Basics of the Basin 2011
Commemorating 10 Years of Research!!

ADDRESSING THE CONDITION OF THE LAKE PONTCHARTRAIN BASIN
Hosted By:
Lake Pontchartrain Basin Foundation
Southeastern Louisiana University
U.S. Environmental Protection Agency
Pontchartrain Research Committee
Pontchartrain Restoration Program
Pontchartrain Basin Research Program

October 27th, 28th and 29\textsuperscript{th}
At
Southeastern Louisiana University
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Funding and Support
Thanks to our Sponsors!!!
Invited Speakers

Thursday, October 27

Lunch
Senator David Vitter

Special Guest on Climate Change
Dr. Virginia Burkette
U.S. Geological Survey
Chief Scientist, Climate and Land Use Change

Dinner
Dr. Sam Hyde
Director of the Center for Southeast Louisiana Studies
Professor of History, Southeastern Louisiana University

Friday, October 28

Lunch
Mark Shleifstein
Environmental Reporter, Times Picayune
Co-Author (with John McQuaid) of "Path of Destruction-The Devastation of New Orleans and the Coming of Age of Superstorms"

Special Guest
Dr. David Burley
Department of Sociology and Criminal Justice, Southeastern University
Author of "Losing Ground: Identity and Land Loss in Louisiana"
Pirogue Award

The Pirogue awards began in 1994 and are awarded to those individuals who have made outstanding contributions to BASICS OF THE BASIN SYMPOSIUM. These are “Chairman Awards” selected by the Pontchartrain Research Committee Chairman.

2011 Recipients

Dr. Nick Norton
Dr. Bob Moreau
Dr. Virginia Burkett
Dr. Dale Manty
Mr. Mark Schleifstein
Dr. Jim Flocks
Mr. Rick Raynie
Dr. Sam Hyde

Past Recipients

1994
Dr. Michael Poirrier
Dr. George Flowers
Dr. Robert Hastings
Dr. Shea Penland
Dr. Jeff Williams
Dr. Richard Miller
Dr. Michael Hirshfield
Mark Davis

1996
Julia Simms
Cliff Kenwood
Neil Armingeon
Ann Jakob

1998
Dr. Don Barbe'
Dr. Don Davis
Carlton Dufrechou
Dr. Jack Kindinger
Dr. Frank Manheim
Dr. Alex McMorquodale
Ben Taylor
Dr. Jeff Waters

2000
Chris Brantley
Dr. Quay Dortch
Claudia Fowler
Carol Franze

2002
Mark Schexnayder
Dr. Mark S. Peterson
Dr. Jimmy Johnston
John Troutman
Dr. A.J. Englande

2004
Patricia Arteaga
Andrea Calvin
Dr. Mark Hester
Dr. Mark Kulp
Dr. John Lopez
MOTIVA
Kerry St. Pe'
Congressman David Vitter

2006
Dr. Dawn Lavoie

2008
Senator Mary Landrieu
Dr. Worth D. Nowlin Jr.
Agenda

DAY 1 (THURSDAY, OCTOBER 27)

8:00 am  **REGISTRATION/Continental Breakfast** (Commons Room next to Theatre, 2nd floor Student Union)

9:00 Welcoming Remarks: John Lopez, Director of Research, LPBF; Nick Norton, Director, Southeastern’s PBRP; and Dr. John Crain, President, Southeastern Louisiana University (Theatre, 2nd floor Student Union)

9:10 Kickoff Charge: Mark Davis, Senior Research Fellow and Director of the Institute on Water Resources Law and Policy, Tulane University (Theater, 2nd Floor Student Union)

9:30 Plenary/Forward: John Lopez, Acting Director, Lake Pontchartrain Basin Foundation (Theatre, 2nd floor Student Union)

9:50 PRP Program Description (Denise Reed, invited, unconfirmed)

10:05 PBRP Program Description: Nick Norton

10:20 BREAK

10:30 Plenary Session on Bonnet Carré Spillway, Introductory Remarks (Theatre, 2nd floor Student Union) Moderator- Rick Raynie

10:35 Christopher Brantley, V.A. Landry, R. Fontenot and J. Smith. USACE - The role of weather and Bonnet Carré Spillway Openings: Comparisons of the 2011 Mississippi River Flood with Prior Events.

10:55 Brian Vosburg, Mead Allison, UT at Austin - Hydrodynamics and sediment transport in the Mississippi River during the 2011 flood

11:15 Denis Demcheck USGS- A Comparison of Water-Quality Effects of the 2008 and 2011 Bonnet Carré Spillway Diversions into Lake Pontchartrain, Louisiana

11:35 Jeff Dauzat LDEQ- Bonnet Carré Spillway Sampling plan


12:15 Question & Answer

12:25 Begin walking over to 12 Oaks Ballroom for Luncheon (see map and signs) Sharp

12:30 LUNCHEON and NETWORKING Key Note Speaker: Senator David Vitter (12 Oaks Ballroom)

1:50 Sharp Begin walking back to Student Union for Afternoon Sessions

2:00 BREAKOUT SESSIONS—15 minute talks with 5 minute Q&A (2nd Floor Student Union Ballroom area rooms, across walkway from Commons Room and Theatre)

**BONNET CARRÉ SESSION** (2nd Floor Student Union Ballroom)

2:00 Introductory Remarks Jim Pahl

2:05 E.D. Roy, J.R. White, S. Bargu, S.J.

**NORTHSHORE SESSION** (2nd Floor Student Union, room 223, “Southeastern Room”)

2:00 Introductory Remarks with Moderator - Gordon Austin

2:05 Andrea Bourgeois-Calvin -
Bentley, C.Y. Li, and N. Walker-Nutrient Dynamics in Lake Pontchartrain during and after the 2011 Bonnet Carré spillway opening


2:45  Emily A. Smith, Sibel Bargu, Eric Roy, John R. White, Sam Bentley, Chunyan Li, Nan Walker- Effects of freshwater input on bioavailable nutrient loading, phytoplankton biomass, and cyanotoxin production in Lake Pontchartrain

3:05  Jeffrey A. Nittrouer, Christopher G. Brantley, Ronald W. Cash, Mathew Czapiga, Gary Parker, and James L. Best - Mechanics of sand transport through the Bonnet Carré spillway, Mississippi River, and implications for river-water and sediment diversions in southern Louisiana

3:20  Additional Q&A Session

3:35  BREAK

BONNET CARRÉ SESSION CONTINUED (2nd Floor Student Union Ballroom)

3:50  Bonnet Carré Session continued

3:55  Sam Bentley, Jeff Fabre, Chunyan Li, Nan Walker, and Randy Paylor-Sediment Flux and Fate to Lake Pontchartrain from the Bonnet Carré spillway in the 2011 Mississippi Flood

4:15  Rachel W. Clostio, Cole Land, Christopher Schultz, Gary Childers, and Crystal N. Johnson - Water quality in association with a historical Mississippi River flood event and its effect on blue crabs (Callinectes sapidus)

4:35  Additional Q&A Session

4:50  BREAK

WETLAND SESSION (2nd Floor Student Union, room 223, “Southeastern Room”)

3:50  Introductory Remarks with Moderator Theryn Henkel

3:55  Christina H. Saltus, Glenn M. Suir, John A. Barras- Land Area Changes and Forest Area Changes in the Vicinity of the Mississippi River Gulf Outlet-Central Wetlands Region from 1935-2010

4:35  Dendrochronology  
   Thomas W. Parker, C. G. Brantley, K. J. Killgore, J.J. Hoover, W. T. Slack, S. G. George, R.T. Ruth, and D. Schultz - Entrainment of Sturgeon through the Bonnet Carré spillway

4:35  Colin R. Jackson - Microbial activity and organic matter processing in western Lake Pontchartrain Basin wetlands

4:55  Janice L. Bossart, Colin R. Jackson, Ryan Clark, - An Index of Biological Integrity for wetlands in the Lake Pontchartrain Basin


5:10  Question & Answer

EVENING LECTURES and DINNER (12 Oaks Ballroom, see map and signs)

5:20  Sharp  Begin walking over to 12 Oaks Ballroom for Dinner and Social/Music (see map and signs)

5:30  Special guest on Climate Change: Dr. Virginia Burkett, U.S. Geological Survey, Chief Scientist, Climate and Land Use Change

6:15  DINNER with Guest Speaker: Sam Hyde, Director of the Center for Southeast Louisiana Studies; Professor of History, Leon Ford Endowed Chair in Regional Studies

7:30  NETWORKING SOCIAL featuring Musical Guests: Moncla Cajun Band—music and instrument commentary

8:30  Adjourn

DAY 2 (FRIDAY, OCTOBER 28)

8:00 am  REGISTRATION/Continental Breakfast (Commons Room next to Theatre, 2nd floor Student Union)

9:00  Welcome Back: Dr. Nick Norton, Director, Southeastern’s PBRP (Theatre)

9:15  Special Guest Speaker: Dr. Dale Manty (EPA)

9:45  Dr. John Lopez, Director of Research, LPBF (Overview for the Day)

10:00  BREAKOUT SESSIONS—15 minute talks with 5 minute Q&A (Ballroom area rooms, 2nd Floor Student Union)

10:00  Introductory Remarks with Moderator Gary Shaffer


10:00  Introductory Remarks with Moderator Dale Manty

10:05  Gary P. Shaffer and William Bernard Wood - de-energizing Hurricanes with Cypress/Tupelo Buffers: a Plan to Restore the Repressed Swamps of the Lake


10:45  William Stein, III - Tarpon, Megalops atlanticus, in Southeastern Louisiana

11:05  Michael S. Kearney, J. C. Alexis Riter, and R. Eugene Turner - Twenty-Six Years of Changing Vegetative Cover and Marsh Area

11:05  Deborah Dardis - Exploring Your Environment: EYE on Southeast Louisiana

11:25  Andy Baker, John A. Lopez - Turbidity sampling at the Caernarvon Diversion: Implications for managing river diversions


11:45-12:50  BREAK and POSTER SESSIONS—including Student Poster Judging (Main Ballroom, 2nd Floor Student Union)

12:50 Sharp  Walk over to 12 Oaks Ballroom for Luncheon (see map and signs)

1:00  LUNCHEON  Key Note Speaker: Mark Schleifstein, Environmental Reporter – Times Picayune, and Co-Author (with John McQuaid) of “Path of Destruction – The Devastation of New Orleans and the Coming Age of Superstorms”

2:10 Sharp  Begin walking back to Student Union for Afternoon Sessions

2:20  BREAKOUT SESSIONS—15 minute talks with 5 minute Q&A (2nd Floor Student Union Ballroom area rooms, across walkway from Commons Room and Theatre)
DISTURBANCES (2nd Floor Student Union Ballroom)

2:20 Introductory Remarks with Moderator Jim Flocks

2:25 Ezra Boyd, J. F. Pereira' J. Lopez; A. Baker- An oil spill surveillance program for Lake Pontchartrain

2:45 James Flocks, Jennifer Miselis, Nathaniel Plant, Abby Sallenger - The northern Chandeleur Islands and the emergency oil spill mitigation sand berm: a proxy for shoreline response to large-scale revitalization projects?

3:05 Ezra Boyd - Did the MRGO create lethal flood conditions?

3:25 Tiffany A. Schriever, Joseph Ramspott, Brian I. Crother, and Clifford L. Fontenot, Jr. - Effects of hurricanes Ivan, Katrina and Rita on Southeastern Louisiana herpetofauna


4:05 Question & Answer

POLLUTION (2nd Floor Student Union, room 223, “Southeastern Room”)

2:20 Introductory Remarks with Moderator Bob Reimers

2:25 Khalid L. Saleh - Physical, Chemical and Biological factors affect Methylmercury in Lake Pontchartrain. Louisiana

2:45 Jonathan M. Willis, and Mark W. Hester - Edaphic and Vegetative Controls on Mercury Cycling in the Lake Maurepas Wetlands

3:05 Ponsawat Srisawat, Brady K. Skaggs, Thomas E. Wiese, Deborah Grimm, Andrew J. Englande, Jr., and Robert S. Reimers - Reduction of estrogenic activity in wastewater following treatment with ferrate

3:25 Sarah Brock and William F. Font - Effects of Pollution on the Heminth Community of Western Mosquitofish and Snail Intermediate Hosts

3:45 William F. Font - Mitigating the Spread of Zebra Mussels into Wetlands from Mississippi River Diversions

4:05 Question & Answer

CONFERENCE WRAP-UP SESSION: Moderated by John Lopez (Theatre, 2nd floor Student Union)

4:15-4:30 Special Guest Speaker: Dr. David Burley, Department of Sociology and Criminal Justice, and author of last year’s Losing Ground: Identity and Land Loss in Coastal Louisiana (book signing immediately after the conference ends outside this Theatre room at the registration table).

4:30-5:00 Final Comments and Question & Answer for Session (including final headcount for tomorrow’s Field Trip Luncheon of Turtle Cove)

5:00 Adjourn (with Losing Ground book signing outside at registration table)
DAY 3 (SATURDAY, OCTOBER 29)

FIELD TRIPS—Use your own transportation

9:00 am  Meet at Hammond Waste Water Effluent Wetland Area (just south of Ponchatoula on Hwy 51—see map and directions)

Or

9:00 am  Meet at Joyce Management Wildlife Area Boardwalk (same as above, just a little farther south of Ponchatoula on Hwy 51—see map and directions)

Then

10:00 am  Meet at Turtle Cove Galva Canal Boatshed/Classroom Area in Manchac, LA (see map). Pontoon Boat departure to Turtle Cove is at 10:15 a.m. CAPACITY OF PONTOON BOAT IS 35 MAX INCLUDING CAPTAIN.

10:45  Arrive at Turtle Cove: Tour grounds, facilities, and boardwalks (new “self-guided tour” of boardwalk in Marsh is highly recommended).

11:30  Lunch is served (Gumbo and Fried Catfish)

1:00  Pontoon Boat ride back to Galva Canal

1:30  Pontoon Boat arrives back at Galva Canal—End of Conference
POSTER PRESENTERS

1. Ezra Boyd. Levee’s Only along the Mississippi River and New Orleans’ Exposure to Storm Surges.
3. Matthew J. Kaller and Mark W. Hester. Role of Nutrient Enrichment, Disturbance, Dispersal, and Herbivory on Oligohaline/Mesohaline Marsh Transitions
8. James W. Pahl. River Diversions as a Component of the State of Louisiana’s Strategy to Achieve a Sustainable Coastal Zone.
10. Lisa Cordes and Kyle R. Piller. To mix or not to mix, that is the question? A case study of a freshwater diversion and genetic diversity.
12. Tiffany Schriever, Clifford Fontenot, and Brian I. Crother. Geographic Variation in Salinity Tolerance among Green treefrog (Hyla cinerea) Schneider Populations in Southeast Louisiana.
13. Volker Stiller. Drought and salinity affect wood density and vulnerability to xylem cavitation of Baldcypress (Taxodium distichum) seedlings.
17. Robert S. Reimers, Yue Xu, Andrew Englande. Study of EDCs in biosolids and residuals.
Research Summaries

*In Alphabetical Order by Presenter*
Monitoring Turbidity at the Caernarvon Diversion Discharge: Implications for Managing River Diversions

Andy Baker and John Lopez
Lake Pontchartrain Basin Foundation

Abstract
We present the initial results of a two-year turbidity monitoring program at the Caernarvon diversion. Levels of suspended solids in river water were found to vary greatly on a weekly time scale. This study adds to a growing body of research suggesting that sediment delivery via diversions can be maximized by adaptive management that increases flow when sediment levels in the river are highest.

Caernarvon diversion sampling charts and data are available at SaveOurLake.org/coastal-resources

Introduction
From December 2009 through 2011, the Lake Pontchartrain Basin Foundation has conducted a weekly sampling program to measure turbidity of water flowing from the Mississippi River through the Caernarvon diversion in St. Bernard Parish, Louisiana. Turbidity is a measure of how much light passes through a sample (transmittance), which is correlated to the density of particles in the sample (total suspended solids, TSS).

The Caernarvon diversion lies on the border of St. Bernard and Plaquemines Parishes. Five underground culverts reach from the river under the levee to the Caernarvon canal, with flow regulated by movable steel gates. Constructed in 1991, Caernarvon is one of the oldest and largest diversions on the Mississippi River, and serves as a model for the positive and negative effects of freshwater diversions on coastal marsh health, resiliency and restoration.

The Caernarvon diversion was designed to convey freshwater while minimizing sediment load. However, the recent emergence of the Caernarvon Delta in Big Mar shows that it is indeed delivering substantial sediment.

Methods
Every week (every other week in some months, twice weekly during floods) an LPBF scientist collected three samples from each of three culverts. Each sample was analyzed with a Hach 2100P portable optical turbidimeter, and the nine results were averaged. The readings ranged from 10 to 290 NTU (nephelometric turbidity units), indicating moderately clear to extremely cloudy water. Turbidity measurements were plotted on a graph along with river stage, allowing a comparison of river conditions and sediment levels (Figure 2).

Measured turbidity is related to the TSS concentration in a sample, but is influenced by optical properties of the particles and thus...
varies for different locations. Previous research at Caernarvon (Snedden et al. 2006) has established a linear relationship between turbidity and suspended solids (Figure 1). Multiplying the calculated TSS concentration by the reported flow through the diversion, we obtain a first-order estimate of how much sediment was delivered to the receiving marsh (Figures 3 and 4).

We acknowledge the limitations of this sampling effort. A single site cannot represent the entire river, and there may be short-term fluctuations that were not captured by our sampling schedule. Our simple handheld turbidimeter, analyzing samples from near the surface, has limited resolution and may underestimate the amount of large particles flowing through the diversion.

Results
Looking at almost 2 years of data, we begin to see some interesting patterns (Figure 2). It was found that turbidity in the diversion water varies greatly over time and is related to changes in river flow, but not in a simple, easily predictable way.

The river behaved quite differently in 2010 (multiple moderate rises through the spring) and 2011 (one historic flood in the early summer). The river’s sediment load was low and steady during times of low flow, then rose and fell rapidly as the river stage increased. Turbidity often
spiked for 1 to 4 weeks at the beginning of a rise and then declined, rather than rising and falling in step with the river stage.

In 2010, four turbidity spikes in the spring appeared to coincide with rises in the river; three of these were on the leading edge of the rise. 2010’s largest and longest spike, in June and July, was not associated with a strong rise but may have been caused by upstream flooding. In 2011, one very large spike occurred at the onset of the historic flood, followed by fairly steady, moderate TSS levels during the rest of the high water.

The rises in turbidity were usually associated with rising river stage (as in January, March and May 2010, and March 2011). The increasing hydraulic energy of a rising river may mobilize a slug of sediment that had been deposited during lower energy conditions (Williams, 1989). Continued rises in flow may mobilize relatively less sediment from the riverbed, while they continue to erode material from riverbanks. Relatively low turbidity levels at the peak of the flood may also partly be due to dilution; more sediment is being carried in the great volume of water, though its concentration is not particularly high.

In 2010, diversions operators planned to open the gates for four experimental 2-week pulses from April to June. In response to the BP oil spill, this and other diversions were opened at full capacity from April to August (Figure 3). This happened to coincide with three large peaks of sediment in the river. A rough calculation of the amount of sediment in the water (magenta line, based on Snedden et al) shows that over 120,000 m³ were delivered to the receiving marshes that summer. Field observations showed extensive land deposition immediately downstream, from sand to fine silt.

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Sediment delivery is a function of the volume of water delivered and the TSS concentration in that water. Diversion flow was low during the turbidity peaks of February and late March, so relatively little sediment was conveyed.

In 2011, the largest diversion opening was in February and early March. Flow was cut back to ~1,000 cfs just as the river was rising for that summer’s historic flood. LPBF’s monitoring showed a great increase in TSS in mid-March (Figure 4), as the river started to rise. Much of the year’s sediment delivery may have occurred in early March when high flow coincided with high TSS.

Conclusions
Sediment load in the Mississippi River varies dynamically in time and space. Turbidity does not directly correlate to river stage, but is a complex product of the river’s kinetic energy, upstream conditions and previous events. Spikes in TSS concentration may tend to occur on the leading edge of a rising river level, but this is not always the case.

The details of how a diversion is operated may be as important as its location and design. Restoration benefits can be maximized if diversions are operated in a flexible, adaptive manner that responds to real-time conditions. River sediment load varies over time, and diversions will deliver the most sediment if they are opened when concentrations are highest.

The Caernarvon diversion was not designed to convey sediment, but the buildup of emergent marsh in Big Mar proves that it does. The 2010 opening fortunately coincided with several spikes in river turbidity, and brought thousands of tons of sand and silt into the marsh. If real-time river turbidity measurements were available, diversion managers could fine tune the
schedule of opening and closing to maximize sediment delivery while also achieving other restoration goals.

The Caernarvon diversion’s operators do not take turbidity into account when deciding when and how much to open its gates. If the goal of a diversion is to convey the most sediment per gallon, operators should monitor river turbidity in real time and “pulse” the flow when the sediment load is highest. Any river diversion will convey more sediment per volume of fresh water if flow is increased during turbidity spikes. In practice, real-time turbidity measurements will be one of a host of factors informing an adaptive management strategy.

Consistent long-term sampling at many sites would reveal more about large-scale sediment dynamics and allow a more holistic view of managing the Mississippi River and its delta. Sediment distribution in the river varies in space as well as time: is it necessary to monitor turbidity at each diversion, or could an average value from several sites be used? Building from this and other studies, we can envision a network of turbidity monitoring stations along the river investigating the following questions:

- Is it possible to derive a meaningful sediment curve for the whole river, or is variation by site too great?
- Can the river’s sediment load be predicted, and at what scales of time and space?
- How can sediment monitoring be best integrated into diversion management systems?

Caernarvon diversion sampling charts and data are available at SaveOurLake.org/coastal-resources

References

Day, J.W et al, 2009. The impacts of pulsed reintroduction of river water on a Mississippi delta coastal basin. Journal of Coastal Research, SI(54), 225-243. West Palm Beach (Florida), ISSN 0749-0208


US EPA. Environmental Monitoring Systems Laboratory, Cincinnati, Ohio. “Method 180.1: Determination of Turbidity by Nephelometry, Revision 2.0.” August 1993

Sediment Flux and Fate to Lake Pontchartrain from the Bonnet Carré Spillway in the 2011 Mississippi Flood

Sam Bentley*1, Jeff Fabre1, Chunyan Li2, Nan Walker2, and Randy Paylor1
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From early May to late June 2011, enormous fluxes of water and sediment were delivered to Lake Pontchartrain by the Bonnet Carré Spillway from the Mississippi River, when river stages approached and locally exceeded records set by the Great Flood of 1927. Although nutrients associated with past spillway openings have been studied extensively, sediment flux to Lake Pontchartrain from the spillway has never received extensive study. In light of the importance of Mississippi river-sediment budgets and anticipated developments of large river diversions for beneficial sediment delivery to the Mississippi Lower Delta Plain, we undertook a study of sediment flux, dispersal, and deposition. Sediment cores collected before and at the end of spillway operations, and again two months after spillway closure, are being examined using 210Pb and 7Be geochronology, X-radiography, and granulometry, in order to identify newly deposited sediment both visually and geochemically. MODIS satellite imagery was used to monitor plume dispersal. Time-series ADCP surveys and water samples have documented water and sediment flux from the spillway into the lake. These results are being compared with estimates of sediment flux into and through the spillway collected by OCPR, USGS, and US-ACE collaborators.

Figure 1: Aerial photograph of sediment plumes entering Lake Pontchartrain in May 2011, courtesy of the US-Army Corps of Engineers.

Initial results conservatively suggest that the total sediment flux into the spillway during May-June was on the order of 1.5-2 Mt, estimated from this year’s water discharge and sediment
concentrations averaged over previous spillway openings. This number will be refined as this year’s suspended sediment measurements become available. MODIS imagery documented rapid and extensive dispersal of fine sediments across nearly the entire lake, and preliminary core measurements 1-6 cm of newly deposited sediment within several kilometers of the spillway entrance to the lake. Further analyses of short-term sediment deposition is under way for stations extending across the entire lake.

As analyses are completed and a sediment budget is established, results should provide insights into the quantities of sediment that can be transferred through large diversions sampling the upper meters of Mississippi River flood waters. Results should also provide insights regarding processes and extent of sediment dispersal for both coarse and fine sediment fractions delivered from the river, into enclosed basins in the Mississippi Lower Delta Plain. We anticipate these findings will provide guidance in the design and construction of proposed large sediment diversions proposed for coastal land restoration and conservation.
The Identification and Analysis of the Basic Degradation Processes Inherent to Nutrient Enrichment and Elevated Water Levels in Natural Wetlands: A Case Study of the Hammond Wastewater Discharge Site

Ed Bodker
Triangle T Sportsmen’s League, 39484 S. Hoover Rd., Ponchatoula, LA 70454

The freshwater marsh at the Hammond wastewater assimilation site has suffered a great deal of direct and/or indirect damage resulting from permitted sewage discharge that began in the fall of 2006. Many questions about the cause-and-effect relationships leading to this stress were raised and continue to persist. A number of possible causes have been identified that most likely contributed to the weakening and degradation of this ecosystem. However, it is likely that many factors played roles in a synergistic degradation of this wetland, including algal blooms, plant diseases, storm events, chronic stress on vegetation from excessive constituent levels, an invasion and dominance of floating and shallow rooted plant species, persistent flooding due to a continuous discharge, alterations of the preexisting hydrology as a result of building a pipeline with an access road, herbivory, increases in alkalinity and pH, the alteration of microiotic populations, and sediment export. Although the complexity of interacting causes makes it difficult to assign a measurable value to each specific impact, it is important to answer two fundamental questions: 1. What are the basic detrimental factors inherent to the discharge of nutrient rich water into any natural wetland? 2. What standard methodologies can be established and used to produce data to quantify existing and potential negative impacts?

By comparing and identifying factors which could be relevant to a particular site but not necessarily relevant to all sites receiving a nutrient rich discharge, many factors could be classified as secondary causes. Of the factors remaining as relevant to all sites, two stand out as primary and direct functions of degradation. These two factors are: the rates of organic decomposition, and, the rates of export of decomposing matter from any given wetland. These factors are linked to each other inherently as a relationship between prolonged nutrient enrichment and increases of water elevations and flow.

Experimentation designing and using incubation chambers to measure short term decomposition rates were conducted during 2010-2011. The preliminary results show that during summer months, decomposition in the discharge zone is 35-45 percent higher than in the control marsh, over a ten day period. Long-term incubation data are currently being studied as well. Additionally, sediment traps were designed and used to measure settable solids (particulates) from both the control site and the discharge zone. The preliminary results show a great variation in particulates moving within and out of the discharge zone. Under normal weather conditions some of these traps collected over 150 ml/day of particulates, and few collected less than 50 ml/day. Particulates in waters from the control marsh are consistently lower, ranging from three to eight ml/day.

The goal of this presentation is to show the need for, and the progress towards, defining a more accurate methodology for evaluating the damage to wetlands caused by accelerated decomposition and sediment export.


An Index of Biological Integrity for wetlands in the Lake Pontchartrain Basin.

Janice L. Bossart, Southeastern Louisiana University  
Colin R. Jackson, University of Mississippi  
Ryan Clark, Southeastern Louisiana University

We conducted a comparative, joint analysis of the benthic macroinvertebrate diversity and microbial enzyme activities of swamp sites in the Western Lake Pontchartrain Basin (WLPB). Our ultimate goal was to develop the first ever Index of Biological Integrity (IBI), a biological yardstick for assessing ecosystem health, that is specific to the forested wetlands of the WLPB. Our study additionally counts as the first time benthic invertebrates had ever before been systematically surveyed within the Basin despite their wide recognition as harbingers of wetlands quality and change.

The six primary sampling sites were selected to span and anchor both ends of a habitat disturbance gradient (largely intact swamp, partially degraded swamp, severely degraded swamp, i.e. marsh). Three sites were located within the 16,000 acre Joyce Wildlife Management Area (JWMA), and the other three in the 62,500 acre Lake Maurepas Wetlands System (LMWS). Each site was sampled between 11 and 15 times throughout the course of the study (spanning a year plus) on an approximately every three to four week rotational basis. Benthic invertebrates were collected using a dip-net, with a multilayer sieve used to separate the specimens from the substrate and vegetation. Sediment samples were collected by reaching underwater and scooping sediment into sterile 50ml centrifuge tubes with screw caps. All invertebrates were identified at least to Family. Insect specimens were additionally identified to species or morphospecies. Sediment samples were analyzed for activities of the hydrolytic microbial enzymes: β-glucosidase (B-gluc), cellobiohydrolase (CBH), N-acetyl-β-glucosaminidase (NAG), β-xylosidase (B-xylos), and acid phosphatase (Phos) using p-nitrophenyl linked artificial substrates; and for the activity of the oxidative enzymes phenol oxidase (Phen Ox) and lignin peroxidase (Perox) using L-DOPA.

Mean enzyme activity levels (i.e. the average activity at that site pooled across sampling dates) were site-specific (Fig. 1). These differences among sites indicate not only different levels of activity, but also suggest that different microbial communities are involved (and presumably different environmental factors driving these differences in activity/community structure). In all cases, microbial enzyme activity levels were lowest at the degraded site. In fact, Phen Ox activity was never detected at the degraded site. Acid phosphatase activity, in particular, may be useful for monitoring ecosystem condition because of the clear decrease in microbial acid phosphatase activity with increased swamp degradation; microbial phosphatase activity was highest at the intact sites (although these sites differed), was intermediate at the partially degraded site, and was lowest at the degraded site.

A total of 5441 benthic invertebrate specimens were collected from the six primary sites. A quarter of these were from the degraded site, and the large majority of these were insects. 16 Orders (insect plus non insects) were represented in the collection (Fig. 2). The intact sites (all sites combined) had the highest community diversity; 14 Orders collected and no single Order dominated. The intact sites had a large number of Isopoda (aquatic sowbugs), Amphipoda (scuds & side swimmers), Coleoptera (beetles), Decapoda (shrimp & crabs), and Odonata (dragonflies & damselflies). In contrast, the degraded site had the lowest diversity; 10 Orders collected and the community was dominated by Diptera (flies). The community at the
intermediate, i.e. partially degraded, site shared characteristics of both the intact (e.g. significant numbers of Decapoda, Odonata, and Ephemeroptera) and degraded sites (e.g. significant numbers of Diptera). Unlike the intact and degraded sites, which had very small numbers of Pulmonata (snails), essentially half of all specimens collected at INT were snails.

There were 75 different insect species collected across all sites combined. However, in nearly all cases, collector curves were still increasing sharply (Fig. 3), indicating that sampling was far from complete and more insect species would have been collected if sampling had continued. Nonetheless, a similar pattern of diversity emerged. Species richness was lowest at the degraded site (despite a much larger total sample collected) and highest at the intact sites. Additionally, a number of insect species emerged as viable indicators of swamp condition. Certain species collected from the intact sites were never collected from the degraded sites, and vice versa. For example, the degraded site lacked Coleoptera and Odonata, except for a single Dytiscid species, which was collected only at the degraded site. The partially degraded site shared features of both the intact (dragonflies & damselflies, mayflies) and the degraded (few beetles, higher % of flies) sites. The degraded site had, by far, the largest proportion of Diptera collected.

These differences in invertebrate community diversity and enzyme activities across sites undoubtedly link to the multiple interrelated abiotic and biotic factors that both lead to and result from ecosystem disturbance and decline. Initial abiotic changes determine the primary biotic players in the community. These, in combination, cause cascading effects throughout the food web and further determine the physical nature of the ecosystem. Our study establishes that disturbance and degradation of Louisiana’s forested wetlands clearly leads to a decline in benthic macroinvertebrate diversity and microbial activity, which implies a concomitant loss of ecosystem function as both groups are foremost drivers of nutrient cycling and energy flow.

Our target groups, microbes and benthic invertebrates, have proved to be superlative indicators of ecosystem health. The distinctive differences we observed among sites more than provided us the suggested 7-10 metrics needed for development of a robust IBI (USEPA 2002a, 2002b; Karr 2005). Total taxonomic richness, relative richness of different groups, proportion of intolerant versus tolerant taxa, relative dominance of particular taxa, and overall enzyme activity levels all changed along our habitat disturbance gradient. Scoring criteria for the most informative metrics have been established using the standard 1-3-5 scoring system, where a score of 1 corresponds to extreme degradation, 3 corresponds to intermediate conditions, and 5 corresponds to non impaired conditions (USEPA 2002b). The IBI is simply the total sum across all metrics.


Fig. 1. Mean microbial enzyme activities in sediment samples. Inset is scaled for phenol oxidase. L1, L2, L3 = intact JWMA sites 1, 2, and 3. IA, INT and DEG = intact, partially degraded, and degraded LMWS sites, respectively. Enzyme abbreviations explained in text.
Fig. 2. Relative abundance of various invertebrate Orders across sites. Four Orders were represented by eight or fewer total specimens and are grouped under ‘Other’. All intact sites are combined.
Fig. 3. Observed rarefied species richness as a function of increasing number of individuals collected.
Levee’s Only along the Mississippi River and New Orleans’ Exposure to Storm Surges

Ezra Boyd

Abstract
The relationship between the management of the Mississippi River and New Orleans’ exposure to hurricane generated storm surges has been highly debated in recent decades. It is generally assumed that the construction of levees along the lower section of the river has severed the river from the coastal wetlands. In turn, these changes have decreased the landscape’s ability to absorb surges and increased the city’s exposure to this flood threat. If this general assumption is true, then one would expect that hurricane generated storm surges that impacted the coast are more likely to reach New Orleans following the implementation of the “Levees Only” policy for managing the Mississippi River. This paper provides an initial empirical examination of this hypothesis by comparing surge impacts before and after the implementation of “Levees Only.”

A database of surge events impacting southeast Louisiana has been compiled using the “Louisiana Hurricanes History” report by David Roth of the National Hurricane Center. From this database coastal surge events and inland urban surge impacts are identified, then the frequency of coastal surge events leading to urban surge impacts is compared for the pre- and post-“Levee’s Only” periods. It was found that storm surges that inundated the outer coast were more likely to impact New Orleans after construction of levees along the entire lower Mississippi River.

Storm Surges Before “Levee’s Only”

In 1885, the Federal government implemented a “Levees Only” policy for maintaining the lower Mississippi River. This policy closed off all outlets of the Mississippi except for the Atchafalaya River (Pabis 2000). One of the unintended, though hypothesized at the time, consequences of this policy was an end to the land creation process for southeast Louisiana. By reducing the frequency of river flooding, the artificial levees also blocked the annual deposition of sediment throughout the deltaic plain. Sedimentation no longer outweighed erosion and the loss of Louisiana’s coastal wetlands began, resulting in increased storm surge exposure for New Orleans and surrounding communities.

