everglades License Plate funds and includes applied research on the role of hydrology in both restoring and sustaining Everglades ecosystem function and structure. More specifically, and elements that will be discussed in this special session, LILA hosts important experiments investigating (1) the role of flow in moving and/or depositing sediments (2) the carbon cycle of the Everglades needed to sustain a healthy ridge & slough landscape, (3) the ability of tree islands to move and concentrate nutrients (4) the flooding tolerance of tree island tree species, 5) the role of hydrology on habitat utilization by fish and wildlife, 6) food-web ecology, and (7) how ground water and surface water interact within the Everglades to maintain and restore critical habitat integrity.

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MAXIMIZING SHORELINE PROTECTION USING VEGETATION AND ARTIFICIAL OYSTER REEF STRUCTURES: LESSONS LEARNED

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Wave attenuation and erosion control is desired in many coastal systems to promote marsh restoration, shoreline progradation, sediment accretion, and protect coastal communities from storm surge and erosion. Living shorelines, such as tidal marshes and living breakwaters (oyster reefs) are preferable to hard structures due to their ability to protect shorelines while providing ecological services and habitat. Improved understanding of the successful placement, deployment, and maintenance of these structures is essential to enhance the capacity of living shorelines to protect coastlines and restore coastal ecosystems.

ReefBLK$_{SM}$ is one of several living breakwater structures used for shoreline protection and oyster recruitment. This particular structure is desired for its ability to stabilize shorelines, provide habitat for fish and fauna, and replenish the shoreline with natural course material. Although long term monitoring of these installation projects is limited, observations from deploying living breakwaters throughout the Gulf of Mexico suggest that the success of these structures, in terms of their ability to promote shoreline expansion and oyster growth, appears to be dependent on salinity, sediment supply, presence of predators, and orientation with the shoreline. Information obtained from these field observations informs restoration planning and enhances the success of shoreline protection and coastal habitat restoration efforts.

Schoenoplectus acutus and *S. californicus* are two species of freshwater emergent macrophytes that are often found growing together in many parts of the world (commonly referred to as a tule association). These species are desired in restoration plantings for their ability to stabilize shorelines and levees. Through a flooding tolerance study, we determined that *S. californicus* maintains stem strength regardless of hydrologic regime, whereas *S. acutus* stem integrity decreased when flooded for more than 40 % of each day. A hydroponic nutrient study revealed that *Schoenoplectus* spp. grown in high Si:N conditions maintained stem integrity better when subjected to high wind speeds than those grown in low Si:N conditions. The findings from these studies elucidate important physiological differences between species, as well as important plant-nutrient interactions. The information from these combined field observations and greenhouse studies should aid ecosystem restoration managers to improve species selection and management of marsh restoration and shoreline/levee protection efforts.

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RESPONSE OF INVASIVE WEEDS IN SOUTHERN CALIFORNIA TO THE HISTORIC CALIFORNIA STATE-WIDE DROUGHT

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California has been experiencing a record breaking drought for the past 5 years (2011-2015). It has affected cities, agriculture, as well as natural areas across the State. Southern California and San Diego and Imperial Counties in particular, are classified in the moderate to extreme drought categories. This analysis evaluates the response of invasive plant species across a multi-site transmission line restoration project to this historic drought. The Sunrise Powerlink spans 117 miles across Imperial and San Diego Counties. The restoration component of this large project includes 234 temporary impact restoration sites and 60 reference sites that transverse desert, mountain, and coastal habitats. The response of invasive plant species to the reduced precipitation as well as the timing of when the rain fell was evaluated at restoration and reference sites across the Sunrise Powerlink project. Understanding the trends observed will aid in anticipating where and when to expect invasive weeds to become problematic. This is especially important as precipitation volumes, frequency, and timing continue to change over time, due to El Nino events or longer-term climate change.

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OBJECT-ORIENTED CLASSIFICATION OF WETLAND VEGETATION: MAPPING FASTER ON A BUDGET ON THE KISSIMMEE RIVER FLOODPLAIN

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Object-oriented classification of imagery offers the promise of having a machine “see” images similarly to how humans do. Rather than seeing the image as a series of pixels, an object-oriented classifier picks out groups of adjacent pixels that have color, texture, or other attributes of interest in common, and forms them into “objects” that can then be processed further or used directly to build a map. The importance of the attributes used to pick out objects is determined by a human operator, but the operations carried out by the machine can save a great deal of time when compared to traditional methods of photo interpretation.

At South Florida Water Management District, we have applied object-oriented algorithms to the mapping of wetland vegetation as part of the Kissimmee River Restoration Project. This restoration, which involves filling parts of a large flood control canal and re-opening flow to quiescent river channels and to a wide floodplain, has been ongoing since 1999 and is set to be complete in 2019. To track wetland community response to restoration, vegetation maps produced through photo interpretation of aerial photo surveys have been generated periodically since 1996. The resulting maps have been used to measure the distributions and relative abundances of wetland vegetation types of interest. Comparisons have been made to pre-restoration landscapes.

In 2016, I will complete a mapping effort using object-oriented algorithms developed through commercial software products. The benefit of using these methods is a quick turnaround and low funding requirements, compared to traditional methods using private mapping contractors. Field-identified signatures were collected concurrent with the imagery missions to act as signature definitions for classification and accuracy assessment. I’ll discuss algorithm development for this mapping project along with some preliminary results from mapping trials and accuracy assessment tests.

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LOUISIANA'S COASTAL MASTER PLAN: COLLABORATIVE DECISION MAKING AND STAKEHOLDER ENGAGEMENT

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Public support of, and participation in, the planning process is essential to effective coastal protection and restoration in Louisiana. Successful community outreach and engagement is based on the clear communication of information to a wide range of audiences from citizens to industry groups, academics, and nongovernmental organizations. While planning efforts are based on highly sophisticated technical analysis, they will not be achievable if the public is not a part of the plan development process and afforded a deeper understanding of the scientific analysis.

Louisiana's Coastal Master Plan is an example of a large-scale planning process that is founded on the practice of building long-term relationships and partnerships with coastal stakeholders. Stakeholders and community members are engaged throughout the process, have access to science and technical information as the analysis unfolds, and are provided a forum to discuss and debate the many complex stakeholder interests. These partnerships include a coastal stakeholder advisory group (Framework Development Team) as well as focus groups that represent coastal Louisiana's communities, landowners, and commercial activities. The stakeholder outreach and engagement approach for the Plan is based upon the following four principles: scope, timing, fair hearing and access. Stakeholders and citizens are given opportunities to learn about and comment on the tools and processes that assist in creating the Plan and not just the finished plan itself.

While it is impossible for every stakeholder or citizen preference to be included, the master plan team is committed to ensuring that each idea will be considered and questions will be answered promptly. Additionally, the team is offering a variety of ways for stakeholders and citizens to learn about and participate in the master planning process, including small groups, web offerings, direct communication with local and state government, and public meetings.

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BUILDING HABITAT: POST-DREDGING RESTORATION DESIGN CONSIDERATIONS AT ONONDAGA LAKE

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The Onondaga Lake Remedial Design Elements for Habitat Restoration includes plans for creation of approximate 35 acres of in-lake wetland habitat along 1.2 miles of shoreline. The wetlands will be constructed on top of an in-lake multilayer isolation cap. Over 250,000 individual plants and 2,500 pounds of seed will be installed from over 100 native species. Establishing wetlands along the shore of a moderate sized lake presents some challenges not normally experienced in more inland settings. The inability to control lake water levels, wave action, disturbance by carp, as well as many other extraneous variables all represent challenges that needed to be taken into consideration prior to and during the implementation stages. In 2014, a 1.5 acre area of the cap designated to be wetland was completed and fully restored. This restored section was then used to test several techniques to mitigate expected challenges, including: wave attenuation measures, protective plant enclosures, and overall planting design. This presentation discusses the overall wetland design, anticipated challenges to wetland establishment, results obtained from the test area, and the changes being implemented based on those results.

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REVITILIZATION OF THE EAST BRANCH GRAND CALUMET RIVE REACHES 4A & 4B

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The Grand Calumet River was once home to diverse natural communities, but has suffered over a century of pollution and degradation. Efforts are underway to mitigate the damage caused by legacy contaminants in this Area of Concern. The revitalization of the Grand Calumet River is a powerful example of a collaborative restoration project. A wide range of stakeholders were involved in restoring the health of the Grand Calumet River, including federal agencies such as the US EPA, United States Army Corps of Engineers (USACE), and the United States Fish and Wildlife Service (USFWS); state agencies such as INDNR and IDEM; nonprofit partners such as Shirley Heinze Land Trust, IL-IN Sea Grant, and TNC; private partners such as Cardno; and local partners such as municipalities. The project was funded by the Great Lakes Restoration Initiative (GLRI) as well as funds from a Natural Resource Damage Assessment settlement with several local industries to reimburse the public for damages to fish, wildlife, and other natural resources. The restoration project included in removal of approximately 300,000 cubic yards of contaminated sediments, geotextile tube dewatering, substrate placement, installation of 45 acres of native seed and 185,000 wetland plantings.

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USING LESSONS LEARNED TO BUILD A ROBUST ADAPTIVE MANAGEMENT PLAN FOR LARGE-SCALE ECOSYSTEM RESTORATION PROGRAMS

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Recognizing the number of large-scale adaptive management (AM) programs underway across the United States, the Missouri River Independent Scientific Advisory Panel (ISAP) recommended that the Missouri River Recovery Program (MRRP) adapt lessons learned from those efforts and experiences in developing a comprehensive AM plan. To accomplish this, the MRRP AM Plan team, composed of U.S. Army Corps of Engineers (USACE) and U.S. Fish and Wildlife Service (USFWS) staff and consultants (Pacific Northwest National Laboratory [PNNL], Louis Berger, and Compass), evaluated AM plans from other programs, and a subset of the team conducted a series of interviews with program staff focused on questions about governance, roles and responsibilities, implementation, and monitoring and evaluation. This subset of the AM Plan team conducted 1.5-hour phone interviews with AM practitioners from nine programs (Platte River, Everglades, Upper Columbia River, Columbia River Estuary, Columbia River Channel Improvement, Glen Canyon Dam, South Bay Salt Pond, San Joaquin River, Bay Delta) to discuss relevant aspects of each program and learn from their experiences through in-depth conversation. Follow-up interviews were conducted with a few programs to seek additional information in areas directly relevant to MRRP (e.g., conduct of large-scale field experiments). The goal of these interviews was to glean lessons learned about the realities and challenges of designing and implementing an AM program, as well as commonly applied best practices that can be integrated into and adapted for the MRRP AM Plan.

This presentation will discuss the results of the interviews, which have been synthesized into a summary report and distributed to the participating programs. We will describe the primary themes and lessons learned derived from the interviews and compare the key AM elements of the most relevant programs with those of the MRRP. Finally we will discuss how those lessons learned were incorporated into the MRRP AM Plan, and present some common challenges faced by the MRRP and other programs in implementing an AM program. Primary themes and lessons learned include: 1) Need to identify the most important management questions upfront so that monitoring and research can effectively inform decision making; 2) Use a collaborative approach to develop and implement an AM program in a transparent and understandable manner; 3) Use of a qualitative or directional approach to evaluate performance is common, due to knowledge gaps at the outset of an AM program; and 4) Need to weave AM into existing program and project management processes to gain acceptance and ensure use.

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HABITAT RESPONSE DUE TO SEAGRASS DIE-OFF IN WESTERN FLORIDA BAY

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Florida Bay, the shallow expanse of water between the Florida mainland and the Florida Keys, experienced a massive seagrass die-off in the fall of 1987 (Robblee et al. 1991). The rapid death of *Thalassia testudinum* and all of the subsequent effects greatly changed the Florida Bay ecosystem (Fourqurean and Robblee 1999). At the time of this die-off, there was no ongoing coordinated research program in Florida Bay, so there is little information on the effect this environmental change had on the mollusk population in the affected areas. The seagrass die-off event of 1987 marked the beginning of more focused research and restoration projects. As part of this effort, the USGS began to collect cores in the mid-1990s to examine the history of the ecosystem. The molluscan faunal assemblages from a core taken at a documented die-off site in Rankin Basin in 2001 indicate an increase in the amplitude of salinity fluxes prior to the 1987 seagrass die-off and an overall decrease in molluscan abundance and species diversity post die-off (Murray et al. 2010).

Today, Florida Bay is experiencing another major seagrass die-off that began in late summer of 2015. The recent lack of rainfall has led to increased salinity in Florida Bay as high as 70 ppt. Studies are currently being conducted to monitor the water quality, seagrass condition, and mollusk species diversity and abundance in three main areas of concern: Rankin Basin, Johnson Key Basin, and Rabbit Key Basin. We are collecting samples approximately every 8 weeks to assess the number and species of live mollusks and what appear to be very recently dead mollusks. These data will be compared to mollusk samples collected at these sites over the past decade. In conjunction with the mollusk sampling, seagrass assessments are also being performed in order to determine the species of seagrass, coverage estimates, and overall health using the Braun-Blanquet method (Braun-Blanquet 1932). The three basins are each at a different phase in the die-off sequence. Rankin Basin is exhibiting signs of complete die-off while Johnson Key is moderate to patchy and Rabbit Key is still relatively healthy.

Over 70 percent of Florida's commercial and recreational fisheries spend part of their lives in estuaries. Florida Bay plays a significant role in the life stages of numerous marine species including the pink shrimp, spiny lobster, and snook. The current die-off could affect the health of Western Florida Bay and impact future fisheries. Currently, a number of researchers are already working in Florida Bay and we now have over two decades of data to examine. The current investigations will capture real time response data from the seagrass die-off and allow for comparisons to the data from the last 20 years.

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HYDROLOGICAL AND ECOLOGICAL BENEFITS OBSERVED FROM THE PICAYUNE STRAND RESTORATION PROJECT

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The Picayune Strand Restoration Project (PSRP) is a component of the Comprehensive Everglades Restoration Program (CERP), which is designed to restore hydrological and ecological function to the Southern Golden Gate Estates (SGGE) and its surrounding public conservation lands. The SGGE was once a portion of a large southwest Florida residential development that was initiated in the 1960s with the creation of 285 miles of roads and 45 miles of major drainage canals. Over 100 structures were built before construction halted. In addition, cypress logging in the 1940s and 1950s left 63 miles of raised railroad beds within the boundary of SGGE that were impeding natural flows through the area.

The primary objective of the PSRP is to establish the pre-development hydrologic regime, including wet and dry season water levels, overland sheetflows, and hydroperiods. Hydrologic restoration would also include eliminating the harmful point-source discharges of fresh water to Faka Union Bay. Hydrologic restoration of SGGE involves filling at least 50% of the length of the larger canals and several smaller ditches draining the area, and eliminating impediments to sheetflow by removing raised roads and logging trams. The protection of residential development upstream of the project site has required the construction of three large pump stations on the three western canals at the north end of SGGE to maintain existing levels of flood protection. Any water pumped for flood protection will be sent as sheetflow across SGGE.

As of November 2015, two of four major drainage canals (Prairie and Merritt) within the PSRP have been backfilled and/or plugged. Over 215 miles of roadways and 58 miles of logging trams have been restored to natural grade. Remaining project roadways (70 miles) and logging trams (5 miles) to be restored total 75 miles. Two pump stations (Merritt and Faka Union) have been completed: one is operational and the second will be operational by early 2016. The remaining pump station at Miller Canal will be completed by 2017. Additional remaining work includes the backfill of the main project canal, Faka Union, and the western-most canal, Miller, as well as the southern "Stairstep Canals". A manatee mitigation feature at Port of the Islands Marina will be completed in April 2016.

This presentation describes some of the early hydrological and ecological benefits observed from constructed features of the PSRP. For example, since it was backfilled, water levels near the Prairie Canal have been approximately 2 feet higher in the dry season and 1-2 feet higher in the wet season compared to areas near the unfilled Merritt Canal. In the cypress forest habitat, wetlands affinity index (WAI) values in restoration plots are increasing and converging with WAI values in target reference plots, while in the wet prairies both reference and restoration plots have maintained relatively constant WAI values in the first 3 years of sampling. No benefits have been observed in the estuarine areas from the newly created overland flow as most of it is recaptured by the East-West Stair-Step Canal and routed as point discharges into Faka Union Bay via Faka Union Canal. Lessons learned from the project to date will be discussed.

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ECOLOGICAL, HYDROLOGIC, AND ENGINEERING DESIGN PRINCIPLES FOR ACEP-WRE RESTORATION PROJECTS

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One of the NRCS ACEP-WRE goals is to create stable, diverse, wetland systems that require only minimal long-term management. The NRCS has designed a process to develop the project design in a stepwise fashion, beginning with identification of ecological expectations and ending with engineering design. The process includes development and testing of alternative plans and selection of the most robust plan set for engineering design and permitting.

A successful restoration is best achieved by a team of diverse experts all of whom develop a general understanding of the ecological restoration design philosophy, which focuses on landscape scale targets with acceptance that the desired vegetation assemblages occur within ranges of stage duration conditions. Understanding that restoration allows a range of hydrologic conditions allows success using hydrologic model results with somewhat lower precision levels than design engineers typically expect as the basis for civil engineering design. The modeling and design efforts also benefit from a general understanding of the ecological design range targets.

First, the NRCS identifies an initial conceptual restoration design including generalized wetland community locations and structure locations. This design provides one of two or possible more restoration alternatives developed by their consultant. Ecologists then develop details of NRCS plan using available aerial historic photography, documentation of preexisting ecological communities, soil maps, recent topographic maps, and close examination of example wetland community descriptions. Site visits are also conducted. Less disturbed adjacent lands may also provide hints of preexisting conditions. The desired restoration endpoints are summarized as a site map of the specific target communities described in detail, estimates of desired water depth ranges, and estimates of seasonal hydrologic fluctuations appropriate for those communities. Alternative restoration targets are then developed. Property owner land uses objectives are incorporated insofar as they do not interfere with the primary restoration project objectives

With quantified ecological targets in hand, hydrologic modeling identifies the stage – duration conditions and hydrologic management structures across the site that will promote development of those communities for each alternative. The hydrologic modeling also considers the minimum number of structures necessary to achieve those conditions. The process is iterative and interim hydrologic findings may spur some reconsideration of the likely wetland communities and their distribution on the site.

Once the restoration alternatives have been defined and modeled, a Wetland Restoration Plan of Operation summarizes the entire effort to date, including all ecological and hydrologic modeling, restoration management plans, and initial construction cost estimates. A detailed review of the report and associated data is by followed a workshop carefully examines the alternatives and their components. Selection of one alternative completes the ecological design component of the project

The engineering designs focus on simple robust structures that will create and maintain the hydrologic conditions with minimum maintenance.

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LINKING WATER QUALITY TO VEGETATION RESTORATION: A CASE STUDY OF *RUPPIA MARITIMA* (WIGEONGRASS) AT THE HIGHLY VARIABLE EVERGLADES-FLORIDA BAY ECOTONE

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Historically, the submerged aquatic vegetation (SAV) species *Ruppia maritima* created critical habitat at the ecotone between the freshwater Everglades and Florida Bay. Hydrological modifications resulted in significant declines in water quality and increased hydrological variability, limiting *R. maritima* in this zone and leading to its designation as a target species in the Comprehensive Everglades Restoration Plan (CERP). We used a population-based approach to understand mechanisms controlling *R. maritima* presence and abundance at the highly variable ecotone to expand the scientific base for management and restoration of this SAV. Life history transitions from seed through sexual reproduction were quantified with a series of field experiments across a range of abiotic and biotic factors known to affect SAV (salinity, salinity variability, light, nutrients (sediment P), seed bank recruitment and competition).

Ruppia maritima life history varied west to east across the Everglades ecotone, driven by gradients in multiple factors that constrained different life history transitions in distinct ways. Seedling and adult survival and clonal reproduction were limited by variable salinity (>10 psu change over 24-72 hours) and low sediment nutrients (P) in the eastern ecotone. In the western ecotone where salinities were more stable and sediment P was higher, seedling and adult survival and clonal reproduction were restricted by light limitation and competition with the macroalga *Chara hornemannii*. Because of low survival rates and limited clonal reproduction, *R. maritima* at the Everglades ecotone is highly dependent on large reproductive events for seed recruitment. In the western ecotone where P levels are higher, *R. maritima* can seasonally produce large reproductive meadows when light levels and clonal reproduction are highest (April-August). However, development of these meadows is highly dependent upon recurrent production of high seed densities (>3000 seeds m^{-2}) to replenish the very ephemeral seed bank.

Based on our research, maintenance of periodic low stable salinities could facilitate seedling and adult survival, which, in turn would increase reproductive adult densities. Higher adult densities would increase viable seed production to more frequent and a broader spatial scale, particularly in the P-limited eastern ecotone. In the west, hydrological conditions that reduce water column phytoplankton to increase light may allow *R. maritima* to persist vegetatively or increase the size and frequency of reproductive events to enhance seed production and augment the seed bank for years when seedling and adult survival are “poor.” If these hydrological patterns are met, the CERP target of higher *R. maritima* densities at the Everglades-Florida Bay ecotone can likely be reached. This case study also shows that research is critical to gain a mechanistic understanding for restoration targets for management, as well as incorporation into modeling to build the scientific base for management and restoration.

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DEVELOPMENT OF A LARGE-SCALE RESTORATION PLAN FOR RIO DE JANEIRO'S GUANABARA BAY BASED ON MARYLAND'S CHESAPEAKE BAY EXPERIENCE

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Rio de Janeiro, Brazil is world famous for its beautiful sub-tropical scenery and beaches, but the water of Guanabara Bay and the South Atlantic just outside its mouth, where Copacabana and Ipanema beaches are located, is seriously polluted due to industrial contamination, poor sanitation and solid waste handling for the 10 million people living in the municipalities surrounding Guanabara Bay. The water quality problems, including high levels of bacteria, viruses and floating trash in Rio's waterways have been covered frequently in the international press in 2015, rasing concerns about the health of athletes competing in the upcoming Olympic swimming, sailing, windsurfing and other water-related events scheduled for August, 2016.

As part of its Olympic bid, the State of Rio de Janeiro committed to install sewer lines and treatment facilities to bring 80% of its citizens on line by the time of the Olympics. Progress has been very slow and this goal is unlikely to being achieved. Over 70% of the residents living in the Guanabara Bay Watershed still lack basic sewage treatment and the large number of citizens living in densely populated, uncontrolled developments, ("favelas") make it extremely difficult to bring in sewer lines. A lot of restoration work has been done and construction is on schedule to control some of the more significant sewage discharges, but with less than a year until the Olympics, it will not be possible to eliminate the sewage flowing into Rio's waterways.

The State of Rio de Janeiro recognized sufficient progress was not being made and initially engaged the U.S. Environmental Protection Agency and the State of Maryland to learn more about the ongoing restoration effort in Chesapeake Bay. The State of Rio subsequently assembled a team, including KCI Technologies, a Maryland-based environmental engineering company, the University of Maryland Center for Environmental Science and a Brazilian company, Fundação Brasileira para o Desenvolvimento Sustentável, to work with multiple stakeholder groups to develop a comprehensive restoration plan for Guanabara Bay and recommend a management and governance structure that will ensure the restoration effort stays on schedule and is sustained over the long-term. The comprehensive cleanup plan for Guanabara Bay includes both long-range strategic planning and short-term "guerrilla tactics" to address industrial waste and garbage, ambient water quality and sanitation of un-sewered areas. To be successful, the cleanup plan must have the full support of the governments, businesses and citizens that must take the actions needed to stem the flow of pollution and continue to protect the Bay in the future. It has taken many decades of consistent effort to protect and restore Chesapeake Bay, and the job is still not done. The restoration of Guanabara Bay will require a similar level of effort, including specific, measurable goals for all sources of pollution and consistent tracking and public reporting of progress. This will enhance accountably to asses that funding is benefiting the collective efforts to increase the public, ecosystem and economic health of the region.