An analysis of the Roth database shows that storm surges rarely threatened New Orleans prior to 1885. This database includes 29 events before 1885 that had some sort of recorded impact on New Orleans. Of these, only 14 events resulted in noteworthy damage in New Orleans. Much of this damage consisted of crop damage due to wind and rainfall. Some storm surge damage to settlements along the shores of Lake Pontchartrain is noted in the database. Among these events, storm surge flooding of coastal areas was common, occurring 22 times, and somewhat common along the shores of Lake Pontchartrain, occurring 9 times (Roth 1998). However, storm surge related flooding of the central settlement was rare, occurring only twice during this 163 year period. The trend during this period seems to be that robust coastal wetlands protected the urban settlement from storm surge inundation.
**Major Hurricanes After “Levees Only”**

In contrast to the previous period, an analysis of the Roth database suggests that storm surges threatened New Orleans more often following the implementation of “Levees Only.” In the period between 1885 and 1998, Roth (1998) lists 27 events that affected New Orleans, 13 of which resulted in significant damage for New Orleans. Along the coastal areas, Roth notes 34 incidences of storm surge flooding during the time period, while four events resulted in storm surge flooding of urbanized areas.

In 1888, a storm considered the most “severest and most extensive” since the Racer’s storm of 1837 caused extensive damage throughout southeast Louisiana. Surge damage extended along the coastline from the Atchafalaya Basin to the Northshore of Lake Pontchartrain. According to Roth, almost the entire city was inundated, though some portion of this flooding was most likely due to the 14” of rain over the city that week (Roth 1998).

Likely the most deadly hurricane in the history of the region, an unnamed hurricane in 1893 took the lives 2,000 people along coastal Louisiana (Roth 1998). Making landfall in early October, this hurricane pushed a 16 ft surge across the Chandeleur Islands and 15 ft of water into the coastal bays that are south and east of New Orleans (Roth 1998). Close to 800 deaths occurred in Cheniere Caminada, near Grand Isle, and another 250 at Grand Lake (Roth 1998). Closer to New Orleans, 200 storm survivors sought refuge from floodwaters in the Port Pontchartrain (also known as Milneburg) lighthouse. This event is the first mention of storm surge posing a peril to the lives of New Orleans area residents in the compilation by Roth.

A storm in 1901, which raised river levels along New Orleans by 7 ft, caused the first incidence of storm surge induced levee breaks listed in the Roth chronology. Ten deaths and $1 million in damages are attributed to this storm (Roth 1998). During a major storm in 1915, newly built 10 foot high levees along the Lakefront were tested (Roth 1998). They held, but barely, prompting the city to heighten the Lakefront levees.

In 1947, an unnamed Hurricane pushed a 15 ft storm surge into Bay St. Louis (east of New Orleans along the Mississippi Gulf Coast) and powered 112 mph wind gusts in New Orleans (Roth 1998). East of New Orleans, the surge peaked at 11.5 ft at the Ostrica Lock and 11.2 ft at Shell Beach. West of New Orleans, the newly built Moisant Airport (now known as the Louis Armstrong International Airport) was covered with 2 ft of water, while lower parts of Jefferson parish flooded under 6 ft of water (Roth 1998). In the city itself, widespread flooding resulted in $100 million in damages. Overall this storm killed 51 people, 12 of whom died in Louisiana (Roth 1998).

Hurricane Betsy made landfall in early September 1965. It created a 15 ft surge in Plaquemines, a 10 ft surge in St Bernard, and 6.2 ft surge in Orleans parish (USACE 1965). Just as Hurricane Katrina did in 2005, Hurricane Betsy caused levees along the Inner Harbor Navigational Canal to fail, flooding most of St. Bernard parish and the Lower Ninth Ward. Sections of Gentilly adjacent to the Inner Harbor Navigational Canal also flooded due to overtopping. The surge flooded 14,000 homes and resulted in 58 deaths in Orleans parish. Of the 14,000 flooded homes, nearly half were in the Lower Ninth Ward (USACE 1965). Occurring right after the construction of the Mississippi River-Gulf Outlet, the widespread flooding from Betsy contributed to public suspicions that the artificial navigational shortcut from the Gulf to New Orleans also served as a
storm surge shortcut.

Results and Conclusion

Administered by the Mississippi River Commission, the Federal government implemented the “Levee’s Only” policy in 1885, thus setting into place a historical path of river management that is widely viewed to have starved the deltaic plain of its sediment and increased the risk of storm surge flooding in New Orleans (van Heerden 2006, Colten 2005). The above review of Louisiana’s hurricane history, based on Roth’s “Louisiana Hurricane History” (1998), supports this conclusion.

During the pre-“Levee’s Only” period from 1722 to 1885, this chronology lists 22 incidences of storm surge inundation of the southeast Louisiana coastal areas and 2 incidences of the storm surge flooding New Orleans. During the period from 1885 to 1998, there were 34 incidences of storm surge inundation of the coast and 4 incidences of surge reaching New Orleans. So during the post “Levee’s Only” period, New Orleans suffered surge inundation for every 8.5 incidences of the surge reaching the coast, while during the previous period New Orleans suffered surge inundation every 11 incidences of coastal surge flooding.

To a large extent, the occurrence of hurricane landfalls and storm surge inundations along the coast reflect climate conditions that are largely independent of river management. However, whether or not a surge that inundates the coast pushes inland to New Orleans reflects the capacity of the coastal wetlands to absorb storm surges which is influenced by the Mississippi River management. As such, the observation that surges that inundate the coast are more likely to inundate the city is consistent with the proposition that the “Levee’s Only” led to increased risk of storm surge flooding for New Orleans.

Naturally, the above simple analysis, based on just one data source, does not fully capture New Orleans’s evolving storm surge risk. The conclusions that surges striking the Louisiana coast were more likely to cause New Orleans flooding after the implementation of the “Levee’s Only” policy is consistent with the widely accepted knowledge that the coastal wetlands;

i) Wetlands reduce the height and energy of storm surges

ii) Wetlands along the Louisiana coast have disappeared at an alarming rate since the implementation of the “Levee’s Only” policy.
Did the MRGO Create Lethal Flood Conditions?

Ezra Boyd

Abstract

Since its construction in the early 1960’s, the Mississippi River-Gulf Outlet (MRGO) has been subject to considerable controversy. Constructed as a navigational short cut between the Gulf of Mexico and the Port of New Orleans, the man-made navigational channel has also been a short cut for saline Gulf waters to enter the wetlands adjacent to New Orleans along with the city’s neighborhoods during Hurricane Betsy in 1965 and Hurricane Katrina in 2005. Under normal conditions, the channel provides a tidal pass for saltwater into the coastal wetlands east of New Orleans, resulting in increased salinity and considerable landloss. During storm conditions, hydrodynamic models have shown that the configuration of levees along the MRGO and the Gulf Intracoastal Waterway (GIWW) creates a “storm surge funnel” which concentrates the surge into a high velocity flow directed into the heart of New Orleans. This funnel effect contributed to major levee failures and catastrophic flooding during Hurricane Katrina in 2005 and likely during Hurricane Betsy in 1965.

In this paper, the hydrologic conditions created by the MRGO surge funnel are related to the observed patterns in flood mortality during the 1965 and 2005 flood events. It is shown that a cluster of flood deaths observed in the Lower Ninth Ward is spatially associated with the MRGO. Further, a regression analysis of the flood fatality rate shows that the velocity of flood waters was an important factor in increasing the lethality of the floods, which in turn links to the MRGO’s role in creating high velocity flood conditions. While not conclusive, this preliminary analysis provided empirical evidence linking the MRGO to the deadly flood conditions that occurred in 1965 and in 2005.

The MRGO Funnel Effect

Computer models have examined the impacts of the MRGO/GIWW configuration on the hydrodynamics of hurricane generated storm surges in Lake Borgne. Figure 1 shows flow velocities for Hurricane Katrina’s storm surge obtained from the ADvanced CIRCulation (ADCIRC) model, which shows a high velocity flow within the MRGO/GIWW and directed toward the heart of New Orleans (van Heerden, et al. 2007, van Heerden, et al. 2009). Physically, this high velocity flow is interpreted as an effect of the levee configuration along Lake Borgne that converges from a broad lake with widely separated levees into a confined channel that is approximately 1,000 ft wide, thus acting as a funnel that causes the water the flow faster. This funnel effect created a high velocity surge moving toward the center of New Orleans at 8 ft/s (5 miles/hr). This simulation assumes that no levee breaches occurred and that the only outlet for the high velocity surge is north through Inner Harbor Navigational Canal (IHNC) into Lake Pontchartrain, which is also shown on the map as the bright red strip in the northern portion of the IHNC. However, once levees breached along the east bank of the lower portion of IHNC, the high velocity flow was directed into the Lower Ninth Ward. It should be noted that ADCIRC simulations for the hypothetical “Hurricane Pam” showed a similar high velocity flow from the funnel effect (Mashriqui, et al. 2005).
The Lower Ninth Ward, the neighborhood immediately adjacent to the breaches in the IHNC, experienced considerable structural damage to property and infrastructure. This damage extended well beyond inundation with many houses experiencing structural damage beyond repair. Every home throughout a ten square block area next to these breaches was completely destroyed, while significant structural damage was observed 1 mile from the breaches. These observed trends in building damage indicate the degree to which the high velocities modeled in the MRGO/GIWW extended into the Lower Ninth Ward once the levee breaches occurred. Indeed, Jonkman, et al. (2010) found that the extreme level of housing damage in that neighborhood relates to the high flow velocities, see Figure 2.

It should be noted that the Corps of Engineers has consistently disputed the funnel effect. Following Hurricane Betsy, a 1966 report by Corps examined the effects of the MRGO on surge height and concluded “Hurricane Betsy would have produced essentially the same peak surge elevations” had the MRGO not been in place (Bretschiener and Collin 1966, p. 3). In a similar manner, a Corps report following Hurricane Katrina concluded that “the simulation without the MRGO/Reach 2 results in very similar water levels in most of the domain for the Katrina event” (Westernik, Ebersole, and Winer 2006, p. 5). However, both times the Corps only examined the MRGO impacts on surge depth and did not look at velocity.

Figure 1: Flow velocity of Katrina’s storm surge as calculated using the ADCIRC model. (From van Heerden, et al. (2007).)
Spatial Association with Flood Deaths

Hurricane Betsy occurred in 1965, just a few years after the construction of the MRGO and caused levee breaches in the IHNC (N.O. S&WB 1965) and substantial flooding in the Lower Ninth Ward. Flooding from Betsy resulted in at least 38 drownings. Figure 3 maps these flood victims over a USACE flood map for Betsy. The figure indicates a cluster of flood deaths in the Lower Ninth Ward, which is spatially associated with the outlet of the MRGO/GIWW into the IHNC.

Figure 4 shows flood deaths that occurred during Hurricane Katrina (Boyd 2011) along with the estimated flood depths (Cunningham, et al. 2006). Again, the patterns of flood deaths exhibit a spatial cluster associated with the high velocity flows created by the MRGO. In Figure 5, a “Hot Spot” analysis (Kernel Density Interpolation) of victim recovery locations shows that the fatality cluster in the Lower Ninth Ward is statistically significant.

Figures 4 and 5 do not reflect population or evacuation effectiveness for that area. The flood fatality rate, defined as the flood deaths divided by the flood exposed population, controls for population exposure. The flood exposed population is the 2005 base population minus the
evacuated population for the areas that flooded. The data and methods used to calculate this layer, along with a field based verification of the flood exposed population in the Lower Ninth Ward, are described in Boyd (2010) and Boyd (2011). In Figure 6, it can be seen that even after controlling for population and evacuation, the Lower Ninth Ward still sticks out as an area of elevated flood risk.

![Figure 3: Hurricane Betsy related drowning deaths listed by the Orleans parish coroner laid over the USACE flood map (from Boyd 2011).](image)

![Figure 4: Direct flood deaths associated with flooding due to Hurricane Katrina along with flood depths and levees in Orleans and St. Bernard Parishes (from Boyd 2011).](image)
Figure 5: A Kernel Density interpolation of flood victim’s recovery locations (from Boyd 2011).

Figure 6: The observed flood fatality rate at the blockgroup level in Orleans and St. Bernard Parishes during and after Hurricane Katrina, August 2005 (from Boyd 2011).
Regression Analysis

In addition to the spatial association described in the previous chapter, further analysis by Boyd (2011) examined the relationship between the flood fatality rate and the flood conditions using data from Hurricane Katrina. Two sets of regression analysis examined this relationship, both of which followed a hierarchical approach of adding variables to find the best-fit model. The first set consists of basic linear (OLS) regressions (Table 1), while the second set consists of non-linear, log-normal regressions (Table 2). In both sets, velocity, more specifically an interaction term for depth times velocity, is shown to be significantly related to the flood fatality rate and provide the best fit to data.

Table 1: A set of linear regressions examined the relative influence of various flood hazard conditions over the observed flood fatality rate for Orleans and St. Bernard parishes during Hurricane Katrina, August 2005. Each row represents a regression equation, while the cells list the obtained regression coefficients for the included terms. Empty cells indicate that the terms were not included in that regression equation. The last two columns provide measures of the goodness of fit, the $R^2$ and the residual squared error (RSE). A higher $R^2$ and lower RSE indicates a better fit. It can be seen that a two term model that includes depth and depth times velocity provides the best fit (from Boyd 2011).

<table>
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<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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Table 2: A set of non-linear, log-normal regressions examined the relative influence of various flood hazard conditions over the observed flood fatality rate for Orleans and St. Bernard parishes during Hurricane Katrina, August 2005. Each row represents a regression equation, while the cells list the obtained regression coefficients for the included terms. In contrast to the linear equation, the log-normal equation includes two coefficients for each term. Empty cells indicate that the terms were not included in that regression equation. The last column provides a measure of the goodness of fit, the residual squared error (RSE). A lower RSE indicates a better fit. It can again be seen that a two term model that includes depth and depth times velocity provides the best fit (from Boyd 2011).

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Conclusion

Hydrological studies have found that the MRGO, a man-made navigational channel, created a landscape that caused storm surges in Lake Borgne to be concentrated into a high velocity flow moving down MRGO/GIWW toward the heart of New Orleans. These studies have found that the MRGO was a decisive factor in contributing the magnitude of flooding associated with Hurricane Katrina in 2005, and likely with Hurricane Betsy in 1965. This study extends this line of inquiry to examine the public health consequences of the MRGO and its influence over surge dynamics. The spatial analysis indentified the Lower Ninth Ward neighborhood as a cluster of flood deaths during both Katrina and Betsy. This cluster was shown to be spatially associated with the hydrologic conditions created by the MRGO. The statistical analysis found the velocity of flood waters was a statistically significant and substantially meaningful variable in the flood fatality regression analysis. Building upon previous hydrologic analyses that linked the MRGO with high flow velocities from the funnel effect, the current results link the MRGO with lethal flood conditions in the Lower Ninth Ward.

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An Oil Spill Surveillance Program for Lake Pontchartrain

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ABSTRACT

This paper describes an ad-hoc oil spill surveillance strategy implemented by the Lake Pontchartrain Basin Foundation and the Pontchartrain Institute for Environmental Sciences at the University of New Orleans in response to the 2010 Gulf of Mexico BP Oil Spill. A three-pronged strategy consisted of GIS monitoring of the surface slick, 3D hydrodynamic modeling of oil particle trajectories, and weekly field reconnaissance of potential oil routes of entry into Lake Pontchartrain. Real-time analysis was performed during the event and helped local response entities minimize impacts in Lake Pontchartrain. These three independent assessments of the surface slick’s movement into Lake Pontchartrain provided a reasonable level of consistency and accuracy.

1 GIS/REMOTE SENSING SURVEILLANCE OF THE SURFACE SLICK

Using data from the Environmental Response Management Application (ERMA) along with other sources, such as the National Weather Service (NWS) forecasts, we conducted near-daily monitoring of the situation to assess risk of oil impacts on Pontchartrain Basin. The NESDIS oil extent layer (obtained from ERMA) allowed us to view the location of the surface oil patches in relation to the Pontchartrain Basin (see Figure 1). Combined with forecasts of weather and surface conditions, we were able to identify the potential oil intrusion into the basin and into Lake Pontchartrain. Finally, the imagery derived boom layer along with other data related to response activities allowed us to monitor the level of protection and response capabilities within the basin.
Figure 1: Map of Oil Spill Extent from the NESDIS anomaly analysis of radar imagery for June 28. As a large patch of oil is seen entering the Pontchartrain Basin, at this time Hurricane Alex is forming off of Mexico’s Yucatan Peninsula and affecting tides and currents off Louisiana’s coastline.

2 HYDRODYNAMIC NUMERICAL MODELING

Currents throughout the Pontchartrain Basin were modeled using FVCOM (Chen et al. 2005), a three-dimensional (3-D) hydrodynamic numerical code. The results were post-processed to obtain trajectories of hypothetical oil patches. These trajectories provided guidance on the direction of movement of surface and submersed material. While initial modeling simulations were done to provide responders with a forecast, additional simulations after the event were used to qualitatively assess the model’s performance.

Three wind scenarios and three tidal scenarios were combined for a total of 9 cases. Wind Scenarios consist of: 1. Typical seasonal winds: generally South and Southeast at 0 to 15 knots; 2. Tropical Storm; 3. Low pressure system in the Gulf of Mexico. The tidal scenarios consist of: a) Spring Tide; b) Neap Tide; c) Mid-Range Tide.

For the initial forecast simulations, the simulation was based on a 48 hour temporally varying wind for a certain tide scenario. The main goal of these simulations was to estimate the possible trajectories of particles under the different wind and tide conditions. Initial particle locations reflected areas of Chandeleur Sound and Lake Borgne where oil had been detected. The release locations for particle tracking were: 1. Chandeleur Sound, North of Breton Sound; 2. Chandeleur Sound, South of Cat Island; 3. Mississippi Sound, East of Bay St. Louis; 4. West of Bay St. Louis.

Some of the results obtained (surface currents for neap and spring tides) are shown in Figure , Figure 2: Forecast simulations showing modeled trajectories in the Chandeleur and Mississippi Sounds for the three wind scenarios and the spring and neap tides. For brevity, the mid-range tide cases are not shown. and Figure 2: Forecast simulations showing modeled trajectories in the Chandeleur and Mississippi Sounds for the three wind scenarios and the spring and neap tides. For brevity, the mid-range tide cases are not shown. Forecast simulations were also
performed to determine the possible paths of particles being launched at locations inside Lakes Pontchartrain and Maurepas. Some of the results obtained (surface currents for neap and spring tides) are shown in Error! Reference source not found., Error! Reference source not found. and Error! Reference source not found.. These results are presented in 48 hour particle tracks for each combination of wind and tide showing the predicted location of surface or average particles at 1-hour interval for several release starting lines. The color code from blue to red indicates the travel times from 0 to 48 hours after the release.

From Figures 3 – 8, it can be seen that the solution obtained is wind dominated. For example, in Scenario 1 which has low wind speeds, the difference between the neap and the spring tide solutions are not very pronounced. With stronger winds, Scenarios 2 and 3 show considerably different trajectories from Scenario 1. It is noticeable that the highest particle movement is generated by Scenario 2, which has the strongest winds.

Following the event, the GIS/RS and field data along with stage and flow data for the first week of July were all used to qualitatively assess the model’s performance. In this stage, we ran the model using wind data from 4 offshore gages: a) Tides&Currents - New Canal, ID=8761927; b) Tides&Currents - Shell Beach, ID=8761305; c) Tides&Currents - Bay Waveland Yacht Club, ID=8747437; d) U.S. Geological Survey (USGS) – Mississippi Sound near Grand Pass, ID=300722089150100. Mississippi Sound, the closest station to the locations where particle release was simulated, gave the most realistic results, which are shown in Figure. In this case, the color code from blue to red indicates the travel times from 0 to 90 hours after the release. Each simulation was run for ‘spin-up’ period of 24 hours before the 90-hour wind scenario was applied.
Figure 2: Forecast simulations showing modeled trajectories in the Chandeleur and Mississippi Sounds for the three wind scenarios and the spring and neap tides. For brevity, the mid-range tide cases are not shown.
Figure 3: Forecast simulations showing modeled trajectories in Lakes Pontchartrain and Maurepas for the three wind scenarios and the spring and neap tides. For brevity, the mid-range tide cases are not shown.
Figure 4: Verification simulation showing oil particles moving into Lake Pontchartrain via the Chandeleur Sound and Lake Borgne.

3 WEEKLY FIELD RECONNAISSANCE

A weekly field reconnaissance comprised the third prong of our comprehensive strategy for monitoring the oil spill’s threat to Lake Pontchartrain. In observationally tracking the oil’s movement into the Pontchartrain Basin, these on-the-water observations “ground-truthed” the GIS and computational modeling analyses and provided additional real time information to the Incident Command.

A total of eight trips were completed between June 2 and July 28 (Table 1). Leaving from Slidell, LA, the reconnaissance mission followed a 125 mile path that covered sixteen designated monitoring sites (Figure 10). Based on insight from the hydrologic modeling along with our knowledge on the landscape, this path was designed to intersect the most likely paths for oil intruding into Lake Pontchartrain.

On several occasions observers noted a petroleum smell when there was no visible oil nearby: this occurred when winds from the south carried vapors from the well site or from large oil patches in the Gulf. Tar balls and sheen where observed on July 2 and 9, while just sheen was seen on July 22 and 28.
Table 1: Summary of LPBF reconnaissance expeditions:

<table>
<thead>
<tr>
<th>Trip #</th>
<th>Date</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>June 2</td>
<td>No Observed Oil</td>
</tr>
<tr>
<td>2</td>
<td>June 10</td>
<td>No Observed Oil</td>
</tr>
<tr>
<td>3</td>
<td>June 17</td>
<td>No Observed Oil</td>
</tr>
<tr>
<td>4</td>
<td>June 24</td>
<td>No Observed Oil</td>
</tr>
<tr>
<td>5</td>
<td>July 2</td>
<td>Tar Balls and sheen in outer Miss. Sound &amp; outer Biloxi Marsh</td>
</tr>
<tr>
<td>6</td>
<td>July 9</td>
<td>Sheen in Lake Pontchartrain, sheen &amp; tar balls in Miss. Sound</td>
</tr>
<tr>
<td>7</td>
<td>July 22</td>
<td>Sheen in outer Mississippi Sound</td>
</tr>
<tr>
<td>8</td>
<td>July 28</td>
<td>Extensive sheen from northern Lake Borgne to Miss. Sound</td>
</tr>
</tbody>
</table>

Figure 5: Field reconnaissance path.

4 RESULTS

In late June, a large surface slick from the BP well blowout sat just offshore from the Chandeleur Islands. As Hurricane Alex moved across the Gulf of Mexico, the wind driven tides from this storm pushed portions of this surface slick north into Mississippi sound, then a subsequent unnamed low pressure system pushed a plume from this slick east toward the entrance into Lake Pontchartrain. While the large plume was visible in the GIS data, the field reconnaissance team observed smaller patches of sheen and groups of tarballs that pushed further east. On July 2, small, weathered tarballs and patches of light sheen were observed in eastern Mississippi Sound and northeastern Chandeleur Sound. On July 4, supplemental reconnaissance observed light tarballs and sheen moving through Pass Rigolets and into Lake Pontchartrain. Of note, our field surveillance teams found little or no smell, an indication that the volatile compounds had evaporated.
Generally speaking, the observed movements (see Figure below) show considerable consistency with the modeled trajectories. The oil’s movement described above was generally consistent with the modeled trajectories shown in Figure using the USGS Mississippi Sound near Grand Pass, ID=300722089150100 data. Further, rough measurements of oil patch velocities based on the GIS analysis were consistent with model predictions. Finally, in Figure below it is noted that a SCAT team observed a small amount of beached tarballs near Pointe Platte along the Lake Pontchartrain shoreline, confirming the predicted path in Error! Reference source not found. below.

Figure 6: The cumulative surface slick (NESDIS anomaly) along with field confirmation, both from LPBF and other government sources. Note the sequence of observations from July 4 - 7, 2010 show a trajectory similar to what is shown in the verification model (Figure 4) and July 13, 2010 SCAT team observation of oiled shoreline near Pointe Platte is consistent with modeling results showing oil particles reaching the shoreline in that vicinity (Figure 3 — Scenario 1, Spring Tide).
The Role of Weather and Bonnet Carré Spillway Openings: Comparisons of the 2011 Mississippi River Flood with Prior Events

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Each of the Bonnet Carré Spillway openings have had distinguishing characteristics as to period and duration of opening, freshwater discharge, sediment accretion within the spillway, and effects in the receiving waters. The spillway opening during the 2011 Mississippi River flood event was no exception, though it does have similarities with the spillway openings of 1945 and 1983. In the 1983 and 2011 flood years, heavy precipitation in the Ohio River Valley and middle Mississippi Valley during the late spring was preceded by melting snow from a large pack in the Upper Midwest (Ropelewski 1984, need other citations). During the spring and summer months of these floods, the southeastern United States was undergoing a severe drought and may have implications as to the effects on spillway receiving waters. The prior two spillway openings (1997 and 2008) occurred earlier in the spring as rainfall in the Upper Midwest coincided with snowmelt and effects on the receiving waters were similar. Regional weather effects will continue to have a large role in future years as global climate change models predict a change in precipitation patterns in the eastern United States (IPCC 1996).


Effects of Pollution on the Helminth Community of Western Mosquitofish and Snail Intermediate Hosts

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In productive coastal aquatic systems, the benthic invertebrate community is a key link between sediments and higher trophic levels. Contaminants that affect the benthic community may be manifested at higher trophic levels including commercial fisheries and piscivorous birds and mammals. The trophic position and microgeographic habitat of snails make them useful as bioindicators of pollution. Snails live at the boundary of sediment and water and pollutants that associate with water, sediment, or lower trophic levels (macrophytes) are available to snails. The ability of snails to selectively accumulate pollutants in their tissues has led to their use as indicators of these pollutants in the environment (Pihan and deVaufleury, 2000).

In addition to their role as bioindicators, snails are also intermediate hosts in the life cycle of digenetic trematodes. The life history of these parasites makes them uniquely suited to respond to pollution at multiple levels in the environment. Digenetic trematodes typically parasitize three hosts during their life cycle including a snail, a fish, and a bird as well as passing through a free-living stage. The pollution responses of any of these hosts are potentially reflected in the community structure of their parasites. Additionally, should pollution reduce, eliminate, or otherwise affect the infectivity of a previous host population, those effects will be echoed in the parasite communities of the subsequent host population (Morley et al. 2003).

Bayou Trepagnier, located on the southwestern shore of Lake Pontchartrain, Louisiana, received untreated industrial effluent (heavy metals and polyaromatic hydrocarbons (PAHs)) from a petrochemical facility during the periods of 1920-1929 and 1951-1995 (LADEQ, 1989). The heteroxenous parasite communities of the western mosquitofish, Gambusia affinis, were surveyed from polluted Bayou Trepagnier and Bayou Traverse, an unpolluted reference site. Eight species of parasites were collected from G. affinis in both bayous: Ascocotyle ampullacea, A. tenuicollis, A. mcintoshi, Echinocochus swartzi, Glossocercus auritus, Phagicola diminuta, Phagicola sp. B, and Posthodiplostomum minimum. Within G. affinis from Bayou Trepagnier, parasite abundance, prevalence, and intensity were significantly less among heterophyid trematodes, parasites that use snails as intermediate hosts.

To examine the effects of pollution on the snail intermediate host of heterophyid trematodes, two snail species, the pulmonate Physa gyrina and hydrobiid Pyrgophorus platyrrachis, were exposed to polluted water and sediment from sites within Bayou Trepagnier. Snails cultured in the laboratory, the F₁ generation of wild-caught snails from Bayou Trepagnier, and the F₁ generation of wild-caught snails from Bayou Traverse were used to determine pollution susceptibility or tolerance to the chronic pollution. Significantly higher mortality was observed when both Ph. gyrina and Py. platyrrachis were exposed to polluted water and sediment from Bayou Trepagnier compared to snails exposed to water and sediment from Bayou Traverse and laboratory controls. Mortality was higher among snails exposed to pollution in sediment than pollution in water. Laboratory-reared snails were more tolerant of pollution than the F₁ generation of snails from either Bayou Trepagnier or Bayou Traverse. Among the F₁ generations, snails from Bayou Trepagnier tended to be more susceptible to pollution than snails from Bayou
Traverse. In general, *Ph. gyrina* demonstrated a greater response to pollution than *Py. platyrachis*.

The complexity of the life cycle of heterophyids makes them more susceptible to the effects of pollution on snail first intermediate hosts. The pollution-induced mortality in the snail population within Bayou Trepagnier accounts for the differences in the helminth community structure of *G. affinis* between Bayou Trepagnier and Bayou Traverse. The negative response of heterophyids to the pollution in Bayou Trepagnier makes them excellent bioindicators of pollution in this system.

The intuitive perception of parasites as indicative of degraded habitats is misleading. Parasites are uniquely vulnerable to perturbations in environmental health as they depend on so many other organisms for their transmission (Marcogliese and Cone, 1997). The direct and indirect effects of pollution are echoed in parasite communities. Thus, parasites are indicative of environmental cohesion, the combined synergistic effects of environment and host that make transmission and infection possible.

**Literature Cited**


Watershed Planning and Monitoring in the Bogue Falaya and Abita Watersheds

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Lake Pontchartrain Basin Foundation

**Introduction:** The Lake Pontchartrain Basin Foundation (LPBF) worked with the Louisiana Department of Environmental Quality (LDEQ) to write a Watershed Protection Plan for the Bogue Falaya and Abita River watersheds in St. Tammany Parish. The Environmental Protection Agency (EPA) is spearheading the writing of such plans across the country for all impaired watersheds that have undergone or will be undergoing watershed modeling under the “Total Maximum Daily Loads” (TMDL) program, a provision of the Clean Water Act (USEPA, 2011a).

The municipalities of the City of Covington, the Town of Abita Springs, and the Village of Folsom are located within the watersheds (Figure 1). However, most of the land in the watersheds occurs in unincorporated St. Tammany Parish. St. Tammany Parish has experienced rapid urbanization for a few decades and the population increased by 22.2% in 2000-2010, making it one of the fastest growing parishes in Louisiana (U.S. Census, 2011). Much of this growth is occurring in the unincorporated portions of the parish and introduces pollutants into the rivers. Figure 1 illustrates the areas that fit the criteria of “urban” as designed by EPA (red hatch marked areas, USEPA, 2011b).

The watersheds have experienced the impacts of rapid urbanization, including both wastewater and stormwater pollutants. With few large-scale “regional” sewage treatment facilities outside of the municipalities, the wastewater pollutants consist of poorly treated or untreated sewer coming from hundreds of individual home and commercial plants. Among the stormwater pollutants is runoff from construction, including sediment, litter, and chemicals.

As part of writing the plan, the LPBF conducted watershed-wide water quality monitoring at ten sites along the two main rivers and their tributaries (Figure 1). The monitoring served to document water quality conditions for physiochemical, bacteriological, and nutrient parameters in the watersheds so that pollution sources could be tracked and ultimately eliminated.

**Methods:** Water temperature (°C), dissolved oxygen (mg/l), specific conductance (µS), pH, and turbidity (NTU) were monitored in situ. Additionally, the LPBF collected one-liter samples for the analysis of a suite of nutrients including: ammonia/ammonium (NH₄/NH₃), nitrate-nitrite-nitrogen (NO₃−NO₂−N), total nitrogen (TN), total organic carbon (TOC), total inorganic carbon (IC), total phosphate (PO₄-P), and alkalinity. Finally, the LPBF collected a 120 ml sterile sample at each site for the analysis of the bacteriological parameters fecal coliform and E.coli. The samples were analyzed at the Microbiology Laboratory at Southeastern Louisiana University.
Results and Discussion: Water temperature, dissolved oxygen, and pH were similar and within expected ranges for all sites. In general, fecal coliform and E. coli levels were below the single-sample DEQ limit of 400 MPN, however, bacteria levels rose at some sites in response to rain events. Turbidity, alkalinity, total organic carbon, and inorganic carbon were greater in the Abita watershed (and generally increased in the downstream direction) but no anomalies were noted. However, specific conductance, phosphate, nitrate-nitrite-nitrogen, and total nitrogen were anomalously high at BFAB 10, downstream of the Town of Abita Springs (Figure 2a-d).
When the data were plotted chronologically, it became clear that the sites were not chronically high (Figure 3). All parameters (specific conductance, nitrate-nitrite-nitrogen, total nitrogen, and total phosphate) showed high values in September and October (purple line denoting BFB10). Corresponding weather for that time period was dry, with less than one quarter of an inch of rain in the week preceding the sample dates (9/20/10, 10/13/10, and 10/25/10). All parameters then dipped in the months of January through April and appeared to be rising again beginning in May. Additional sampling through at least two years will help to determine if there is potentially a seasonal pattern.

Nevertheless, the fact that site BFB10 remains higher than all other sites throughout the months sampled indicates that a contributing source(s) must exist.
Figure 3. Chronological Patterns of Anomalously High Parameters

To track the sources contributing to the high nutrients, wastewater inputs in the area (upstream of BFAB10) were plotted using LPBF’s geographic information system (GIS) capabilities and utilizing a wastewater treatment data layer produced by LPBF (Figure 4). The area in question is downstream of the Town of Abita Springs. It is located in unincorporated St. Tammany Parish, yet within the “urban area” as defined by EPA (Figure1). The area is highly developed, with dense residential and commercial corridors. Within the area are the discharges of two regional sewer treatment plants, the Town of Abita Springs and the Arrowood Regional Treatment Facility (to serve some of the unincorporated area) (sewered areas shaded tan, Figure 4). Finally, outside of the sewage treatment services, there are a few densely-packed neighborhoods with individual home wastewater treatment plants (shaded red).

LPBF continues work on tracking down the nutrient sources with additional water sampling (points 1-11, figure 4). It is anticipated this sampling will target specific sources of nutrient input. The data obtained will then be used in the Watershed Protection Plan to recommend projects to address the sources. Potential projects include regionalization of sewer for the entire area and tertiary treatment for the regional sewer treatment plants. Addressing these sources will help the LPBF and LDEQ fulfill the goal of the Watershed Protection Plan to improve water quality in the Bogue Falaya and Abita Watersheds.
Figure 4. Abita River and Watershed Upstream of BFAB 10 (with Sewered and Unsewered Areas and Targeted Water Sampling Sites)

References:


Andrea Bourgeois-Calvin
Lake Pontchartrain Basin Foundation

Introduction: The Lake Pontchartrain Basin Foundation (LPBF) has monitored water quality weekly on the shores of Lake Pontchartrain since 2001. Water quality parameters measured include water temperature, dissolved oxygen, salinity, specific conductance, turbidity, and fecal coliform bacteria. This data is released to the public on a weekly basis to help them make informed decisions about using the lake. The data is also stored and analyzed to assess temporal and spatial water quality trends in Lake Pontchartrain.

The LPBF’s weekly water monitoring program captured the water quality fluctuations associated with hurricanes and other major weather events, the closure of the Mississippi River Gulf Outlet (MRGO) in July 2009, and the 2008 and 2011 openings of the Bonnet Carré Spillway.

In 2008, the Bonnet Carré Spillway was opened 27 days, from April 11th to May 8th. 160 bays were opened and the maximum flow was 160,000 cubic feet per second (cfs, Moffatt & Nichol, 2010). In 2011, the Bonnet Carré Spillway was opened 42 days, from May 9th to June 20th. 330 bays were opened and the maximum flow was 304,494 cfs (COE Communication). The openings greatly differed in timing, scale, and duration.