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WATER QUALITY AND OTHER CHALLENGES WITH A.R.M. LOXAHATCHEE NATIONAL WILDLIFE REFUGE ECOSYSTEM RESTORATION

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Historically, Everglades water quality was characterized by low nutrient, mineral, and ion concentrations with waters from Lake Okeechobee moving as sheetflow across the landscape and maintaining adequate water depths for native flora and fauna. Presently, agricultural and urban runoff and point discharge of these waters to the Refuge have systematically been altering the ecosystem. The Refuge, located at the head of the Everglades, has been completely impounded, and water inflow occurs via a perimeter canal inside the levee canals. These canals are enriched with nutrients, minerals, and ions from upstream agricultural runoff. This canal water intrudes into the Refuge marsh when water levels are higher than marsh water levels, thus enriching the marsh. Phosphorus enrichment in the marsh results in ecosystem alteration beginning with microphytes and cascading up to macrophytes. One major shift in vegetation dynamics is the establishment of dense cattail (*Typha domingensis*) stands replacing sawgrass (*Cladium jamaicense*) that is more typical in oligotrophic waters. These dense stands of cattail are concentrated along the perimeter of the marsh adjacent to the canals and are poor habitat for native fauna of the Everglades. Further, enrichment of minerals and ions in the marsh results in a reduction in productivity of sensitive native vegetation species in the Refuge. For example, *Xyris complanata*, an emergent vegetation species, has a 50% reduction in growth rate with exposure to enriched levels of minerals and ions.

There are measures in place to help reduce phosphorus loads delivered to the Everglades. However, there are no direct means of reducing mineral or ion loads or to restore the historic sheetflow to the Refuge. A result of a lawsuit and subsequent settlement agreement between the State of Florida and the United States over failure to maintain state water quality standards has resulted in the establishment of 23,100 ha of constructed wetlands designed to reduce phosphorus loads delivered to the Everglades. Reducing canal water intrusion into the Refuge marsh by maintaining marsh water levels higher than canal water levels has been the only effective means of reducing mineral and ion intrusion into the marsh, but this configuration is difficult to sustain. Therefore, a major challenge for the Refuge from a water quality perspective, assuming the Stormwater Treatment Areas achieve their long-term phosphorus reduction goals, is developing technology or enhanced management methods to reduce mineral and ion inputs to the marsh.

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COMPARING PHYSICS-BASED AND EMPIRICAL-STATISTICAL METHODS OF REPRESENTING HYDROLOGY

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A variety of computational tools have been applied by the U.S. Geological Survey to delineate hydrology and provide useful information for ecosystem and water resources management in Florida and Puerto Rico. The tools can be grouped in two categories: physics-based and empirical-statistical. Each category has inherent advantages and disadvantages in its implementation, requirements, and prediction capabilities.

The physics-based tools include a variety of numerical models which solve hydrologic flow and transport equations. The coupled groundwater/surface-water models designed to represent the Everglades and surrounding areas use the best-known representations of the governing physics and the supporting parameters. Although physics-based models are conceptually the most direct method to represent hydrology, they are intrinsically limited by sparse data and unavailable information. This absence of information leads to substantial uncertainty and errors in physics-based model predictions.

An example of a physics-based numerical model is the Biscayne Southern Everglades Coastal Transport (BISECT) model. The BISECT model represents the physics of hydrodynamic surface-water flow, three-dimensional groundwater flow, salinity transport in both the surface water and the groundwater, and leakage between the two systems. Covering Everglades National Park and the Biscayne Bay urban area, BISECT requires extensive input data. It is capable of representing hydrologic conditions over a large area with a range of water-management and climate conditions. BISECT, however, has limited accuracy and spatial resolution. Additional complications include defining realistic boundary conditions and highly uncertain input parameters for hypothetical conditions, such as future rainfall. These factors create uncertainty in model results which must be quantified and considered.

Empirical-statistical tools derive functional relationships between hydrologic variables for predictive purposes. The Artificial Neural Network (ANN) is an empirical-statistical tool which uses a series of interconnected nodes that recognize relationships between input and output variables. A training process allows the ANN to determine useful relationships, even with minimum information on the controlling physics. There can be substantial uncertainty in using predictions from an ANN, however, beyond the range of calibration or training conditions.

An example of an empirical-statistical ANN application is the Lago Loíza reservoir application in east-central Puerto Rico, where rainfall and temperature data are used to predict inflows to the reservoir through the ANN algorithm. This prediction is used in conjunction with a reservoir water budget to predict the impact of potential future rainfall scenarios. This method is capable of accurately representing flows and reservoir volumes with far less input data than the numerical models, but is limited to data output at the locations at which the ANN training occurred. Because the physical processes of the system are not explicitly represented, the parameter relationships are subject to potential misinterpretations by the ANN training algorithm. For example, an input parameter may act as a surrogate for a correlated parameter that has been ignored.

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REGIONAL CHALLENGES, REGIONAL SOLUTIONS: A WATERSHED APPROACH

Roberta Swann
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The Mobile Bay Watershed is over 43,600 square miles and drains most of Alabama and parts of three other states. It comprises many subwatersheds classified numerically by the USGS into Hydrologic Unit Codes, or HUCs. For planning purposes, the EPA prefers a scale of 12-digit HUCs, the smallest scale used by USGS. There are ninety-eight 12-digit HUCs in Alabama's two coastal counties draining into receiving waters like Fowl River, Magnolia River and many others.

Towards developing a five-year ecosystem restoration strategy, MBNEP's Project Implementation Committee (PIC) adopted a protocol of watershed management planning at the 12-digit HUC level to guide science-based project implementation. The PIC sought community input to prioritize coastal watersheds to pursue planning and project implementation and then worked to develop an inventory of resources and needs for each of the prioritized watersheds to guide project implementation. Additionally, the PIC agreed to include any other 12-digit HUC with direct tidal influence on the priority watersheds list because they have a demonstrable nexus to the resources potentially injured during the Deepwater Horizon incident, elevating their priority for possible settlement funds.

Currently, the MBNEP has secured funding through the National Fish and Wildlife Foundation's Gulf Environmental Benefit Fund (GEBF) to develop comprehensive watershed management plans (WMPs) for eight coastal basins: Fowl River, Dog River, Bayou La Batre, West Fowl River, Tensaw-Apalachee, Fish River, Bon Secour River, and Wolf Bay. Once completed, these plans will comprise twenty 12-digit HUCs and provide a roadmap for restoring and conserving watersheds and improving water and habitat quality in areas where resources may have been damaged by the Deepwater Horizon incident.

This planning process, guided by the PIC and watershed stakeholders, charts a conceptual course for improving and protecting the things people most value about living along the Alabama coast: access to Gulf waters; abundant fish and shellfish; protection of heritage; environmental health and resilience; and water that is fishable, drinkable, and swimmable. In addition to meeting the requirements for watershed planning specified by the EPA's Nine Key Elements, these plans also encompass issues related to environmental health and resiliency, culture and heritage, public access, and critical coastal habitats identified by the MBNEP's Science Advisory Committee as most threatened by anthropogenic stressors (freshwater wetlands; streams, rivers and riparian buffers; and intertidal marshes and flats).

To date, development of WMPs is underway for Fowl River, Bayou LaBatre, Dog River, and Bon Secour River, and Fish River with the rest to follow in succession. Key projects identified by the WMPs will feed into the upcoming Coastal Alabama Restoration Plan. This effort is focused on improving the quality of the water entering Mobile Bay, as well as the Gulf of Mexico, and increasing the amount of nursery habitat necessary for sustaining a healthy fishery. This plan will include an inventory of restoration and conservation opportunities to guide future restoration.

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THE REGIONAL WATERWAY MANAGEMENT SYSTEM: INCORPORATING RESTORATION INTO A GENERAL PERMIT FOR MAINTENANCE DREDGING

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Florida's coasts have transformed over the past half century as population growth and demand for access to coastal waters led to the creation of residential canal developments. Thousands of miles of channels and basins were dredged as a by-product and increasing boat traffic and canal-side activities are stressing the resulting navigable waterways. With a common goal to preserve the recreational and ecological value of Florida waterways, the Department of Environmental Protection, the West Coast Inland Navigation District, and Florida Sea Grant developed a Regional Waterway Management System (RWMS), an approach to waterway planning and permitting based on mapped channel depths, a census of boat populations, and the spatial extent of natural resources. The RWMS provides comprehensive, regional overviews of channel conditions and the distribution and severity of existing impediments to safe navigation and resource protection. RWMS information and analyses have resulted in regional-scale permitting to accommodate water-dependent uses while minimizing environmental impacts and reducing public expenditures in four heavily populated counties in southwest Florida. This talk will be about what lessons have been learned; what has worked and what has not; and how to move forward.

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APPLICATION OF SYNTHETIC FLOC TO EVALUATE SEDIMENT TRANSPORT WITHIN THE EVERGLADES RIDGE AND SLOUGH LANDSCAPE AS PART OF THE DECOMPARTMENTALIZATION PHYSICAL MODEL PROJECT

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Particle transport is essential for the development and maintenance of the Everglades ridge & slough landscape by redistributing entrained sediments. The Decompartmentalization Physical Model (DPM) is a landscape-level field test to reduce uncertainties associated with sheet-flow, sediment redistribution and the resulting characteristic patterning and microtopography. The DPM utilizes a "Before-After-Control-Impact" (BACI) experimental design, consisting of field monitoring of hydrologic and biological parameters under low flow (baseline) and high flow (impact) conditions in both impacted and non-impacted sites. DPM uses an inflow structure (S-152) consisting of 10 gated culverts on the L67A to provide high sheetflow velocities into an area between the L67A and L67C levees known as the pocket.

We hypothesized that increased sheet-flow would entrain and transport sediments in slough habitats, where velocities are highest, and deposit sediments in sawgrass ridges, characterized by denser vegetation and slower water velocities. To measure sediment movement and redistribution, we used a dual signature tracer (DST) hydraulically matched (i.e., representative) to the mean particle size and settling velocity of particles collected from the study region. The DST particle is an inert fluorescent material in which magnetite inclusions are imbedded. DST was deployed during the 2013, 2014, and 2015 DPM high flow events at impact and non-impact (control) sites within the DPM footprint. Spatial experiments were designed to assess particle transport through Everglades slough, slough/ridge transition, and ridge landscapes. DST was deployed prior to the opening of the S152 structure. To measure spatial movement, 20-24 magnets were placed radially around the deployment location and retrieved the week after the initial flow. DST collected on each magnet was then dried and weighed.

The spatial experiment demonstrated that DST was entrained under high flows created by the S152 structure and travelled in a southerly direction. At the low-flow site, DST travelled mainly east, consistent with baseline landscape flow. Sediment moves unimpeded through the slough while movement through the ridge is moderated by velocity. While sediment movement into the ridge does occur, it moved at most 10 meters into the ridge. These results confirm the importance of sheet-flow in redistributing sediment from sloughs to ridges, a critical mechanism for rebuilding topography and patterning of the landscape.

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A GIS-BASED DECISION SUPPORT TOOL FOR OYSTER REEF HABITAT RESTORATION

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The global decline of many recreationally- and commercially-important marine species has prompted the use of habitat restoration, such as the construction of oyster reefs, as a management tool to combat population declines. Inadequate scientific information to guide site selection is one of the most common causes of unsuccessful habitat restoration. In this study, we developed a hierarchical, GIS-based optimization approach to selecting the most suitable sites for oyster reef habitat restoration in Pamlico Sound, North Carolina, USA. Our novel approach linked relevant biological, physical, and socioeconomic information within a unifying GIS-based decision support tool framework to guide habitat restoration prioritization using oyster reef habitat restoration in Pamlico Sound, North Carolina, USA as a model system. The underlying framework of this decision support tool is adaptable to inform habitat restoration in other systems.

This presentation will focus on the GIS-based decision support tool that we have generated for oyster sanctuary site selection in Pamlico Sound, North Carolina, USA, and will focus on our approach, including the: 1) selection of relevant biological, physical, ecosystem services, and socioeconomic spatial layers, 2) convening of an expert panel (including academia, non-profits, and government agencies) to assess underlying model weightings within the tool, 3) development of the tool framework, 4) validation of tool output, and 5) translation of the tool output into meaningful information for decision-makers tasked with oyster reef habitat restoration. The presentation will also introduce ongoing updates to the tool to inform intertidal oyster reef habitat restoration and incorporate ecosystem services (i.e., oyster filtration and finfish habitat enhancement).

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DRAINAGEWAY IMPROVEMENTS AND LAKE DREDGING CLEAR THE WATER AT FORT DES MOINES PARK

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A 14-acre lake is the centerpiece of the heavily used Fort Des Moines Park, a 117-acre urban park owned by Polk County Conservation Board (PCCB) but located within Des Moines, Iowa. The lake is fed via four drainage ways that originate at a nearby golf course and other developed lands. These highly eroded and destabilized waterways were sloughing off and discharging significant sediment loads in the lake. Over time, the sediment significantly deteriorated the lake's water quality and caused the lake's three major coves to silt in that vegetation was growing on the sediment surface, making the coves unusable for the public.