The data collected in LPBF’s program was used to assess 1) long-term salinity trends in Lake Pontchartrain and 2) the salinity impacts of the 2011 Bonnet Carré Spillway opening as compared to the 2008 opening.

Methods: Water quality sampling was conducted at ten sites weekly from January 2001- July 2011. During and following the 2011 opening of the Bonnet Carré Spillway, three additional sites on the Causeway Bridge (at crossovers 2, 4, and 6) were tested weekly for all parameters (Figure 1). The sites were tested for the physiochemical parameters of water temperature (°C), dissolved oxygen (mg/l), salinity (ppt), specific conductance (mS), and Secchi disk clarity (m). These parameters were sampled 3x’s in situ and averaged for a daily value and for quality control purposes. For turbidity (NTU), the “average” function on the turbidimeter was employed to average 10 readings. Sterile “grab” samples of 120 ml volume were collected at each site and taken to a LELAP (Louisiana Environmental Laboratory Accreditation Program)-accredited laboratory for analysis of fecal coliform and Enterococcus bacteria (MPN/100 ml water). Data was stored in a Microsoft Excel database and analyzed with JMP statistical software.
Figure 1. LPBF Weekly and Bonnet Carré Water Quality Monitoring Sites

**Results and Discussion:** January 2001 through mid-July 2011, LPBF collected 4,497 data points from eight sites located along the north and south shores of Lake Pontchartrain (Sites 1-4 and 7-10, Figure 1). Salinity trends show higher salinities in 2001 as a result of salinity inundation during Hurricane Georges in 1998 and a drought following. The salinities dropped through 2003 and began to rise again through 2004 and 2005, peaking in late 2006. Salinities began falling again in 2007. The Bonnet Carré opening in April 2008 caused a temporary dip in the lake’s salinity, but it rebounded by November of the year- seven months after the opening. In July 2009 the MRGO was closed, which was predicted to slightly lower the lake’s salinity. The Bonnet Carré opening in May 2011 again greatly decreased the lake’s salinity (Figure 2), but it has yet to be seen how the system will rebound.

Superimposed on the longer salinity trends is the annual/season trend with salinities generally peaking in the late summer to fall (the dry season, July-September) and hitting their lows in the late-winter to spring (the wet season, January-March, Carlson, 2006).
Figure 2. Salinity at Eight Stations Sampled Weekly in Lake Pontchartrain.

In assessing the 2011 spillway opening on water quality in Lake Pontchartrain, it becomes apparent that the Mississippi River water impacted the south shore of Lake Pontchartrain first, with salinities falling from 4-5 ppt to less than 1 ppt about one week after the opening. Sites along the north shore remained at about 2 ppt salinity, indicating a mixing, but not full inundation, of river water (Figure 3). Satellite images confirm this (Figure 4). Following the full closure of the spillway on June 20th, south shore water salinity began to partially rebound, with salinity values rising above 1 ppt. Sites on the north shore experienced a drop in salinity to below 1 ppt, in response to strong winds from the south (Figure 3). As of the writing of this paper, Lake Pontchartrain’s salinity remains low, between 0.4 and 3 ppt and it is unknown to what extent, and to what new equilibrium, the lake’s salinity will rebound due to the compounding issue of the MRGO closure.

When the 2011 spillway opening was compared to the 2008 opening, some similarities and differences in average lake-wide salinity emerge. In both years, there was a rapid drop in salinity lake-wide within days of opening the spillway. In 2008, the lake reached its average lowest salinity by May 20th (39 days after the spillway opening and 12 days after the closing), and then began to slowly recover. In 2011, the lake-wide salinity also hit its lowest level on May 20th, only 11 days after the spillway opening. By mid-July 2011, average lake-wide salinities had only just begun to recover, although the spillway had already been closed almost a month. In 2008, the salinity rapidly returned to the lake within a two-week period due to the back-to-back hurricanes Gustave and Ike (Figure 5). It remains to be seen whether any such extreme weather event will impact the salinity in Lake Pontchartrain in 2011.
Figure 3. Salinity at Water Quality Sites Around Lake Pontchartrain During 2011 Bonnet Carré Spillway Opening

Salinity decreases around lake, but more so on the south shore, with Bonnet Carré Spillway opening.

Sample Dates:
1. 5/3/11
2. 5/10/11
3. 5/17/11
4. 5/24/11
5. 5/31/11
6. 6/7/11
7. 6/14/11
8. 6/21/11
9. 6/28/11
10. 7/5/11

Bonnet Carré closes 6/20/11

Figure 4. Satellite Image of Mississippi River Water Inundation in Lake Pontchartrain, Taken May 27, 2011, During Opening of the Bonnet Carré Spillway

MODIS satellite image
Taken May 27, 2011
Source: NASA
**Conclusion:** LPBF’s long-term weekly monitoring of water quality in Lake Pontchartrain has produced an extensive database that can be used to assess the impacts of major weather events, temporal patterns, and human hydrologic changes to the system. The impacts of such events can be seen in the lake-wide salinity since 2001. The 2011 opening of the Bonnet Carré Spillway predictably decreased the salinity in Lake Pontchartrain. While it remains unknown how long the salinity will be low, the 2008 opening showed that major weather events can rapidly change the salinity. In addition, the closure of the MRGO will, undoubtedly, bring the Lake’s ultimate salinity to a new, probably fresher level. While, (as of the writing of this paper) the ultimate transition remains to be seen, past opening show that the ultimate salinity should be reached within six months (Moffatt & Nichol, 2010).

**References**


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**Figure 5. Average Lake-wide Salinity Comparison Between 2008 and 2011 Bonnet Carré Spillway Openings**
Effects of the Morganza Spillway on dissolved organic matter composition in the Atchafalaya Basin

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Severe flooding of the Mississippi River warranted the opening of the Morganza Spillway for the first time in over thirty five years. The composition of the dissolved organic matter (DOM) in the Atchafalaya Basin was expected to change as the Morganza Spillway emptied Mississippi River water into it. In this work, the changes made in the composition of the Atchafalaya Basin were studied using fluorescence and ultraviolet-visible spectroscopy. DOM is the water soluble portion of natural organic matter, which is a complex heterogeneous mixture made up of the decomposition products of plants and organisms. DOM is an important part of the ecosystem as it controls the bioavailability of trace metals and hydrophobic compounds, acts a food source, as well as contributes to the control of the depth of the photic zone, which affects the growth of many organisms found in the Atchafalaya Basin. Spectroscopy plays an important role in the analysis of DOM and was used to characterize both the chromophoric and fluorophoric dissolved organic matter. Chromophoric compounds absorb UV and visible light and the absorbance at 254 nm tells the degree of aromaticity of DOM. Fluorophoric compounds are chromophoric compounds that also undergo fluorescence.

Several fluorescence indices were used to characterize DOM, such as: the fluorescence index (FI 450/500), the freshness index (BIX), and the humification index (HIX). The fluorescence index FI 450/500 is given as the ratio of emission intensities at 450 and 500 nm with an excitation wavelength of 370 nm. The value of FI 450/500 correlates with the origin of DOM; a value of ~1.9 indicates aquatic origin of DOM, whereas 1.3 indicates terrestrial origin. BIX is determined from the ratio of emission intensities at 380 nm and 430 nm, while using an excitation wavelength of 310 nm. The BIX value is related to the amount of β fluorophore present and the presence of fresh organic matter. The HIX is used to determine the extent of humification of DOM or its degree of maturation. HIX is calculated at an excitation of 254 nm by taking the ratio of the areas under 300 to 345 nm to 435 to 480 nm. A higher HIX value implies a higher degree of aromaticity and humification of dissolved organic matter. Fluorescence excitation emission matrices (EEMs) and UV-Vis spectroscopy were used to determine the overall distribution of fluorophores and chromophores at each sampling site.

Water samples from 15 sites in the Atchafalaya Basin were collected throughout the months of May-July to span pre- and post- opening of the Morganza spillway. This approach allowed for comparison of the composition of the original Atchafalaya Basin waters with those sampled during and after the spillway was opened. Grab samples were filtered through 0.20 μm filters to remove any biological materials. Samples were stored in the dark at 4°C until the analysis was performed.
Water quality in association with a historical Mississippi River flood event and its effect on blue crabs (*Callinectes sapidus*)

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Human exposure to pathogens via contaminated drinking water and recreational waters are a major concern. On May 9, 2011, the Bonnet Carré Spillway was opened to relieve stress on river levees in New Orleans. This introduced contaminated water from the Mississippi River into Lake Pontchartrain, a major recreational water body. The opening of the Bonne Carré Spillway in 2008 led to minor algal blooms and had negative impacts on fishing. The Morganza Spillway was then opened May 14, 2011, introducing flood water into the Atchafalaya Basin. We enumerated microbiological indicators (fecal coliform and enterococci) from water samples taken from the Mississippi River, Atchafalaya River, Bonnet Carré Spillway, and Lake Pontchartrain during the flood event as a measure of water quality. Quantitative PCR was also used to examine total *Bacteroidales*, another indicator of water quality. In addition we isolated strains of *Vibrio cholerae* from water samples and compared these with strains isolated from Lake Pontchartrain blue crabs (*Callinectes sapidus*). With this study we aim to better understand how flood events impact water quality and seafood in Lake Pontchartrain.
GIS Application for Pollution Source tracking in the Bogue Falaya and Abita Watersheds

Chelsea Core
Lake Pontchartrain Basin Foundation

Introduction: In 2009, the Lake Pontchartrain Basin Foundation (LPBF) started working on a Watershed Protection Plan (WPP) for the Bogue Falaya and Abita River watersheds located in St. Tammany Parish, Louisiana. WPPs are plans being developed and implemented throughout the State of Louisiana and are funded by the Louisiana Department of Environmental Quality (LDEQ) 319 Nonpoint Source (NPS) Pollution Program. The goal of these programs are “to educate people about NPS pollution and best management practices (BMPs) that can be implemented to reduce and control this type of pollution” (LDEQ -Nonpoint). The ultimate result of writing and implementing the WPP is to improve water quality. An important component of the WPP is the use of Geographic Information Systems (GIS). GIS allows users to view, understand, question, interpret, and visualize data in ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts (ESRI, 2009). When applied to a watershed approach, GIS lends the opportunity to spatially reference, track, and manage sources of pollution. In the Bogue Falaya and Abita River watershed WPP, GIS processes were used to locate, quantify, and qualify point and nonpoint sources of pollution, including sewered and unsewered subdivisions, and individual home sewer systems. The information produced from GIS in conjunction with water quality data will be used to target areas requiring water quality improvement.

Methods: In order to characterize the Bogue Falaya and Abita River watersheds, a base map was created with the following layers: land/water, municipalities, streams, parish boundaries, local and state roads, and 10 and 12-digit hydrologic codes (HUCs) (Figure 1). These layers were accessed through the Louisiana State University GIS data clearing house, Atlas, The Louisiana Statewide GIS. Other layers were available through the LPBF’s GIS databases, TIGER census data files, and LDEQ’s GIS Department.
Figure 1. Bogue Falaya River and Abita River Watersheds with 12-Digit HUC’s, located in St. Tammany Parish, Louisiana

**Sewered vs. Unsewered:** LPBF used the St. Tammany Parish Government website to find a list of subdivisions along with utility provider information (St. Tammany, 2011). The subdivision and sewer data were used in combination with a subdivision shapefile layer acquired from the St. Tammany Parish Department of Geographic Information Services to produce a map illustrating which subdivisions had community sewerage versus those in which homes were on individual sewer/septic systems. More subdivisions were discovered in a local atlas (Navigator) and were also included within the database and map layer. Remaining subdivisions were located by LPBF staff through field visits. During the field visits, coordinates were acquired using a GARMIN eTrex Legend HCx handheld (Wide Area Augmentation System-WAAS, <10 meter accuracy) and exported into a database containing information and subdivision locations within the watershed (Figure 2).
Figure 2. Combination of data used to compile a complete subdivision layer and database for the subdivisions located in the Bogue Falaya and Abita River Watershed.

**Individual Home Wastewater Systems**: The LPBF received access to St Tammany Parish’s 911 home address data, a GIS shapefile point layer. The point layer contained two categories, "residential" and "businesses." Since the interest was in individual homes, only the "residential" was selected to create a new shapefile point layer. LPBF randomly selected several points from the individual homes layer and compared the locations to a Google map to identify that homes did exist in those locations.

The newly created shapefile point layer was imported into ArcMap (Figure 3). Using ArcMap tools, the LPBF removed all points that were located within sewered subdivisions (LPBF produced Subdivision Layer) and municipal boundaries. This was done to exclude all home systems that are considered to be on community/regional sewer service.
Figure 3. Verified shapefile point layer illustrating all home addresses presumably unsewered within the Bogue Falaya and Abita River Watershed.

Results and Discussion: Subdivisions: 57 subdivisions exist in the Bogue Falaya Watershed and 51 exist in the Abita Watershed for a total of 108. Of those, 4 have community sewer (7.1%); 53 (92.9%) are on individual home sewer in the Bogue Falaya Watershed and 16 have community sewer (31.4%) and 35 (68.6%) are on individual home sewer in the Abita watershed (Figure 4). Within both watersheds, 20 have community sewer (18.5%) and 88 (81.4%) are on individual home sewer systems (Figure 5).
Figure 4. LPBF database containing all combined subdivision information reveals a large portion of subdivisions are unsewered.

Unsewered subdivisions—many times they are older and/or the homes are spread far apart. Most individual home wastewater units consist of aerated treatment plants as soils are typically not conductive to septic systems. Some old septic systems exist and many of these do not have functioning leach fields and have had discharges installed (LPBF Draft 2011).
Figure 5. Wastewater Point Sources, Municipalities, and Subdivisions (Sewered and Unsewered)

**Home Systems:** Based on St. Tammany 911 addresses there are a total of 2,345 individual homes (excluding homes within municipalities and sewered subdivisions) located within the Bogue Falaya and Abita River Watersheds. 1,009 of the homes fall within unsewered subdivisions leaving 1,336 homes located outside of all subdivisions and municipality boundaries (Figure 6).

From LPBF’s previous knowledge of working in the St. Tammany area, the majority of individual home systems that exist outside of subdivisions are mainly aerated treatment plants with some old, discharging septic systems. A previous study completed by St. Tammany Parish, used census records to estimate the number of home sewer treatment plants in the Bogue Falaya and Abita Watersheds. The study used the average number of people per household and total persons on failed home systems to assume a 50% failure rate (St. Tammany 2007). If assuming a 50% failure rate, which from past work done in the watershed is conservative, of 2,345 homes, 1,173 homes would be on failed systems.
Figure 6. Map of all individual homes located in the Bogue Falaya and Abita River Watershed (red dots).

**Future Research:** The next objective for the WPP is to employ GIS analysis to assess home and commercial density data. Density analysis utilizes known quantities of some event such as, a point layer consisting of individual home sewer systems, and spreads the event across a surface based on the quantity that is measured around a specified location. The analysis also identifies the spatial relationships of the locations of each of the measured quantities. Density surfaces demonstrate where (in this specific case of pollution sources) point features are concentrated.

LPBF is currently using the individual home location data to perform density analyses using the Kernel Density tool within the ArcGIS Desktop 10 Spatial Analyst Extension. When using the Kernel Density tool, density is greatest at the point location and diminishes to zero at the specified radius. The sum of the intersecting spreads is calculated for each output raster cell and is illustrated by a certain color (Figure 7). The result is a smoothly curved surface fitted over each point. Illustrating the individual homes density surface within the watershed will define “hotspots” or areas of interest/concern for pollution sources.
Conclusion: GIS has greatly assisted the LPBF with the watershed planning process. GIS is used to characterize the Bogue Falaya and Abita Watershed and provides a spatial element to tracking sources of pollution. Spatial data along with water quality data, give an overall depiction of possible sources of impairment within the watershed, allowing the LPBF to focus on areas needing water quality improvement.

References:


Exploring Your Environment: EYE on Southeast Louisiana

Deborah Dardis
Southeastern Louisiana University

*EYE on Southeast Louisiana* was the education outreach component of Southeastern Louisiana University’s EPA sponsored research program. The goal of this project was to increase public awareness of: the deterioration of southeast Louisiana’s wetlands and the contribution of human activities to that deterioration, the economic, cultural, and social ramifications of the ecosystem’s demise and the research performed by local universities on habitat restoration and sustainability.

The targeted audiences were K-12 teachers and students and members of the community. Our intent was to provide experiences that would have a sustainable impact and a vital, first step in the process of educating and impacting the general public is to educate teachers, who in turn, will impact thousands of students of all ages. Students ultimately become the stakeholders and decision-making citizenry of the future.

This project provided hands-on, interdisciplinary, educational experiences through K-12 teacher workshops, student field trips and camps and community outreach. A variety of activities were offered to introduce participants to the ecology of the Lake Pontchartrain Basin and the wetlands of southeast Louisiana. Among these activities were canoeing and boating explorations of the wetlands, physical and chemical testing of the water and soil, identification of local plant and animal life, opportunities to observe researchers at work in the field and didactic experiences. In addition to attending workshops, a smaller cohort of teachers was invited to work as research associates of university faculty and graduate students on EPA-funded research projects. Impact and sustainability of the project were ensured by requiring that teachers incorporate what they learned into their classroom lessons. Faculty and staff modeled relevant, standards-based activities appropriate for upper elementary, middle and high school classroom implementation. University faculty visited schools to observe teachers and students.

The total number of teachers, parishes and schools served are listed below. In addition, an estimate of the students impacted is provided. This is calculated by assuming that each teacher has 25 students per class in 5 classes per day. That total is multiplied by the total number of teachers. In Phase IV, teachers invited 20 members of the community to attend field trips.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Summer</th>
<th>Academic Year</th>
<th>Impact per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Teachers</td>
</tr>
<tr>
<td>I</td>
<td>2002</td>
<td>2001 - 2002</td>
<td>20</td>
</tr>
<tr>
<td>I</td>
<td>2003</td>
<td>2002- 2003</td>
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</tr>
<tr>
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<td>2004</td>
<td>2003 - 2004</td>
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</tr>
<tr>
<td>II</td>
<td>2005</td>
<td>2004 - 2005</td>
<td>23</td>
</tr>
<tr>
<td>III</td>
<td>2006</td>
<td>2005 - 2006</td>
<td>26</td>
</tr>
<tr>
<td>IV</td>
<td>2008</td>
<td>2007 - 2008</td>
<td>12</td>
</tr>
</tbody>
</table>
The project was assessed through pre-test and posttest comparisons of teacher knowledge, attitudinal surveys and classroom observations. Post-test knowledge gains were significant and attitudinal surveys revealed high ratings on the overall experience of the workshop, the expertise of faculty and staff, and the provision of a wide variety of learning experiences.
LDEQ Bonnet Carré Spillway Sampling Plan 2011

Jeff Dauzat
Louisiana Department of Environmental Quality

Background

To relieve the pressure on the New Orleans area levees, the Bonnet Carré Spillway was opened May 9, 2011. Mississippi River water passes through the spillway, enters Lake Pontchartrain and eventually makes its way into Breton Sound, Chandeleur Sound and Mississippi Sound. The Louisiana Department of Environmental Quality (LDEQ) is monitoring the waters in Lake Pontchartrain for affects that the river water may have on water quality.

Parameters

Several sites associated with the LDEQ Ambient Water Quality Monitoring Network (AWQMN,) will be monitored monthly or every other month for routine parameters associated with that program (see Attachment 1). In addition, measurements are taken with in-situ probes (see Attachment 2) every two weeks at these same sites plus three additional sites on the Causeway (Crossovers 2 and 6) and one at the US Hwy 90 bridge at Chef Menteur Pass. All parameters will be sampled at one meter depth, except that parameters taken with in-situ probes will be measured at one meter depth, mid-depth, and at one-half meter from bottom. All samples will be handled in accordance with established standard operating procedures associated with the LDEQ AWQMN. When algal blooms are observed at the monitoring sites, additional sampling for algal taxonomy may be conducted to determine if harmful algal species are present. All sampling activity is subject to availability of adequate time and resources, and may be adjusted at any time.

Sampling Sites

LDEQ will sample the Lake Pontchartrain water at five strategic locations within the Lake Pontchartrain Basin. A sampling map has been developed and is included as Attachment 3.

LDEQ staff will sample at the following locations:

Site 0035 – Pass Rigolets
Site 0109 – Chef Menteur Pass
Site 0216 – Lake Pontchartrain at Causeway Bridge crossing # 6
Site 0138 – Lake Pontchartrain at Causeway Bridge crossing # 4
Site 0217 – Lake Pontchartrain at Causeway Bridge crossing # 2
Sample Dates

A list of tentative sample dates is included as Attachment 4.

Data Management

Data will be transmitted to the LDEQ via specific Electronic Data Deliverable to the mainframe data base LEADMS. Data retrievals and summaries will be made available to all interested parties upon request, but issues associated with adverse human health (e.g., significant levels of *Mycrosistis*) will be transmitted to the State Health Officer as soon as possible.

Project Management

Direct-level project management will be accomplished by Jeff J. Dauzat, LDEQ Staff Scientist in the Southeast Regional Office (SERO) with support from Headquarters. Contact information for Mr. Dauzat and the SERO is:

Louisiana Department of Environmental Quality
Southeast Regional Office
201 Evans Road, Building 4, Suite 420
New Orleans, LA 70123-5230
phone: (504) 736-7704
Jeff.dauzat@la.gov
Attachment 1
Routine parameters associated with the Ambient Water Quality Monitoring Network

The water samples will be analyzed for the following parameters:

<table>
<thead>
<tr>
<th>Analysis</th>
<th>RL</th>
<th>Units</th>
<th>Method</th>
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</thead>
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<tr>
<td>Specific Conductance</td>
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<td>umhos/cm</td>
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<td>TDS</td>
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<td>Ppm</td>
<td>160.1</td>
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<tr>
<td>TSS</td>
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<td>Ppm</td>
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<td>Sulfate</td>
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<td>Ppm</td>
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<td>Ppm</td>
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<td>Biochemical Oxygen Demand 5 day</td>
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<td>Ppm</td>
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</table>
Attachment 2

*In-situ* parameters

<table>
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<th>Value</th>
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<tr>
<td>Temperature (°C)</td>
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</tr>
<tr>
<td>Conductivity (umhos/cm)</td>
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</tr>
<tr>
<td>Salinity (ppt)</td>
<td></td>
</tr>
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<td>pH (SU)</td>
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<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td></td>
</tr>
<tr>
<td>% Dissolved Oxygen</td>
<td></td>
</tr>
</tbody>
</table>
Attachment 3

Map of sampling locations
Attachment 4

Tentative Sample dates

5/3/2011 - Background samples at Sites 0216, 0138 and 0217
5/5/2011 – Background samples at Sites 0035 and 0109
5/12/2011 – All sites
5/25/2011 – All sites
6/7/2011 - All sites
6/21/2011 – All sites
7/12/2011 - All sites
7/26/2011 – All sites
8/9/2011 - All sites
8/23/2011 – All sites
9/13/2011 – All sites
9/27/2011 - All sites
10/11/2011 – All sites
10/25/2011 - All sites
11/8/2011 – All sites
11/22/2011 – All sites
A Comparison of Water-Quality Effects of the 2008 and 2011 Bonnet Carré Spillway Diversions into Lake Pontchartrain, Louisiana

Dennis K. Demcheck and Scott V. Mize
US Geological Survey, Louisiana Water Science Center, Baton Rouge, LA

The periodic release of Mississippi River water into Lake Pontchartrain during exceptionally high flood years has the potential to affect the chemistry and ecology of the lake. In this presentation, we compare the water-quality response in the normally brackish lake to two recent (2008 and 2011) river introductions which differed in magnitude and timing. The US Geological Survey monitored the chemical and ecological response in cooperation with the US Army Corps of Engineers. We are presently monitoring the latest incursion from May-October (planned) 2011. Constituents monitored during both events included major inorganic ions, nutrients, chlorophylls, phytoplankton, and triazine herbicides. Both events were similar in that the initial water-quality response for both events was characterized by shifts in inorganic constituents such as chloride and inorganic nitrate. The emphasis shifted to biological effects as the lake system responded to the influx of freshwater and nutrients.

In 2008 the phytoplankton community, as an indicator of water quality, showed an extended response to the influx of river water that was evident even after the water-chemistry indicated that the lake had returned to pre-diversion conditions (Mize and Demcheck, 2009). The 2008 diversion delivered a maximum of about 169,000 cubic feet per second (cfs) from April 11-May 8. The 2011 diversion delivered a maximum of 316,000 cfs from May 9- June 20. We will compare differences in the amount and timing of major inorganic ions, nutrients, and atrazine. Also, a limited proof-of-concept comparison of two kinds of deployable nitrate analyzers, one using cadmium reduction colorimetry (deployed in 2008) and the other using UV spectrophotometry (deployed in 2011) are presented.

The northern Chandeleur Islands and the emergency oil spill mitigation sand berm: a proxy for shoreline response to large-scale revitalization projects?

James Flocks, Jennifer Miselis, Nathaniel Plant, Abby Sallenger
U.S. Geological Survey, St. Petersburg Coastal and Marine Science Center, 600 4th Street South, St. Petersburg, FL 33701
jflocks@usgs.gov

The Chandeleur Islands are experiencing the highest rate of land-loss amongst barrier islands in the northern Gulf of Mexico. A diminishing budget of sandy sediment needed to maintain the islands is continually scavenged by storms, reworked by prevailing wave climate, and inundated by a relative sea level rise, resulting in a net loss of island area. Researchers have documented an increasing inability of the island chain to recover from storm-induced breaching and dune erosion through the natural redistribution of sediment. The fate of the islands has been the focus of intense study by the U.S. Geological Survey (USGS) and collaborators over the past decade. The most comprehensive studies to date occurred in 2006 and 2007, when projects sponsored by the Louisiana Department of Natural Resources, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, in collaboration with the USGS and the University of New Orleans, were conducted to provide a comprehensive characterization of the geology and morphology of the islands (results are compiled in the USGS Scientific Investigations Report: Lavoie, 2009). Through these studies the large sand deposit at Hewes Point was evaluated and identified as a possible sediment source if restoration of the barrier island chain were to proceed. Prograding clinoforms identified in geophysical data indicate that Hewes Point is a large terminal spit formed by predominant northward transport of sediment into the deeper waters north of the barrier island platform (Figure 1). The deposit is approximately 27 km², 8 m thick and is composed of 97% well-sorted fine sand. The development of Hewes Point at the northern terminus of the Chandeleur Islands was the result of unique geologic conditions. The combination of the island orientation parallel to the prevailing wave climate, a centralized source of sandy deposits, and terminal accommodation space produced an efficient littoral transport and deposition system that rapidly formed the largest sand body among Louisiana’s barrier islands, approximately 258x10⁶ m³.
In April 2010, the Deepwater Horizon Oil Spill occurred and within weeks oil was observed along the shorelines of the Chandeleur Islands. The State of Louisiana requested emergency authorization in May 2010, to perform spill mitigation work on the Chandeleur Islands by building a barrier berm to protect the mainland wetlands from oil (Lavoie et al., 2010). The proposed project originally involved removing sediment from a linear source approximately 1.6 km gulfward of the barrier islands and placing it just seaward of the islands in shallow water to form a continuous berm rising 2 m above sea level. Through discussion with the USGS and others it was determined that point-source locations for sediment, such as Hewes Point, would provide better quality sediment and would not destabilize the natural island platform. It was the presence and proximity of Hewes Point that allowed for the rapid construction of the emergency oil spill mitigation sand berm (E-4), the largest coastal engineering project in the state to date. Data from the earlier USGS studies were heavily utilized to locate the borrow sites for the E-4 berm.

Construction of the berm continued from June 2010 through March 2011 (Figure 2), long after the MC252 well was capped (July 2010) and observations of surface oil within the Gulf had ceased (August 2010). In its post-construction form, the berm extends along the submerged axis of the Chandeleur Island chain for approximately 8 km and then joins the island shoreface for an additional 4 km. During construction, periods of increased wave action caused breaches along the berm, the locations of which often corresponded to the antecedent morphology.
Figure 2. Time series representation of the E-4 berm construction, from LANDSAT and SPOT satellite imagery. Length of the berm at time of image is shown. Prior to November, the berm was constructed adjacent to the pre-Katrina island footprint, after which it was appended to the shoreline to reduce sand volume. Red arrow shows location of a breach that occurred in January 2010 at the site of a natural inlet. The breach expanded 600 m in less than one month.

The construction of the berm and the rapidly changing Chandeleur Islands provide a natural laboratory to explore the evolution of distinct barrier island morphologies in response to short-term processes (e.g. storms) and the influence of antecedent geology on those processes. Through continued monitoring of the northern Chandeleur Islands and the E-4 berm, the USGS hopes to answer fundamental questions about how geologic variables (e.g. sediment composition and stratigraphic variability) influence the present and future morphology of the islands and berm. Through observations using remote sensing (e.g. satellite imagery, lidar topography, and bathymetric surveys), and numerical modeling (e.g. wave and current forecasting, runup estimates), a short-term morphological response can be predicted and validated as the islands and the berm rapidly react to seasonal and climatic conditions (Figure 3). With large-scale restoration efforts being proposed for coastal Louisiana and the northern Gulf of Mexico, results from this study will provide insight into the viability of reconstructing our coastlines.
Figure 3. Predictive model of berm evolution. Berm response to wave action was applied using February 2011 lidar topography as starting conditions. Above plot shows predicted elevations (color plot) and potential breach locations (black arrows) after two months of simulated change. Red circles mark locations of breaches observed in aerial and satellite imagery (inset).

References


Mitigating the Spread of Zebra Mussels into Wetlands from Mississippi River Diversions

William F. Font
Department of Biological Sciences, Southeastern Louisiana University, Hammond, Louisiana 70402

Zebra mussels, *Dreissena polymorpha*, were introduced from Europe into North America where they have spread rapidly and extensively, causing environmental and economic damage. Following their introduction into the Great Lakes in 1988, they colonized many watersheds in the eastern United States and were first reported from the Mississippi River at New Orleans in 1993 (Ludyanskiy et al., 1993; Allen et al., 1999). The first objective of this research was to determine whether zebra mussels have dispersed via diversions of water from the Mississippi River and have colonized wetlands in southeastern Louisiana. Diversion of water from the Mississippi River has occurred for decades through flood control structures such as the Bonnet Carré floodway, and more recently through structures located at Davis Canal and Caernarvon that were built to release freshwater and sediments from the river for the purpose of wetland restoration. Additional diversions in Port Allen and Harvey, LA provide passages for watercraft from the river into the Intracoastal Waterway. A second research objective was to determine if abiotic conditions or biotic factors exist in Louisiana wetlands that have the potential to mitigate the spread of zebra mussels. Zebra mussels disperse via microscopic veliger larvae that use cilia for swimming prior to attachment to hard substrate. Several methods, including scraping of hard, submerged substrate, were used to sample habitats for adult zebra mussels. The most effective and extensively used sampling method was to deploy nylon mesh bags filled with oyster shells in aquatic habitats under study. Mussels that attached to oyster shells and grew were detectable when nylon mesh bags were checked periodically. Zebra mussels successfully colonized the Intracoastal Waterway via the Mississippi River locks at Port Allen. These mussels reached adult size and were sexually mature, having gonads filled with viable eggs and sperm. Zebra mussels also colonized the Intracoastal Waterway via locks in Harvey and dispersed at least as far as Lafitte. A major focus of this research was to assess the population dynamics of mussels in the Bonnet Carré floodway following its opening for flood control in the spring of 2008. Zebra mussels successfully colonized the floodway and attached to sentinel oyster shells. These same oyster shells were also colonized by Conrad’s false mussel, *Mytilopsis leucophaeta*, a native mussel that is the closest living relative (i.e. sister species) of zebra mussels. Conrad’s false mussels survived and reached sexual maturity, but zebra mussels died by August when water temperature reached its maximum in the floodway. Interestingly, zebra mussels from the floodway that were placed in laboratory aquariums maintained at 21°C in July 2008 survived and grew for several months. Zebra mussels did not spread from sites within the floodway into Lake Pontchartrain. No zebra mussels were detected at 15 sites in the Lake Pontchartrain – Lake Maurepas estuary, but native false mussels were commonly found at these locations. Field and laboratory observations indicate that warm water temperatures that are reached in Louisiana wetlands in late summer may be the most important abiotic factor that could limit the dispersal and establishment of zebra mussels. Other researchers have demonstrated that zebra mussels can survive low salinities equaling the oligohaline conditions that occur in Lake Maurepas and western Lake Pontchartrain (Strayer and Smith, 1993). However, the higher salinities encountered in eastern Lake Pontchartrain have the potential to limit the spread of zebra mussels into this part of the ecosystem. Biotic factors that could potentially limit the spread of
zebra mussels include predators, competitors, and parasites. Predators that are known to feed on mollusks, including several species of fishes and crustaceans were detected in both freshwater and estuarine habitats that harbored either zebra mussels or false mussels, but the actual predation of mussels by these fishes and crustaceans was not studied. The role of interspecific competition as a potential control measure for zebra mussels was assessed in the Bonnet Carré floodway where alien zebra mussels co-occurred with native false mussels. The greatest effort to identify a biotic factor that could mitigate the dispersal of zebra mussels was directed to a study of parasites. Trematodes are excellent candidates as biological control agents because they use mollusks (snails and bivalves) as intermediate hosts and when they parasitize these hosts, the trematodes castrate them. Native false mussels were examined for trematode parasites. Three species of trematodes assigned to the families Bucephalidae, Zoogonidae, and Monorchiidae were found to infect false mussels. Because zebra mussels are sister species of false mussels, these parasites have the potential to infect zebra mussels and prevent the reproduction of these alien hosts. The taxonomy and life cycle of the monorchiid trematode was investigated. This parasite was determined to be an un-described species that can be assigned to the genus Lasiotocus. It was determined that naked gobies, Gobiosoma bosc harbor the adult stage of Lasiotocus n. sp. and that these fish hosts serve as sources of trematode eggs that can be used to infect zebra mussels. Future studies will be directed toward experimental infection of zebra mussels in the laboratory and assessment of the pathology that this potential biocontrol agent inflicts on its zebra mussel host.

Literature Cited


The Search for Hydrocarbons in Lake Pontchartrain Following the Deepwater Horizon Spill and the Removal of Hydrocarbons from Natural Water by Rangia Clams

Caitlyn Guice and Phillip D. Voegel
Department of Chemistry & Physics, Southeastern Louisiana University

Introduction: On April 20, 2010, the Deepwater Horizon oil platform exploded leading to the deaths of eleven workers and the largest oil spill in U.S. history. The oil spread throughout the Gulf Coast. Polycyclic aromatic hydrocarbons (PAH’s) were found in water samples collected from Bay St. Louis near the eastern end of the Lake Pontchartrain Basin [1] and tar balls and hydrocarbon sightings were reported in eastern sections of Lake Pontchartrain following Hurricane Alex in July [2]. Concerns that oil from the spill could pollute Lake Pontchartrain led to the collection of surface water samples and Rangia clams from multiple locations across the north shore of Lake Pontchartrain from June through October 2010 (Figure 1). Only samples collected on July 25 from three sites in the eastern portion of the lake showed signs of contamination by hydrocarbons. However, GC/MS analysis of the extracted water samples demonstrated that the contamination is unlikely to be associated with the Deepwater Horizon Spill. The potential for pollution of fragile habitats along the Lake Pontchartrain Basin and other estuaries by future spills demonstrates the need to develop more environmentally friendly methods of removing these pollutants.

Figure 1. Sampling locations (□) in the eastern portion of Lake Pontchartrain including three sites where hydrocarbon pollution was observed on July 25, 2010 (■)

Rangia clams are filter feeders commonly found in shallow estuaries with salinities ranging from 1 – 15 ppt [3-5], conditions commonly observed in the Lake Pontchartrain Basin. As filter feeders, Rangia clams are expected to bioconcentrate hydrocarbons. Bioconcentration has been studied in several different types of invertebrates, including Rangia clams [6-8]. Earlier
studies of hydrocarbon bioconcentration by invertebrates have focused on the amount of hydrocarbons found in the clams to assess environmental health and food safety issues. In this study, the ability of *Rangia* clams to bioconcentrate hydrocarbons, thereby removing them from surface water, is being examined to determine if clams could be employed to remediate contaminated sites in an environmentally friendly manner.

**Methods:** Water samples were collected by boat and returned for analysis during 10 trips from June 14 through October 10, 2010. Water samples were extracted into tetrachloroethylene and analyzed for total hydrocarbon content by FTIR. For total hydrocarbon analysis, trichlorotrifluoroethane called for in the Standard Methods 5520C, is replaced by tetrachloroethylene as suggested by Farmaki [9] because the original compound is not readily available due to its ozone depleting properties. Total hydrocarbon content of extracted water samples is determined by the IR absorbance of the CH bond around 2926 cm⁻¹ and compared to standards prepared from a reference oil mixture. GC/MS analyses of samples extracted into both dichloromethane and tetrachloroethylene have been completed. To study the effectiveness of *Rangia* clams to remove hydrocarbons from water, clams and natural water are collected from Lake Pontchartrain near the Tangipohoa River and transported to the lab. 5 gallon experimental tanks containing 5 clams and 5 gallon control tanks containing no clams are prepared. Hexadecane is added to both tanks to a total concentration of 50 ppm. Water samples were removed in the initial experiment at 24 hours and extracted into tetrachloroethylene. In ongoing experiments, water samples are removed from the tank hourly for four hours and then at 24 hours. The extracted water samples are analyzed by GC/MS.

**Results:** In the course of monitoring Lake Pontchartrain for hydrocarbons pollutants from the Deepwater Horizon Oil Spill, only three samples showed the presence of hydrocarbons through the total hydrocarbon analysis by FTIR. Typical total hydrocarbon analysis results are shown in figure 2 below. Samples taken on July 25 ranged in concentration from 16.8±0.2 ppm to 71.9±0.7 ppm. These samples were further analyzed by GC/MS to determine the specific hydrocarbon compounds present. Typical alkane hydrocarbons expected from petroleum were not present in the resulting chromatograms which contained only one significant peak. While mass spectral library matches were relatively low quality, the spectra were consistent with phthalate based surfactants commonly found in industrial lubricants and hydraulic fluids and not those used in dispersants associated with the oil spill.
In the first experiment involving hydrocarbon removal by clams completed in July 2011, the water in the control tank was cloudy while the water in the tank containing clams was clear after 24 hours. Water samples from each tank were extracted into tetrachloroethylene and the extracts were analyzed by GC/MS. The extract from the control tank contained a large amount of hexadecane while the amount of hexadecane in the tank with clams was nearly non-detectable. Because of the rapid removal of hexadecane by the clams, in ongoing experiments samples will be taken hourly to better gauge the rate of hydrocarbon removal by the clams. While this portion of the study is just beginning, it is clear that Rangia clams are capable of rapidly removing hydrocarbons from water at the laboratory scale.

References:

Accelerated Wetland Growth and Cypress Planting of the Caernarvon Delta Complex, Big Mar Pond – Southeast Louisiana

Theryn K Henkel¹, Andy Baker¹ John Lopez¹, and Ezra Boyd¹
¹Lake Pontchartrain Basin Foundation, P.O. Box 6965, Metairie, La 70009

Introduction
The Caernarvon Freshwater Diversion and conveyance canal was constructed in 1991. The structure was designed to divert up to 8,000 cfs from the Mississippi River into the local estuary, but has rarely flowed at this capacity. Big Mar Pond (2.7 square mile) is part of the receiving area for waters diverted 1.5 miles from the Mississippi River through the Caernarvon Diversion. Although the Caernarvon conveyance canal is directly connected to Big Mar Pond, it is estimated to receive less than half of the Caernarvon Diversion discharge due to the hydrologic efficiency to flow toward Bayou Mandeville and Lake Lery. From 2001 to the present, the structure has been occasionally operated under a pulsing regimen to mimic historical spring floods. The structure was also opened to maximum discharge during the BP oil spill in an attempt to prevent oil from moving inland. In spring 2011, during historic flood occurred on the Mississippi River, the discharge was generally less than 1000 cfs.

Big Mar Pond is an accidental lake formed by a failed agricultural impoundment. Since the construction of the diversion sediment has been deposited in Big Mar Pond. Over time there has been enough accumulation in some areas to support emergent wetland plant life permanently. Two studies conducted just south of Big Mar, one from 1996 to 2000 (Lane et al. 2006) and another in 1998 (DeLaune et al. 2003), found significant sediment accumulation in the area, both mineral and organic accumulation. Since 2005, a delta has formed at the end of the outfall canal. Also, in the sites just south of the Big Mar pond freshwater marsh vegetation has replaced Spartina patens, which is found at slightly elevated salinities (DeLuane et al. 2003). In this area, cattail (Typha sp.), bulktongue (Sagittaria lancifolia), maidencane (Panicum hemitomon) and Sesbania macrocarpa were replacing brackish marsh vegetation. There has also been establishment of some black willow (Salix nigra) trees. The area is currently thriving with different kinds of birds, water fowl, numerous alligators and diverse insect life.

The Caernarvon Delta Complex
Prior to 2004, wetland growth (defined as persistent emergent wetland vegetation in formerly open water) within Big Mar pond was negligible. Since 2004, wetland growth is significant and appears to be accreting annually. This wetland growth is a result of an active delta that has two distinct zones, and therefore, is referred to as the Caernarvon Delta Complex (Figure 1). The total area of Big Mar Pond is 1,720 acres. The emergent portion of the Caernarvon Delta Complex now occupies 35% to 50% of Big Mar Pond.

In the northeast quadrant of Big Mar Pond, near the terminus of the Caernarvon conveyance canal, a mineral platform of radiating, bars and shallow inter-bars (i.e. the delta platform) has become vegetated. This has a classic delta geomorphology of bars and small bifurcating distributary channels. The other area of land growth is in the southwest quadrant of Big Mar Pond. Wetland growth here was initiated by wrack or marsh balls deposited from Hurricane Katrina. This zone of hurricane deposition became nucleation points in which wetland extent expanded since 2005. This expansion is initially floatant marsh, but appears to be acting as a sediment trap for fine sediment from Carnarvon Diversion discharge, thus comprising a proto-
Further, the appearance of some black willow indicates the marsh is not entirely floatant and has become more stable (Table 1). In summary, the Caernarvon Delta Complex in Big Mar Pond is composed of a delta platform and pro-delta, which have both had significant land growth since 2004.

**Land Change Methods**

The wetland growth of the delta platform and the proto-delta in Big Mar Pond was estimated by manual interpretation of color infrared imagery (SONRIS), supplemented by field mapping, and aerial reconnaissance. These values were compared to the USGS land classification by extracting the land growth from the USGS land-change raster file over comparable time periods (Couvillion et al. 2011).

**Land Change Results**

LPBF estimates 19 acres of wetland growth from 1998 to 2004. We estimate that the total wetland growth in Big Mar pond from 1998 to 2011 is 600 acres. Of this total, 581 acres are new growth since 2004. The USGS data set indicates 23 acres growth from 1998 to 2004, and 321 acres of growth from 2004 to 2010. In March of 2011, large bare mud flats were observed near the existing delta. In August 2011 (5 months later), the same bare mud flats had nearly 100% coverage of emergent vegetation (Figure 2). This represents 104 acres of conversion in one growing season. We estimate that the wetland growth rate in Big Mar Pond from 1998 to 2004 is 3 acres per year (Figure 3). The rate of growth from 2004 to 2011 is 83 acres per year. Both LPBF and USGS data clearly indicate an increase in rate of wetland growth after 2004. The rate of wetland expansion after 2004 is 14 times (1400%) greater than before. Big Mar Pond in 2011 is at least 40% emergent wetlands, but the remaining open water areas are all less than a foot deep under normal marsh water levels. Remaining accommodation space will compete with the needed capacity to allow Caernarvon Diversion flow through Big Mar Pond, and so may soon reach a maximum capacity to retain sediment and eventually to expand wetland extent.

This pattern of dramatic increase in the rate of wetland growth is similar to that documented for other larger diverted flows, such as the Wax Lake Delta. In similar cases of introduced river flow, there was an initial delay in wetland growth as mineral soil platforms vertically accrete to a threshold on which emergent vegetation can survive. Once this occurs a much higher rate of wetland growth occurs. Nevertheless, the current higher growth rate in Big Mar pond is startling considering that: (i) the diversion was designed to minimize sediment delivery, (ii) that the maximum discharge capacity is small, (iii) that the diversion has been under-operated, (iv) that the diversion has not been operated to efficiently deliver sediment, and (v) that most of the discharge does not flow into Big Mar Pond. Beyond Big Mar there is undoubtedly a much larger area of mineral accretion, that is, the submerged, pro-delta extends beyond Big Mar Pond. Although to date, only isolated sites of land building occurred outside of Big Mar Pond, it is likely that within a few years new wetland creation will begin occurring outside of it. This is more likely if the Caernarvon Freshwater Diversion is operated in a manner that effectively delivers sediment to the receiving basin. It is likely the rate of growth could be increased by a different operation scheme to increase efficiency of sediment delivery.
Figure 1: Color Infrared imagery of Big Mar Pond illustrating the emergence of the Caernarvon Delta Complex between 2005 and 2010. Wetland growth increases after 2005 at the delta platform (east side) and at the pro-delta in the southwest quadrant of Big Mar Pond.
Figure 2: Overlay of 2011 wetland growth over 2010 CIR imagery of the Delta area in Big Mar Pond. 2011 growth (104 acres) was mapped by field survey conducted September 16, 2011.

Figure 3: Bar Graph of Wetland Growth Rates in Big Mar Pond
### Table 1: Plants Identified September 16, 2011 on the Caernarvon Delta Complex (Yellow Highlight are more dominant species)

<table>
<thead>
<tr>
<th>Delta Area -Northeast Portion</th>
<th>Pro-Delta- Southwest Portion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Common Name</strong></td>
<td><strong>Common Name</strong></td>
</tr>
<tr>
<td>water hyacinth</td>
<td>black willow</td>
</tr>
<tr>
<td>giant cutgrass</td>
<td>water hyacinth</td>
</tr>
<tr>
<td>elephant ear</td>
<td>cattail</td>
</tr>
<tr>
<td>bulltongue</td>
<td>giant cutgrass</td>
</tr>
<tr>
<td>black willow</td>
<td>smartweed</td>
</tr>
<tr>
<td>alligator weed</td>
<td>elephant ear</td>
</tr>
<tr>
<td>cattail</td>
<td>alligator weed</td>
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<tr>
<td>gooseweed</td>
<td></td>
</tr>
<tr>
<td>groundsel bush</td>
<td></td>
</tr>
<tr>
<td>frangrant flatsedge</td>
<td></td>
</tr>
<tr>
<td>roseau cane</td>
<td></td>
</tr>
<tr>
<td>panic grass</td>
<td></td>
</tr>
<tr>
<td><strong>Scientific Name</strong></td>
<td><strong>Scientific Name</strong></td>
</tr>
<tr>
<td><em>Eichhornia crassipes</em></td>
<td><em>Salix nigra</em></td>
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<tr>
<td><em>Zizania pitiacea</em></td>
<td></td>
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<tr>
<td><em>Typha sp.</em></td>
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<tr>
<td><em>Alternanthera philoxeroides</em></td>
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<tr>
<td><em>Sphenoclea zeylanica</em></td>
<td></td>
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<tr>
<td><em>Baccharis halimifolia</em></td>
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<tr>
<td><em>Cyperus odoratus</em></td>
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<tr>
<td><em>Phragmites australis</em></td>
<td></td>
</tr>
<tr>
<td><em>Panicum sp.</em></td>
<td></td>
</tr>
</tbody>
</table>

**Cypress Planting**

In an attempt to help claim newly formed land and increase species diversity, the Lake Pontchartrain Basin Foundation (LPBF) partnered with the Coalition to Restore Coastal Louisiana (CRCL) to conduct a cypress planting in late fall of 2010. With about 20 volunteers, 200 donated cypress trees were planted on various open bars and small islands in Big Mar Pond. Just prior to the next planting in March 2011, we discovered that none of the plants of the first planting remained. The likely cause of tree loss was thought to be from winter storms that hit the area and redistributed the bare soil, making an unstable environment for cypress tree growth. Nutria were not initially thought to be the blame because of a robust population of alligators (which are predators that control the nutria population).

Another planting was conducted in March 2011, and regular monitoring was established. At this planting, 225 donated trees were planted. During this planting tree locations were chosen more strategically and only planted in areas where there was established herbaceous vegetation or on seemingly stable soils. LPBF returned to inspect the trees on April 1, 2011 and found that only 44 remained. It was confirmed that nutria were the main culprit for tree mortality. Most of the dead trees had been chewed off at ground level. However, they did not appear to have been consumed by the nutria (Figure 4). Other trees had been chewed higher on the tree, so the tops were gone but the stem remained in the ground. On this day we observed about 10 nutria in the area. To save the remaining trees, LPBF staff and volunteer returned on April 6, 2011 and installed nutria protectors. When the LPBF staff returned on June 8, 2011, 38 of the 44 protected trees were thriving (Figure 5). We now suspect that nutria may have also contributed to mortality of the first tree planting in 2010.

Another tree planting is planned for October of 2011 when approximately 800 donated trees will be planted. We will apply the lessons we learned in the first two plantings and predict that this planting will be more successful. Trees will only be planted on what can be determined to be solid ground that is vegetated and would be likely to remain during average storm activity. Also, nutria protectors will be placed on all trees. The combination of sediment deposition through the Caernarvon diversion, natural recruitment of black willow and other native trees and the planting of cypress will help to reclaim this once open water area to a viable habitat that supports wildlife, provides storm protection, and adds to the aesthetic scenic value of the area.
Figure 4: Picture of cypress tree that was chewed at ground level and found laying on the ground adjacent to where it stood.

Figure 5: Tree that received nutria protector is thriving and looks very healthy.
Summary
The Caernarvon Delta Complex demonstrates that a even a small “freshwater” diversion can generate wetland growth. The expression of this growth is a classic delta morphology, but also includes an atypical pro-delta growth due to the interaction of the surrounding marsh. The delay in wetland growth until 2004, should be expected, and the higher rate wetland growth can be expected to generally persist as long as the Caernarvon structure is operated. We attribute 600 acres of wetland growth in Big Mar Pond to the Caernarvon Diversion discharge since 1998, but 97% of growth has occurred since 2004. Based on the observed trends, we project the annual rate of wetland growth to be approximately 80 acres per year for the Caernarvon Diversion which should be expected to be expressed outside of Big Mar Pond in future years.

The cypress planting demonstrates that even with significant alligator population, nutria can survive sufficiently to damage planted cypress. The nutria protectors are effective and the Big Mar Pond. By using nutria protectors and more carefully selecting planting sites we hope to reduce tree mortality. An expanded planting program is planned for 2011 and 2012.

References Cited


Constraints on Baldcypress Regeneration and Stand Dynamics in the Lake Pontchartrain Basin: Field Germination Trials and Dendrochronology

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Wetland restoration and management success requires a thorough understanding of environmental constraints on plant species establishment, population dynamics, and associated community change. Large tracts of baldcypress swamp have been harvested in southeastern Louisiana with many areas demonstrating limited or no regeneration of this valuable habitat type. A large body of work exists regarding the physiological tolerance of baldcypress seedlings to many environmental stressors, however, field evaluations of constraints on baldcypress germination and establishment are limited. In this project we investigated environmental factors that influence baldcypress seed germination and establishment success and stand age structure at two locations within the Lake Pontchartrain Basin. We conducted field germination experiments over two years (2002 and 2003) in conjunction with dendrochronological assessments of several existing baldcypress stands to investigate potential factors limiting baldcypress recruitment and establishment. Sites included an area that historically was an oligohaline marsh, but currently contains several isolated baldcypress stands located in southeastern wetlands of Lake Maurepas. The second site was as a baldcypress swamp that was previously harvested, and has subsequently converted into a fresh marsh that also supports several isolated baldcypress stands located in Joyce Wildlife Management Area (Joyce WMA). Three distinct stands were chosen at each study site (Joyce WMA, Maurepas). To assess germination and establishment success, three zones were established at each stand that represented the center of the stand, the stand edge, and the open marsh outside of the stand. Zones were chosen along the southern portion of each stand to minimize shading effects over the course of the study. Replicate 1 m² plots were established approximately 1 m apart from each other within each of these zones. At the center of each 1 m² plot a 0.25-m² circular plot was established for germination assessment. In the open marsh areas, the effect of competing vegetation was also assessed. To accomplish this, a total of 6 plots (3 pairs) were established in the open marsh zone at each of the three stands at each site. One plot of each pair served as an undisturbed control. The other plot of a pair was manually clipped to remove all competing vegetation twice yearly (at the initiation of the experiment and in the middle of the growing season). All plots were enclosed with galvanized wire mesh to eliminate mammalian-herbivore interactions and retain baldcypress seeds within the plot area during flood events. Baldcypress seeds were collected from multiple stands throughout the Lake Maurepas Basin in the fall of 2001 and 2002. Seeds were, scarified at 4°C, homogenized, and 25 seeds randomly allocated to each plot in early March of each study year. Successful seed germination occurred under a variety of conditions in both years, with the effect of site and zone within site displaying inter-annual variation. However, an extremely important finding is that seedlings experienced essentially complete mortality towards the end of the growing season in both study years. Meteorological events, particularly the occurrence of tropical storms, resulted in excessive and extended inundation of the young seedlings late in the growing season leading to near complete mortality. Inundation durations of 40 days or greater resulted in complete mortality of recently
established seedlings. Although salinity levels increased with storm flood events, these increases were minor and are not believed to be as important as the associated flooding stress in explaining seedling mortality. Dendrochronological characterization of several existing baldcypress stands further document that successful natural regeneration events of baldcypress have generally not occurred in the study areas for the past quarter century. The median age of baldcypress in the stands investigated ranged from 34 to 36 years, with only a few older trees, which indicates that there have been very few favorable years for establishment in the recent past. The results of these studies suggest that baldcypress recruitment in these areas is primarily limited by pulsed events. The sensitivity of successful establishment of baldcypress seedlings to such stochastic events makes proper management approaches to these habitats paramount. Specifically, it cannot be anticipated that baldcypress swamps in these areas will be capable of natural regeneration, even if viable seed sources are available and average environmental conditions are within physiological tolerances of larger seedlings and adults. Assisted regeneration via planting saplings may be successful in areas where other constraining factors, such as herbivory, are not intense. We suggest that until effective strategies for baldcypress restoration are implemented in these areas, the conservation of existing baldcypress swamp may be the best management strategy to ensure the continuation of this valuable wetland habitat type.
Response of a Louisiana Oligohaline Marsh Plant Community to Nutrient Availability and Disturbance

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In St. Tammany Parish, Louisiana, urban encroachment (from the greater New Orleans area) to the north shore of Lake Pontchartrain has the potential to increase the nutrient loading on the wetlands, with Big Branch Marsh National Wildlife Refuge, Louisiana, USA, being the largest remaining area of relatively undisturbed oligohaline to mesohaline marsh in this area. Achieving a greater understanding of plant community response at Big Branch Marsh NWR to controlled nutrient enrichment in experimental plots is of importance in developing sustainable restoration and management plans, especially in light of the relatively high occurrence of disturbance (both direct and indirect) from tropical storms and hurricanes in this region. In this study, aboveground plant community dynamics in an oligohaline marsh at Big Branch Marsh National Wildlife Refuge, Louisiana, USA, were assessed in response to nutrient loading (3 N x 3 P factorial) and disturbance (both planned herbicide treatment and stochastic tropical storm/hurricane disturbances). The three levels of nitrogen (0, 20 and 40 g N m⁻² yr⁻¹) and three levels of phosphorus (0, 15 and 30 g P m⁻² yr⁻¹) were added in a completely cross-classified factorial manner to create nine nutrient loading combinations. In addition, an herbicide treatment was used to impose a lethal disturbance that killed both above- and belowground tissues. Using a randomized block design, each of the ten treatments (3N x 3P + herbicide) had five true replicates (as blocks) yielding a total of 50 experimental units. During the course of the experiment, several tropical storms and hurricanes also impacted the area with impacts ranging from prolonged inundation events from tropical storms to direct destruction and scouring of areas of marsh from Hurricane Katrina. An extensive boardwalk system was constructed to minimize physical disturbance during sampling. Fifty (50) large treatment plots (3 m x 6 m each) were established off the boardwalks. Sampling was conducted seasonally from April 2004 to September 2006. Spartina patens and Schoenoplectus americanus are co-dominant plant species in this marsh. Although S. patens displayed increased aboveground cover under the low N addition (20 g N m⁻² yr⁻¹) relative to ambient conditions or high N addition (40 g N m⁻² yr⁻¹), increased N or P loading did not result in a shift in plant community composition or species richness during the study period. Schoenoplectus americanus consistently had higher leaf tissue N and generally higher leaf tissue P than S. patens regardless of treatment. Our results indicate that S. americanus is more resilient than S. patens to disturbances that do not increase marsh surface elevation, such as minor disturbances (e.g., prolonged flooding events) or prescribed burning, which is often utilized as a management technique to increase the relative abundance of S. americanus in this marsh type. Similarly, S. americanus was able to re-colonize the herbicide treatment plots to some degree during the study, via a combination of seed bank and rhizome tillering, whereas S. patens remained essentially absent. Hurricane Katrina deposited significant amounts of sediment (average of + 27 cm) into plots that survived the storm (August 29, 2005). By 2006, this elevation increase resulted in a significant increase of both S. patens cover and species richness, suggesting that a shift in the relative abundance of the two co-dominants is mitigated by disturbance type and the resultant effect of disturbance on the abiotic environment, particularly marsh surface elevation.
Role of Nutrient Enrichment, Disturbance, Dispersal, and Herbivory on Oligohaline/Mesohaline Marsh Transitions

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Achieving a thorough understanding of environmental factors that influence plant species establishment and community change is vital to wetland restoration and management success. In this project we investigated the effects of increased nutrient loading, disturbance, and vertebrate herbivory as potential drivers in the transition of oligohaline marshes (dominated by Sagittaria lancifolia or bulltongue) to mesohaline marshes (dominated by Spartina patens or marshhay cordgrass) in the Lake Pontchartrain Basin. In 2001 and 2002 a reciprocal transplant study of intact marsh sods was established and monitored within these two marsh types in the Pontchartrain Basin to investigate the possible causation of vegetation change in that area. Interactions between herbivory, nutrient loadings, and disturbances were investigated as possible contributing factors of these changes. Research plots were established at Pass Manchac (mesohaline marsh) and Tobe canal (oligohaline marsh). All research plots were 4 m². The herbivory exclusion treatment was applied at two levels (exclusion fence that surrounded the plot and no exclusion fence). The nutrient addition treatment also consisted of two levels (reference conditions and nutrient enrichment loadings of 22 g N m⁻² yr⁻¹; 3.2 g Pm⁻² yr⁻¹; 10.4 g K m⁻² yr⁻¹. A two-level disturbance regime (lethal and non-lethal) was also implemented. The lethal disturbance treatment was accomplished via application of Rodeo. The non-lethal disturbance treatment was applied by clipping all vegetation in a plot at soil level and then removing the vegetation. Edaphic characteristics differed greatly between the marshes. Elevated salinity levels and increasing sulfide concentrations were identified as being primarily responsible for the conversion and persistence of oligohaline to mesohaline marsh transition. Exclusion of mammalian herbivores increased plant productivity, although at levels lower than expected. Disturbances (whether lethal or non-lethal) expedited the expansion of transplant species in either marsh type. The results of this study indicates that shifts from an oligohaline (bulltongue-dominated) marsh to a mesohaline (marshhay cordgrass-dominated) marsh appear to be driven primarily by increased salinity levels (whether chronic or acute) and associated changes in soil water chemistry (such as elevated sulfide concentrations). The effect of disturbance was shown to be an important contributing factor in accelerating plant community change. Nutrient addition did lead to an increase in plant growth, but interestingly this only occurred during the peak of the growing season. Overall, this study revealed that edaphic conditions are crucial drivers of plant community change and that disturbances can further accelerate plant community shifts when release from interspecific competition occurs. In this particular study, the effects of nutrient enrichment at the levels applied were not as great as anticipated and had only a minor influence on plant community dynamics. Herbivory in this study also played a minor role in influencing productivity and community change. However, results from the non-lethal disturbance treatment (vegetation clipping and removal) do highlight the potential importance of herbivory in contributing to plant community change when herbivory intensity is greater than what was observed in our study areas. In summary, we suggest that knowledge of current, site-specific conditions (both biotic and abiotic) must be part of the decision process when considering coastal restoration and management strategies.
Microbial Activity and Organic Matter Processing in Western Lake Pontchartrain Basin wetlands

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Microbial processes involved in the decomposition of plant detritus are vitally important to the function of wetlands. Most wetland plant material is not consumed by herbivores, but rather it senesces, enters the sediment, and becomes subject to microbial activity. The rate of processing of this organic matter can have major impacts on whether sediment accumulates or erodes, especially in organic rich sediments such as those in wetlands around Lake Pontchartrain. Determining these rates of organic matter processing can be difficult, particularly for fine particulate organic matter (FPOM) which often forms the bulk of organic sediment material. This FPOM is an important source of carbon and energy in wetlands, but its decomposition has rarely been studied.

As part of this project, litterbags were used to study the decomposition of two size fractions of FPOM in surface sediments of a western Lake Pontchartrain cypress swamp. For the period studied (just over 1 year), particles in both size fractions followed linear decay models but larger (0.25-1 mm diameter) organic particles that were the remains of plant material decomposed at slower rates than finer (0.063-0.25 mm) organic material derived from multiple sources. The activities of microbial enzymes involved in the degradation of plant material were related to the rate of decomposition, and enzymatic decomposition models were developed to predict organic matter processing rate from enzyme activity were developed. Although the finer particles decomposed at faster rates, these particles showed lower microbial activity, suggesting that this material is degraded more efficiently by microorganisms.

A concurrent study monitored in situ microbial enzyme activity associated with the same sizes of sediment material in western Lake Pontchartrain wetlands, and the enzymatic decomposition models used to predict instantaneous decomposition rates for this organic material. In situ material appeared to decompose much faster than that in litterbags suggesting that microbial enzyme measurements may provide a truer estimate of organic matter processing rates in these ecosystems. Different sizes of sediment particles consistently showed differences in microbial activity and predicted degradation rates, implying that accurate assessment of sediment processes in these wetlands should account for different particle sizes, and that even grouping material below 1 mm diameter as FPOM is overly simplistic. A more accurate concept would recognize that fine organic particles can be derived from multiple sources and show heterogeneity in microbial activity and processing rate.

Because organic matter decomposition and nutrient mineralization in western Lake Pontchartrain wetlands these wetlands is tied to microbial activity, a separate study investigated how saltwater intrusion and nutrient enrichment affects sediment microbial communities in these systems. Sediments were collected from a cypress-tupelo swamp and maintained in laboratory microcosms treated with elevated salinity (to 3.5 parts per thousand), nitrogen (+5 mg/L and +50 mg/L), or phosphorus (+0.5 mg/L and +5 mg/L) for two months. Impacts of these treatments on bacterial community diversity and composition were determined via molecular techniques, while effects on function were assessed through measurement of microbial enzyme activity. In terms of bacterial community structure, elevated salinity increased bacterial diversity; increased phosphorus had no effect, and increased nitrogen reduced diversity. Bacteria affiliated with the Deltaproteobacteria dominated all treatments, although their
representation, along with that of bacteria belonging to the Alphaproteobacteria and Planctomycetes, was reduced following nitrogen addition. Phosphorus amendment reduced the proportion of Alphaproteobacteria, while salinity increased the proportion of Betaproteobacteria in the sediment community.

Elevated levels of salinity and nutrients also affected microbial activity. Higher salinity reduced the activities of phosphatase and N-acetylglucosaminidase, enzymes that are involved in phosphorus and nitrogen mineralization, by almost 20%. Effects of salinity on enzymes involved in organic matter decomposition were less pronounced, suggesting that salinity may have more impacts on nutrient cycling than organic matter processing in these ecosystems. Even high concentrations of phosphorus had no effect on sediment enzyme activity, while high concentrations of nitrogen increased the activity of phosphatase, an enzyme produced by microorganisms to acquire phosphate. Together, these findings suggest that exposure to salinity levels typical of tropical storms and hurricanes depress some microbial functions and change the sediment bacterial community. Sediment microbial communities in these wetlands are also likely to be nitrogen-limited, and while nitrogen additions may help to regenerate plant communities they are also likely to change the structure of the sediment microbial community, decreasing its diversity and potentially impacting the mineralization of other nutrients. Restoration strategies for western Lake Pontchartrain wetlands should therefore take a whole ecosystem approach, considering both above-ground and below-ground communities during decision making and environmental action.

Research Program in the Bohemia Spillway in Southeast Louisiana
Lopez, J.A.¹ Andy Baker¹, Ezra Boyd¹ and Theryn Henkel¹
¹Lake Pontchartrain Basin Foundation

Introduction
The Bohemia Spillway area is the 11.8 mile reach on the east bank of the Mississippi River approximately 45 miles downriver of New Orleans extending below the terminus of the Mississippi River (MR&T) levees to Bayou Lamoque (Figure 1). The Bohemia Spillway area has a fascinating history that pre-dates the physical creation of the spillway in 1926 by removal of artificial river flood protection levees. Prior to 1926, several small communities had permanent residence along the river bank that were protected by the river by a formidable artificial river levee. When the levee was removed in 1926 to create the spillway, this ended permanent residence within the spillway.

Figure 1: Bohemia Spillway area is east of the Mississippi River downstream of the terminus of the Mississippi River levee (source basemap: SONRIS CIR 2005).

The legal and management history of the Bohemia Spillway since 1926 to the present day is complex and cryptic. 33,000 acres were authorized to be purchased or expropriated in 1924 by the Louisiana State legislature (United States Court of Appeals, the Fifth Circuit, 2002). The land acquired from private holding has been transferred to the heirs of the original landowners in 1984 by an act of the State legislature. The Bohemia Spillway is now primarily used for oil and gas activities, hunting, and as a spillway outlet. Since 1926, it has also been identified as the Pioneer Spillway, the Pointe a la Hache Wildlife Management Area.
Research Program Purpose
Due to the removal of the artificial river levees in 1926, the Bohemia Spillway provides a truly unique opportunity to investigate a long-term response of wetlands to discharge of the Mississippi River by processes that emulate the natural process of seasonal overbank flow. Because the Bohemia Spillway may be instructive to restoration, LPBF has been investigating the Bohemia Spillway since 2007. This work now spans two significant flood events in 2008 and 2011. In 2010, LPBF completely surveyed the road elevation of the road through Bohemia Spillway. In 2011, extensive hydrologic surveys were conducted (see companion paper).

Three segments of the original river levee are still present in the Bohemia spillway. The total length of levee segments is less than ½ mile representing < 5% of the spillway. These levees appear to be well engineered and often include concrete embankments one or both sides of the levee. The largest segment of original levee is ¼ mile long (~8 feet high) is shown in the figure below. It is noteworthy during 2011 flood, the levee segments were not overtopped, indicating that if the all of the levees had not been removed in 1926, they might, even now, have precluded flow through the Bohemia Spillway.

Figure 2: Segment of the pre-1926 levee still present in the Bohemia Spillway. The river (flood side) is on the left side of the levee/road. The elevation of the road bed on the levee is approximately 8 feet NAVD.
An intriguing aspect of the Bohemia Spillway is low rates of land loss (see Figure below). The observed land loss is generally the direct loss due to dredging of canals and due to shoreline erosion near the sound. Other causes of loss do not seem to be active, such as the indirect loss due to oil and gas canals. Rather, what has been observed is that some canals in the Bohemia Spillway have converted to marsh again. This is presumably due to the inorganic and organic accretion that may be resulting from the active spillway. Small amounts of land gain are present.

![Land Change map comparing east Bohemia Spillway to the west bank patterns of wetlands loss](image)

**Figure 3:** Land Change map comparing east Bohemia Spillway to the west bank patterns of wetlands loss (Couvillion and others, 2011).

**LPBF Research Program in the Bohemia Spillway:**
- Vibracore program and recent geologic history - Coring was completed in 2010. XRF and age dating are in progress.
- Vegetative mapping – This was based on 2010 field ground-truthing and typical remote sensing imagery. The work is complete except for spoil bank vegetation. 
- Geomorphic and image analysis - ongoing
- Hydrologic survey during high and low water – 2011 survey complete
- Hydrologic survey of the river during high water – 2011 survey complete
• Hydrologic modeling - complete
• Forensic study of residual features and paper record of Bohemia management - ongoing
• Land change analysis – ongoing
• Comprehensive synthesis - pending

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Preliminary Hydrologic Observations of 2011 Riverine Discharge through the Bohemia Spillway in Southeast Louisiana

John Lopez¹, Andy Baker¹, Ezra Boyd¹, Theryn Henkel¹  
Lake Pontchartrain Basin Foundation

Introduction  
The Bohemia Spillway area is the 11.8 mile reach on the east bank of the Mississippi River approximately 45 miles downriver of New Orleans extending below the terminus of the Mississippi River (MR&T) levees to Bayou Lamoque (see companion paper for an overview). The spillway is not an engineered water control structure such as the Bonnet Carré Spillway. Rather, it is simply the absence of the artificial river levee that was removed in 1926. It is estimated that 550,000 cubic yards of material were removed from the “front line” levee (OLB, circa 1926). Since 1926, for 85 years, the Bohemia Spillway has had the potential to allow overflow across the natural levee due to high water of the Mississippi River. The landscape has had pre-and post 1926 modifications related to local activities which incidentally affect the potential flow or nature of the flow through the spillway. In spite of these anthropogenic alterations, the Bohemia Spillway seems to represent the best modern example of the overbank flow across a natural levee along the lower Mississippi River. As such, it has significance to understanding a key deltaic process, and a process that may need to be emulated by artificial diversions for coastal restoration in Louisiana. Although, prior hydrologic work was conducted by LPBF in the 2008 flood, the epic river flood of 2011, created an ideal opportunity to directly observe and measure the distribution and nature of the discharge through the Bohemia Spillway.