Watershed improvements included reshaping the highly incised drainage ways. The bank slopes were flattened, formed into channels, and lined with cobblestones and boulders. Strategically placed sheet pile letdowns were used to flatten the downhill slopes of the channels which reduced water velocity, particularly during heavy rains. Use of natural river cobblestone and boulders produced a more visually pleasing stair step-effect. When necessary, the channels were redirected to avoid the removal of large, mature trees.

A special infiltration basin was incorporated into one of the drainage ways to serve as a natural groundwater recharge. It was formed by digging a trench the width of the channel and lining it with an engineered soil consisting of sand, compost, and soil. Water flows through the cobblestone-lined channel, to the infiltration basin, through the engineered soil and recharges the water table. The engineered soil acts as a natural filter.

To further prevent sediment from entering the lake, natural sediment traps were constructed at the entrance of each cove where the drainage ways enter the lake. The sediment traps consist of rock piers that extend from either side of the cove and almost, meet in the middle. Any sediment that manages to pass through the drainage way and the infiltration basin is caught in the sediment trap before entering the main lake area.

One of the most significant health aspects of the project is the vast improvement in water quality. Prior to the project the water quality was abysmal. The water was murky, creating a disagreeable experience for park users. The improvement in the water quality following drainageway improvements and lake dredging is noticeable as the bottom of the lake is now easily visible to a depth of 12 feet.

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SERFIS: AN ECOSYSTEM MONITORING TOOL FOR RAPID ASSESSMENT OF ESTUARINE HABITAT RESPONSE TO FRESHWATER INFLOW MANAGEMENT

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As part of the Greater Everglades Ecosystem Restoration efforts undertaken by the South Florida Water Management District (SFWMD), movement of water out of Lake Okeechobee (Lake O) is a critical and key element of the overall plan. Currently, the Caloosahatchee and St. Lucie receive the bulk of Lake O water with a much smaller portion moved south into the historic Everglades. Freshwater inflow to estuaries influences both water quality and ecological function (e.g. nursery) by relocating isohalines, nutrient loading, and coloring the water with tannins. As Everglades restoration efforts continue and a greater portion of water is moved south or diverted as part of the Comprehensive Everglades Restoration Plan, it is important to understand how freshwater flows affect estuarine health and critical nursery function.

To that end, the SFWMD has developed and refined methodology for a flow-through system that collects continuous water quality and zooplankton data along salinity gradient transects. This flow-through system has been applied to the Surveying Estuarine Responses to Freshwater InflowS (SERFIS) project. This project is designed to examine the Low Salinity Zone (LSZ) hypothesis that states freshwater inflows bring nutrients to the estuary creating areas of high primary and secondary productivity that result in fish larvae feeding zone "hot spots" which are protected from predators that prefer higher salinity levels. This LSZ serves as an estuarine nursery important for fish production. However, the magnitude of freshwater inflow can impact if and how the high productivity areas are established. Low flow can result in a compressed LSZ, while high flow may push the LSZ significantly downstream or even out of the estuary.

The SERFIS project is designed to assess the impact of freshwater flow rates on the LSZ for different northern estuaries of south Florida. The flow-through system allows for very discrete spatial and temporal sampling of entire estuaries that can be replicated over short time frames (within the same day for smaller estuaries) with minimal post-processing of the data. The parameters collected include surface water (0.5 m depth) temperature, specific conductivity, salinity, turbidity, chlorophyll a, dissolved oxygen, and color (using a YSI and C-3), and zooplankton biomass. Periodic grab samples of chlorophyll a are collected to calibrate the YSI results. Geospatial data are collected concurrently with the continuous sampling, and all data are spatially and temporally integrated using StreamlineGeo software. Data are collected at 5 second intervals allowing for very discrete spatial sampling (approximately one sample every 10 m depending on boat speed). This system allows for the collection of comprehensive data sets with sampling flexibility to address different management questions that have different temporal scales (episodic event, 7-day pulsed lake water release, seasonal patterns).

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ESTABLISHING EXPLICIT BIOLOGICAL OBJECTIVES TO GUIDE STRATEGIC HABITAT CONSERVATION FOR THE GULF COAST: CASE STUDY WITH THE BROWN PELICAN

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Wildlife losses were some of the most conspicuous effects of the Deepwater Horizon spill. In the wake of various settlements and judgments, many restoration efforts are explicitly and implicitly targeting benefits to numerous impacted species. Clear objectives that reflect a common vision across the multitude of partners involved in Gulf restoration can bring focus to the myriad of funding streams and ensure ultimate success. To that end, the U.S. Fish and Wildlife Service and U.S. Geological Survey are working with conservation partners across the Gulf to collaboratively define (1) focal conservation areas, (2) species that are representative of these areas and population objectives for those species, and (3) habitat objectives necessary to achieve those population objectives. To date, the team has defined and mapped fifteen biological planning units (BPU) on or adjacent to the Gulf Coast, identified 108 target species representative of BPU habitats, and gathered population data and objectives for each species from the literature. For a subset of these species, the group is deriving habitat objectives from spatially explicit Bayesian networks (i.e., models of the relationships between habitat characteristics and population objectives). The outputs of these models when coupled with population objectives provide insight into how much habitat is available, how much more is needed, and where those habitats can be most conserved or restored to most efficiently achieve established objectives. A case study of the brown pelican will be used to demonstrate the benefits of this approach for informing restoration and monitoring efforts for large marine vertebrates.

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CHANGING COURSE: NAVIGATING THE FUTURE OF THE LOWER MISSISSIPPI RIVER

Brian Jackson *Presented by:* ***Alan Travers***
Environmental Defense Fund, Boulder, CO, USA

Changing Course is a design competition to reimagine a more sustainable Lower Mississippi River Delta, bringing teams together from around the world to create innovative visions for one of America's greatest natural resources. Building off of Louisiana's Coastal Master Plan, and answering a key question from that plan, three winning teams (Baird & Associates, Moffatt & Nichol and Studio Misi-Ziibi) have generated designs for how the Mississippi River's water and sediment can be used to maximize rebuilding of delta wetlands while also continuing to meet the needs of navigation, flood protection, and coastal industries and communities.

While each of the winning teams offered a different vision, all three identified the same key requirements as critical to sustaining the Mississippi River Delta today and into the future:

- Reconnecting the Mississippi River to its wetlands to help restore southeast Louisiana's first line of defense against powerful storms and rising sea levels.
- Planning for a more sustainable delta, including a gradual shift in population to create more protected and resilient communities.
- Protecting and maximizing the region's port and maritime activities, including a deeper more sustainable navigation channel upriver from Southwest Pass.
- Increasing economic opportunities in a future smaller delta through expanding shipping capacity, coastal restoration infrastructure, outdoor recreation and tourism and commercial fishing.

This session will give a high level overview of the design competition process, results, similarities and differences in their designs, and how the ideas generated will inform coastal stakeholders and official government processes.

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COASTAL RESILIENCE AND LANDSCAPE CONSERVATION DESIGN IN SW FLORIDA

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The Resilient Lands and Waters initiative, as called-for by the President's *Priority Agenda for Enhancing the Climate Resilience of America's Natural Resources*, will build upon the *National Fish, Wildlife, and Plants Climate Adaptation Strategy* (NFWPCAS: http://wildlifeadaptationstrategy.gov) as well as the work of landscape-scale collaboratives nationwide to demonstrate the resilience benefits of the landscape-scale approach to planning. Identifying such priority areas also benefits wildfire management, mitigation investments, restoration efforts, water and air quality, carbon storage, and the communities that depend upon natural systems for their own resilience. SW Florida was selected as one of the seven resilience pilot study areas in the US. The Peninsular Florida landscape conservation Cooperative (PFLCC) and NOAA are using previously developed sea level rise and climate change scenarios and a modified DPSIR (Driver-Pressure-State-Impact-Response) model and will map ecosystem services and resilience in SW Florida. Products from this effort will be incorporated into agency and non-governmental organizations management plans to guide future planning decisions.

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FOOD WEBS, INTERACTION WEBS, AND MONITORING: USING A TROPHIC CONCEPTUAL MODEL TO SELECT ECOLOGICAL INDICATORS

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A major goal for the Comprehensive Everglades Restoration Plan (CERP) is to restore apex predators including wading birds and alligators to their historical abundance and distribution. The CERP Monitoring and Assessment Plan (MAP) is a system-wide monitoring and assessment program for evaluating CERP performance and ecosystem responses. Analyses of fish monitored for the MAP has focused on their role as limiting resources for wading bird nesting success, but it is believe that food availability is also a limiting factor in the restoration of alligator populations of the Everglades. A conceptual ecological model similar to one developed for wading birds has been developed for alligators and describes linkages between performance measures of alligator health and ecosystem stressors such as water depth patterns and salinities, and biotic parameters such as their prey. In this talk, we discuss the use of this conceptual model to identify prey-based performance measures for evaluating the mechanisms behind alligator restoration. Understanding the mechanisms linking alligator health to management action is critical to determining if management efforts are responsible for observed improvements in alligator health or if they are to blame for lack of improvement. We will focus on the role of small and large fishes in the food web and feedbacks that may obscure restoration improvements because their intermediate trophic status. These feedbacks will be used to propose performance measures for evaluating the role of food availability in restoration of alligators.

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MISSISSIPPI RIVER DELTA RESTORATION, CORPS-STATE RELATIONS AND WRDA CREDITING

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The Delta of the Mississippi River, the 7th largest delta in the world with a watershed that covers 40% of the continental US land mass, is the most important coastal ecological and geologic treasure in North America. The River built this 7000 square mile wetland ecosystem with its sediments over the last 7000 years through overbank flooding. Over the last century, this Delta has lost 2000 square miles of its wetlands, its barrier islands have eroded and the Gulf's salty waters have penetrated ever further into its estuaries. Scientists predict that the Delta will lose almost another 2000 square miles of wetlands in the next 50 years, and the Delta could almost disappear by the end of this century in the face of sea level rise and coastal subsidence.

The basic causes of this egregious loss are well understood. The River's sediment resources sources have been cut off from the Delta by its congressionally authorized flood control and navigation levees. Thousands of miles of oil and gas canals that support both the on-shore and off-shore oil and gas industries have added to these stresses.

Since former Governor Michael Foster hosted a Coastal Summit in August 2001, the State and Corps have made major progress in advancing Delta restoration planning. The 2004 Corps Louisiana Coastal Area (LCA) Ecosystem Restoration report formed the basis of the congressional authorization of the 2007 WRDA Title VII restoration program. The State has completed Coastal Restoration and Protection Master Plans in 2007 and 2012 and is working on its 2017 Plan. With the availability of BP CWA criminal penalties and its own financial resources, the State has advanced design work on major diversion projects and barrier island restoration construction. In 2011 and 2012, the State pulled out of all of its LCA cost-share agreements with the Corps. One of the irritants in that relationship was the Corps' absurd construction of the cost share provisions in WRDA 2007. The Corps' defense was the plain language of that statute. Fortunately, Congress amended that provision, albeit imperfectly, in the 2014 WRRDA, authorizing credit transfers from one LCA project to another for work done before, during or after the signing of a partnership agreement.

The relationship between the Corps and State is now largely back on track, a very good development, and they are jointly working on a number of LCA projects. With the hundreds of millions of dollars that it is spending on the design and construction of approved LCA projects, the State understandably wants full credit so that it does not have to spend cash on LCA projects that the Corps is advancing. The Corps wants to make sure that the federal interest in completed projects is protected. A key question is to what degree crediting for the "separable elements" of LCA projects will be recognized. Given the broad national purposes of Delta restoration and the need for long-term congressional and State financial resources to augment BP and GOMESA dollars to expedite restoration, the crediting provisions of 2014 WRRDA applicable to the LCA program should be given the most liberal construction possible.

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MESOCOSMS FOR ESTIMATING CLIMATE-CHANGE-INDUCED PEAT COLLAPSE

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Organic carbon (C) storage in peat soils is critical to maintaining wetland elevation and coastal wetland stability. As sea level rises, coastal freshwater and brackish wetlands like the southern coastal Everglades are being exposed to increased duration and spatial extent of inundation and salinity, which can affect soil C balance through soil redox potential, microbial respiration, and the intensity of osmotic stress to vegetation. The term "peat collapse" has been used to describe a relatively dramatic shift in soil C balance, leading to a rapid loss of soil elevation, and culminating in a conversion of vegetated freshwater marsh to open water. Evidence of freshwater peat collapse has been observed in lower Shark River Slough, Everglades, Florida, suggesting that this process is ongoing and may be affected by factors of reduction in freshwater discharge, recent storm surges (e.g., Hurricane Wilma), sea level rise, and possibly fire. The process has been documented to varying degrees across the U.S., contributing to instability of coastal marshes and degradation of important ecosystem services including fisheries habitat, shoreline stabilization, and C sequestration provided.