Methods  
The 2011 hydrologic investigation of the Bohemia Spillway used four survey methods.

1. **Riverside ADCP** – ADCP surveys were conducted on the Mississippi River above and below the Bohemia Spillway based on the assumption that the reduction in flow would indicate discharge on the east through the Bohemia Spillway. This work was contracted to the University of New Orleans and overseen by Dr. Ioannis Georgiou.

2. **Bohemia Road Overflow Survey** - Measurements of water depth, velocity and direction were taken along the road which runs the length of the spillway near the crest of the natural levee. This survey was conducted by LPBF staff and overseen by Dr. John Lopez.

3. **Local Channel Flow Marsh Survey** – Selected canals on the marsh side of the natural levee were monitored briefly during the flood to gage to tidal effects of the spillway discharge. This work was contracted to the University of New Orleans and overseen by Dr. Ioannis Georgiou.
Figure 1: Bohemia Spillway area is east of the Mississippi River downstream of the terminus of the Mississippi River levee (source basemap: SONRIS CIR 2005).

4. **River Hydrodynamic Modeling** – Specific modeling of the Bohemia Spillway was incorporated into a regional modeling effort of the Lower Mississippi River to access current hydrologic conditions. This modeling utilized a recent elevation survey of the Bohemia road acquired in Fall 2010. This work was contracted to the University of New Orleans and overseen by Dr. Alex McCorquodale.

The preliminary compilation of data of these three surveys has been completed, and in a September 2011 work meeting we reviewed preliminary results of all four approaches with PI’s. The high water survey was conducted from May 17 to June 7 during which the West Pointe a la Hache gage ranged from 7.2 to 7.66 feet (see Figure 2). The work by UNO will be documented in two or three reports that should be available by December 2011. All of these survey approaches have various limitations and inherent errors, but together may provide a new level of accuracy for the hydrology of the Bohemia spillway. Field reconnaissance was also conducted pre and post high water (see Figure 2).
Total Bohemia Spillway Discharge estimate for the peak 2011 flood

**Riverside ADCP** – 15,000 cfs to 45,000 cfs. The lower estimate is likely to be an underestimate because it is based on an extrapolation of flow from the two upriver ADCP river surveys. The lower river ADCP near Bayou Lamoque was found to have higher discharge than the upper and was discounted. Based on the Bohemia Road Overflow Survey, it is likely the upper portion of Bohemia did have lower flow than the downriver section. Considering uncertainties UNO estimates the maximum flow through the Bohemia survey may be as high as 45,000 cfs.

**Bohemia Road Overflow Survey** – This survey involved over 118 measurements along the road. The entire spillway length was subdivided into 18 reaches and discharge was estimated for each reach. In addition, discharge was estimated through several culverts and road washouts (breaches). Since the entire survey was not conducted at the exact peak flood small adjustments were made to estimate the discharge at each reach for the peak of the Flood (May 17). The total discharge of the spillway was estimated by summing the entire road overflow discharge for all reaches, culvert discharges and the estimated discharge through breaches at the maximum stage. The combined discharge for the peak flood is estimated to be 49,000 cfs.

**Local Channel Flow Marsh Survey** – This survey by itself cannot estimate a total discharge through the Bohemia Spillway. Nevertheless, some relevant observations are that the discharge seen in the canals in the marsh were influenced by astronomical tides. Highest velocity and discharge was observed on falling tides. In spite of the tidal influence flows were not significantly reversed and were dominated by riverine influence.

**River Hydrodynamic Modeling** – UNO modeling at this time has included the Bohemia Road elevations acquired in 2010, but has only modeled the 2008 flood. The peak flood in 2008 at
West Point a la Hache was 7.46 feet, which is slightly lower than 2011 (7.66 feet). Preliminary modeling indicates the maximum discharge through the Bohemia Spillway in 2008 was 30,000 cfs. Modeling of the 2011 hydrograph is underway, and is expected to generate a slightly higher discharge.

Considering the uncertainty and preliminary nature of this investigation, the most likely peak discharge through the Bohemia Spillway for the 2011 flood is estimated to be 30,000 to 50,000 cfs. An engineering report describing pre-construction designs estimated a cross sectional area of flow of 145,700 sq ft, and an estimated velocity of 2.5 ft per second (implied average flow depth is 2.5 feet). Therefore, it was estimated the spillway could flow 350,000 cfs in 1927 (Orleans Levee Board, 1926). The Orleans Dock Board was reported to have measured discharge around March 1927 as 133,000 cfs through the Bohemia Spillway, and suggested it could flow as much as 250,000 cfs (Times Picayune, 1927). A URS report dated 1984 reported that measured discharge in the Bohemia Spillway for the 1927 flood was 300,000 cfs (URS, 1984). However, the flow through Bohemia was influenced by the artificial crevasse at Caernarvon in 1927, which was estimated to flow at 275,000 cfs (La. State Engineer Report, circa 1929). At the time of the URS report (1984), URS estimated the peak flow through Bohemia Spillway could be as large as 177,000 to 477,000 cfs. According to the URS report, efforts were made to reduce discharge through the Bohemia Spillway. Examination of the West Point a la Hache hydrograph shows that historically river stage exceeded the peak stage in 2011 (7.66 feet), and was as great as 9 feet. Therefore, it is probable that historical peak flow through the Bohemia Spillway was substantially higher than in 2011. The lower stages at West Point a la Hache in recent floods, may be explained by increased flows at sites such as near Ostrica and Fort St. Phillips.

**Bohemia Spillway Overbank Flow Patterns**

As described previously, the Bohemia Road overflow survey was analyzed into 18 different reaches. These analyses along with geomorphic and other cumulative observations in the spillway provide a basis for a hydro-geomorphic classification and description. The length of the spillway was described as generally one of the following hydro-geomorphic types:

**Trenasses-Back levee Canal**- Examination of aerial photography reveals that much the marsh side of the natural levee has a rectilinear pattern of small channels. These are typically less than 30 feet wide and less than 6 feet deep. It is likely these canals are trapper canals that pre-date the creation of the Bohemia Spillway in 1926. Due to the uncertainty, these are referred to as trenasses simply because of their small dimensions. A subset of these trenasses actively captures overbank flow, which is then generally discharged into a back canal which nearly runs the length of the spillway.

**Natural Levee-Back levee canal**- This classification is entirely in the lower reach of the Bohemia Spillway where the Harris Bayou tributary drainage is present. This is an integrated drainage pattern flowing across and away from the natural levee and to Breton Sound. The drainage is slightly influenced by some linear trenasses, but most flow appears to be captured initially by the natural meandering drainage. This flows into and across the back levee canal. Flow continuing past the back levee does reach the shallow bay of the larger Breton Sound. In the late 1930’s Harris Bayou breeched into the river and was dammed in 1940 (LA. State Board of Engineers, circa 1940).
**Oil and Gas Canals** – Oil and gas canals were dredged with development of the Potash and Quarantine Bay oil and gas field first discovered in 1937/1938. Corps of Engineers’ land change maps indicate canal dredging was primarily from 1932 to 1956, but as late as 1974 (Britsch and Dunbar, 1996). These canals have typical widths of south Louisiana oil and gas canals with a typical rectilinear distribution. However, the canals are often shallower than typical oil and gas canals, and some are as shallow as two feet. Some of these canals were dredged relatively close to the river and therefore, at a high bank elevation since they are cut into the natural levee. These canals significantly affect local overflow patterns through the spillway. For example, many of the oil gas canals have prominent erosional gullies near their termination close to the river. Some of these gullies had significant flow during the flood (2,000 to 3,000 cfs). The spoil banks are generally present and where present may deflect or impound flow.

**Road Blocking or Deflecting Flow** – In a few places it was apparent that the road elevation was significant enough to impede or deflect flow. This was most evident near the upper end of the Bohemia Spillway where two parallel roads are present, which together significantly reduce the discharge.

**Artificial River Levee** – At three locations in the Spillway the road is more uniformly elevated (7 to 9 feet), and there is also present a partial concrete embankment. It is strongly suspected these are remnants of the original front line river levee constructed prior to 1926. Records indicate that at least 90% of the “front line” river levees were removed in February 1925 (LA. State Board of Engineers, circa 1929) and September 1926, and thus brackets the physical creation of the spillway. A pre-construction engineering report says a short “spur” of the Bohemia levee would be left in place at the upper end of the spillway (OLB, circa 1926). The remaining levees represent approximately 3% of the length of the spillway. It is interesting that during the 2011 flood these remnant levees were not overtopped even though they presumably have not been maintained as levees since pre-1926. Therefore, this implies that if the levees had not been removed in 1926, they would still be effective at preventing flow into the Bohemia Spillway even during the current flood events.

**Constructed Hydrologic features, e.g. culverts, conveyance canals** - There are basically two types of engineered hydrologic structures in the Bohemia Spillway. Round metal culverts have been placed underneath the Bohemia Road at various times to reduce damage to the road when it is overtopped by river overflow. These culverts vary from approximately 2.5 feet to 6 feet in diameter. Altogether there are eight, round, metal culverts at four locations that have been identified in-place in 2011. The other type of constructed hydrologic feature is a structure composed of 4 concrete box culverts (4 feet by 4 feet) located near the upper end of the Bohemia spillway. These culverts have adjacent conveyance canals running toward the river and to the Back levee canal. We refer to this feature as the Bohemia diversion. It was built in 1979 by Plaquemines Parish, is currently inoperable, and prior to the 2011 flood largely blocked by siltation.

The overall flow through Bohemia Spillway is roughly a three-way split through three of the hydro-geomorphic types, i.e. Natural Levee/Bayou Drainage and Back Levee Canal, Trenasse and Back Levee Canal, and Oil and Gas Canals. Analyses suggest that the flow is slightly suppressed by the Oil and Gas canals, and by the presence of the Road Blocking or Deflecting Flow reaches. Overall the effect of flow reduction due to anthropogenic features is probably less than 15%.
Conclusions

Specific Bohemia Spillway discharge estimates are preliminary, but the total discharge for the peak flood condition of river stage in 2011 is estimated to be 30,000 to 50,000 cfs. Prior estimates of historical discharges are being investigated, but suggest that the discharge through the Bohemia Spillway has been reduced over time. More detailed forensic and historical investigation may substantiate this important aspect of the spillway history. Flow patterns can be readily characterized through the various reaches of the spillway, and the majority of the discharge is through hydro-geomorphic types that are similar to what might be expected from overbank flow across a river’s natural levee, i.e. flow through small trenasses or bayous. Oil and gas canals (and spoil banks) short circuit flow and also locally impound river water. Nevertheless, the Bohemia Spillway provides great insight into the physical and biologic processes that have been occurring for over 85 years due to the river’s reconnection to the adjacent wetland landscape.

![Classification of the hydro-geomorphic areas identified for the various reaches through the Bohemia Spillway](image)

**Figure 3:** Classification of the hydro-geomorphic areas identified for the various reaches through the Bohemia Spillway,
**Figure 4:** Preliminary Discharge estimate for the various reaches through the Bohemia Spillway and the hydro-geomorphic classification. The majority of discharge occurs in three types: Natural levee/bayou, Trenasse/Back canal, and Oil and gas canal.

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Enhancing Environmental Field Education in the Lake Pontchartrain Basin Through University Collaboration


Southeastern Louisiana University’s Turtle Cove Environmental Research Station (SLU-TCERS, or “Turtle Cove”) and The University of New Orleans’ Coastal Education and Research Facility (UNO-CERF) both received funding through the NOAA Pontchartrain Restoration Program (FY 2009) for the establishment of field-based educational programs that bring young people of the Lake Pontchartrain Basin to their two field stations. Both groups recognized the importance of collaboration and partnership development as a way to enhance environmental field education in the Lake Pontchartrain Basin. Both projects’ goals included strengthening inter-institutional partnerships in order to provide the best possible field-based environmental science experiences for students and teachers. In addition to partnering with each other, both groups also partnered with state and federal agencies and other programs in the area to increase the impact of their work. The two NOAA-funded projects were The Establishment of an Education Training Program for Young Scientists and Ecosystem Tours for Students and Community Leaders at Galva Canal Marsh and Manchac Swamp (Turtle Cove) and Establishing a Coastal Education Field Program at the University of New Orleans Coastal Education and Research Facility (CERF).

Our two facilities – Turtle Cove in the upper estuary and the CERF in the lower estuary are both located on important tidal passes (Manchac and Chef Menteur, respectively). There are sharp differences between the habitats and the issues faced by the two regions, yet both have much in common and are linked ecologically, hydrologically, and in many other ways. Our programs have developed in parallel ways over the past decade and we have worked together in an unofficial capacity, so this collaborative project provided an opportunity to formalize the partnership and produce tangible results.

The goal of the collaboration was to provide high quality estuary-wide opportunities for teachers and other educators, and pre-college students, to learn about the coastal systems in the Lake Pontchartrain Basin. To this end, the staff from both facilities developed teaching and interpretive materials that emphasize the diversity and importance of Lake Pontchartrain estuary wetland habitats. These included:

1. a publication entitled Field-based Educator’s Guide to the Lake Pontchartrain Estuary, which features the field-based activities commonly used in CERF’s and Turtle Cove’s education programs (D. Maygarden and H. Egger);
2. laminated wetland vegetation field guides and corresponding PowerPoint on wetland vegetation of the Lake Pontchartrain estuary (B. Wood and S. Hamilton);
3. Purchase of equipment and supplies for water quality sampling and measurement demonstrations;
4. Installation of Sediment Elevation Table (SET) for demonstrating and documenting subsidence and accretion in the Galva Marsh at the Turtle Cove-Galva Canal site (B. Wood and F. Stouder);
5. fold-out orientation map and guide of the programs including a species checklist data documentation (R. Moreau and S. Hamilton);
(6) development of approximately 55 different signs used on the “Turtle Cove Self-Guided Tour” in the Manchac Marsh behind Turtle Cove on Pass Manchac (F. Stouder and R. Moreau);

(7) survey of vegetation for both of the Turtle Cove sites (Turtle Cove-Galva Canal Marsh Site and Turtle Cove-Pass Manchac Site) (B. Wood and F. Stouder).

(8) Facebook page was developed by Michaelyn Broussard for the program (and for Turtle Cove) and has to date garnered 1,300 “Friends of Turtle Cove;” (find link at www.selu.edu/turtlecove);

(9) Website developed by Simone Hamilton for the program under the Turtle Cove website (www.selu.edu/turtlecove);

(10) Evaluation tools were developed by Dr. Deborah Dardis for both participants and teachers;

(11) 35 groups (1,000 individuals) participated in Ecosystem field tours to both CERF and Turtle Cove (see below for more information) (H. Egger, D. Maygarden, R. Moreau, F. Stouder, H. Reno, B. Wood)

(12) The project culminated in a two-day teachers’ workshop that took place on concurrent days, one at UNO CERF and the other at Turtle Cove. Approximately 30 teachers and informal educators attended the two workshops and learned about the programs offered at the two facilities. This will lead to further educational programming in the coming school semesters. (H. Egger, D. Maygarden, R. Moreau, F. Stouder, and also including Dr. Gary Shaffer)

During the course of the project a total of 17 groups with a combined 482 students visited Turtle Cove and 18 groups of students visited UNO-CERF with approximately 517 total students. The total number of students served at the two facilities during this time was approximately 1,000 covering 35 k-12 and other community-based groups. In addition to these partnership activities, UNO continued to build the program at CERF, which is a new facility. Other activities included community workshops, planting native vegetation and maintaining aquaria with native estuary organisms for educational purposes. Partnerships with other agencies were also fostered through this project. These included cooperative activities between Turtle Cove and the Lake Pontchartrain Basin Maritime Museum (LPBMM) and Louisiana Department of Wildlife and Fisheries (LDWF) and between UNO-CERF and the US Fish and Wildlife Service (USFWS).
Hydrodynamic and Sediment Transport of the Mississippi River Below Belle Chasse

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The presence of man-made levees and dikes along the Lower Mississippi River (MR) has significantly reduced sediment input to coastal wetlands in the delta plain. As a result, much of the River’s sediment is thought to be lost off the continental shelf. Historically, this input maintained a closer balance between the subsidence and deposition rates throughout the delta, when compared to modern rates. While the current land loss is partly due to the construction of levees and partly due to the reduction in the sediment load caused by dams and river revetments along the Upper MR, freshwater and sediment diversions are still valid alternatives under consideration to combat coastal land loss. To test and help implement solutions to coastal land loss, numerical models capable of simulating hydrodynamics and sediment transport in the MR are required to support proposed restoration projects, as well as to improve our understanding of the resulting River responses.

One part of the Lower River that is relatively unaffected by artificial levee construction is the reach of the East Bank from Bohemia (RM 44) to the Gulf of Mexico. There are several natural and man-made diversions that have helped to sustain the adjacent wetlands in this reach. By contrast the West Bank has levees down river to Venice (RM 11) and the adjacent wetlands are experiencing high rates of loss. The hydrodynamics and sediment dynamics of the East Bank can serve as a case study for the validation of models for future design freshwater/sediment diversions. The focus of this paper is the development of models to simulate flow and sand transport and distribution in the Lower River from Belle Chasse (RM 74) to the Head of Passes (HOP) at RM 0. The two periods of interest are: the 2008 and 2011 Mississippi River Spring Floods. Model development involves 1-D and 3-D hydrodynamic and sediment transport response models. The models are used sequentially, and either share, or provide boundary conditions to other models, and are designed to assess and evaluate coastal restoration strategies utilizing the Mississippi River.

In 2008, a 1-D quasi-steady flow mobile-bed model (HECRAS 4.0) was used to model the Lower MR, followed by a more extensive 1-D unsteady hydrodynamics model (HECRAS 4.1), developed
in 2009, to include the Barataria Basin, the existing diversions, and the bird’s foot delta with all major distributaries. This model was improved using sill elevation data obtained from a recent survey of the Bohemia spillway by the Lake Pontchartrain Basin Foundation (LPBF). The 1-D hydrodynamic/sediment transport model, CHARIMA, which is capable of simulating unsteady water and sediment was applied to the Lower MR to obtain information on the sand loads in the River and in the diversions. In addition, a 3-D unsteady flow mobile-bed model (ECOMSED) of the Lower MR was calibrated using data from 2001 – 2010. This model was prepared to simulate River currents, diversion sand capture efficiency, erosion and depositional patterns with and without diversions. The sand sub-model calibration was based on field data provided by Dr. Mead Allison. The calibrations of all of the models were revised using data from the 2011 MR flood.

The revised models with the correct elevations at the spillway provided by LPBF indicate that the Bohemia Spillway carries considerably lower flow compared to earlier model predictions; however, overflows along the East Bank south of the Bohemia Spillway, e.g. Fort St Philip, carry greater peak flows compared to previous estimates. At peak River stages nearly 40% of the total flow at Belle Chasse is lost through the East Bank outflows between Belle Chasse and Venice. The models showed that at high River stages between 14% and 25% of the peak suspended sand load at Belle Chasse is discharged through the East Bank between Belle Chasse and Venice. The model shows a total peak extraction, upstream of the HOP, of 53% of the peak flow at Belle Chasse. The sand load diverted in this reach amounted from 29% to 34% of the peak suspended sand load at Belle Chasse.

The model was also applied to the proposed Multiple Lines of Defense (MLODS) suite of diversions and channel modifications which involves a total peak extraction, upstream of the HOP, of 79% of the peak flow at Belle Chasse. The sand load extracted for the whole reach is between 46% and 62% of the upstream sand load at Belle Chasse.

These results are encouraging and suggest that it is possible to divert a significant portion of the River sand load during spring floods in a reach of the River with relatively low energy; however, the implementation of additional diversions along this reach will likely result in increased shoaling and possibly accompanied with reduced sand load input to the wetlands.
Mitigation Banking in the Lake Maurepas and Manchac Swamps: 
An Assessment of LIDAR and the Viability of Mitigation Banks and Sites in the Region

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Purpose and Goal of Study

The purpose of this project is to study the viability of wetland mitigation in the Maurepas/Manchac Swamp in Southeast Louisiana. The overall goal is to create tools to help stakeholders identify viable mitigation areas within the site. The project has two aims: 1) determine potentially sustainable mitigation sites in the Maurepas/Manchac Swamp region and 2) to identify the hurdles and solutions to mitigation success.

Background and Literature Review

Need for Mitigation Sites

The need for suitable mitigation sites across coastal Louisiana has increased as has growth in the metropolitan region in recent decades, specifically on the north shore of Lake Pontchartrain. As an example, St. Tammany Parish has seen population growth well above the national average, stabilizing at an estimated 231,495 in 2009---a 21% increase from year 2000 (U.S. Census Bureau, 2010). This example of high population growth (viewed as a proxy for development) in the sub-urban (and wetland-dominated) region around New Orleans point toward the need for comparable mitigation sites available within the Pontchartrain Basin. The Manchac/Maurepas Swamp would be appropriate if mitigation sites can be identified, approved, and are reasonably sustainable. This region historically was dominated by Bald cypress and Tupelo Gum (Saucier, 1963, and Shaffer, Wood, Hoeppner, Perkins, Zoller, and Kandalepas,. 2008).

Impediments to Mitigation

One of the primary impediments to sustainable mitigation sites are physical characteristics of the land. The health of the Maurepas/Manchac Swamp has been studied on a comprehensive ecosystem basis for the past 12 years by G. Shaffer, with data showing a declining system caused by four primary factors: (1) Loss of elevation; (2) Rising Salinities; (3) Lack of oxygenated fresh water and nutrient through-put; and (4) Nutria herbivore damage.
This research resulted in a “sustainability map” (Figure 1 below). Note only 13.3% of the region is considered “sustainable.”

**Figure 1**: Sustainability Map of Maurepas/Manchac Swamp Region. Only 13.3% of the region is deemed “sustainable” (green areas). Yellow areas represent “relic swamp”, and red areas represent “degraded swamp.”

Source: Original Sustainability Map of Maurepas Swamp (via Thematic Mapping with Ground Truthing), Gary Shaffer, Southeastern Louisiana University, first provided on 9/25/06.

**Public vs. Private Ownership of Land**

Ownership of land has a significant impact on mitigation potential. In general, public lands may be more difficult to designate for mitigation, since lands are already assigned a management status. Private landowners may choose from many government-sponsored programs that compete with mitigation, such as the Conservation Reserve Program (CRP), Wildlife Habitat Improvement Program (WHIP), and forthcoming Carbon Sequestration Programs, among others, and do not allow for “double dipping,” or having land placed under more than one designated category. Other competing issues include leasing (i.e., hunting, fishing, or mineral rights) or outright sale, although some may allow for simultaneous mitigation. Land ownership designation in the study site (Figure 2) is currently 64% private lands and 36% public lands.

**Preservation as Mitigation**

One interesting and recent development is the capability of public agencies to purchase land for public use with mitigation funds, thereby having the land also be “preserved” as a mitigation site. For example, the purchased land, if in good shape environmentally, may provide a large mitigation ratio (recent examples are as high as 40:1) and may be used to offset development. However, calculation of ratios can be controversial (Myers, personal communication).

**Municipal Waste Water Effluent Inputs as a Wetland Restoration Technique**

Although the study site is in a state of declining ecosystem function, there are restoration techniques that could provide positive impacts, including input of fresh water from municipal wastewater discharge. Both natural and constructed wetland systems have been
shown to effectively treat secondary stage wastewater (Kadlec and Knight 1996). The benefits of treating sewage effluent using wetlands (specifically swamps) include improved water quality, financial and energy savings, increased vegetative production, and vertical soil accretion (Day et al. 2004).

**Mapping Techniques of Wetland Resources**

Traditional mapping and analysis of this site has been done (Shaffer, Perkins, Hoeppner, Howell, Bernard, and Parsons, 2003) thru Thematic Mapping (TM) from satellites, usually at a standard resolution of 30m². During the past decade, LIDAR (Light Detection and Ranging) has been conducted at resolution levels of as much as 5m² for canopy height and 1-2M² for vegetation height, which provides a much clearer picture of parameters such as tree canopy height. A comparison of TM and LIDAR is therefore warranted.

**Methods**

The study site was defined as the two-foot contour around the Manchac/Maurepas swamps, consisting of a terrestrial area approximately 460.5 sq miles (294,735 acres). Establishment of the contour is appropriate because it divides the land neatly between undeveloped marsh and swamp habitat from more developed agricultural and residential upland sites, and is also cadastrally appropriate (Campanella, 2006).

**Figure 2**: Terrestrial study area of Manchac/Maurepas Swamp Region, 2010: 1,193 km² (460.5 sq miles, 294,735 acres). State-owned lands approximately 36%. All other (private) ownership lands approximately 64%. By end of 2011 additional purchases may have ratio closer to 47% (public) to 53% (private). Source: Marty L. Beasley, I-T Geographic Manager, Louisiana State Land Office, originally produced 03/28/06. Updated with Louisiana Department of Wildlife and Fisheries information in 2010. Map produced by Richard Campanella (2006) and revised January 2011.

A specific component of the project was to analyze raw LIDAR data from state-funded fly-over’s in 1999/2000 for a 75m² sample site in the project area (Figure 3), and to compare that data with known TM and groundtruthing data from previous studies. Comparisons were analyzed to test the capability of LIDAR to provide adequate (and more detailed) information on tree canopy height as a proxy of overall sustainability. Additional groundtruthing was done to address any noticeable disconnect between the two methods.
Figure 3: 75m² sample site of LIDAR Test data.

Availability of suitable sites for mitigation required the additional steps of identifying potential sources of fresh water inputs from nearby waste water effluent and storm water runoff sites. This was accomplished by GIS overlay maps containing (a) currently sustainable sites (from sustainability mapping) (b) population demographic data (from census data bases), (c) public/private ownership areas (from the Office of State Lands) and (d) potential sources of waste water effluent sites.

Results

Research Question #1: Are there suitable areas for Mitigation within the Manchac/Maurepas Swamp System? If sources of waste water effluent can generate wetland sustainability, then those areas closest to potential waste water inputs represent areas that are reasonable candidates for mitigation (see Figure 4).

Figure 4: GIS Overlay of Study Site, incorporating population distribution, land ownership, and location and size of waste water effluent inputs.

A review of mitigation sites in South Louisiana show that prices for cypress mitigation cost a minimum of $8,000/acre (much more when considering the ratio calculation between developed land and needed mitigation acreage).
Research Question #1A: Is LIDAR effective in determining wetland forest characteristics relative to sustainability? The 75m² sample of LIDAR data was compared to existing TM satellite data, and groundtruthed again for accuracy. A factor analysis shows that certain LIDAR variables (SDheight, Mground, Cvground), with some groundtruthing variables added (TUPstem and OTHERstem) provide excellent separation of Degraded areas (100% of time). Separation of Relic (74%) and Sustainable (79%) is not as clean, but neither is it in reality (difficult to assess under any method).

Conclusions and Recommendations
The Maurepas Manchac wetland complex is in the process of converting from cypress tupelo swamp to marsh and open water, and there are no areas where sustainable Cypress Tupelo mitigation can take place unless (a) the preservation model of mitigation is considered or (b) reliable multiple sources of fresh water (which could be in the form of waste water effluent and/or storm water runoff from nearby populated areas) are introduced. LIDAR data for use in discerning various states of healthiness works well and provides a level of detail greater than traditional Thematic Mapping, especially when discerning degraded sites, and when used with groundtruthing, though it is more expensive to obtain than TM. Impediments to mitigation include: suitability of land; competing choices of land use for owners; ignorance/complexity of mitigation regulations; and accessibility to sites. Various Farm Bill programs compete with mitigation, but prices for sites continue to rise, making mitigation a valuable business option for land owners.

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Effects on the 2011 Bonnet Carré Spillway Opening on Lake Pontchartrain Sediment Phosphorus Loading and Concentrations with Potential for Release to the Water Column

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Evidence from field monitoring of the 2011 Bonnet Carré Spillway opening indicates that phosphorus (P) limits phytoplankton growth in Lake Pontchartrain due to the high molar N:P ratio (~43) in inflowing Mississippi River water. Additionally, P availability is an important factor in the growth of nitrogen-fixing harmful algae in the estuary during summertime low-nutrient, N-limited conditions like those we have observed in 2011 as of July 7th. Phosphorus can be an important nutrient in regulating primary productivity in lakes. The ability of lake sediments to retain P from external sources depends on the physiochemical characteristics of the sediment. Previous research indicates that internal loading of P from sediments by diffusion accounts for ~517 mt SRP-P y⁻¹, an amount similar to that loaded by Bonnet Carré Spillway openings. Internal loading of P from sediments is dependent upon sediment P chemistry.

Further, knowledge about the role of the internal sediment P load on surface-water P enrichment is limited (Pant and Reddy, 2001; Reddy et al, 2007). The ability of lake sediments to retain P depends on the physiochemical characteristics of the sediments and oxidation-reduction conditions at the sediment-water interface (Istvanovics et al., 1989; Bostic and White, 2007). High loading of inorganic P in lake water can lead to P retention by oxides and hydrous oxides of iron and aluminum or calcium carbonate, while at low P concentrations, flooded soils or sediments can release P (Pant et al., 2001; White et al., 2004, 2006). For many lakes, reduction in external nutrient loads will not result in immediate improvement in water quality. Lake sediments can function as a source of or sink for dissolved nutrients to the overlying water column (Fisher et al., 2004). For example, the sediments of Lake Okeechobee, a large (1730 km²), shallow (average depth of 2.7 m) lake in the peninsula of south Florida, strongly influence the overlying water quality. These sediments are a large internal source of P (Moore et al., 1998).

The goal of this study was to analyze P chemistry using a P fractionation scheme for Lake Pontchartrain sediments before and after the 2011 Bonnet Carré Spillway opening to (1) determine locations where P release from sediments may be more significant than others and (2) investigate how the Bonnet Carré Spillway opening impacted sediment P chemistry spatially throughout the lake. Sediment cores were collected from 17 sites in Lake Pontchartrain on May 12, 2011, 3 days after the Bonnet Carré Spillway was opened, and again on July 7, 2011, 17 days after the Spillway was closed. Cores were sectioned into 0-5 cm and 5-10 cm intervals for sediment characterization and P fractionation. The fractionation scheme included five sequential extractions that subsequently determine readily available P, alkali extractable organic
P, iron/aluminum-bound P, calcium/magnesium-bound P, and residual P. Taken together, these five forms of P equate to the total P in the sediments. The order of the fractions is based on availability from highest to lowest. Sediment total P values can also be used to determine locations (e.g., near tributary outflows) where there has been significant external loading of P in the past. A set of samples collected prior to the 2011 Spillway opening will be compared with samples collected after the end of the 2011 event to determine the net total P loading to the lake as well as the potential for P release from this sediment pool to drive algal productivity.

References


Mechanics of sand transport through the Bonnet Carré spillway, Mississippi River, and implications for river-water and sediment diversions in southern Louisiana

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The magnitude of the 2011 Mississippi River flood necessitated the simultaneous opening of the Bonnet Carré and Morganza spillways (Louisiana) for the first time since 1973. The purpose of these two diversion structures is to decant and route water from the mainstem Mississippi River to neighboring floodways, in order to ease hydraulic strain on downstream river levees. Associated with diverted water is suspended sediment, which under appropriate fluid-stress conditions, will fall from suspension and deposit in the spillway. Our research measures the spatial extent and grain-size character of sand deposits in the Bonnet Carré spillway, and evaluates the mechanics for sand movement from the river channel through this spillway. Two field campaigns were conducted during the passing and subsequent fall of the flood wave: the first survey measured the distribution and grain size of channel-bed sands in the Mississippi River within ten kilometers of the diversion; the second survey collected numerous grab samples and deep (5 m) cores from sand deposits in the Bonnet Carré spillway, in order to examine planform and vertical variation of grain size. Aerial reconnaissance and ground surveys measured meter-scale bedform features and sand deposit thickness; these data are used to evaluate style of sand transport through the spillway. Preliminary data analyses indicate a significant overlap between grain-size populations of channel-bed and spillway sands, which is unexpected given physical models predicting grain-size character at the height of the water column where the diversion weir is located. Additionally, alluvial sand cover on the channel bed of the Mississippi River is discontinuous in the two bends upstream of the diversion, indicating removal and suspension of bedload sand. These results indicate that river-channel planform has an important role for mixing coarser bed sediment into the water column, and that a significant proportion of this channel-bed sand is routed through the Bonnet Carré spillway. Low-amplitude bedform features in the spillway indicate that sand transport is very near the critical phase for suspension, and much of the sand is deposited as sheet flow. We estimate volume of sand transported into the spillway by coupling estimates of sand concentration from the neighboring river channel with water discharge measurements at the diversion; this volume of sand is compared to measured sand deposits in the spillway, and used to assess the extent of sand trapping in the spillway and transport into Lake Pontchartrain. Our presentation will detail these results and analyses, and describe how information from the Bonnet Carré spillway can be used to understand the efficiency of proposed diversions in the lowermost Mississippi River seeking to route water and sediment to neighboring wetlands.
River Diversions as a Component of the State of Louisiana’s Strategy to Achieve a Sustainable Coastal Zone

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The State of Louisiana has experienced a severe loss of coastal wetlands during the past century, much of which has been due to the decoupling of the flow of the Mississippi River from coastal wetlands that resulted from the leveeing of the river in the 19th and 20th centuries for flood control and navigation purposes. The State, together with its federal partners and the academic and non-governmental community, has developed a number of plans for achieving a sustainable coastal zone. These strategies envision a toolbox of coordinated protection and restoration actions that will need to be undertaken.

A critical component of that toolbox is to construct new and operating existing diversions from the river to distribute freshwater, nutrients and sediments to the coastal wetlands. The State has, together with its federal partners, built and is currently operating several diversions and siphons in southeast Louisiana intended to deliver freshwater into coastal basins. One diversion (West Bay) was built to deliver sediment from the Mississippi River to build coastal wetlands. The State and its partners are currently evaluating the physical and ecological responses of those receiving basins to diversions operations.

Additional diversions for the delivery of freshwater and sediments in coastal wetlands have been identified as future components of State, federal, and non-governmental strategies. These projects are being planned to coordinate with other protection and restoration actions. For example, diversion inflows would nourish wetlands created with dredged sediment in addition to creating new land themselves. This poster will detail the State’s integrated strategy for achieving a sustainable coast, with diversions as a component. This poster will specifically detail the past diversions that have been constructed throughout southeast Louisiana, as well as the multiple diversions that have been proposed or are currently in some level of study or planning.
Understanding the Technical Issues Associated with the Construction and Operation of River Diversions in the State of Louisiana

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The State of Louisiana has experienced a severe loss of coastal wetlands during the past century. Much of this wetland loss has been due to the decoupling of the flow of the Mississippi River and its distributaries from the interdistributary coastal basins that resulted from the leveeing of the river in the 19th and 20th centuries for flood control and navigation purposes. The State, together with its federal partners and the academic and non-governmental community, has developed a number of plans for achieving a sustainable coastal zone. A key component of all of these strategies is to reconnect the river to the coast constructing new and operating existing diversions from the river to mimic the pre-levee hydrology distribution of freshwater, nutrients and sediments to the coastal wetlands.