In field and mesocosm experiments, we are increasing salinity in freshwater and brackish marshes of the southern coastal Everglades, to investigate auto- and heterotrophic mechanisms hypothesized to contribute to peat collapse. Evidence from our previous experiments with mangrove peats showed predicted shifts in soil redox and enhanced C loss from soils exposed to increased salinity. Preliminary results from our marsh studies show reduction in phosphorus and increase in C acquisition by soil microbes in brackish marshes, which become stronger C sources during the dry season than freshwater marshes. Our long-term study will elucidate plant-soil mechanistic responses to elevated salinity that are hypothesized to stimulate loss of soil C in the coastal Everglades.

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LONG-TERM MONITORING AND MANAGEMENT OF RESTORED WETLANDS IN FLORIDA

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The Natural Resources Conservation Service (NRCS) has been restoring wetlands in Florida under the Wetlands Reserve Program (WRP) and more recently, the Agricultural Conservation Easement Program – Wetland Reserve Easements (WRE) since 1998. During the past 18 years, over 175,000 acres have been enrolled in the two programs. Once properties are acquired and restored, the monumental task of habitat management in perpetuity begins.

The goal of WRP/WRE in Florida is to restore wetlands to their natural, historic state prior to hydrological manipulation and conversion to agriculture. Managing and maintaining these restored sites in perpetuity is challenging, but can be accomplished through monitoring and adaptive management. Maintaining restored wetlands in their appropriate ecological successional stage is vital to providing wetland dependent wildlife the habitat necessary to not only survive, but thrive.

NRCS conducts annual monitoring on all WRP/WRE properties to ensure restoration objectives are met. Information gathered during monitoring events is utilized to formulate specific habitat management strategies for each easement. Conservation practices regularly employed to maintain and manage habitat on restored properties include invasive/exotic vegetation control, prescribed burning, brush management, and prescribed grazing. Habitat management activities are accomplished in several ways: landowner performs work through either a compatible use authorization (CUA) or landowner agreement contract, NRCS assigns work to state or federal agency partners, or NRCS contracts work through traditional federal contracting methods.

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PHOTOINTERPRETATION – HOW AN OLD-SCHOOL METHOD STILL HAS RELEVANCE AND BENEFIT TO ECOSYSTEM-SCALE HABITAT RESTORATION

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Aerial photography and subsequent photointerpretation (PI) has its roots in strategic military applications dating back to World War I, when the integration of cameras and airplanes was first realized as a yet unexploited intelligence resource. Quick advances in the quality of hardware (e.g. cameras, lens, GPS, filters, etc.) resulted from the military's focused investment in resources. Since this time, the postwar usefulness of aerial PI has been expanded to an abounding number of applications from geologic and soil mapping to urban planning. More recently, aerial PI has been adapted to the identification of ecological habitats vulnerable to climate change as well as to the identification of direct/indirect and primary/secondary impacts of climate change on these habitats. Aerial PI is now an invaluable tool in both the conceptual and design phases of ecosystem-scale habitat restoration projects aimed at minimizing the damage of climate change.

The benefits of aerial PI begin with the diverse identification techniques available to the interpreter, such as: size, shape, tone, color, pattern, texture, and scale and continue with the applications of temporal comparisons, such as in seasonal vegetation differences and long-term trends in land cover as well as having the ability to scale-up habitat mapping from micro- to biome-scale ecosystems. Aerial PI is also better suited, and more resource efficient, than old-school methods of field reconnaissance alone in the delineation of best-fit boundaries within ecotones.

For the application of habitat mapping, the order of aerial PI sub-tasks is critical to the credibility of the end product. A well-organized aerial PI effort begins with planning for the intended use - as the time of year and day of data collection is directly linked to phytological development and tides (for coastal applications) and there are several types of aerial photography which can be acquired (e.g. oblique vs. vertical and color vs. near-infrared). Ideally, an initial desktop analysis of aerial photography would occur consisting of contextual assignments, followed by an initial field visit to calibrate PI efforts to actual conditions, then the full-fledged desktop aerial PI effort would ensue for an entire site, and finally ground-truthing efforts accompanied by an accuracy assessment of habitat assignments would take place. Experience says that the time of year and scale at which ground-truthing occurs should reflect the time of year of aerial photography acquisition and the scale at which desktop PI activities were conducted. Other considerations, such as the combination of field tasks, such as vegetation sampling via the point transect method, with a larger scale ground-truthing effort must be made.

While aerial PI can be combined with light detection and ranging (LiDAR) derived digital elevation models for automated habitat classification for ecosystem-scale sites, there are limitations to LiDAR's usefulness - such as the systematic bias associated with elevation data in areas of standing vegetation. LiDAR is an effective supporting tool for aerial PI efforts. Examples and general findings of projects for which aerial PI was an integral component will be presented – including several salt marsh enhancement projects conducted for the U.S. Fish and Wildlife Service along the New Jersey coastline. Lessons learned from both the eyes of a civil/environmental engineer bridging the gap between engineering and science and an experienced senior ecologist will be highlighted.

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LEAVING A LEGACY IN THE FLORIDA PANHANDLE

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After years of litigation, BP reached a settlement from the 2010 Deepwater Horizon oil spill in July 2015. There are four avenues of funding associated with the spill: Natural Resource Damage Assessment, Clean Water Act Fines, Gulf Environmental Benefit Fund and Economic Settlement. In 2012, the RESTORE Act was passed which established a Gulf Coast Restoration Trust Fund to receive 80% of any Clean Water Act fines. In the RESTORE Act funding distribution, the eight disproportionally affected counties receive 75% of the Direct Component funds allocated to the State of Florida. These eight counties have recently formed a coalition. In addition, there is a $2 billion economic settlement for Florida which is being administered by Triumph Gulf Coast. A panel of key Florida Panhandle leadership will highlight lessons learned from trying to leverage all these funding sources, working with the Department of Treasury during the grant application process and ensuring this once of a lifetime opportunity to truly make a difference for the Panhandle region is optimized.

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UTILIZING ONLINE MAPPING TOOLS FOR PARTNERSHIP ENGAGEMENT

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Soon after the birth of on-line mapping technologies in the early 1990s, the utility of such maps quickly found their way into academic research. One of the more recognized achievements benefitting environmental conservation came when the Environmental Systems Research Institute (Esri) launched ArcIMS (Internet Map Server) 3.0 in 2000, the first publicly available on-line map service integrating with Esri's GIS software. Users of GIS could finally transition their geospatial work into shareable, interactive maps on websites, blogs, or for internal use. On-line conservation mapping achieved yet another development boost in 2009 when ArcGIS Online was established, providing a cloud-based global library of geospatial information to explore and use.

Esri's latest suite of on-line mapping tools called Story Maps "let you combine authoritative maps with narrative text, images, and multimedia content. They make it easy to harness the power of maps and geography to tell your story." The National Parks Conservation Association (NPCA) has started to explore the use of Story Maps for conservation advocacy, using internal and partner data to help convey targeted messages. This presentation will feature general use of Story Map technology in conservation advocacy with selected examples as to how it can provide internal and external tools and resources for improving partner communication in landscape protection and restoration around national parks.

As a primary example, NPCA has implemented the use of Story Maps in advocating for the proposed Lone Star Coastal National Recreation Area (LSCNRA), an innovative and collaborative approach to protect the critical flood mitigation aspects of coastal lands, while at the same time promoting this unique part of the upper Texas coast as a destination for eco-tourism. Other examples of the use of Story Maps include highlighting the impact of oil trains on national parks, developing internal tools to better understand the benefits of the proposed national monument designations in the southern California desert, and creating partner mapping tools to assist in wildlife resource management of the Gateway National Recreation Area. Story Maps enable NPCA to share stories about our national parks and what it takes to protect them, and it does this through a new, dynamic, and engaging geographic narrative.

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DEVELOPING INDICATORS TO ASSESS PROGRESS AND ENVIRONMENTAL CONDITIONS RELATED TO CHESAPEAKE BAY AGREEMENT OUTCOMES

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The Chesapeake Bay Program regional partnership is managing the restoration of a large complex ecosystem while embracing new goals and outcomes, a recently developed adaptive management approach, and an emerging understanding of the broader knowledge base and science needed to guide implementation now and into the future. With the adoption of new outcomes and the Chesapeake Bay Decision Framework to guide adaptive management, the conceptual model that framed our indicators also needed to be updated and expanded. The newly revised Chesapeake Bay Program Indicators Framework is aligned to the Chesapeake Bay Watershed Agreement (Agreement) and supports both our adaptive management and communication needs.

The partnership has identified three information types needed to adaptively manage and communicate progress towards achieving each of the 31 outcomes. This information includes indicators and metrics and will be used to guide implementation work and support several steps of the Decision Framework. The first indicator type is *influencing factors*: what are the KEY influencing factors that impact the ability of a management approach to support achievement of an outcome. The second information type is an *output indicator*: are we doing what we said we would do in our work plans and management strategies? The third indicator type is a *performance indicator*: are we achieving the outcome within the expected trajectory and are our outputs having the desired effect? Lack of achievement requires us to test our key assumptions and determine whether this new information requires re-visiting the influencing factors or even refining our outcomes. A simplified Decision Framework was developed to explain the connections between the Indicators Framework and the Decision Framework.

Using the revised Indicators Framework, the Chesapeake Bay Program is currently assessing our existing indicators, identifying information gaps and needed monitoring for our expanded set of outcomes and deepening understanding of the information needed to support our efforts. An opportunity for growth includes expanding our scientific understanding of ecosystem response and how progress toward some outcomes can support the achievement of other outcomes. The partnership will use the Indicators Framework as a tool to explore the connections between our work. This simple conceptual model is scalable to any ecosystem restoration effort.

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MICROALGAE AS A POWERFUL TOOL IN ASSESSMENT OF ECOLOGICAL HEALTH OF BISCAYNE BAY NEARSHOR HABITATS IN SUPPORT OF THE BISCAYNE BAY COASTAL WETLANDS RESTORATION PROJECT

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The major goal of the Biscayne Bay Coastal Wetlands Project (BBCW) is to replace lost overland fresh water flow and partially compensate for the reduction in groundwater seepage by redistributing, through a spreader system, available surface water entering the area from regional canals. It is expected that these actions will improve the ecological health of Biscayne Bay coastal wetlands and nearshore habitat by improving the quantity, quality, timing, and distribution of freshwater entering the Bay and Biscayne National Park. This project will alter external nutrient loading, light availability and salinity patterns in nearshore areas of the Bay. To determine the influence of potential physicochemical changes on ecological community dynamics, it is important to quantify current relationships between microscopic primary producers and variables likely to be influenced by the restoration process, and identify the regions that will be impacted the most by the restoration efforts. This information will be useful in the future assessments of restoration effects.

In order to assess the current ecological status of the Biscayne Bay nearshore habitats, spatial and temporal changes in phytoplankton communities and epiphytic diatom assemblages were assessed at 21 and 47 locations, respectively, in nearshore areas of the Bay between Rickenbacker Causeway and Barnes Sound, between August 2014 and September 2015. Epiphytic samples were collected at the 47 permanent sites of the Integrated Biscayne Bay Ecological Assessment and Monitoring Project (IBBEAM) between Shoal Point and Turkey Point, while phytoplankton samples were obtained from locations lateral to (i.e., seaward of) some of the IBBEAM sites and were near the mouths of the major drainage canals. Information about algal biomass, community structure and water quality collected during the study was used to develop robust assessment models for phytoplankton biomass and abundance of a bloom-forming diatom taxa *Chaetoceros* spp. and to identify areas of the major shifts in the structure of microalgal communities.

The study showed that epiphytic and planktonic algal communities in nearshore areas of Biscayne Bay are significantly influenced by seasonal changes in water quality. The results showed that water coming from the major drainage canals is the major driver of shifts in the structure of epiphytic diatom assemblages and phytoplankton communities in the Bay. This study also showed that a common approach to determining algal biomass based on chlorophyll *a* measurements, which is often used in monitoring programs in this region, is not a sufficient method for assessing the extent, origin and possible harmful effects of episodically occurring algal blooms on the Bay's biota. Artificial Neural Networking (ANN) and weighted averaging partial least squares (WA-PLS) regression produced reliable estimates of algal biomass and *Chaetoceros* spp. abundance under different water management scenarios (R2 = 0.24 and R2 = 0.39 for algal biomass, respectively and R2 = 0.43 and R2 = 0.36 for Chaetoceros spp. abundance, respectively).

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LESSONS LEARNED FROM VALUING ECOSYSTEM SERVICE BENEFITS OF INVASIVE PLANT CONTROL

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Many federal agencies invest in non-native invasive species control and would like to demonstrate the value of their actions in terms of ecosystem service benefits. Ecosystem service analysis has matured to the point that the preferred analytic methods are emerging, but the execution of those methods remains challenging. Three issues, in particular, make such work difficult 1) a lack of robust cause-and-effect impact analyses of invasives, 2) the difficulty of creating counterfactual no-action scenarios of invasives spread, and 3) insufficient data on how beneficiaries value some of the ecosystem services changes that may be most relevant to agency missions. However, these challenges do not have to derail analyses of the value of invasive species control, if some of the data and modeling gaps can be filled and economic co-benefits can be effectively used.

We will present a case study of water hyacinth (*Eichhornia crassipes*) control in Louisiana to demonstrate methods we used to leverage available data and overcome data and information gaps. For the economic analysis, we evaluated the ecosystem services that could be monetized to demonstrate that benefits exceeded costs of herbicide and biocontrol programs in that state. However, the study raised questions about which ecosystem services were most appropriate for informing US Army Corps of Engineers' decisions. Because the study area was data-rich but still contained significant gaps, it provided insights into targeting future data collection to facilitate future economic analysis of ecosystem services.

The key approach to overcoming information gaps was to create models of intermediate complexity so that they could capture spatial and temporal differences that affected user benefits. However, they also needed to use a modest level of analytic resources to enable multiple ecosystem services to be evaluated. An economic methodological challenge arose because the no-action scenario of water hyacinth spread projected extensive loss of ecosystem services. As a result, the scenario created a need to estimate how users would be likely to substitute other ecosystem services to avoid overstating benefits of invasive control. The economic data available to make such adjustments was limited, but such adjustments are critical to accurate valuation, when ecosystem changes are extensive. The overall findings were that ecosystem service cost-benefit analyses could be efficiently tailored to federal decision-making by pre-screening ecosystem service changes by the magnitude of potential value, science gaps (i.e., deal-breakers), and relevance to decision-making.

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OPTIMIZING FRESHWATER DELIVERY INTO COASTAL ECOSYSTEMS WITH A FUZZY RULE-BASED OPERATION CONTROL MODEL

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Restoration of coastal ecosystems in subtropical Florida relies heavily on creation of storage reservoirs along with stormwater treatment areas (STAs) that help attenuate high discharges during the wet season, while providing treated freshwater inflow in the dry season. Many such systems are in varying phases of planning, design and construction in support of the Comprehensive Everglades Restoration Plan (CERP). A well-recognized need is to develop operational protocols for adaptive management when these systems are constructed and operational, as well as to incorporate optimal operational strategies within the planning and design stages. In this work, we introduce an operation control model that provides adaptive operational protocols via a fuzzy rule-based system, with rule parameters optimized using a genetic algorithm interacting with a hydrologic simulation model of the storage system. Through a series of sensitivity tests, we demonstrate that the model can be used to develop feedback operational policies for adaptive, real-time management of the quantity, quality and timing of releases from and to the storage system for optimal freshwater deliveries into coastal ecosystems.

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THE IMPORTANCE OF ECOLOGY AND ENGINEERING IN COASTAL RESTORATION: LESSONS LEARNED IN ALABAMA

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The restoration of our nation's coastal ecosystems—like sandy shorelines, marshes, and reefs—often require an engineered solution for re-establishing or enhancing ecosystem function. The engineering solution is generally designed to facilitate ecosystem function by addressing, through mitigation, the primary physical or biological stressors on the system. In coastal areas, the physical stressors are often wave action, currents, and even long-term sea level change. There are mature engineering tools and methods for dealing with these stressors, but they may not yield a solution that is compatible with the ecological needs of the system they are used to protect. For example, emergent reefs and breakwaters are very effective at reducing wave energy but, in many cases, do not achieve a habitat value equal to that of a submerged reef. From experience we have learned that careful consideration must be given to the interactions between the ecological and engineering components of these natural systems. Recent successes in the restoration of Alabama's coastal ecosystems have demonstrated the benefits of addressing site-specific ecological needs and engineering requirements by integrating the expertise of coastal scientists, coastal ecologists, and coastal engineers. This oral presentation will describe the importance of integrating ecology and engineering through descriptions of some recent coastal restoration projects in Alabama. Some specific lessons learned as a result of these highlighted case studies will be identified and explained.

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WATER-QUALITY RESULTS FROM THREE CHESAPEAKE BAY SHOWCASE WATERSHEDS: MONITORING AND ANALYSIS DESIGNED TO ASSESS AND INFORM RESTORATION

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In 2010, the U.S Geological Survey partnered with the U.S. Department of Agriculture to characterize water-quality conditions within three Chesapeake Bay showcase watersheds that were targeted for increased implementation of conservation practices. The Smith Creek watershed is located in Virginia's Shenandoah Valley and is dominated by cattle and poultry production. The Upper Chester River watershed is located on Maryland's eastern shore and has heavy row cropping activities. The Conewago Creek watershed is located in southeastern Pennsylvania and is characterized by mixed agricultural activities. A fourth watershed, Difficult Run, located in northern Virginia and characterized by suburban development, was included in this study to contrast the water-quality conditions found in the agricultural showcase watersheds. Water-quality monitoring within each of these watersheds aims to assess the effectiveness of implemented conservation practices and to better inform future management decisions.

Spatial analysis of water-quality monitoring data within the Smith Creek and Upper Chester River watersheds demonstrated differences in stream chemistry that were largely driven by patterns in land-use. In these watersheds, streams draining forested headwaters showed generally dilute chemistry, and made minimal contributions to downstream nutrient and sediment loads. In contrast, streams draining agricultural areas had variable stream chemistry that typically included higher nitrate concentrations.

Calculated nutrient inputs from surrounding land-use and nitrogen isotope data, where available, were used to characterize the dominant sources of nitrate within each watershed. These evaluations indicated that the dominant source of nitrate is likely manure in Smith Creek, inorganic fertilizer within the Upper Chester River, a combination of manure and fertilizer within Conewago Creek, and a mixture of sources that likely include septic system leachate within Difficult Run. An expanded analysis of the wastewater infrastructure within Difficult Run demonstrated a statistically significant ($p<0.05$) positive correlation between nitrate concentrations and areas served by septic systems, with a sharp increase in concentrations as septic density exceeded 100 units per square mile.

Despite the on-going implementation of conservation practices, long-term trends in Smith Creek (1979-2013) and Difficult Run (1972-2013) demonstrate that nitrate concentrations are increasing at an annual rate of 0.01 mg/L and 0.02 mg/L, respectively. Historical data from the Upper Chester River exist back to 1990 and show a similar increase in nitrate concentrations.

These findings provide critical information for nutrient management activities within the Chesapeake Bay watershed. This understanding of spatial patterns in water-quality and of dominant nutrient sources can help target the placement and type of restoration activities within a watershed, while a trend evaluation can address overall change in water-quality. Additionally, these comprehensive watershed characterizations can serve as a framework for future water-quality monitoring programs.

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LINKING DOWNSCALED GLOBAL CLIMATE MODELS TO PLANNING LEVEL ECOSYSTEM MODELS

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The Integrated Compartment Model (ICM) consists of a comprehensive numerical hydrodynamic model coupled to a suite of geophysical and ecosystem models. The ICM was developed to model coastal land loss and potential restoration project impacts for Louisiana's 2017 Coastal Master Plan. The master plan is updated every five years in order to incorporate the latest in scientific and technological advances. To this end, the 2017 Coastal Master Plan was able to take advantage of publically available projections of future climate patterns that were not previously incorporated in the 50-year master plan.

Climate scientists have developed numerous future climate projection datasets at various spatial and temporal scales. General circulation models have been widely used to analyze the impact of greenhouse gas emissions on future climate, and are increasingly used to develop regional models of future climate. Recent efforts by the United States Geological Survey have made various regional climate projections available for use by the general science and engineering communities. Three of these available regional climate projections, all dynamically downscaled via the RegCM3 regional climate model, were used to determine a range of future precipitation and evapotranspiration scenarios across coastal Louisiana for use in the 2017 Coastal Master Plan. These downscaled climate projections were used in conjunction with other potential future environmental conditions (e.g. relative sea-level rise) to develop numerous plausible future scenarios used in the planning analyses.

This presentation will present the methodology developed to apply downscaled climate projection data used in the 2017 Master Plan. The model sensitivity to these uncertain future environmental conditions and the development of future scenarios will be discussed. Further discussion will focus on the interactions and relative sensitivities between the future scenarios and model parametric uncertainties (e.g. model validation error).

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ELECTROMAGNETIC SURVEYING IN THE MANGROVE LAKES REGION OF EVERGLADES NATIONAL PARK

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The Mangrove Lakes are an interconnected set of shallow (~ 1m), brackish lake and creek systems on the southern margin of the Everglades adjacent to Florida Bay. Current efforts associated with the Comprehensive Everglades Restoration Plan (CERP) aim to increase freshwater flow into this region. This study describes preliminary results of geophysical surveys in the lakes conducted to assess changes in the groundwater chemistry as part of a larger hydrologic and geochemical study in the Everglades Lakes region.

Marine geophysical profiles were conducted in Alligator Creek (West Lake) and McCormick Creek systems in August 2013 and May, 2014. Data included marine electromagnetic (EM) profiles and soundings, water depth measurements, surface water conductivity and salinity measurements. A GSSI Profiler EMP-400 multi-frequency EM conductivity meter continuously recorded in-phase and quadrature field components at 1, 8, and 15 KHz. The system was deployed in a flat bottomed plastic kayak towed behind a motorized skiff. Lake water depths were continuously measured with a sounder/chart plotter which was calibrated with periodic sounding rod measurements. At periodic intervals during the survey, the profiling was stopped and surface water conductivity, temperature and salinity are recorded with a portable YSI probe on the tow boat. Over 40,000 discrete 3-frequency EM measurements were collected.

The data were inverted to 2-layer models representing the water layer thickness and conductivity and the lake bottom conductivity. At spot locations, models were constrained with water depth soundings and surface water conductivity measurements. At other locations along the profiles, the water depth and conductivity were allowed to be free, but the free models were generally consistent with the constrained models. Multilayer sub-bottom models were also explored but were found to be poorly constrained. In West Lake, sub-bottom conductivities decreased from 400 mS/m in the west to 200 mS/m in the east indicating a general W to E decrease in groundwater salinity. In the McCormick Creek system, sub-bottom conductivities increased from 200 mS/m at the north end of Seven Palm Lake to over 650 mS/m at the southern end of Monroe Lake indicating a general N to S increase in ground water salinity. Additional profiles are planned in the winter of 2016.

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HYDRAULIC PULSING IN MANAGED WETLANDS TO IDENTIFY PHYSICAL PARAMETERS

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In South Florida, large constructed wetlands, known as stormwater treatment areas (STAs) and proposed reservoirs known as flow equalization basins (FEB) are water management infrastructure features used for reducing phosphorus and storing agricultural runoff prior to discharging water into America's Everglades. These features can be considered as engineered systems that are can provide quantifiable level of performance in terms of flood control, phosphorus (P) treatment, regulatory compliances and environmental sustainability.

With the goal of better understanding the complex physical dynamics observed in these wetlands, field experiments have been carried out in several STA flow-ways using hydraulic pulse tests which operationally force a water disturbance with a known analytic solution to propagate through the STA. These tests are commonly referred to as "wave tests" since the shape of target discharge curve over time is typically a repeating sinusoidal or square wave. By monitoring the stage and P responses to these operations in a structured way across the wetland footprint, causal relationships between the operational stress of a unique frequency signal and the resulting hydraulic / P signal can be observed free of noise from other influences (once these frequencies are filtered out of the data response).