A large number of academic studies have been conducted on the wetlands and estuaries receiving diversion flows to improve the understanding of the responses of specific ecosystem and sociological components of the coastal ecosystem to these diversions. As well, the State and federal governments have conducted extensive monitoring in these same systems, and have been conducting detailed studies during the project planning process to maximize project benefits and minimize potential negative outcomes. All aspects of this scientific inquiry provide critical information needed to define response to diversion operations and inform stakeholder discussions of trade-offs and management decision-making. Likewise, there are caveats and limits to extrapolation in all of these efforts that need to be explicitly defined to ensure that unjustifiable conclusions of diversion benefits or detriments are not made or perpetuated. This poster will describe some of the technical investigations and independent peer reviews that the State of Louisiana is conducting or coordinating in order to understand the benefits and risks in constructing and operating river diversions.
Entrainment of Sturgeon through the Bonnet Carré Spillway

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The Bonnet Carré Spillway diverts flood waters from the Mississippi River into a floodway that empties into Lake Pontchartrain to reduce river stages at New Orleans. The spillway has been opened twice over the past four years, although frequency of openings prior to this period was approximately once every 10 years. In 2008, it was open for 27 days beginning April 11th, maximum number of bays in operation was 160 out of 350, and maximum discharge through the structure was 160,144 cfs. In 2011, it was open for 42 days beginning May 9th with a maximum of 330 open bays, which created discharges twice as high (315,930 cfs) compared to 2008. Once the structure is closed, discharge depends on the amount of water leaking through the pins.

During both openings, the U.S. Army Corps of Engineers (Corps), Louisiana Department of Wildlife and Fisheries (LDWF), and Nicholls State University evaluated entrainment of the federally-endangered pallid sturgeon (Scaphirhynchus albus) through the structure. In both cases, sturgeon were captured during the first week after closing with sampling continuing for numerous weeks. Sampling also occurred one week prior to the 2011 opening, but no sturgeon were captured. Multiple sampling gears were used including electroshocker, seines, trawls, and gill nets. Three primary areas of the floodway were sampled regularly: stilling basin, canals (primarily Barbars and Y), and lakes (Figure 1). Over 24 days were expended by three crews working either together or separately representing LDWF, Nicholls State, and the Corps (ERDC and Bonnet Carré project staff primarily Bill Maus and Steve Stone).

In 2011, acoustic telemetry was used to monitor movement of entrained shovelnose sturgeon (Scaphirhynchus platyrynchus), a species closely related to and sympatric with pallid sturgeon. Shovelnose sturgeon caught in the floodway were fitted with V9 coded acoustic transmitters and released into Barbars Canal and other locations. A total of 12 VR2Ws (remote receivers) were deployed from Bonnet Carré Spillway down Barbars Canal to Lake Pontchartrain to establish an automated acoustic telemetry array for determining movement patterns of individual shovelnose sturgeon throughout the floodway (Figure 2). In some cases, individuals equipped with transmitters were manually tracked with a V100 manual receiver.

Discharge patterns after the structure was closed differed substantially between the two years (Figure 3). The 2008 hydrograph exhibited a slow decline over a period of four weeks, whereas the 2011 hydrograph dropped to almost zero discharge in the floodway within a week. Pallid and shovelnose sturgeon catch generally followed the same trend as the hydrograph (Figure 3). Sturgeon were caught over a four-week period in 2008, whereas almost all sturgeon captured in 2011 occurred within the first week after closure. The greater magnitude of discharge through the floodway in 2011 may have been one contributing factor by displacing sturgeon to a greater extent. However, the abbreviated period of flow in the canals during 2011 also contributed to sturgeon catch patterns. Both pallid and shovelnose sturgeon are strongly rheotactic and orient into the direction of the flow. Water velocity in the canals below the structure essentially went
to zero within a week after the 2011 closure and water levels dropped precipitously throughout the floodway. Therefore, displaced sturgeon were less likely to move towards the base of the structure as they did in 2008 when currents persisted for 4-5 weeks in the canals where most sturgeon were caught. Rapid drop in water levels in 2011 also hampered physical movement through or over road crossings that crisscross the floodway. Sturgeon essentially became stranded in 2011, with most individuals caught in the stilling basin below the structure or in floodway lakes that became disconnected with the canals.

Higher discharge and longer opening in 2011 resulted in greater number of sturgeon caught. In 2008, a total of 14 pallid and 41 shovelnose sturgeon were collected over a 4-week period. In 2011, a total of 20 pallid, 78 shovelnose, and one possible intermediate sturgeon were collected over a 1.5-week period. A notable collection was a tagged pallid sturgeon originally captured in the floodway during 2008 and released back into the Mississippi River. Pallid to shovelnose ratio were similar between the two years; 1:3 in 2008 and 1:4 in 2011. Ratio in this reach of the lower Mississippi River is typically 1:3. Mean length of pallid sturgeon collected in 2011 was 773 mm FL, compared to 712 mm FL in 2008. Sizes in 2011 ranged from 449 – 924 mm FL corresponding to ages ranging from 3 to greater than 15 years. Mean size of shovelnose sturgeon caught in 2011 was slightly smaller (607 mm FL) than in 2008 (665 mm FL).

Eighteen shovelnose sturgeon ranging in size from 501-830 mm FL were captured from upper Barbars, Y-Canal, and Bonnet Carré stilling basin and equipped with acoustic telemetry tags (289 day battery life) during the period 20-27 June 2011. Tagged fish were then redistributed within the system near telemetry buoys (Barbars 1, 2, 4, 5, 8 and Y-canal 1, see Figure 2). As of 8 August 2011 we have accumulated 118,441 total detections, no mortalities have been reported, and all fish appear to be actively moving. Telemetry did confirm one shovelnose sturgeon moving into Memphis Lake and becoming stranded when water levels dropped. Data are still being accumulated and analyzed, but at this time, no fish have been documented moving into Lake Pontchartrain from the guide/suction canals.

The USFWS issued a non-jeopardy, emergency Biological Opinion for the 2008 opening with an estimated incidental loss of 88 adult pallid sturgeon. A Biological Opinion will likely be issued for the 2011 opening. Differences in hydrograph and catch rates should be considered for future operations. Rapid decreases in discharge below the structure, which happened in 2011, will probably result in more sturgeon becoming stranded and non-recoverable. Gradual decreases in discharges, like 2008, will provide rheotactic cues for sturgeon to move upstream towards the structure, congregate, and become easier to catch. Regardless of the discharge patterns, however, it has been demonstrated twice under different circumstances that rapid rescue of entrained pallid sturgeon can be successfully accomplished to minimize impacts to this endangered species.
Figure 1. Three primary areas where sturgeon were collected in 2011: Stilling Basin, Canals (Barbars and Y), and Lakes.
Figure 2. Location of 12 VR2Ws (remote receivers, green dots) deployed in the Bonnet Carré Spillway down to Lake Pontchartrain. Red arrows indicate relocation of receivers from waterbodies that became disconnected from primary canals.
Figure 3. A summary of discharge (CFS) in the floodway and sturgeon catch after closure of the Bonnet Carré spillway in 2008 and 2011.
To mix or not to mix, that is the question? A case study of a Freshwater Diversion and Genetic Diversity

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The Lake Pontchartrain Basin in southeast Louisiana is an ecologically complex system that ranges from nearly pure seawater (Lake Borgne) in the southeastern portion of the Basin to pure fresh water in the western-most portion of the Basin (Lake Maurepas). The basin contains a unique and ever-changing fish fauna that is comprised of more than 100 marine, estuarine, and freshwater species. Due to environmental problems in the Lake Pontchartain Basin, a freshwater diversion has been proposed between the Lake Pontchartain and Mississippi River Basins, essentially re-connecting these basins, thereby allowing for the influx of freshwater, sediments, and organisms into the Lake Pontchartrain Basin. Although the influx of water is aimed at restoring the wetlands in the western portion of the basin (Lake Maurepas), it may negatively impact the ichthyofauna of the basin through homogenization of genetically distinctive stocks, strains, or populations of fishes. Disruption of distinct stocks either through intentional or unintentional avenues can have detrimental effects on the genetic integrity of native fish populations through decreased levels of fitness and lower survivability in offspring derived by hybridized stocks. Therefore, the objective of this study was to assess levels of genetic variation of blue catfish (Ictaluridae: Ictalurus furcatus) and bluegill (Centrarchidae: Lepomis macrochirus), two of the most abundant species in the region, within and between the Lake Pontchartrain and Mississippi River Basins using high-resolution microsatellite DNA markers. Specimens of blue catfish and bluegill were obtained either by electrofishing or from commercial fisherman during the summer and Fall of 2004 and 2005 from five sampling locations in the Lake Pontchartrain and Mississippi River Basins. Two-hundred fifty blue catfish and 207 bluegills were collected, clipped, and released. Fin clips of each specimen for DNA analysis were preserved in 95% ethanol. This study is particularly important for coastal restoration because the often-used freshwater diversion restoration tool has the potential to disrupt the genetic integrity of these, and other aquatic species through homogenization. The results from this study indicate high levels of intra-specific variability for the markers examined in this study. Multiple independent genetic analyses of these markers suggest that there is no genetic structuring within or among the Lake Pontchartrain and Mississippi River Basins, resulting in limited genetic differentiation of Blue Catfish or Bluegill. Based on these findings, Blue catfish and Bluegill appear to each consist of a single panmictic stock distributed across both basins. High levels of gene flow have been shown to limit the amount of genetic differentiation among populations of other species in other environments. In this study, one artificial factor contributing to the high levels of gene flow is the Bonnet Carré Spillway, which serves as a corridor for dispersal of fishes between the Mississippi River and Lake Pontchartrain Basins. The combination of the life-history characteristics and large population sizes of both species, along with the Bonnet Carré Spillway has allowed for the high degree of mixing among populations. Historical connections of Lake Maurepas and the Mississippi River, and multiple levee breeches in the 1800’s may have facilitated gene flow and inhibited differentiation between Basins. Based on the results for his study, the proposed diversion of the Mississippi River into Lake Maurepas would likely have minimal effect on the genetic integrity and concomitant fitness of these fishes.
Nutrient Dynamics in Lake Pontchartrain during and after the 2011
Bonnet Carré Spillway Opening

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Lake Pontchartrain is a large, oligohaline estuary located in coastal Louisiana, U.S.A. that receives episodic, managed diversions of nutrient-rich Mississippi River water via the Bonnet Carré Spillway to alleviate flood threats to the city of New Orleans. Most recently, the Bonnet Carré Spillway was opened from May 9 to June 20, 2011. These events may lead to expressions of eutrophication in the estuary (Turner et al. 2004, Mize and Demcheck 2009, Bargu et al. 2011) and it is therefore critical to understand nitrogen and phosphorus dynamics during diversion events. In this study, we monitored nutrient concentrations and water quality parameters along a 30-km, 11-station transect extending northeast from the Spillway inflow to the lake center (White et al. 2009) before, during, and after the 2011 Bonnet Carré Spillway event (May 9 – June 20). In addition, we monitored nutrient concentrations exiting Lake Pontchartrain via the Rigolets and Chef Menteur passes on 3 dates during the Spillway opening and completed pre- and post-diversion lake-wide sampling efforts (15 total sampling trips as of July 22, 2011).

Pre-Spillway opening nitrate (NO₃⁻) concentrations ranged from 0.02-0.55 mg NO₃-N L⁻¹, with highest concentrations occurring near the Spillway inflow, indicating leakage of Mississippi River water before the Spillway was opened. Soluble reactive phosphorus (SRP) concentrations in the estuary before the Spillway opening averaged 0.06 mg SRP-P L⁻¹ with little variation along the 30-km transect. After the Spillway was opened on May 9th, Mississippi River water began entering the lake with NO₃⁻ and SRP concentrations of 1.17 mg NO₃-N L⁻¹ and 0.06 mg SRP-P L⁻¹, respectively, indicating a molar N:P ratio of ~43 and thereby suggesting P limitation on phytoplankton growth. On June 8th, the surface water NO₃⁻ concentration of water exiting Lake Pontchartrain via the Chef Menteur was 0.69 mg NO₃-N L⁻¹ (uncorrected for salinity), indicating that a significant portion (~60%) of the nitrate load from the Bonnet Carré Spillway was being transported to Lake Borgne in the early phase of the Spillway opening. SRP concentrations were below detection at the Chef Menteur on June 8th and near the southern end of the Causeway on June 13th, suggesting a P limitation on phytoplankton growth was occurring in the eastern portion of the estuary. The P limitation in this region was confirmed during sampling on June 15th, when SRP concentrations within the freshwater plume from the Causeway to the Chef Menteur Pass were below detection and NO₃-N concentrations remained fixed at ~0.3 mg L⁻¹. Finer spatial scale data on June 16th from our 30-km transect suggests that uptake of P and N by phytoplankton occurred rapidly near the freshwater plume edge until P limitation (SRP conc. ≈ 0) set in when NO₃-N = 0.34 mg L⁻¹, restricting further phytoplankton growth and nitrate assimilation.

The Bonnet Carré Spillway was closed on June 20th and by June 25th NO₃⁻ concentrations had fallen to 0.06-0.95 mg NO₃-N L⁻¹, with highest concentrations again closest to the Spillway indicating further leakage of river water after Spillway closure. Data from a July 7th lake-wide cruise indicated that no NO₃⁻ remained in the lake by this time (concentrations below detection
at all sites) and that SRP concentrations were ~0.01-0.04 mg SRP-P L^{-1} in many locations, signaling a new source of phosphorus and a return of N-limitation on phytoplankton growth.

In addition to external loading of nutrients to Lake Pontchartrain, internal nutrient cycling and loading could have implications for ecosystem responses to Spillway events. To better understand nutrient dynamics at the sediment-water interface including denitrification and phosphorus flux, we performed (1) intact sediment core incubation experiments, (2) in-situ measurements of the vertical profiles of dissolved inorganic nutrient species at the sediment-water interface, and (3) acetylene-block batch incubation experiments. Maximum rates of NO_3 flux into the sediments for intact cores were 26.4-61.9 mg NO_3-N m^{-2} d^{-1} and 24.3-53.0 mg NO_3-N m^{-2} d^{-1} for aerobic and anaerobic treatments, respectively, with no significant differences between treatments. Mass transfer coefficients ranged between 0.009-0.019 m d^{-1}. Flux rates by Fickean diffusion based on in situ porewater measurements averaged 29.7 mg NO_3-N m^{-2} d^{-1} and were remarkably similar to rates determined based on intact core experiments. The acetylene-block batch incubations suggest a greater activity of denitrifying microorganisms in sediments near the Spillway inflow that are exposed seasonally to Spillway leakage compared to those in the lake center. Based on measured rates and a simple model, we estimate that denitrification accounted for ~4.2% (422 mt NO_3-N) of water column NO_3 loss during the entire 2008 Bonnet Carré Spillway diversion event (10,000 mt NO_3-N) and a similar percentage during the 2011 event. Denitrification in Lake Pontchartrain therefore appears to play a relatively minor role in the removal of nitrate received during Spillway freshwater diversion events.

SRP flux from sediments averaged 0.26-0.87 mg SRP-P m^{-2} d^{-1} and the mean internal SRP load was estimated to be ~517 mt y^{-1}, or 44% of the annual lake SRP budget during non-Spillway opening years and 30-33% in years when the Bonnet Carré Spillway is opened. The internal SRP load may be an important contributor in promoting blooms of nitrogen-fixing harmful algae under summertime low-nutrient, N-limited conditions like the environmental conditions observed in 2011 as of July 7th. Currently, we are working to determine the source of the new phosphorus observed as of July 7th and hypothesize that much of it is generated by internal sediment loading.

References:


Physical, Chemical and Biological factors affect Methylmercury in Lake Pontchartrain, Louisiana

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Lake Pontchartrain is at the receiving end of many tributaries, which may contribute to the total input of mercury and other contaminants to the lake. Bottom sediment is the main reservoir for mercury in aquatic ecosystems; therefore, understanding the mechanisms of release and transport of mercury species in these sediments is significant when considering inputs from contaminated tributaries to the lake.

Hurricane Katrina devastated the Gulf Coast of Louisiana and Mississippi on August, 29 of 2005. One of the major concerns was the impact that storm surges and flood waters had on the water quality of Lake Pontchartrain. The storm surges delivered saline water to the brackish lake, and flood waters from New Orleans were pumped into the lake at various locations along the southern shore. Flood waters contained contaminants (nutrients, metals, and organics) typically found in waters influenced by urban runoff.

Sediment, water and fish samples were collected through three seasons each year March 2005, and July 2005, (March, July and November 2006) from each site. Sampling was not collected during November 2005 due to Hurricane Katrina. Collected samples were preserved in the field according to sampling protocol and transported to Tulane University Laboratories within 6 hours of collection. Measurements of pH, ORP, Temperature, Dissolved Oxygen and salinity were conducted in the field. All samples were analyzed for total mercury and total methyl mercury. Sediments were collected using a core sampler (Fisheries Suppliers); the core dimension is 2.5 in diameter x 6 in height. Samples were collected from off-shore locations, approximately 3-4 feet deep at each designated site. A core sample from each site was sliced into 2 in intervals for depth profiling. A minimum of 5 sediment cores were collected from each designated site during each sampling season. Core from each site was utilized immediately for evaluation of contaminant concentrations and organic matter analysis. Each slice was analyzed for total mercury, methyl mercury and organic matter. The remaining cores were stored at 4° C until analysis time.

The purpose of this study was to determine the levels of total mercury and methylmercury at each selected site and to examine the effect of seasonal variation on mercury and methylmercury concentrations in Lake Pontchartrain bottom sediments. Total mercury and methylmercury were found to be higher in the subsurface sediments than surface sediments. Their concentration increased with depth, this can be related to the decrease of Dissolved Oxygen level and the increase of SRB (sulfate reducing Bacteria) after Katrina in Lake Pontchartrain.

Total mercury (Hg) and methylmercury (MeHg) concentrations were determined in sediments from 8 selected stations around Lake Pontchartrain. Hg and MeHg concentrations in sediments ranged from 45 to 177 μg/kg, and from 0.39 to 2.5 μg/kg, respectively.

Seasonal variations significantly affected Hg and MeHg concentrations in sediments and Total Hg concentrations in sediments were significantly (p<0.05) higher in spring and summer than in winter and also MeHg concentrations were lowest in winter compared to the other seasons, and were significantly(p<0.05) during spring and summer of 2006. Statistical analysis of 2006 data samples shows that it passes the normality test (P<0.05) with the value of P <0.042
between the (0-2) inches depth and the (4-6) inches depth profile. Temporal differences in total mercury and methyl mercury concentration between the (0-2) inch depth and the (2-4) inch sediment depth profiles still represent a relatively small range, but falls short of being significant (Pearson’s correlation analysis: p=0.505, n= 24).

Statistical analysis of total mercury concentration at different depths indicates a dramatic increase with depth. The total mercury concentration for (0-2 in, 2-4 in, and 4-6 in) was found to have mean concentrations of 102.8 ppb, 108.7ppb, and 120.9 ppb, respectively. This mean difference is statistically significant with (p< 0.05) between 2 and 6 inches with a mean difference of 18.1ppb. Throughout all selected sites, total mercury concentration increased between the (0-2 in) and the (4-6 in) layers with nearly 14%.

Also a total of 243 collected fish samples were analyzed for mercury and methylmercury concentration. The data indicate that mercury concentration in fish samples were significantly (p<0.05) higher in the fish collected in the summer than fish collected in the winter. Mercury concentration in fish varies based on the type species, size, and length of each fish. Analyzed fish samples were collected from Lacombe, Bonfouca, and LaBranche areas around Lake Pontchartrain. The number of analyzed fish samples were 10 carp, Common samples,49 of Spotted Gar, 16 of Gulf Menhaden, 29 of Mullet, 20 of Bluegill, 7 of American eel, 15 of Inland Silverside, 28 of Largemouth Bass, 20 of reedear Sunfish, 34 of Red spotted Sunfish, 6 of Warmouth, 3 of Bowfin, 3 of Yellow Bullhead, and 2 of Alligator gar. Mercury concentration in fish samples ranged from 0.035 ppm to 1.13 ppm. Mercury concentration were significant (p<0.05) with location. Also the mercury concentration varies among each fish species based on the weight and the length of each sample and season.

Bioavailability and accumulation was studied using Mesocosom experiment. Methylmercury concentrations in clams’ tissue from (1ppt, 4ppt, 7ppt, and 12 ppt) aquaria were found to be 43±2.93ppb, 36 ±2.25 ppb, 18 ± 1.78 ppb and 10±1.24 ppb. The concentration of mercury and methylmercury shows an inverse correlation with salinity. As the salinity level increased the methylmercury concentration decreased and therefore the bioaccumulation in biota decreased.

References/Citations
Table 1: Effect of seasonal variation on Total Mercury and Methyl mercury (ppb) Concentrations:

<table>
<thead>
<tr>
<th>Season</th>
<th>THg (ppb)</th>
<th>MeHg (ppb)</th>
<th>DO (mg/l)</th>
<th>OM (%)</th>
<th>Salinity(ppt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 05</td>
<td>88.0</td>
<td>0.84</td>
<td>7.3</td>
<td>1.6</td>
<td>2</td>
</tr>
<tr>
<td>July 05</td>
<td>96.5</td>
<td>0.93</td>
<td>6.5</td>
<td>2.3</td>
<td>5</td>
</tr>
<tr>
<td>March 06</td>
<td>102.0</td>
<td>1.4</td>
<td>3.9</td>
<td>6.5</td>
<td>7</td>
</tr>
<tr>
<td>July 06</td>
<td>119.0</td>
<td>1.6</td>
<td>3.2</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>November 06</td>
<td>95.2</td>
<td>1.3</td>
<td>5.6</td>
<td>1.9</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Table 2: Comparison of Mercury and Methyl mercury Concentration in Lake Pontchartrain.

<table>
<thead>
<tr>
<th>Reference</th>
<th>THg (µg/kg)</th>
<th>MeHg (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.D. Delaune (2004)</td>
<td>67.0 µg/kg</td>
<td>0.49 µg/kg</td>
</tr>
<tr>
<td>This Study (2005)</td>
<td>92.3 µg/kg</td>
<td>0.94 µg/kg</td>
</tr>
<tr>
<td>This Study (2006)</td>
<td>105.3 µg/kg</td>
<td>1.45 µg/kg</td>
</tr>
</tbody>
</table>
Land Area Changes and Forest Area Changes in the Vicinity of the Mississippi River Gulf Outlet-Central Wetlands Region from 1935-2010

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Recent studies have shown an increasing connection between historical episodic events and current landscape condition (Barras et al. 2008; Morton and Barras 2011). The importance of historical landscape reconstruction through the interpretation of aerial photography has increased because it provides synoptic views of hydrology, vegetation, and ecosystems for time periods when data options are limited (Harvey and Hill 2001). The goal of this study was to provide a refined landscape history for the Central Wetlands Unit (CWU) that both exceeds and supplements information provided by existing coastal habitat and land loss data sets. The research identified and quantified recent and historical land change trends and general forested habitat changes within the CWU from 1935 to 2010. As part of the overall Mississippi River Gulf Outlet (MRGO) Ecosystem Restoration Study, the CWU is a critical coastal restoration project designed to mitigate the effects of the MRGO dredging and spoil placement in southeastern coastal Louisiana. The study area encompasses 31,875 acres and is located adjacent to the MRGO channel. This historically freshwater dominated landscape now has limited hydrologic connectivity to freshwater inflows and is bound on all sides by levees and spoil containment banks. Like many other areas in coastal Louisiana, the CWU has experienced a high rate of land loss through storm events, human-induced impacts, saltwater intrusion, and subsidence.

The CWU land area changes were analyzed using a sequential series of 32 land-water data sets obtained from classified Landsat Thematic Mapper (TM) Satellite imagery (1983 to 2010). However, assessing historical land change trends within the CWU before 1983 (prior to Landsat TM 5 satellite imagery collection), and linking those changes to specific events, may not be possible without examining aerial photography bracketing prior episodic events. Therefore, four additional historical data sets were selected and classified to increase the CWU comparison period to seventy-five years. These datasets include USGS topographic quadrangles and panchromatic and color infrared aerial photography. Land and water area from 1935 to 2010 was summarized for the CWU. The land area measurements were then used to calculate net land losses or gains by comparison period and annual trend rates by period. The time periods evaluated were 1935-1958, 1958-1965, 1965-1978, 1978-1990, 1990-2001, 2001-2004, 2004-2006, and 2006-2010. Linear regression analysis provided a more robust estimate of recent trends within the CWU from 1983 to 2010 by comparing land area over time using all applicable higher temporal frequency data sets. Forested habitat changes were evaluated using two pre-construction (1935 and 1956) and two post-construction (1965 and 1974) data sets bracketing the construction of the MRGO (1965). Identifying the changes within the CWU required standardization of forested habitat across the four data sets. For this study, forested habitat was defined as predominantly cypress and tupelo swamp, but included other swamp forest species and limited amounts of bottomland hardwoods.

The study revealed that the CWU net land loss from 1935 to 2010 was 6,688 acres (Figure 1). Over the last 75 years, the assessment interval that accounted for the largest percentage of land area change within the CWU was the 1935-1958 period (40%). The 1958-1965 period encompassed a total loss of 606 acres (Table 1). The second greatest loss (1,864 acres) occurred during the 1965-1978 period, followed by the 2004-2006 period (965 acres). The 2006-2010
period's gain of 638 acres is partially related to the end point classified Landsat TM image of February 25, 2010 reflecting lower water level conditions and possible partial recovery after Hurricane Katrina. The 1978-2004 period contained no major hurricane landfalls affecting the CWU and was characterized as stable with moderate land change, and accounted for 18% of the CWU total loss. Recent land area trends (1983-2010) calculated using Landsat TM imagery for the CWU revealed a land area change rate of -87.6 ± 11.1 acres/yr ($r^2 = 0.68$).

Rapid loss of forested habitat occurred within the CWU throughout the 1935 to 1974 analysis period. In 1935, 44% (13,924 acres) of the CWU consisted of forested habitat. However, by 1956 the majority of the forested area near the fresh and non-fresh transition zone converted to fresh marsh (Wicker, 1980). This habitat conversion accounted for the majority of the 3,420 acre decline in CWU forested habitat between 1935 and 1956. Forested area continued to decline during the 1956 to 1965 time period. By 1965, an additional 3,812 acres of forest were lost. The highest net loss of forest occurred during the 1965 to 1974 period (6,692 acres) and signified a complete conversion of forest within the CWU to marsh, water, spoil, or impoundments in the 9-year time frame.

The primary events affecting historical landscape change within the CWU over the past 75 years are linked to (1) cumulative hurricane impacts causing physical removal of marsh, (2) partial flooding of impounded areas after Hurricane Betsy, (3) construction of the MRGO, and (4) salinity increases causing habitat conversion.

The majority of land loss observed in the CWU occurred within the 1935-1958, 1965-1978, and 2004-2006 time periods. These time periods accounted for 82% of the 1935-2010 CWU net loss. These losses are primarily due to episodic impacts from hurricanes, impoundment development and flooding, and MRGO related dredging. It is likely that a conservative 50% of CWU loss over the past seventy-five years is linked to these cumulative episodic impacts and non-linear events. The 1983 to 2010 assessment period represents consistent loss rates within the CWU. However, the southwest CWU area land loss was dominated more by habitat switching than land loss.

Shifts in salinity regime may have contributed to the conversion of forested habitat to marsh over the 1935 to 1974 assessment period. Additional causes of this loss include commercial development, forest removal, MRGO construction, and hurricane related flooding of impoundments. Although the MRGO related dredging caused land loss in the CWU, the placement of dredge material also resulted in land gains adjacent to the GIWW and the MRGO. Regeneration of forested habitat may have resulted due to the increased elevation in these areas as noted by the evaluation of 2008 aerial photography.
Figure 1. Central Wetlands Unit land change trends 1935-2010.

Table 1. Central Wetlands Unit Net Land Area Trends by Period.

<table>
<thead>
<tr>
<th>Interval</th>
<th>Net Loss (Acres)</th>
<th>Period (Years)</th>
<th>% Total Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1935-1958</td>
<td>-2,688</td>
<td>23</td>
<td>-40.2%</td>
</tr>
<tr>
<td>1958-1965</td>
<td>-606</td>
<td>7</td>
<td>-9.1%</td>
</tr>
<tr>
<td>1965-1978</td>
<td>-1,864</td>
<td>13</td>
<td>-27.9%</td>
</tr>
<tr>
<td>1978-1990</td>
<td>-421</td>
<td>12</td>
<td>-6.3%</td>
</tr>
<tr>
<td>1990-2001</td>
<td>-565</td>
<td>11</td>
<td>-8.4%</td>
</tr>
<tr>
<td>2001-2004</td>
<td>-217</td>
<td>3</td>
<td>-3.2%</td>
</tr>
<tr>
<td>2004-2006</td>
<td>-965</td>
<td>2</td>
<td>-14.4%</td>
</tr>
<tr>
<td>2006-2010</td>
<td>638</td>
<td>4</td>
<td>9.5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>-6,688</strong></td>
<td><strong>75</strong></td>
<td><strong>-100.0%</strong></td>
</tr>
</tbody>
</table>
REFERENCES:


Impact of two Mississippi River Flood Events on the Resilience of the Chandeleur Island Fish Assemblage.

Chris S. Schieble, Martin T. O’Connell, Patrick W. Smith, Kenneth G. Blanke, and Jeffrey M. VanVrancken.

1Pontchartrain Institute for Environmental Sciences, University of New Orleans, New Orleans, LA., 2Earth and Environmental Sciences Department, University of New Orleans, New Orleans, LA., 3U.S. Army Corps of Engineers, New Orleans, LA., 4U.S. Fish and Wildlife Service, Niceville, FL.

The Chandeleur Islands are a crescent-shaped barrier island chain located approximately 120km east of New Orleans that comprise the eastern-most boundary of the Pontchartrain Basin. This barrier island chain contains the largest expanse of seagrass habitat in coastal Louisiana. Compared to other coastal Louisiana habitats, relatively pristine ecological conditions exist at these islands due to their remote locality. The seagrass and the fishes associated with them are primarily influenced by natural disturbances, including hurricanes, river flooding, and other high energy events like winter cold fronts (Penland et al., 1988; Ritchie et al., 1992). As with most barrier islands, the Chandeleur Islands play a crucial role in diminishing the negative impacts of approaching hurricanes. However, the physical protection provided by this barrier island chain is diminishing due to accelerated erosion rates caused by the sequential impacts of major hurricanes. Recently, a unique opportunity presented itself to study the impact of two major Mississippi River flood events on the Chandeleur Islands within a three year period. In April of 2008 the Mississippi River exceeded flood stage at the Carrolton Gauge in New Orleans and the Bonnet Carré Spillway was opened. Similarly, in May of 2011 the river exceeded flood stage and the spillway was once again opened.

To assess the response of the Chandeleur fish assemblage to these two disturbances, we sampled nearshore habitats consisting of three seagrass species, marsh grass, and black mangrove utilizing a 15.25 m x 6.25 mm mesh bag seine making triplicate 50 m hauls perpendicular to shore. This sampling was conducted in May of 2004, 2005, 2006, 2007, and 2010 to provide pre-flood data, and May of 2008 and 2011 to provide flood data. To test the hypothesis that Mississippi River flood events could elicit a possible fish assemblage response at the Chandeleur Islands, we assessed the composition of the samples collected using a one-way analysis of similarity (ANOSIM, α = 0.05) to test for significant differences between non-flood and flood assemblages among months sampled. Assemblage data were square root transformed and a Bray-Curtis similarity matrix of all pair-wise comparisons was calculated for all samples per month. If a significant difference in assemblages was observed, a 2D non-metric multidimensional scaling plot (MDS) was constructed and then the Similarity percentage (SIMPER) routine was used to determine which species were the major drivers of the observed assemblage variation. Simply stated, the SIMPER routine will show which species exhibited a percentage increase or decrease for each month sampled due to river flooding. By examining the same month over seven years, we had hoped to minimize any possible seasonal variation in assemblage composition.

The MDS plot revealed that fish assemblages collected in non-flood years were significantly different (Fig. 1) than those collected in flood years (2008 and 2011), (ANOSIM, R = 0.258, p = 0.004). SIMPER analysis of flood and non-flood years indicated an average dissimilarity of 71.32%. The average abundance of five species: *Lagodon rhomboides*, *Leiostomus xanthurus*, *Menidia*
beryllina, Fundulus similis, and Bairdiella chrysoura increased during flood years, while the decrease in abundance of other species was not significant enough to show a percent contribution to the overall change in assemblage (Table 1). This significant change in the assemblage shows the impact of intense floods on the seagrass associated fish assemblage of the Chandeleur Islands and may be closely associated with the overall land loss in Louisiana. Concern about the effects of either a natural or anthropogenic impact should be raised when there is a significant permanent change in a fish assemblage (O’Connell et al., 2004).

Table 1.

<table>
<thead>
<tr>
<th>Species</th>
<th>Non-Flood N</th>
<th>Flood N</th>
<th>Av. Diss</th>
<th>%Contrib.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagodon r.</td>
<td>125.07</td>
<td>216.67</td>
<td>+32.34</td>
<td>45.34%</td>
</tr>
<tr>
<td>Leistomus x.</td>
<td>15.03</td>
<td>172.83</td>
<td>+21.37</td>
<td>29.96%</td>
</tr>
<tr>
<td>Menidia b.</td>
<td>10.33</td>
<td>37.08</td>
<td>+7.07</td>
<td>9.92%</td>
</tr>
<tr>
<td>Fundulus s.</td>
<td>2.10</td>
<td>12.75</td>
<td>+2.68</td>
<td>3.76%</td>
</tr>
<tr>
<td>Bairdiella c.</td>
<td>0.73</td>
<td>12.58</td>
<td>+2.10</td>
<td>2.95%</td>
</tr>
</tbody>
</table>

Figure 1.


Geographic Variation in Salinity Tolerance among Green treefrog (Hyla cinerea) Schneider Populations in Southeast Louisiana

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Saltwater intrusion is among one of the highly detrimental factors contributing to wetland loss in the Lake Pontchartrain area in southeast Louisiana. Studies have documented salinity effects on plant communities in southeastern Louisiana, but none has dealt with its effect on the anuran community. Salinity increases can have profound effects on the reproductive success of amphibians as well as the fitness of their progeny. However, the effect of salinity is unknown for any amphibian in this area. This study investigates the effects of various salinity levels on mortality, larval growth, and metamorphosis on one of the most abundant frogs (Hyla cinerea) in the Manchac swamp area. The Manchac Wildlife Management Area (MWMA) is located in the Lake Pontchartrain Basin in southeastern Louisiana. Salinity tolerance was determined using four clutches of eggs, two from intermediate salinity marshland sites and two from freshwater sites during different ontogenetic stages in a common garden experiment. For each clutch 20 tadpoles were reared in each of six salinity levels (2, 4, 6, 8, 10, and 12‰) and a freshwater control. Preliminary data indicate that water salinity has a distinct effect on embryonic mortality. Salinity effect varied among populations and developmental stages. Salinity stress during the late larval stages (25–46) showed substantial influence on developmental rate. My data indicate that mean developmental time is longer than currently noted in literature, possibly due to salinity stress. In addition, weight and SVL are strongly linked and show similar trends among populations at metamorphosis.
Effects of Hurricanes Ivan, Katrina, and Rita on a Southeastern Louisiana Herpetofauna

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E-mail: tiffany.schriever@utoronto.ca

Tropical weather disturbances are a major influence on coastal wetlands in North America. However, studies of their impact on biotic communities are rare. The abundance and species composition of amphibians and reptiles were investigated within levee, herbaceous marsh, and forested swamp habitats in southeastern Louisiana from 2002 to 2004 and again in 2005 to 2006. During the course of this study, three major hurricanes (Ivan, Katrina, and Rita) affected our study sites. This allowed us to opportunistically document the effect of major storm disturbances by comparing species richness, diversity, community assemblage, and abundance of amphibians and reptiles before and after hurricane events. We also used a previous study conducted in the same area during the late 1980’s to assess long term community composition changes. We documented the highest species richness in the forested swamp habitat (23 species), but the most diverse assemblage was found in marsh habitat ($H_9 = 2.082$). Overall, herpetofaunal diversity decreased and evenness increased in each habitat following hurricanes Ivan and Katrina/Rita. Drastic decreases in overall abundance of amphibians occurred, while the effect on reptile abundance varied with habitat. Reduced abundance of reptiles in marsh was recorded over the course of the study, while abundances in adjacent levee habitat increased, suggesting displacement of certain reptiles from the marsh to the levee. Significant saltwater intrusion was recorded in marsh and levee habitats, but not in the forested swamp. The hurricanes altered community composition and increased species evenness within each habitat, potentially affecting long-term community dynamics and species interactions.
The Trend and Impact of Climate on Fecal Indicator Bacteria in the Tangipahoa River, a Decade of Data.

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Southeastern Louisiana University, Hammond, LA 70402

Water resource management has relied on the assumption of stationarity in assessing the hydrology of river systems. The concept of stationarity in water systems is essentially that system variables (such as surface water runoff) are time-insensitive and can be estimated as such (Milly et al., 2008). The southeast United States has experienced changing precipitation patterns in comparison to historical trends. Changing precipitation trends violates the assumption of stationarity, and calls into question the accuracy and validity of any water quality assessment or recommendation.

Climate driven processes are nonlinear and non-stationary in nature. Nonpoint source fecal pollution is influenced by climate (hydrologic drivers), as well as source characteristics on timescales that can range from hours to decades. Surprisingly, few time-series studies of fecal pollution have utilized spectral analysis to assess these impacts. A recently developed technique based on empirical mode decomposition and Hilbert spectral analysis, the Hilbert-Huang Transform (HHT), is unique among spectral analysis tools in its ability to decompose nonlinear and non-stationary time-series into meaningful components (Huang et al., 1998 and Huang and Wu, 2008).

Weekly fecal coliform (FC) samples were analyzed (1999-2010) from the Tangipahoa River, LA. Time-series of climatic, hydrologic, and fecal coliform data was decomposed using ensemble empirical mode decomposition (EMD) into intrinsic mode functions (IMFs) and overall trend.

EMD produced six IMFs for precipitation, discharge, and fecal coliform time-series. EMD was orthogonal in all cases. All had a strong seasonal mode (IMF 3) and lower frequency signal (IMF 6, 8yr + period). Precipitation IMF 6 and FC IMF 6 was highly correlated (R=0.89), discharge and FC IMFs 3, 5, and 6 were significantly correlated (R=0.45, 0.83, 0.77). Hilbert energy spectra of EMD revealed mode interaction. The trend of precipitation slightly increased, discharge remained constant, and FC decreased.

![Figure 1. The trend (FC r), and sum of decadal through annual frequency components, or IMFs (FC r + c5,c6, and c3:c6) of fecal coliforms in the Tangipahoa River, LA. Month 1 is January 1999.](image)

**Figure 1.** The trend (FC r), and sum of decadal through annual frequency components, or IMFs (FC r + c5,c6, and c3:c6) of fecal coliforms in the Tangipahoa River, LA. Month 1 is January 1999.
The EMD and HHT revealed climatic forcing of FC loading operating on multiple timescales and further identified a trend of decreasing FC (Figure 1) not coupled to climate. This analysis also provides information on time-scale dependent mode interactions. Most importantly, the methods used in this study provide a needed tool to assess nonpoint source impacts to water quality under changing climate conditions.


METABOLIC CHANGE: The evolving urban metabolism of the North Shore region of the Pontchartrain Basin and projected scenarios of socio-ecological systems

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5 Department of Geography, LSU

Abstract

As environmental conditions change in Southern Louisiana so do the patterns of settlement and their relationships to the landscape they occupy. With both the gradual change due to land subsidence, sea level rise, and environmental degradation, as well as the punctuated change of storm events such as Hurricane Katrina, there has been, and will continue increasingly to be, a migration of people to safer, higher ground. The I-10 corridor has assumed this role, acting as a spine of rapid development. This project proposes to study these newly and quickly developing communities within the nested scales of the Pontchartrain Basin, focusing on the North Shore region through the lens of urban metabolism. By quantitatively measuring a city’s load on surrounding ecosystems this region will be investigated as a growing organism where input/output analysis will be carried out for water, materials, energy, and nutrients. This data will then be visualized through a series of spatial mappings and diagrams exploring the natural history of the north shore and projecting visual scenarios of future socio-ecological systems. The visualization of future growth and new land-use will ultimately provide a series of alternatives to current development patterns.

Project Outline

As of 2010, 53% of the United States’ total population (~163.6 million people) lived in coastal counties and current forecasts estimate that an additional 15.6 million people will populate coastal areas by 2020 (US Census Bureau 2011). While living by the coast allows access to environmental amenities and socioeconomic opportunity, it also comes with risk at a time of extensive ecosystem degradation and uncertain environmental change occurring across a wide range of spatiotemporal scales. Often used to exemplify this point is Hurricane Katrina (2005) and the havoc it reaped upon the city of New Orleans (e.g., Duxbury and Dickinson 2007). Whereas hurricanes and tsunamis happen almost instantly, other potential coastal disasters, including sea-level rise and coastal wetland loss, unfold much more slowly on a decadal time-scale. Once again the Louisiana coast provides a case in point given the continuing loss of coastal wetlands and its high vulnerability to sea level rise. Therefore, while the national trends indicate population growth in coastal areas, human settlement will likely have to confront increasing environmental challenges in vulnerable areas and in the most extreme cases people may abandon deteriorating coastal regions for safer, higher ground within the coastal zone. How will this movement of people impact coastal ecosystems? How can blossoming coastal areas develop in a way that increases the chances of a sustainable existence at the dynamic land-water interface well into the future?

Recent changes in the Lake Pontchartrain Basin in southeastern Louisiana offer us a chance to observe these issues unfold in real-time and challenge us to begin envisioning
sustainable futures. Between 2000 and 2010, total population in 5 parishes located in the northern/northwestern region of the Lake Pontchartrain Basin increased by 155,087 persons, with much of this growth occurring on the North Shore of Lake Pontchartrain. During the same time period, human population in the 3 parishes south of Lake Pontchartrain (including Orleans Parish) declined by a total of 195,091 persons (US Census Bureau 2011, Table 1). While researchers in Louisiana justifiably continue to prioritize issues related to the most vulnerable areas of Louisiana’s coast, relatively little attention has been paid to the places to which people are seeking refuge and beginning anew.

The first step in any project focused on sustainability or ecological dynamics is to define the scale of study. In reality, processes occurring in multiple nested scales interact to produce complex dynamics. For example, in lakes biogeochemical processes (e.g., nutrient resuspension via zebra mussel excretion) interact with ecosystem-scale dynamics (e.g., watershed nutrient loading) within a socioeconomic and political context (e.g., regional debates on nutrient management levels for farms) (Roy et al. 2010, Roy et al. 2011). For this study, the basin scale (Lake Pontchartrain Basin, Fig. 1) suggests a logical boundary beyond the political that subsequently leads to a focus on a region with a unique, evolving identity (e.g., the North Shore region). The project contains the following objectives:

(1) **Determine the “urban metabolism” of the North Shore region in 2000 and 2010.** In ecology, metabolism refers to the production (photosynthesis) and consumption (respiration) of organic matter and is commonly expressed in terms of energy. Kennedy et al. (2007) define urban metabolism as “the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste.” An urban metabolism analysis quantitatively assesses a city’s load on surrounding ecosystems. In effect, the North Shore region will be investigated as a growing organism and input/output analysis will be carried out for water, materials, energy, and nutrients. The analysis will help answer questions such as:
   (i) How efficiently are incoming nutrients (i.e., food, fertilizer) utilized within the region and what are the implications for local aquatic ecosystems? Answering this question will integrate past, present, and future ecological studies on water quality in Lake Pontchartrain and the North Shore region.
   (ii) How sustainable is the North Shore’s water supply & wastewater treatment systems?
   (iii) How much has energy consumption increased in the North Shore region following the recent population influx?

   This objective is both novel from a theoretical perspective and critical on a practical level for coastal sustainability efforts. Few urban metabolism studies have been conducted in a manner that measures changes over time due to population growth and examples that do exist are focused on mega-cities (e.g., Warren-Rhodes and Koenig 2001). No literature has been identified focusing on changing coastal urban metabolism in the context of human population displacement related to coastal disasters.

(2) **Produce visual representations of the methods and results for Objective 1 that can facilitate communication.** Objective 2 will require collaboration between the science, engineering, and design disciplines. Scientific data harbors much power in the information contained and the conclusions drawn through analysis, but often affect little when presented outside its disciplinary field, and less on a societal level. The visualization of information and scientific data
is advantageous in cross-disciplinary communication and vital in popular dissemination. This formulation of a visual language in which to represent raw data and matrices of values will also help to illustrate the multiplicity of connections between fields of information. These representations will also spatialize data to facilitate understanding on a geographic scale. By interpolating data into a visual language easily digested by a variety of individuals, public opinion can be affected and thus public policy.

(3) Identify ways in which to improve the urban metabolism of the North Shore region assuming continued population growth and visually project future scenarios.

Objectives 1 & 2 will help improve understanding of how the North Shore region has changed from 2000 to 2010 and quantify the impact of this change on the basis of water, materials, energy, and nutrients. However, this project moves past this assessment phase (where most ecological science stops) into a speculative phase that incorporates design expertise to help envision future scenarios. This speculative phase begins with a graphic visualization of a comprehensive strategic regionalism.

By first rendering a natural history of the North Shore region we can then begin to trace the effect of settlement on the landscape over time. This involves researching historic mappings of the North Shore. Subsequently projecting forward through future scenarios, we can begin to gather a qualitative understanding of three North Shores: one that follows the current metabolism or pattern of development and land use, one that amplifies this spatial and material consumption while resisting environmental change, and one that values conservation through an embracing of flexibility and impermanence. Through integrating urban planning, architectural intervention, and ecological analysis in a manner where potential benefits can be assessed within the framework created during the initial urban metabolism study this project can quantitatively evaluate future potentials. We can begin to see our past gradual effect on the landscape mosaic, comparatively understand the velocity at which we are currently affecting our future, and forecast alternative methods of North Shore habitation.

This regional scale strategic visualization will ultimately lead to the development of a comprehensive methodology in organizing and arranging a generative interface between the North Shore’s built environment and the biological landscape that supports it.
## Lake Pontchartrain Basin Population Data from US Census Bureau

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| Lake Pontchartrain Basin | 2130722 | 2098400 | -32322 | -15.2 |

**Table 1.** Human population in the Lake Pontchartrain Basin in 2000 and 2010.

**References**


De-energizing Hurricanes with Cypress/Tupelo Buffers: a Plan to Restore the Repressed Swamps of the Lake Pontchartrain Basin by Using Point and Nonpoint Freshwater Sources

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Southeastern Louisiana University, Hammond, LA 70402

INTRODUCTION
Degradation and mortality of baldcypress-water tupelo (Taxodium distichum-Nyssa aquatica) swamps in the Pontchartrain Basin of coastal Louisiana is caused primarily by four interacting stressors, namely saltwater intrusion, impoundment, nutrient starvation, and seedling herbivory by the non-native rodent nutria (Myocaster coypus) (Chambers et al. 2005, Shaffer et al. 2009a, b). Furthermore, two of these stressors, saltwater intrusion and impoundment, will continue to be exacerbated by climate change as rising tides encroach further inland and as droughts and storms intensify. Fortunately, climate change as well as the three abiotic stressors mentioned above can be ameliorated by reliable sources of nutrient-rich fresh water that can be provided by (1) reintroducing the Mississippi River (Day et al. 2000, 2009, Shaffer et al. 2009a), (2) sheet flowing treated wastewater over these wetlands (Day et al. 2004, 2009), and (3) creating gaps in existing levees and spoil banks.

METHODS

In 2000, we originally selected 20 study sites with paired 625-m² stations, primarily in the southern wetlands of Lake Maurepas to capture three different hydrological regimes within the swamp: (1) RELICT - stagnant, nearly permanently flooded interior sites, characterized by trees with broken canopies and a few mid-story species; well-defined herbaceous community, (2) DEGRADED - sites near the margin of Lake Maurepas that are prone to severe saltwater intrusion events characterized by dead trees, sparsely dotted with baldcypress, and dominated by herbaceous species and open water, and (3) THROUGHPUT - sites receiving reliable nonpoint sources of freshwater runoff, characterized by mature overstory and midstory stands; little herbaceous cover (Figure 1).

Four additional sites were installed in 2004 to capture the effects of the levee-gapping project. Taken together, these study sites characterize an area roughly 80 km² and are replicated to reflect the relative proportion

Figure 1. The Maurepas swamps rim the margin of Lake Maurepas in southeastern Louisiana, and are bounded by urban development to the north, west, and south. In early 2000, twenty sites were selected to represent the three major habitat types: throughput (green), relict (yellow), and degraded (red). AW = Assimilation Wetlands; LG = Levee and Spoil Bank Gapping; RR = River Reintroduction. Four additional study sites were installed just west of “LG” in 2004 to better capture the effects of the gapping project.
of each habitat type (Figure 2). Annually, we measure net primary production of over 2,000 trees and nearly 100 herbaceous plots as well as many abiotic variables (Shaffer et al. 2009a). Our baseline data capture the effects of severe droughts (2000 and 2006), normal weather conditions, and the hurricanes of 2002, 2005, and 2008. They will enable spatial quantification of benefits—in terms of improved ecosystem function—of three different large-scale restoration techniques.

RESULTS and DISCUSSION

The Maurepas swamps are characterized by nutrient-poor waters with nitrate levels less than 1% of those found in the Mississippi River (Lane et al. 2003). In addition, the soils are of extremely low strength (Shaffer et al. 2003, Hoeppner et al. 2008) indicative of stress such as saltwater intrusion events that typically occur during late summer and fall. The mean salinity of Lake water measured at the Manchac land bridge also has increased gradually, beginning in the early 1960s with the opening of the MRGO (Shaffer et al. 2009b, Thomson et al. 2002). Severe increases in salinity, like those experienced during the droughts in 1999 and 2000, can be prevented or greatly ameliorated by the increased freshwater throughput that treated wastewater or a River reintroduction would offer.

This study (Shaffer et al., 2009a), and previous studies by Boshart (1997), Effler et al. (2006), Green (1994), and Myers et al. (1995) all indicate that the herbaceous and woody vegetation in the Maurepas swamp is nutrient starved. Large increases in herbaceous standing crop with increased nutrient loading were only evidenced in caged plots because herbivores targeted the vegetation with increased protein content in un-caged, fertilized plots (Shaffer et al. 2009a). Fertilizing at a loading rate of 22.5 g N m⁻² y⁻¹, which simulates a river diversion of 85 m³ s⁻¹, more than doubled biomass production when compared with caged control plots.

The ecosystem integrator, net tree primary production, is clearly separated for the different condition classes (Figure 4). Although it appears that the relationship between herbaceous NPP and tree NPP is compensatory, Degraded habitats are transitioning to open water and the Relict habitats are in transition to Degraded. We fully expect the restoration projects to reverse the trajectory of some Relict habitats to Thoughput status, but only further study will enable us to determine where the tipping point is for potential reassembly or further degradation.
Neither water tupelo, nor ash, or swamp red maple can tolerate the chronic salinity conditions of 2–4 ppt found at these sites (Conner et al. 1997, Pezeshki 1989). Likewise, the relatively low stem densities observed at the Relict swamp sites are primarily the result of the decreased abundance of ash and swamp red maple in the impounded and stagnant hydrologic regimes characteristic of these sites (Hoeppner et al. 2008). To date, over 32% of the monitored trees have suffered mortality, with mortality as high as 100% at several Degraded sites (Shaffer et al. 2009a).

In contrast to stem density, tree NPP in the Maurepas’ most productive sites are comparable to healthier sites in other parts of the southeast USA. These healthier sites are similar to natural, periodically flooded baldcypress–water tupelo swamps (Carter et al. 1973, Conner and Day 1976, Conner et al. 1981, Megenigal et al. 1997). The vast majority of the Maurepas swamp is either Relict or Degraded (83%, Figure 2), and these areas range in total tree production between swamps that have been identified as either nutrient-poor and stagnant (Schlesinger 1978), just stagnant (Mitsch et al. 1991, Taylor 1985), or near-continuously flooded (Megenigal et al. 1997). As mentioned above, the appearance of a compensatory relationship between herbaceous and tree NPP (Figure 4) is illusory, as the Degraded habitats are converting to open water and the Relict habitats display a clear trajectory towards Degraded (Figure 5). In contrast, the Throughput habitats show no overlap with other habitat types (Figure 5), although they do vary over time, especially with respect to hurricane years. During hurricane years prolonged flooding during the fall causes high levels of mortality of herbaceous vegetation. The year following hurricanes, annuals from the seedbank respond immediately (especially Polygonum punctatum) with relatively high levels of NPP (Figure 6, 2003, 2006, but not 2009).

Healthy baldcypress–water tupelo swamps require a reliable source of fresh water for system flushing following tropical storm events and during droughts to decrease soil salinity. Currently, many sources of fresh water exist within the Pontchartrain Basin (Figure 7), such as treated wastewater and nonpoint source runoff. However, most of these sources are currently input to the Basin to maximize drainage efficiency. Fresh water is routed into ditches and canals that carry it directly to lakes and rivers, bypassing wetland contact. This creates a “lose–lose” situation because potential for eutrophication is maximized and the wetlands remain nutrient starved. In contrast, rerouting the water to maximize sheet flow will improve water quality and increase wetland net primary production, while decreasing saltwater

![Figure 5. Non-metric multidimensional scaling of Herbaceous production from 2000 to 2010 for Throughput (green), Relict (yellow), and Degraded (red). Note tight clustering of Throughput (control) sites. Note trajectory of Relict sites toward Degraded sites. Size of bubbles indicates relative abundance of herbaceous NPP. Numbers indicate year and letters indicate habitat types (T=Throughput, R=Relict, and D=Degraded).](image)

![Figure 6. Total net primary production of trees (black) and herbaceous vegetation (gray) from 2000 to 2010.](image)
interior (Shaffer and Day 2007).

Despite the degraded condition of the majority of the baldcypress–water tupelo swamps of the upper Lake Pontchartrain Basin, healthy areas of swamp still exist (i.e., the bright green Throughput areas in Figure 2). Without exception, each of these swamps receives some form of reliable high-quality, nutrient-rich fresh water.

In summary, the Maurepas swamp is characterized by nutrient poor waters, soils of extremely low strength, nearly permanent flooding in most areas, and severe saltwater intrusions. The Maurepas swamp is nitrogen limited (Lane et al. 2003), and nutrient stress is potentially as important as salt or flood stress.

REFERENCES


An Analysis of the Hammond Assimilation Wetland: System Response, Nutria Herbivory, and Vegetation Recovery

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Abstract

For decades municipalities in coastal Louisiana have successfully used baldcypress – water tupelo swamps to bioremediate treated wastewater while improving swamp function. Discharge into marshes, however, began only recently when the City of Hammond initiated outfall of 4-million gallons per day of secondarily-treated municipal effluent into a nearby degrading marsh beginning fall, 2006. Herbaceous vegetation growth was robust during the following growing season and baldcypress grew 3-fold greater than in the surrounding Maurepas swamp. By late fall 2007, however, the emergent wetlands in the immediate vicinity of the effluent discharge began to decline, and within a year, nearly the entire 320 ha marsh had converted to open water. Numerous individuals and environmental organizations began to express concern about this conversion and attributed the decline to the poor quality of the effluent. We set up several experiments to delineate the relative importance of potential toxins in the wastewater, excessive nutrient loading, excessive flooding, and herbivory by waterfowl and the introduced rodent nutria (\textit{Myocastor coypus}). Our studies clearly demonstrate that the marsh loss was primarily caused by nutria and secondarily by waterfowl, but that excessive flooding also has slowed recovery. Because of aggressive nutria management, the system is converting back to marsh, especially closest to the area of discharge. As a whole, the system has converted from one primarily dominated by perennials to one dominated by annuals. Though still controversial, use of assimilation wetland technology remains as the most cost-effective means of protecting and restoring coastal Louisiana wetlands.
Effects of freshwater input on bioavailable nutrient loading, phytoplankton biomass, and cyanotoxin production in Lake Pontchartrain

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The Bonnet Carré spillway is a managed river diversion, which is used several times to prevent flooding in New Orleans by allowing a large amount of Mississippi River water into Lake Pontchartrain. During these pulsed river events, an influx of nutrients occurs that potentially leads to an increase in primary production, phytoplankton community shifts and toxic bloom formation. The goals of this study are to understand how nutrient enhancement, changes in salinity, pH, and turbidity affects the phytoplankton community response and their potential toxicity.

Water samples were collected along a transect that started at the Bonnet Carré spillway and extended in a northeast direction for 30 km until intersecting with the Causeway bridge. There are 11 stations along the transect, 3 km apart, except for the two stations nearest the spillway. Phycocyanin pigment, turbidity, and light measurements were completed in the field at the time of the collection. Collected water samples were processed for chlorophyll a (Chl a), nutrients, alkaline phosphatase activity (APA), phytoplankton species diversity and particulate and dissolved cyanotoxins using an ELISA assay in the laboratory. APA activity was determined by fluorometric method after the cells were labeled with ELP-97.

Initial sampling was conducted on May 8, the day before the spillway was opened, indicated low Chl a concentrations (2-5 µg/L) throughout the transect, except the closest station to the spillway reaching to 10 µg/L. After the spillway was opened, Chl a concentrations remained below 5 µg/L during the month of May inside the river plume, but increased up to 23 µg/L at the edge of the plume. Starting in June, higher Chl a concentrations appeared at all stations with higher levels remaining at the edge of the plume, reaching up to 45 µg/L. Lake water was well mixed throughout the transect at the end of June and Chl a levels were more evenly distributed, averaging 21.5 ± 9 µg/L. In July, levels dropped again below 10 µg/L at all stations corresponding to lower nutrient levels. Phycocyanin levels were well correlated with the Chl a levels indicating cyanobacteria presence. Light levels at mid-depth and bottom were low but were still supporting phytoplankton growth. Microscopy observations are ongoing but initial scanning revealed mixed phytoplankton community including potentially toxic cyanobacteria *Microcystis* sp. Microcystin (MC) equivalents in surface water subsamples were determined using a commercially available highly sensitive (0.04 µg MC/L) enzyme-linked immunosorbent assay (ELISA) kit (Abraxis LLC), with a detection range of 0.05–5.0 µg MC/L. The analysis are also ongoing but MC has been found below the detection limit for most of the lake in June and the stations that did have detectable limits were below World Health Organization limits for drinking water (1 µg MC/L). Understanding of these interactions will help regulate other future pulsed river events for Lake Pontchartrain regarding harmful algal blooms.
Reduction of estrogenic activity in wastewater following treatment with ferrate.

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Endocrine disrupting compounds (EDCs) in wastewater present an emerging category of pollutants that have the potential to adversely interfere with the reproduction and development of humans and wildlife. Conventional wastewater treatment plants are not designed to remove EDCs. The purpose of this study was to evaluate effectiveness of ferrate, Iron(IV), in the removal of EDCs from New Orleans wastewater effluent.

Ferrate is used to disinfect effluent before discharge into ten-acre wetland cell. According to previous study, the estrogenic activity of the wastewater effluent decreased following disinfection with ferrate, with higher doses of ferrate resulting in greater reductions in estrogenic activity (Figure 1). The optimal reduction occurred during treatment with 4 ppm ferrate, resulting in a 61.05% reduction in estrogenic activity. However, the fluctuation (standard error) of estrogenic activity was very high. Then, the other ferrate doses were chose. The optimal dose for estrogenic activity reduction in the whole wastewater sample was 6 ppm which 54.18 % reduction was selected.

![Figure 1](image-url)

**Figure 1** Effect of ferrate treatment on estrogenic activity in the whole wastewater effluent (TOC=11) after 30 minutes contact time

However, these measurements were performed on effluent collected in the fall of 2008, which had a lower organic strength, as measured by TOC (Table 1). Because of the selective oxidation property of ferrate, 54.18 % reduction of estrogenic activity was obtained at low organic
contents in wastewater effluent (TOC=11mg/L). When wastewater with a higher organic contents (TOC=20 mg/L) was treated with ferrate at 6 ppm, there was a lower effect on estrogenic activity which 23.7% reduction was achieved.

Table 1 Effect of wastewater organic content (e.g. TOC) on EDC reduction following treatment with ferrate at 6 ppm.

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Raw wastewater influent, pre-chlorination and post-chlorination effluents were collected from the New Orleans metropolitan wastewater treatment plant. Pre-chlorination effluent was treated with optimum doses of ferrate (6 mg/L). 1 L of each wastewater sample was filtered through a 1 μm filter followed by a 0.7 μm filter to remove suspended solids. Methanol and methylene chloride were used as the extraction solvents for both liquid and solid extraction processes. EDCs were extracted from the solid phase using an accelerated solvent extractor, Dionex ASE 200 Extraction System. EDCs were extracted from the liquid phase using solid-phase extraction cartidges. Extracted samples from both liquid and solid phases were evaporated to dryness using heat and N2 blowdown in a Rapidvap N2 Evaporation System. Residuals from the evaporated samples were reconstituted in 1.3 mL of 100% ethanol. The estrogenic activity in wastewater sample was measured using the MVLN bioassay that consists of human breast cancer cells stably transfected with an estrogen responsive luciferase reporter gene which is quantified in a luminometer. The estrogenic activity of the wastewater samples was compared with the activity of 17-β-estradiol (E2) used as standard. Each sample was run in quadruplicate and the average value was reported as percent of the average maximal response for E2 at 10-9 M. The assay was performed three times for each sample.

In this paper, the further work as the EDCs extractions, and human hormone and yeast assays will be elucidated. This work is to finalize the dose of ferrate for the pilot demonstration study. This work leads into the monitoring of this ferrate disinfection process.

Treatment of wastewater with ferrate has a potential benefit over treatment with chlorine in that ferrate is able to reduce the presence of EDCs in the wastewater, as indicated by the reduction in estrogenic activity, while chlorine increases the estrogenic activity of the wastewater effluent as a result of production of disinfection-by products such as trihalomethane and haloacetic acids.
Tarpon, *Megalops atlanticus*, in Southeastern Louisiana

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Tarpon (*Megalops atlanticus*) are an important economic resource in the Gulf of Mexico. They support a multi-million dollar sport-fishing industry from the Florida Keys to the lower Texas coast (Dailey, Landry et al. 2008). This species is migratory within the Gulf of Mexico, although resident populations are found in the Florida Keys and along the southwest coast of Florida (Luo, Ault et al. 2008; Ault, Luo et al. 2009). Tarpon are thought to spawn in the Gulf of Mexico in the Yucatan Channel, off the Yucatan Peninsula, and off the southwest coast of Florida from April through June (Smith 1980; Crabtree 1995; Baldwin and Snodgrass 2008). Large numbers migrate down the east and west coasts of Florida in the spring after which they migrate back northward during June. Pop-off archival tag (PAT) data have confirmed movement as well as late summer migration northward to Marsh Island from the Bay of Campeche (Ault, Humston et al. 2002; Ault, Luo et al. 2009). It is not known if these fish over winter in the northern Gulf of Mexico. Tarpon are routinely caught in fishing rodeos and tournaments during the summer in Louisiana. During the summer, juveniles have been occasionally reported in Louisiana. Currently, the accepted assumption is that fertilized tarpon eggs and leptocephali enter the northern Gulf of Mexico by the Loop Current and are transported to the coast in eddies (Ault, Humston et al. 2002). Very little is known about the natural history of tarpon in the northern Gulf and, in particular, in Louisiana.

Reports suggest that tarpon stocks in the northern Gulf of Mexico began to decrease precipitously in the 1950s and 1960s (Winemiller and Dailey 2002). It has been suggested that this was a result of nursery habitat loss in the Yucatan, Mexico and South Florida. Based on anecdotal evidence, though, juvenile tarpon may use other areas of the Gulf of Mexico nursery habitats. For example, during several successive years since 2000, juvenile tarpon have been collected in two sloughs near Ocean Springs, Mississippi and during the fall of 2010, there were anecdotal reports of juvenile tarpon at multiple sites in Louisiana: Hopedale, Cocodrie, and north of Grand Isle (Franks, Grammer et al. 2009).

In the fall of 2010 as part of another research project, we collected juvenile tarpon on three occasions from a roadside ditch near Port Sulphur, Louisiana, 23 km from the Gulf of Mexico. The ditch was less than 1 m deep and had a direct connection less than 1 km from marsh wetlands to the southwest. Tarpon were collected using castnets (1-2 hours sampling during midday) and early October sampling produced 14, 21, and 22 tarpon in successive weeks. Water temperatures ranged from 16.0°C to 26.0°C, air temperatures ranged from 13.8°C to 27.0°C, and salinity ranged from 8 psu to 11 psu. October tarpon sizes ranged from 85 to 245 mm SL. Tarpon diet consisted mostly of sailfin mollies (*Poecilia latipinna*) and sheepshead minnows (*Cyprinodon variegatus*), both of which were common in the habitat (as determined by seine samples from the other project). Ratios of fish weight and presence of stored fat were examined, with potential correlations between low temperature and empty stomachs. The mean ratio of gut item weight to fish weight during warm water temperature (27°C) was 3.54% (range 0.81%-7.35%). This ratio was 0.63% (range 0%-1.95%) when the water temperature was 13.8°C. Juvenile tarpon have been reported to be intolerant of temperatures below 10°C. These diet results suggest that at temperatures well above 10°C, juvenile tarpon may reduce feeding. It is yet to be determined if this negatively affects their survival or if they have adaptations to survive low winter temperatures in this habitat. These preliminary results suggest juvenile tarpon may not be able to survive the cold months or reach sufficient maturity
to survive in the warmer waters of the Gulf of Mexico except in warm winters. These data do suggest that tarpon nursery habitat may span a wide range of salinity and dissolved oxygen content.

We have been working with sport divers of the Louisiana Council of Underwater Dive Clubs and with Louisiana tarpon fishermen including members of the Louisiana Tarpon Club to document the natural history of tarpon in the Louisiana waters. One product of this collaboration is a video of large numbers of adult tarpon around offshore petroleum platforms during January 1999. Examination of the Louisiana State Spearfishing Records confirms that 9 of the 10 largest tarpon were captured during January, February, and March. In June 2011, a solitary 33 kg tarpon was speared during a tournament at an offshore petroleum platform 20 km from the coast. Based on its size, we presume this fish developed in local coastal nursery habitat.

We now report the capture of a 284 kg, female tarpon in July 2011, 32 km off the coast of Fouchon, Louisiana, containing eggs and in spawning condition. A second female tarpon weighing 330 kg was captured a week later 22 km off Red Pass, Louisiana, with ovaries containing eggs and evidence of spawning. These observations suggest that adult tarpon overwinter off of the Louisiana coast in the vicinity of petroleum platforms. Some of these tarpon may migrate along the Gulf coasts towards Florida and Mexico. These observations further suggest that tarpon spawn in the northern Gulf of Mexico off of the Louisiana coast as late as early July and that juvenile tarpon found along the Louisiana coast come from this spawning activity and not from the southern Gulf via the Loop Current. During warm years, these Louisiana juvenile tarpon may recruit into coastal stocks. Ongoing research is being conducted to: 1) better define essential tarpon nursery habitat in Louisiana; 2) provide further documentation of tarpon spawning in the northern Gulf of Mexico; and 3) further document overwintering by adults in the northern Gulf and the possible presence of a non-migratory resident population on the Louisiana coast.

Juvenile tarpon showing stomach contents (*Poecilia latipinna*)
Ovaries from 330 kg tarpon

Eggs in ovary from 284 kg tarpon (6X photomicrograph)


Drought and salinity affect wood density and vulnerability to xylem cavitation of Baldcypress (*Taxodium distichum*) seedlings Volker Stiller
Department of Biological Sciences, Southeastern Louisiana University

In the past, considerable efforts have been undertaken to restore Baldcypress (*Taxodium distichum*) around Lake Pontchartrain in Southeastern Louisiana. Vast amounts of cypress trees have been planted with varying rates of success. Increased salinity is often cited as one reason for the high tree mortality, yet it is not clear whether trees are affected by NaCl toxicity or whether salt-induced reduction of soil water potentials lead to xylem cavitation and high tree mortality. The aim of this study was to investigate the role of hydraulic conductivity, wood density, and xylem cavitation in the response of baldcypress (*Taxodium distichum*) seedlings to increased soil salinity and drought.

1-yr old, greenhouse-grown seedlings were irrigated daily with a 100 mM (6 %o) salt solution (salt treatment) or with fresh water (controls). Drought plants were irrigated once per week with fresh water.