This technique of structured hydraulic field experimentation couple with advance analytical techniques has shown to be useful in estimating the resistance to flow exerted by wetland topography and vegetation. Shallow water wave velocities and wave attenuation rates are used to determine variations in flow resistance in the wetland vegetation. Wave velocity contours and wave decay rate contours plotted for the wetlands can show vegetation density variations and preferential flow pathways through the wetland. The results can be translated into parameters such as effective transmissivity that can be used to assess the optimal density of vegetation suitable for through flow and hydraulic residence in treatment wetlands. Once this information is obtained, vegetation management and operational strategies to maintain desired water levels in the wetlands can be better informed. A second type of field test approach uses the shape of the profile and conditions at the wave front to provide insight into physical parameters with potential implications on mixing dynamics and operational management strategies.

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GULF COUNTY RESTORE ACT MULTI-YEAR IMPLEMENTATION PLAN: RESTORATION PLANNING THROUGH STRUCTURED DECISION MAKING

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On July 6, 2012, the President signed into law the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States (RESTORE) Act, establishing the Gulf Coast Restoration Trust Fund. Eighty percent of the civil penalties resulting from the Deepwater Horizon oil spill will be deposited into the Trust Fund to be used for programs, projects, and activities that restore and protect the environment and economy of the Gulf Coast region. Thirty-five percent of the civil penalties deposited into the Trust Fund are available to four Gulf Coast states, 23 Florida Counties, and 20 Louisiana parishes. In July 2015, British Petroleum (BP) settled with the U.S. government for a total amount of $18.7 billion, $5.5 billion of which is dedicated to RESTORE Act fines. For the small community of Gulf County, Florida, the agreement equates to a direct County allocation of $18.4 million. This is an unprecedented opportunity for Gulf communities; but with eleven broad categories of eligible activities in the RESTORE Act ranging from workforce development to promotion of fisheries, how does a County decide which projects will have the most beneficial impact to their community?

Each applicant (states, counties, parishes), including Gulf County, must submit a Multi-year Implementation Plan (MYIP) to the U.S. Department of Treasury meeting the requirements of the RESTORE Act before any funds can be accessed. The MYIP must describe each activity for which the applicant seeks funding for and provide: a need for, purpose and objectives of the activity; location; budget; milestones; completion dates; evaluation of success; and how the activity is eligible for funding. It must also describe how the applicant incorporated significant public involvement during the development of their MYIP. In the absence of any guidance regarding how applicants should determine the best approach and methodology to allocate funding, Gulf County chose to hire the consulting firm, Dewberry, to navigate the MYIP process and create a funding scenario which promotes the highest and most beneficial impact to the community.

Dewberry developed an MYIP framework consisting of six major phases: 1) Community Needs Assessment, 2) Development of Selection Criteria, 3) Project Submittal Process, 4) Project Scoring and Ranking, 5) Leveraging Analysis, and 6) MYIP Development. Every phase incorporates significant public outreach through the establishment of a local RESTORE Act Advisory Committee (RAC), comprised of community stakeholders, who hold monthly public meetings to discuss the MYIP. Gulf County is currently in the Leveraging Analysis phase of the overall process and received 32 project proposals through the web based Project Portal developed by Dewberry. At this early juncture, the success of the process to date can be measured by many factors, perhaps the most notable of which is the $50 million dollars in matching funds brought to the table with the 32 submitted project proposals. This equates to an overall leveraging factor of 3.17, allowing Gulf County to magnify the benefits of RESTORE funding alone by more than 3x.

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RECONCILING COASTAL WETLAND RESTORATION WITH METHYLMERCURY EXPOSURE: HOW DOES SAN FRANCISCO BAY COMPARE TO OTHER ESTUARIES?

Lisamarie Windham-Myers *and Mark Marvin-DiPasquale*
U.S. Geological Survey, National Research Program, Menlo Park, CA

The restoration of wetland ecosystems is a critical component of improving estuarine function along many developed coastlines of the world. Reversing the loss of tidal wetlands in the San Francisco Bay-Delta (SFB-Delta; 95% loss since 1880) is an active goal of state and federal land management agencies, with 28,000 acres being actively restored currently and a commitment for 100,000 acres by 2030. Active restorations in fresher regions of the San Francisco Bay-Delta may also be subject to a methylmercury (MeHg) TMDL regulation. A 2003 strategy to reduce MeHg exposure in biota from the SFBD suggested 3 approaches: reducing Hg sources, monitoring and reporting Hg concentrations in target fish species, and a novel prescription to reduce net methylmercury production through wetland management. As of 2014, >$18M has been spent on more than 14 research and monitoring projects to document the factors controlling wetland production, export, and bioaccumulation of MeHg in the Delta region alone. Efforts thus far have focused, to a large extent, on examining wetland management practices available to constrain MeHg production. This talk will review the knowledge gained by comparing the results of management studies across a range of wetland environments of San Francisco Bay. We will review the feasibility of these management options and also how the knowledge gained in San Francisco Bay may be relevant to other Hg impacted estuaries with tidal wetlands undergoing active restoration.

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SURVIVAL AND EXTINCTION DURING PAST CLIMATE CHANGES – INSIGHTS FROM THE PALEONTOLOGICAL RECORD

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Change occurs on many time scales and it is an inevitable and natural component of ecosystems; however, the concept of restoration can lead to a mind-set of a static system as resource managers set targets and performance measures. Paleoecologic data and long-term research programs can be utilized to examine the nature and direction of changes in the biological, physical and chemical components of a system. These methods have been employed successfully in many restoration efforts around the country, including the Greater Everglades Ecosystem, but a primary question remains – how will ecosystems and individual species respond to changes in climate and sea level predicted for the next few centuries? Does the paleontological record provide insight into biological and physical responses?

To begin to address these questions, records of molluscan taxa for the late Pleistocene (126,000 to 11,700 years before present) of south Florida were extracted from The Paleobiology Database (https://paleobiodb.org/#/) and compared to living species from the same region (boundary drawn at 27.5 N). These data were checked for taxonomic consistency and validity, and all duplicate taxa were deleted. The list of fossil species was compared to modern south Florida molluscan taxa and worldwide occurrences using USGS data and published species lists. Of the 291 fossil species validated from The Paleobiology Database, 26 species and one genus went extinct by the end of the Pleistocene; of the remaining 265 species, 3 appear to have migrated out of the region, but 262 species (90%) are still alive in South Florida today. One caution in interpreting these numbers – the fossil data most likely do not include rare species, which may be more susceptible to extinction.

These surviving taxa endured significant changes in climate and sea level during the last 126,000 years, including the last glacial cycle when sea level was approximately 100 m lower than today; the Younger Dryas, a period of abrupt cooling; the Medieval Climate Anomaly, a period of sustained drought conditions; and the Little Ice Age, another period of abrupt cooling. From a resource management perspective, the key question is how did they survive such significant changes to their environment and what strategies can be adapted to increase the likelihood of survival in the face of predicted climate and sea level changes? Typical survival mechanisms under changing conditions include persisting if species tolerances are high enough, adapting through either physical or behavioral change, or migrating to new areas. By directly comparing the living taxa of south Florida to the fossil taxa for south Florida and to modern global lists, large-scale migration is eliminated as a mechanism of survival for all but three species. However, in order to examine survival strategies such as robustness or resiliency, careful examination of finely-scaled stratigraphic sequences using multiple proxies could provide information on causes and mechanisms for survival and extinction. Understanding these processes is a management challenge that can be addressed by paleontological data and it is essential to achieve the ultimate goals of restoration – sustainable ecosystems and species survival.

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APPLICATION OF STRUCTURED DECISION MAKING IN DEVELOPMENT OF A GULF-WIDE AVIAN MONITORING NETWORK

***Mark S. Woodrey*[1,2]*, Randy Wilson*[3]*, Jeff Gleason*[4]*, Jim Lyons*[5]*, Robert J. Cooper*[6] *and John Tirpak*[7]

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Birds are a conspicuous and remarkable natural resource of the Gulf of Mexico. Hundreds of species and millions of individual birds are supported throughout their annual life cycle by barrier islands, beaches, marshes, nearshore and offshore waters, and coastal forests. Although many avian monitoring projects have been implemented, almost all are either temporally short-term (e.g., graduate student projects of 2-5 years), of limited geographic scope (i.e., most are local-scale efforts), or a combination of both. Thus, scientists and conservationists lack a comprehensive and coordinated approach to monitoring avian resources across the northern Gulf of Mexico, a critical need that was highlighted during and after the Deepwater Horizon Oil Spill. To address this need, a diverse group of conservation partners including state and federal agencies, NGOs, and academic institutions across the northern Gulf of Mexico were convened.

To make sense of the monitoring challenges and complexities across species, habitats, and the region, the Gulf of Mexico Avian Monitoring Network (GoMAMN) was formed to define a vision and process for developing the role of bird monitoring in achieving integrated, efficient, and effective Gulf of Mexico management and recovery of impacted avian species. Utilizing a Structured Decision Making process, the team developed a set of fundamental objectives along with an explicit objectives hierarchy that reflects the goals, objectives, values, and information needs for an integrated Gulf avian monitoring strategy. The fundamental objectives developed included: (1) Maximize the relevancy of monitoring data within the northern Gulf of Mexico (i.e., ensure monitoring projects are addressing current data needs), (2) Maximize rigor of monitoring projects (i.e., emphasize scientific rigor [study designs, sampling frameworks, power analysis, etc.] underpinning monitoring projects), and (3) Maximize integration of monitoring projects (i.e., increased integration and explicit linkages to avian and non-avian monitoring efforts and data needs for the Gulf of Mexico). In addition, the network partners identified three over-arching data needs (sub-objectives under Objective #1 above) including (A) Maximize the Network's ability to conduct population and habitat status assessments (i.e., collect baseline information related to the status and trends of priority bird species and their primary habitats in the Gulf of Mexico), (B) Maximize the Network's ability to understand management actions and their respective impacts on avian populations, and (C) Maximize the Network's ability to understand ecological processes and their respective impacts on avian populations.

GoMAMN members are currently using this objectives hierarchy to: (1) facilitate communication regarding avian monitoring needs; (2) guide development of a comprehensive, region-wide, coordinated monitoring strategy; and (3) utilize the objectives and value models to develop a prioritization tool to assist funding agencies in selecting among competing bird-focused restoration proposals.

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PERSISTENCE AND DIVERSITY OF DIRECTIONAL LANDSCAPE CONNECTIVITY IMPROVES BIOMASS PULSING IN EXPANDING AND CONTRACTING WETLANDS

Simeon Yurek[1], *Donald L. DeAngelis*[2], *Joel C. Trexler*[3], *Jessica A. Klassen*[4], *Laurel G. Larsen*[5]

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Hydrology and landscape structure in pulsed aquatic ecosystems mediate transfers of energy up the food chain. To examine these interacting effects on energy transfer, we developed a realistic, empirically-based computer simulation model, GEFISH, of a pulsed, transient food web, with dispersal dynamics in an expanding and contracting wetland ecosystem driven by the annual rainfall cycle. We applied the model to the Everglades, an oligotrophic system that historically sustained large numbers of wading birds and other top predators, due in part to pulses of fishes that become concentrated and made available during the wetland drying phase. This ecosystem no longer supports the large, thriving populations of the past. It has been hypothesized that intensive draining and reduction of freshwater flows, and loss of patterned vegetative structure, have led to population declines. Restoring hydrology, landscape structure, and populations of top predators, and their prey base, is a Federal initiative, and requires understanding of the complex interactions of these components.

To quantify interacting effects of hydrology and landscape structure on fish resource pulse generation and persistence, we simulated dispersing communities of three functional fish groups on two different landscapes, one with intact and one with degraded ridge-and-slough landscape (RSL) structure, and applied two twelve-year time series of managed water levels for these areas. Each year of simulations represented a potential scenario for hydrological restoration. Connectivity of the RSL in the Everglades is a key element that enables spatial expansion and rapid growth of fish populations during rising water levels, and their local concentration and stranding as water levels decline. We calculated a hydrological directional connectivity index (DCI) over the eight windrose directions.

Results showed large pulses of biomass forming during the onset of the drying phase, when fish began to converge into the sloughs and were bottlenecked in narrow embayment sinks. Falling water levels initiated concentration immediately preceding marsh drying; then, as water levels fell below the ridges, DCI declined over different directions closing down dispersal lanes, and fish density spiked. Intermediate levels of connectivity on the intact RSL enabled persistent concentration events throughout the drying phase. Fish concentrations were negatively affected by water level reversals that deplete fish populations without allowing enough time for them to regenerate. Overall, longer periods of diverse levels of connectivity, maintained by the anisotropic geomorphology of the intact landscape, produced the longest intervals of high fish concentration.

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A PARTNERSHIP APPROACH TO RESTORATION OF CYPRESS CREEK IN THE LOXAHATCHEE RIVER WATERSHED

Michael Yustin
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The potential to successfully complete complex, ecosystem scale restoration projects is greatly enhanced when multiple agencies and non-governmental entities coordinate their resources. The federally designated Wild and Scenic Loxahatchee River provides an excellent example of how partners with diverse responsibilities have come together to restore this unique resource. Due to development, over-drainage, and wetland compartmentalization, the Loxahatchee River has suffered from a lack of dry-season freshwater flows. Additionally, several miles of freshwater riverine systems have been lost due to salt water intrusion. The focus of this presentation is to review the role of a local governmental agency in taking incremental steps to restore the Loxahatchee River. It will highlight how capturing water within natural systems that form the headwaters of the Loxahatchee is critical to meeting the restoration targets within the river. It will demonstrate how relatively small, focused projects can result in improved hydrology within a watershed encompassing thousands of acres of land. It will also discuss how specific projects are part of a much broader strategy to capture and store water, and provide dry season freshwater flows to the Loxahatchee River. Finally, it will highlight the power of partnerships in successfully addressing complex ecosystem restoration projects.

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BENTHIC FORAMINIFERA AS BIOINDICATORS OF ENVIRONMENTAL CONDITIONS IN THE INDIAN RIVER LAGOON, BREVARD COUNTY, FL

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Florida Institute of Technology, Melbourne, FL, USA

Foraminifera have been used as environmental bioindicators of water quality and pollution in estuarine ecosystems. Foraminifera can be an effective tool for assessing and monitoring ecosystem quality due to their pervasive distribution, high abundances, short generation time, reliable fossil record, and sensitivity to certain environmental factors. Indices have been proposed whereby resource managers can monitor the condition of benthic environments and evaluate restoration efforts by using the presence and abundance of living foraminiferal assemblages. In addition to monitoring efforts, paleoecological data from fossilized foraminiferan tests provide invaluable temporal perspectives to ecologists and restoration planners. To evaluate this indicator for the Indian River Lagoon (IRL) benthic ecosystem, the densities and distributions of foraminifera are being measured in Turkey Creek (Palm Bay, Florida) and the nearby IRL. Spatial and temporal population patterns are being followed for comparison with key environmental parameters characterizing benthic sediments. *Ammonia parkinsoniana* is an abundant foraminiferan in this region of the IRL. Densities of large individuals (tests >500µm) range from 0 to 4,592 (n=3, SE +/- 20.4) m^{-2} in Turkey Creek sediments. Samples were collected from May to December 2015 with peak abundances occurring in May. *A. parkinsoniana* abundances are being checked for correlations with sediment components such as silt/clay, organic material, and water content.

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INVESTIGATION OF STA-3/4 PSTA PERFORMANCE, DESIGN, AND OPERATIONAL FACTORS

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The concept of using periphyton to cleanse stormwater prior to entering the Everglades has been investigated by South Florida Water Management District (SFWMD) scientists and other researchers for over twenty years. The STA-3/4 Periphyton-based Stormwater Treatment Area (PSTA) facility, located in southwestern Palm Beach County, FL, was constructed in 2005 by the SFWMD to investigate the uncertainties associated with large-scale implementation of the PSTA treatment technology. The PSTA Project is comprised of a 200-acre Upper submerged aquatic vegetation (SAV) Cell, a 100-acre Lower SAV Cell and a 100-acre PSTA Cell. The PSTA Cell is unique among STA treatment cells in that the extant peat was scraped to expose the underlying rock.

During the past eight years, the PSTA Cell has shown promising performance by achieving outflow flow-weighted mean (FWM) total phosphorus (TP) concentrations ranging from 8 to 13 $\mu g\ L^{-1}$. In 2013, the SFWMD identified several key studies to be included as part of the comprehensive Restoration Strategies Science Plan. One of these studies is the “Investigation of STA-3/4 PSTA Performance Design and Operational Factors (PSTA Study)”. The primary objective of the PSTA Study is to address gaps in the current understanding of the PSTA technology related to design, operations, and sustainability.

While this is an ongoing effort, preliminary results are offering insight into the factors contributing to the PSTA Cell’s treatment performance. This presentation will provide the overall context of the PSTA Study and will highlight preliminary findings as well as remaining questions associated with the potential further implementation of the PSTA technology in the SFWMD’s stormwater treatment areas.

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NCER 2016 APPLYING RESEARCH, MONITORING, AND EVALUATION TO HABITAT RESTORATION IN THE COLUMBIA BASIN

Katie M McDonald[1]*, Gary E Johnson*[2]*, and* ***Benjamin D Zelinsky***[1]
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This presentation will provide an overview of Bonneville Power Administration (BPA) funded Research, Monitoring, and Evaluation (RME) of both the habitat conditions and related fish populations relevant to tributary habitat restoration. We will provide an assessment of our progress to date and identify areas for future improvement. Ultimately our goal is for RME to inform and improve the biological performance of tributary habitat projects in the Columbia River basin.

Topics will include balancing centralized and decentralized approaches to RME and data management, shifting from data collection to an emphasis on evaluation, synthesis, and application, and defining the conditions necessary for successful application of RME to the design and prioritization of habitat restoration.

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MODELING THE DYNAMICS OF THE INVASIVE TREE, *MELALEUCA QUINQUENERVIA,* IN THE EVERGLADES, WITH AND WITHOUT BIOLOGICAL CONTROL

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Melaleuca quinquenervia is an invasive tree that has spread over the freshwater ecosystems of southern Florida, displacing native vegetation such as slash pine (Pinus elliottii), pond cypress (Taxodium ascendens), and sawgrass (Cladium jamaicense), thus threatening native biodiversity and Everglades restoration. Suppression of Melaleuca appears to be progressing through the introduction of insect species. It is important to project the long-term effects of the biocontrol on suppression of Melaleuca. Our objective is to help provide a better understanding of the dynamics of the Melaleuca in native southern Florida plant communities, and the effect that the biocontrol is having on those dynamics. In addition, we are using modeling to project likely future changes in the plant communities over the next few decades. The individual based model, JABOWA, was used as a basis for developing a model to simulate successional processes occurring in areas of Everglades occupied by native species and Melaleuca, both in the absence and presence of the biological control agents. JABOWA simulated plant succession in a 0.1 hectare plot, given the characteristic of a number of plants and a set of environmental conditions. Five native species, slash pine, sawgrass, pond cypress, dahoon holly and sweet bay, were included in the model.

The JABOWA model was started with different initial conditions and parameters based on field data, mimicking stands dominated by young, intermediate-aged, and old Melaleuca, to determine how the other species populations would behave after the application of biocontrol to the Melaleuca. In addition, we simulated different hydrological conditions to determine the effect of biocontrol on tree communities across a spectrum of environmental conditions. We simulated the function of biocontrol through a reduction in reproductive and growth rates of Melaleuca. Each of the simulation scenarios was run for 300 years and replicated 50 times. Our simulation results overall showed that the density and total basal area of Melaleuca decreased after the bio-control, in agreement with empirical data, and that native species tended to increase in density and total basal area. The results also showed that the biocontrol had a better effect if it was applied in the earlier stage of Melaleuca stand. The species that we selected had different tolerances to water level depths; therefore, the future forest community combinations that emerged after biocontrol differed depending on the hydrologic environment. In summary, our simulation results show that the bio-control will help in the reestablishment of the native community, although the Melaleuca were not entirely eliminated.

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A FRAMEWORK TO COMBINE THREE REMOTELY SENSED DATA SOURCES FOR VEGETATION MAPPING IN THE CENTRAL FLORIDA EVERGLADES

***Caiyun Zhang**, Donna Selch, and Hannah Cooper*
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A framework was designed to integrate three complimentary remotely sensed data sources (aerial photography, hyperspectral imagery, and LiDAR) for mapping vegetation in the Florida Everglades. An object-based pixel/feature-level fusion scheme was developed to combine the three data sources, and a decision-level fusion strategy was applied to produce the final vegetation map by ensemble analysis of three classifiers k-Nearest Neighbor (k-NN), Support Vector Machine (SVM), and Random Forest (RF). The framework was tested to map eleven land-use/land-cover level vegetation types in a portion of the central Florida Everglades. An informative and accurate vegetation map was produced with an overall accuracy of 91.1% and Kappa value of 0.89. A combination of the three data sources achieved the best result compared with applying aerial photography alone, or a synergy of two data sources. Ensemble analysis of three classifiers not only increased the classification accuracy, but also generated a complementary uncertainty map for the final classified vegetation map. This uncertainty map was able to identify regions with a high robust classification, as well as areas where classification errors were most likely to occur.

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EVALUATING CHANGES IN FRESHWATER FLOWS INTO FLORIDA BAY AND THE COASTAL ESTUARIES OF SOUTHWESTERN EVERGLADES NATIONAL PARK IN SUPPORT OF THE COMPREHENSIVE EVERGLADES RESTORATION PLAN

***Mark A. Zucker*[1]**, *Eric Carlson*[1], *Eduardo Patino*[2], *and Amanda Booth*[2]
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The goal of the Comprehensive Everglades Restoration Plan (CERP) is to restore freshwater flows to the Everglades and adjacent estuaries. Restoration requires redirecting excess freshwater runoff lost to tide into the Everglades and to the coastal waters of Everglades National Park (ENP). The challenge is to manage the quantity, quality, timing, and distribution of the freshwater flow through ENP to the coast more like natural conditions to restore Florida Bay and adjacent estuaries. The U.S. Geological Survey, in cooperation with the Greater Everglades Priority Ecosystem Science Program and the CERP Restoration Coordination and Verification Monitoring Assessment Plan operate hydrologic stations at select tidal creeks and coastal rivers to quantify freshwater flow discharging into northeastern Florida Bay and the Gulf of Mexico. These stations measure water level, flow volume, salinity, and temperature along major flow paths in ENP (Shark Slough and Taylor Slough). These long-term data (1995 to current) are essential to evaluate environmental impacts from storms, droughts, and various water management operations. A goal of monitoring is to evaluate the effects of the construction projects and water management operations on the coastal Everglades. Flow volumes near the Everglades coastline before and after the Tamiami Trail bridge construction (completed March 2013) will be compared as well as flow volumes before and after the implementation of the Aerojet Canal features (completed January 2013) located eastward of Taylor Slough and upstream of northeastern Florida Bay.

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ACTIVE MANAGEMENT IN SUPPORT OF ECOSYSTEM RESTORATION

Christa Zweig, *Susan Newman, Colin Saunders, and Fred Sklar*
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In ecological restoration, many ecosystems are so different from their original state that simply changing ecological drivers will not restore the landscape. The ridge and slough landscape of the Florida Everglades is an excellent example where the loss of landscape pattern may not be reversed by restoring historical flow, depth, and or hydroperiod. Particularly in over-drained areas, established sawgrass (*Cladium jamaicense*) can persist for decades in sub-optimal, wetter conditions. We had the opportunity to perform active management within an experimental flow footprint (Decomp physical model) in the Everglades, to test the feasibility and benefit of creating new sloughs to increase the velocity and spatial extent of flow through the wetland. We created two types of connecting sloughs—one by completely removing sawgrass biomass (“cut”) and another by compacting sawgrass with an airboat (“smash”). Pre-experimental flow in the ridges and sloughs were < 1 cm/sec. Flows during the experiment in the cut slough were significantly higher than the surrounding ridge: maximum of 16 cm/sec versus 3.5 cm/sec, and flows in the slough downstream of the cut were higher than the upstream slough. The cut slough also conducted flow in a different direction than water in the surrounding ridge, but still exchanged flow and sediment with the ridge. Submerged aquatic plants grew in the cut slough during the non-flow months and no sawgrass was able to reinvade—it is now functioning as an open-water slough. The smash sloughs generally had 1 cm/sec or greater flows inside the slough then the surrounding ridges. The smash sloughs conduct more flow than the ridges around them, but less than the cut sloughs, and did not change the direction of flow. We also observed preferred flow paths in the area, paths that were not immediately obvious from the landscape. Our results suggest that propagating flow further into a landscape is possible through active management, but we must take care to work with the natural flow paths of the system to maximize benefit.

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