Gas exchange rates of stressed plants were reduced by approximately 50% (salt) and 70% (drought), resulting in a 50-60% reduction in diameter growth for both treatments. Stem-specific hydraulic conductivity ($K_{\text{native}}$) of stressed plants was 33% (salt) and 66% (drought) lower than controls and we observed a strong positive correlation between $K_{\text{native}}$ and gas exchange. In addition, we found a strong relationship between CO$_2$ assimilation rate ($A$) and the soil-to-leaf hydraulic conductance ($k_l$). The relationship was identical for all treatments, suggesting that our moderate salt stress (as well as drought) did not affect the photosynthetic biochemistry of leaves, but rather reduced $A$ via stomatal closure. Lower $K_{\text{native}}$ of stressed plants was associated with increased wood density and the plants vulnerability to xylem cavitation. Xylem pressures causing 50% loss of hydraulic conductivity ($P_{50}$) were $-2.88\pm0.07$ MPa (drought), $-2.50\pm0.08$ MPa (salt) and $-2.01\pm0.04$ MPa (controls). $P_{50}$s were strongly correlated with wood density ($r = -0.71, P < 0.01$) and $K_{\text{native}}$ ($r = 0.74, P < 0.01$). Our findings support the hypothesis that there is a trade-off between a plant’s cavitation resistance and its hydraulic efficiency. In addition, our results indicate that stressed plants partitioned their biomass in a way that reduced cavitation vulnerability. Hence, these plants could be better suited to be planted in environments with elevated soil salinity. Whether the observed stress acclimation does indeed translate into reduced seedling mortality under field conditions is currently under investigation.
Use of Remote Sensing Technology and a Nutrient-Sediment Model to Assess the Effects of Crevasse Splays and Freshwater Diversions in Coastal Louisiana

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One process that significantly contributed to the formation of the modern Mississippi River Delta (MRD) was the crevassing of the river. Crevasses, which occur as large breaks in the natural levees, promote infilling of shallow inter-distributary ponds with sediment-laden river water, ultimately resulting in vegetated deltaic splay deposits. From 1750-1927 as many as 20 natural crevasse splay deposits were active in the MRD, accounting for more than 80% of its subaerial land (Davis 1993). However, human alterations to the MR system (e.g. artificial levees) have eliminated the majority of crevasses above the MR Head of Passes, thereby reducing the supply of nutrient- and sediment-rich water that is vital for the subsistence of deltaic wetlands. Successful delta progradation through natural crevassing and diversions has inspired the utilization of artificial crevasse splay cuts and diversions as a viable engineering technique for marsh management in the lower MRD complex. With numerous artificial crevasses and diversions currently constructed or proposed, quantifying the effects of active natural and constructed crevasses is critical to the planning and success of future projects. This poster summarizes the methods and preliminary results of an ongoing study to assess the effects of crevasse splay deposits and freshwater diversions on coastal landscapes through the use of remote sensing techniques and a nutrient-sediment model.

Comparative assessments of past, present, and proposed crevasses and diversions have been difficult to quantify. These comparisons require, in addition to land change assessments, hindcasting and forecasting capabilities to determine both the quantity and characteristics of material needed to create coastal marshes (Boustany 2010). Systematic assessments of historical crevasse splay deposits and diversions in Southeastern Louisiana were performed to link historical land change rates (1956-2010; Barras et al. 2008) with current high spatial and temporal frequency assessments of the modern coastal landscape (2000-2010), and available LIDAR and bathymetry data, to quantify the benefits associated with natural and artificial crevasses and diversions in the MRD. Combining these geospatial analyses with nutrient and sediment models provide measures necessary to calculate the benefits and trends of freshwater introduction into wetland ecosystems and the capability to forecast parameter response to proposed restoration actions. The NSED2 model, which estimates the rate of both the organic and mineral fraction of soil formation based upon the loading of nutrients and sediments, utilizes the flow rate, materials concentrations, geometry of the receiving basin, and retention of materials to determine the efficiency of assimilation (Boustany 2010). The NSED2 model provides a tool that can simulate land building processes and therefore compare the benefits (habitat and cost) associated with coastal restoration alternatives.
Figure 1 illustrates the land change analysis that was performed to determine the area and rate of observed land change in Breton Sound and the eastern portion of the Mississippi River Delta area from 1985 to 2008. This area experienced approximately 91,000 acres of land lost, and 31,000 acres of land gain, during this period of analysis. A substantial portion of these land gains occurred in the vicinity of crevasses and fresh water diversions. Comparing these land changes to simulated pre- and post-construction benefits within select crevasse/diversion areas of influence allows for the calibration and validation of the NSED2 model. A validated NSED2 model was used to predict environmental benefits, determine the zero loss rate, proper location and sizing, and cost-effectiveness of those crevasses and diversions necessary to satisfy ecosystem restoration objectives.

For example, previous validations of the NSED2 model were performed in the Naomi Siphon areas of influence, southeastern Louisiana (Boustany 2010). Land-water data were used to determine the rate of pre-project land change in the Naomi Siphon area from 1956 to 1990, and from 1990 to 2008 to determine the post-project rate of change (the effects from Katrina were minimal in this area). The pre-project rate (-0.6070 %/y) was inserted into the model as the future without project land loss rate. The model-adjusted rate (-0.1254%/y) based upon the model input date was then compared to the 1990 to 2008 rate (-0.1526%/y), which represents the observed post-project rate to determine the accuracy of the model output. The results of the model were analyzed to determine the accuracy of the output in comparison to observed data. The difference in model-predicted and the calculated loss rate was 4.5% for the Naomi Siphon area of influence.

The NSED2 model also allows for the comparison of existing and proposed diversion projects to marsh creation projects through a cost-effectiveness comparisons. Previous studies show the value of diversion projects increase substantially with each year of operation and the long-term benefits well exceed that of marsh creation projects. For example, the 100-year value of the Caernarvon Diversion in today’s dollars is estimated to be $606 million dollars with a benefit of 18,699 acres. This estimated value is orders of magnitude greater than the initial cost of the project. On the other hand, the benefit of a marsh creation project is immediate and finite. These projects are sure to get more expensive with time, whereas once a crevasse or diversion is in place, the costs would be limited to O&M (Boustany 2010).
Figure 1. Land Area Change (moderate resolution) within Breton Sound and East Mississippi River Delta area -1985-2008 - Coastal Louisiana.
References


Annual and seasonal patterns in phytoplankton biomass and nutrients in Lake Pontchartrain

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We will report on the consequences of a study the changes in phytoplankton that developed in Lake Pontchartrain in summer 2011. The cause for the anticipated changes is nitrogen loading from the opening of the Bonnet Carré spillway, just upriver from New Orleans, a city of 1.3 million on the southern edge of the lake. We expect that a bloom should last about 1 to 2 months, with a particularly strong spike when the winds abate. The 1997 opening, for example, lasted about 1 month, and the Lake took about 3 months to recover to baseline conditions (Fig. 1). The diversion opening delivered a water volume that is four times the Lake’s volume. This result is that the turbid and nutrient-rich river water is a perfect medium for phytoplankton growth once the suspended sediments fall out of suspension. The late spring opening of the Bonnet Carré will end about the time that the winds decrease to their annual minimum, resulting in a kind of photosynthetic frenzy by a variety of species. The 1997 opening of the Bonnet Carré resulted in a Chl a concentration maximum of 855 µg L⁻¹ at one station, and an average of >80 at the 7 Causeway stations we sample in the middle of the lake (Fig. 1). These amounts compare to the pre-diversion concentrations of 5-15 µg/l Chl a. The peak N loading for the lake from the diversions is strongly related to the highest Chl a concentration for 3 diversion openings. We expect and similarly high average Chl a concentration in 2011, because the concentration of nitrate was 80 µmol in 1997, but this year it was 120.75 µmol in April (+51%).

The conditions stimulating phytoplankton growth rates and accumulation in the lake are also the conditions that are likely to favor the formation of noxious and toxic phytoplankton blooms, either in Lake Pontchartrain or in the nearby coastal waters. The 1997 opening of the Bonnet Carré resulted in the closure of the lake due to a building up of toxins released by a microcystis/anabaena bloom.

These data will be compared to the monitoring of the lake done on a monthly basis since 1994 (Fig. 1), and occasionally for 6-12 months in a row before then.
Figure 1. The amounts of Chl a at the 7 Causeway stations from 1996 to present (top) and during 2011 (bottom).
Three The river from diversions. We provide Fertilization and early flooding weakened freshwater occurred. Recent marsh accumulation has been substantial, partly because of increased inputs from agricultural use. Excessive sediment influx into the Caernarvon diversion marshes (the largest freshwater diversion created) is linked to the widespread occurrence of low soil strength, indicating that these marsh sediments are potentially highly erodible; in fact, land losses from Hurricane Katrina were especially high [Howes et al., 2010].

The effectiveness of diversions to mitigate marsh loss has not been quantitatively evaluated. Three major diversions, Caernarvon, West Point a la Hache, and Naomi, were in operation since the early 1990s, however, and provide an opportunity to assess trends in plant condition and total marsh area before and after diversions began. The Caernarvon diversion is more directly influenced by the Gulf of Mexico through Breton Sound than are the smaller Naomi and West Point a la Hache diversions, and has a substantially greater river freshwater inputs. Hurricane Katrina (2005) passed directly across it.

We use Landsat Thematic Mapper imagery in a spectral mixture model developed in studies of low salinity, microtidal marshes, which was cross-referenced with comparisons from aerial photography, to analyze changes in marsh vegetation cover and total marsh area since 1984 for these three diversions. The inherently wide geographic capture of changes afforded by high resolution satellite imagery provide a spatial and temporal perspective on the conflicting ideas about the efficacy of diversions to restore marsh.

The evidence indicates that diversions not only fail to conserve mature brackish and tidal freshwater marshes, but disrupt plant physiology in ways that endanger individual plant vigor and overall marsh survival. We believe that the three freshwater diversions failed to increase vegetation health or area because of the physiological consequences of high nutrient flux and greater flooding of marsh plants [Swarzenski, 2008]. The agricultural literature has established that N loadings of as little as 30 kg ha⁻¹ can cause severe lodging (stem collapse) and low root growth in cereals (i.e., graminoids. Recent (2002) estimates of the annual nitrate and total N inputs at the Caernarvon diversion range from 2-5 million kg (45-114 kg ha⁻¹), and 3-7 million kg (68-159 kg ha⁻¹), respectively [Hyfield et al., 2008]. Fertilization of brackish marshes would promote lower rhizome and root biomass [Valiela et al., 1976], accelerated decomposition rates [Godshalk and Wetzel, 1978; Sundareshwar et al., 2003] and stems
vulnerable to collapse (lodging) from high winds [Resio and Westerink, 2008]. In fact, research on Louisiana wetland vegetation [Darby and Turner, 2008; Turner, 2010] documented shallow and limited rooting in Spartina alterniflora, resulting in weak substrate structure and shear strength [Howes et al., 2010; Turner 2011]. Moreover, nitrogen additions to freshwater wetlands enhance carbon losses [Bragazza, et al., 2006; Mack et al., 2004].

Ultimately, the scientific basis for river diversions needs to be more convincing before embarking on a strategy that may result in marshes even less able to survive hurricanes.

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Changing Nutrient Levels in Lake Maurepas in Response to Shifts in Human Population after Hurricane Katrina and Lake Pontchartrain in Response to the 2008 Opening of the Bonnet Carré Spillway.

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Hurricane Katrina and Lake Maurepas

In August 2005, Hurricane Katrina moved across Louisiana and Mississippi. The damage left in its wake led to a significant shift in the populations of many parishes in the Lake Pontchartrain Basin. The population of parishes in the Lower Lake Pontchartrain Basin on the south side of Lake Pontchartrain decreased by 5-58% while the population of parishes in the Upper Basin increased by 2-10%.

Nonpoint source pollution from urban and residential areas, particularly from construction sites, can adversely affect the concentration of nutrients and sediments in a watershed leading to the expectation that increasing population in the Upper Lake Pontchartrain Basin would lead to higher concentrations of phosphate and silicate in Lake Maurepas and could lead to excessive algal growth. Valiela demonstrated that 39% of nitrogen loading in the Waquoit Bay Estuary in Massachusetts is from residential runoff and an additional 16% is from turf such as golf courses and lawns [1]. Carpenter found the discharge of total nitrogen, total phosphate, and sediment from construction sites, lawns, and golf courses to be 250 – 300 times greater than those from undisturbed vegetative areas [2]. Line found that erosion rates from construction sites were 500 times greater than those of undisturbed areas and up to 50 times greater than those from agricultural areas [3]. The work described here has been presented in detail and has shown increasing levels of silicate and phosphate in the Upper Lake Pontchartrain Basin in the years following Hurricane Katrina [4].

Immediately following Hurricane Katrina, the number of people living in the parishes in the Lower Lake Pontchartrain Basin decreased rapidly while the population of parishes in the Upper Lake Pontchartrain Basin increased. For example, the average population in Orleans Parish in the three years before the hurricane was 464,000 and averaged 249,000 in the three years following Katrina. Livingston, Ascension, and Tangipohoa Parishes, draining at least in part into the Upper Lake Pontchartrain Basin, saw average population increases ranging from 11 – 16% [5].

Water samples were collected from 9 sites in Lake Maurepas about once per month from June 2007 – March 2008 and analyzed from pH, phosphate, and silicate. Both absolute concentrations and discharge weighted concentrations were then compared to available historical data from similar sample sites taken before Hurricane Katrina. The average pH at sites near Pass Manchac, the Tickfaw River, and the Blind River showed no statistical differences from those collected by LDEQ in 2001 (p ranged from 0.22 to 0.98) [6].

The annual average phosphate concentrations in Lake Maurepas was 4.5±0.3 μM in this study and ranged from 1.2μM to 8.5μM for individual samples. The annual average concentration phosphate from sites near the Blind River, the Tickfaw River, and Pass Manchac were not statistically different from those collected by LDEQ [6] in 2001 (p > 0.23) but were 75 – 205% higher (p > 0.2) than those observed by Day, et al. [7], from 2002-2003 at the Blind River, Reserve Canal, and Pass Manchac. Annual average discharge weighted phosphate concentrations were calculated for all three data sets using river discharge information available for the USGS. These values were higher for all sites in this study compared to the data reported by Day and at two of the three sites compared to LDEQ (p ranging from
Despite a 76% larger discharge weighted phosphate concentration in this study at Pass Manchac compared to LDEQ data, it was not statistically different (p = 0.19) (Figure 1A).

The annual average silicate concentration in Lake Maurepas during this study was 105±4 μM and ranged from 68 – 159 μM for individual samples. The annual average concentration of silicate at Pass Manchac in this study was 96±11 μM compared to 61±11 μM in samples collected by the USGS [8] in 1963 and 60±20 in samples collected by Day from 2002-2003 [7]. The concentration in this study was statistically higher than in either of the previous studies (p < 0.001). Silicate concentration near the Blind River (114±14 μM) and the Reserve Canal (117±11 μM) were also higher than the silicate concentrations of 71±18μM and 64±21μM respectively as recorded by Day. Average annual discharge weighted silicate concentrations all were statistically higher in this study than those derived from historical data (p ranging from 0.001 – 0.03) at all locations (Figure 1B).

Figure 1. Annual discharge weighted concentrations of (A) phosphate at Pass Manchac and the Blind and Tickfaw Rivers in studies by Voegel, Day, and LDEQ and (B) silicate in at the Reserve Canal, Blind River, and Pass Manchac in studies by Voegel, Day, and USGS.

**Bonnet Carré Spillway and Lake Pontchartrain**

In April 2008, the Bonnet Carré Spillway was opened in response to rising water levels in the Mississippi River. Samples were collected from April to August 2008 at six sites in Lake Pontchartrain near the spillway and analyzed to determine if higher nutrient levels in fresh Mississippi River water affected the level of chlorophyll in Lake Pontchartrain. During the opening of the spillway, silicate and nitrate levels in Lake Pontchartrain increased by 560% and 126% respectively compared to concentrations just before the opening of the spillway. Conductivity levels at the same time decreased by as much as 94%. Chlorophyll levels increased by as much as 13.5 times shortly after the closing of the spillway demonstrating a significant effect of increased nutrients in Lake Pontchartrain [9]. The concentrations of silicate and nitrate increased rapidly and reached maximum levels within a few days while little change was observed in phosphate concentrations (Figure 2A). Chlorophyll levels remained low throughout the opening of the spillway despite high nutrient levels. Low chlorophyll levels are attributed to low temperatures in the Mississippi River water and high levels of sediment that limited the amount of light available for algal growth. Shortly after the closing of the spillway, amount of chlorophyll (Figure 2B) increased rapidly which was followed by a rapid decrease in nitrate and silicate.
By the end of May, nitrate levels decreased to non-detectable levels that led to a rapid decrease in algal populations as indicated by a rapid decrease in chlorophyll levels.

Figure 2. (A) Average concentrations of silicate (■), nitrate (♦), and phosphate (▲) and (B) chlorophyll near the Bonnet Carré Spillway from April through August 2008.

References:


Impact of the 2011 Opening of Bonnet Carré Spillway on Sediment Transport in the Adjacent Mississippi River Channel

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There is a long-standing concern that operation of Mississippi River diversions could lead to downstream deposition of river-borne sediments, especially coarse sediments (sand), due to a reduction in the available hydraulic energy in the river flow needed to keep those sediments in suspension. Such shoaling of sediments threatens commercial operations in the river and the continued viability of the river as a transportation corridor. The May-June 2011 opening of the Bonnet Carré Spillway above New Orleans provided an opportunity to examine the extent to which future large diversions in the tidal reach of the river might impact sediment transport. To address this issue, three boat-based field studies were conducted in the Mississippi Channel adjacent to the structure for the LA Coastal Protection and Restoration Authority: 1) a pre-opening survey conducted over three days (May 9-11) during the first phase of gate opening, 2) a two day survey (May 21-22) carried out when the structure was operating at full capacity and the 2011 flood was near its peak, and 3) a post-opening survey conducted immediately after final structure closure (June 21-25). These field studies had two major objectives—to examine channel bed bathymetric change induced by the structure by mapping before and after the period of structure operation, and to examine sediment transport (suspended and bedload) in the channel above and below the structure while it was operating at full capacity (and again after closure).

The channel bed change mapping was carried out bank-to-bank with a multibeam bathymetric profiler (Reson 7101, 240 kHz, 512 beams) over a 12 river mile reach centered on the structure (Fig. 1). The reach was divided into four river mile sections that were mapped in a single field day and then combined. Each survey required three days to carry out. Bathymetric differencing of the before and after channel bed elevation was carried out at a 1 m² grid scale and measured elevation change volumes (m³) were converted to sediment mass (metric tons and cubic yards) using a value of 1,362 kg/m³ (85 lbs/ft³). Initial results from this geomorphic analysis lend some credence to the concerns about the potential shoaling impact of large diversions. An estimated 3.51 MT (6.17 million yd³) of sand (based on bottom grabs) were deposited in the two river mile reach in front of and slightly downstream of the spillway in the main stem of the river (Fig. 1). While the deposition does not appear to have intruded into the actual main-stem navigation channel, it did reduce depths in the Bonnet Carré Anchorage immediately in front of the spillway structure, contributing to the running aground of the Long Range 1 (45,000–79,999 dead weight tons) tanker BW Thames on June 21st, 2011. Net shoaling extended, with declining magnitudes with distance downstream, to the lower limit of the survey area. In total, an estimated 4.89 MT (8.38 million yd³) were deposited in the channel below the structure.

The sediment transport study was carried out during the period the structure was operating at full capacity and was repeated immediately following closure at three study grids—one above the structure (river mile 138), one immediately below (RM 127), and a third downstream of the Luling Bridge near the lower limit of the multibeam bathymetric survey (RM 120). At each of the two upriver grids, suspended sediment load and grain size were measured using a point-integrated isokinetic sampler (P-6, 200 lb) along a cross-section of verticals, with individual samples at each vertical at 0, 0.3, 0.5, 0.7 and 0.9 total water depth. Water discharge was measured along these cross-sections using a pole-mounted, 600 kHz RD Instruments acoustic doppler current profiler (ADCP) and WINRIVER software. Discharges were
averaged over four individual river crossings conducted over about a 30 min period at each cross-section. ADCP discharges and isokinetic sampler loads were utilized to calculate cross-sectionally integrated total and sand suspended loads (in metric tons/d). Bedload sand transport was measured utilizing a repeat multibeam methodology developed in previous Mississippi River channel studies that examines the downstream migration of dunes over two surveys separated by 6-24 h, depending on discharge. Only bedload measurements were carried out at the Luling grid study area.

Preliminary results from these measurements indicate that suspended load transport was significantly reduced in the river during the operation of the structure. Suspended loads during the period of capacity operation (Fig. 2) were reduced for both mud (82% of the above structure load) and sand (54%). After closure, while total loads were significantly lower during this falling discharge limb, suspended loads for sand were higher in the channel below the structure, perhaps indicating remobilization of the sand stored in this reach. Previous studies of bedload in the tidal reach of the Mississippi have shown that bedload rates increase exponentially with discharge, with bedforms increasing both in size (e.g., mass) and celerity. Despite a reduction in water discharge of ~20% caused by the operation of the structure, bedload transport rates at the site above the structure are lower than the site immediately downriver of the structure (Fig. 3) and equivalent to the Luling site. This suggests that other factors are at work than simply discharge: reach-specific energy fields and sediment availability, for instance. While bedload transport rates are reduced overall in the lower discharge post-closure surveys, the relative magnitude of the three sites remains the same (Fig. 3).

Figure 3 also presents bedload transport rates divided into an “erosion” and “accretion” component. These are derived from the change-mapping comparison that yields an erosional zone upriver of a migrating bedform, and an accretionary zone on the downriver (lee) side of the dune. If the dunes are translating across a static underlying surface, these values should be equivalent. When the structure is open, however, the accretion averaged cross-sectionally is only 69% of the erosional value (Fig. 3). This suggests that the underlying bed is deflating and losing sand to suspension, even as the dunes translate downstream. In effect, this is an observation of a benthic regime beginning to transition from bedload to suspended load transport at the very high discharges above the structure. The geomorphic survey supports this concept: showing that the bars upriver of the structure deflated when compared before and after the opening, and sand was re-deposited at the downstream edge of each bar (Fig. 1). As the stream power induced by water discharge and water surface slope are reduced below the structure, so too is this erosion-accretion differential. Interestingly, after closure, the site immediately below the structure still showed an excess erosion in the bedload measurements—again suggestive of remobilization of the sand deposit mapped in the geomorphic survey.

While the initial analysis documents the deposition of sediments in the Mississippi River associated with the operation of Bonnet Carré, at this time it is not understood whether this newly-deposited material will persist and what impact it may have on future navigation in the river. Specifically, we have no information to conclude whether repeated operation of Bonnet Carré leads to incremental accumulation of deposited sediments in specific areas of the river over time, or whether such deposition would be a hazard to future navigation and riverborne commerce. This information will be critical for federal and state emergency and resource managers to understand the trade-offs that need to be understood when planning flood response options.
Figure 1. Bathymetric change map between the multibeam bathymetric surveys conducted before and after the 2011 opening of the Bonnet Carré Spillway.
Figure 2. Suspended load statistics for surveys conducted above and below the Bonnet Carré Spillway in the Mississippi River channel while the structure was operating at full capacity in May 2011 (open) and immediately following closure (closed).

Figure 3. Bedload transport statistics for surveys conducted above and below the Bonnet Carré Spillway in the Mississippi River channel while the structure was operating at full capacity in May 2011 (open) and immediately following closure (closed).
Edaphic and Vegetative Controls on Mercury Cycling in the Lake Maurepas Wetlands

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Continued expansion of both the human population and associated industrial activities has resulted in greater consumption of resources as well as increased generation of waste and deleterious by products. Mercury is a naturally-occurring toxic metal whose concentration and availability in the ambient environment has increased substantially in recent years through human industrial activity. Additionally, mercury exhibits a complicated and unique biogeochemical cycle, such that it is often a contaminant of ecotoxicological concern in unindustrialized aquatic habitats. This research seeks to elucidate various aspects of the behavior of mercury in oligohaline wetland habitats relevant to southeastern Louisiana, particularly in respect to the roles of soil and vegetation as controlling factors. This was accomplished through a field-based characterization study and a series of manipulative greenhouse and laboratory experiments. The field investigation was conducted at six locations in the Lake Maurepas wetlands selected for optimal spatial coverage and to represent a salinity gradient. Sampling occurred in spring, summer, and fall of 2007 as well as winter of 2008, which happened to correspond to a period of low water levels at these study sites. Results of the field study indicated that during the time of the study, biogeochemical processes in these soils were dominated by the microbial reduction of nitrate to ammonia, with little reduction of sulfate to sulfide and thus soil methyl mercury concentrations were quite minimal. Further, total mercury concentrations in local vegetation were found to be typical of uncontaminated environments in the U.S. and likely play a minor role in local mercury cycling. The first experimental study was a hydroponic greenhouse study that evaluated the capacity of several species of wetland plants common to the oligohaline wetlands of southeastern Louisiana to function as phytoremediation agents for aqueous mercury contamination. Several of the species tested demonstrated the ability to reduce aquatic inorganic mercury levels, but generally not to a greater extent than has been shown for other plant species in the mercury phytoremediation peer-reviewed literature. The second experimental study assessed the ecophysiological response of three local oligohaline wetland plant species to elevated surface water inorganic mercury levels as well as the fate of elevated surface water inorganic mercury into soil components and vegetation partitions in a wetland mesocosm. Notably, surface soil mercury levels became elevated, but mostly occurred in biologically unavailable forms, while substantial mercury uptake by plants occurred only in belowground tissues. Importantly, minimal impacts to the plant photosynthetic processes of the three species were found, reflecting the nominal translocation of mercury into aboveground tissues. The final experimental study investigated the potential stimulation of soil methyl mercury concentration via elevated surface water nutrients in a benchtop soil core incubation study. Short-term alterations to soil biogeochemical status subsequent to nutrient addition to surface waters were indicated by the alteration of surficial soil redox potential. However, minimal differences were found between surface water nutrient treatments in surficial soil redox potential by the end of the 14 day study. Correspondingly, no evidence of significantly increased soil methyl mercury concentration was found in the range of nutrient concentrations studied.
Management of drainage-ditch systems for water quality enhancement on the north shore of Lake Pontchartrain

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The north shore of Lake Pontchartrain has experienced rapid development during the past two decades with a concomitant increase in human use pressure on Lake Pontchartrain itself. Eutrophication and microbial contamination rank among the most pressing of the water quality problems that face Lake Pontchartrain. One of the primary contributors of nutrient and bacteria contamination to surface waters in this area are drainage ditch systems occurring in heavily populated neighborhoods where individual residential septic systems are frequently employed. However, these drainage ditch systems routinely exhibit minimal water flow except in cases of high rainfall events and are often colonized by herbaceous wetland vegetation. Thus, it may be possible to manage these ditch systems as microscale tertiary wetland treatment systems to improve ambient water quality prior to transfer into adjacent waterbodies. As these systems are interconnected with regional primary waterbodies, the remediation of drainage ditch system water quality should result in a corresponding improvement in primary waterbody water quality. In this study, seasonal and use type (storm water only versus storm water and septic tank drainage) trends in drainage ditch water quality, as indicated by fecal coliform counts, as well as nitrate-nitrite, ammonium, and inorganic phosphorus concentrations, in Mandeville, Louisiana were assessed. Additionally, correlations of these water quality indicators with the type and amount of naturally occurring vegetation were performed. Finally, surficial soils were characterized for toxic metal content (cadmium, chromium, copper, nickel, and lead) and soil redox potential. The majority of inorganic nitrogen occurring in these systems appears to be ammonium rather than nitrate nitrite. No consistent trends in water quality indicators were discernable by season. However, the highest concentrations of inorganic phosphorus and ammonium, as well as the highest fecal coliform counts were detected during the sampling efforts in spring and early summer of 2005, whereas nitrate-nitrite concentrations were the highest in spring of 2006. Fecal coliform loads were higher in ditches draining septic and storm water than in ditches draining storm water only. Interestingly, both ditches draining septic and storm water as well as ditches draining storm water only were above recreational guidelines. These high concentrations of fecal coliform bacteria present in the drainage systems of neighborhoods using centralized treatment likely indicate mixing of water from the two ditch types during high flow events or possibly the presence of another source of fecal coliform bacteria. As anticipated, inorganic phosphorus, ammonium and nitrate-nitrite concentrations trended higher in ditches draining septic and storm water as compared to those draining storm water only. Generally those drainage ditch systems categorized as containing high levels of vegetation had slightly lower concentrations of ammonium, but had higher concentrations of fecal coliforms, than drainage ditch systems categorized as containing low levels of vegetation. However, no significant effect of vegetation presence was detected on nitrate-nitrite or inorganic phosphorus concentrations. Concentrations of cadmium, chromium, copper, nickel, and lead in surficial sediments were essentially below detection for both drainage ditch system types. Surficial soil redox potential was significantly lower in ditch systems draining septic and storm water than in ditches systems draining storm water only.
Study of EDCs in biosolids and residuals

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Rationale:
Endocrine disrupting compounds (EDCs) have been posing an increasing threat towards public health due to their exponential effects even at low dose. While studies have revealed the tendency of many endocrine-active compounds to partition to the sludge flocs over the course of conventional wastewater treatment, relatively little work has been conducted to systematically track the fate of EDCs during various common sludge stabilization processes, such as anaerobic or aerobic digestion, alkaline treatment and composting, via chemical analysis. Far less research has focused on using in vitro bioassays to determine the total endocrine-active potency of biosolids, as opposed to pinpointing the concentrations of specific known and suspected EDCs. (Citulski and Farahbakhsh 2010)

Goal and work needs to be done:

In order to apprehend the nature of EDCs existence in biosolids and sludge in New Orleans, along with the prolonged effects of disinfection agents on the fate of EDCs, bioassays would be conducted. MVLN cell assay focuses more on if any carcinogenicity presents, while yeast assay tests to what degree the targeted receptor is activated or inactivated, where flexibility is ensured since any receptor could be combined into yeast’s DNA by microbial engineering. The outcomes of these two assays would provide us with some multi-dimensional picture about EDCs and possibly, serve as the foundation of regulation and criteria on the subject of concern.

Methods:

With respect to EDCs and PPCPs, there are possibly 200 to 300 of these compounds in the ng/kg range, and the measurement of the concentration of a few EDCs would be meaningless so it recommended utilizing molecular assays. The organic compounds described in the section on emerging chemicals of concern could perform as carcinogens or bind with certain gene receptors. MVLN/MCF-7 cell proliferation assays and yeast estrogen screen (YES) cell assays have been used for endocrine screening.

MVLN/MCF-7 cell assay

The MCF-7 cell line, which was developed at the Michigan Cancer Foundation in the early 1970s, derives from the pleural effusion of a 69-year-old human female in the late stages of metastatic mammary carcinoma. Early investigations found it to express the estrogen receptor, androgen receptor, progesterone receptor, glucocorticoid receptor, vitamin D receptor, and retinoic acid receptor. The MCF-7 human cell line has been used widely throughout the last 23 years in the study of cancer biology, steroid hormone biochemistry, and, more recently, toxicology. One of the most common applications of MCF-7 is for the characterization of estrogenic compounds (Gray et.al., 1997).

Yeast estrogen screen (YES) assay

Recombinant yeast strains expressing nuclear receptors (NRs) and ligand-dependent reporter genes have been useful for testing environmental components (air, soil, waste and water), drugs, herbal supplements, plant extracts, foods and other materials for the presence of NR agonists or antagonists (Collins et.al., 1997, Bovee et.al., 2006, Escher et.al., 2005).
The yeast *Saccharomyces cerevisiae* is a useful tool for the study of NR signal transduction pathways. It provides a relatively simple and well-defined eukaryotic system for the expression of genes from other organisms (Strausberg et al., 2001). Numerous studies, using yeast strains designed to express metazoan NRs and restriction endonuclease (RE)-driven reporter genes have demonstrated ligand dose dependent activation of NR-responsive reporter genes. Such ligand-dependent NR reporter assays have been extensively used to analyze signaling from a wide variety of NRs, including, but not limited to, estrogen and glucocorticoid receptors, aryl hydrocarbon receptor (AhR) and ecdysone receptor (Collins et al., 1997, Miller, 1999, Routledge et al., 2000).


PONTCHARTRAIN RESEARCH COMMITTEE

The Pontchartrain Research Committee (PRC) was formed in 1992 shortly after the first "Basics of the Basin" research Symposium was held. The mission of this committee is to promote good science for the Pontchartrain Basin. Committee members also have been called upon in an advisory capacity to various governmental and environmental groups. The PRC welcomes these opportunities such as this to share ideas and resources. This committee plans to continue to be active and is willing to consider project proposals related to the basin. We intend to continue to work closely with the scientific community, and with environmental groups whose primary concern is the Pontchartrain Basin. We also intend to continue to hold this symposium biennially.

2011 PRC MEMBERS

Dr. John A. Lopez--Committee Chairman  
Lake Pontchartrain Basin Foundation
Dr. Robert Moreau  
Southeastern Louisiana University - Turtle Cove Environmental Research Station
Dr. Nick Norton  
Southeastern Louisiana University
Dr. Dale Manty  
US Environmental Protection Agency – NCER, Dallas Tx.
Theryn Henkel  
Lake Pontchartrain Basin Foundation
Dr. Bob Reimers  
Tulane University
Gordon Austin
Dr. Chris Brantley  
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(CPRA) La. Dept. of Natural Resources - Coastal Restoration Division
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Area Conservationist, NRCS – Lafayette, LA
Dr. Jimmy Johnston  
U.S. Army Corps of Engineers
Dr. Jim Flocks  
USGS - CENTER FOR COASTAL AND WATERSHED STUDIES
Dr. Mark Hester  
University of Louisiana – Lafayette

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Dr. Crain,
President – Southeastern Louisiana University

I wanted to let you know how appreciative Dr. Nick Norton and I are for all of the help and support we received from so many people across our Southeastern campus in hosting what turned out to be a very successful Basics of the Basin 2011 Symposium last week. Starting with you providing the facilities for the conference, and going down the list of all of those who were critical to helping with all of the details of a conference this size (160 professionals plus 80+ students attending over the course of 3 days), this could not have been accomplished without such an effort. I had so many conference participants telling me this was one of the best BOB Conferences they had attended, and comments like that are a nice reward for all of the hard work everyone put in. In no particular order I’d like to acknowledge and thank the following Southeastern and Aramark employees for their efforts (my apologies if I am forgetting anyone)—they are all copied here as well:

Jonathan Ambrose and his entire Student Union Staff for providing us with such a nice and functional setting for the conference----we were complimented again and again on the quality of facilities Southeastern has;

Dr. Tena Golding and her staff at the Center for Faculty Excellence, who provided us with all of the equipment we needed to host the conference (projectors, lap tops, etc.:---Dane Bounds helped me organize, set up and test the equipment for our key-note speakers);

The Administrative Computing Services Department who started us off in the right direction by helping create the registration forms we needed to be able to receive on-line registrations and payments (Dave Koch, Amber DeJean and Jason Domiano were all key in this effort);

Nettie Burchfield and her Controller’s Office staff, including all of the cashiers that helped process all of those credit card registrations (Lori Stillwell I think was the person doing most of these);

Erin Cowser and Kathy Pittman who provided me with lots of advice and equipment (the Alumni Office provided flags and dining table center pieces) on what we needed for Senator Vitter’s visit as well as all of the other items I would have never thought of;

Karen Cockerham at The Document Source---Karen went above and beyond the call of duty in helping me to print all of the last minute items we needed, as we needed them!;

Martin Balisteri and Sena Gulotta of Aramark for the wonderful dishes they served for our conference participants—the food was great;

Dr. Sid Guedry and the Horticulture Staff for providing the beautiful plants that were placed on the stages at the 12 Oaks Ballroom and the Union Theater;

Dean Morgan of Physical Plant for helping to set up and test the sound system in 12 Oaks for Senator Vitter’s talk and the other Key-Note speakers who presented there;

Byron Patterson and the Physical Plant who provided (as usual) such beautiful grounds as a backdrop to the conference outside of 12 Oaks and the Union;

Rene Abadie and his staff at the Office of Public Information, who provided coverage of the event and helped with lots of other particulars as needed;
Kevin Knudsen and the Campus Police, who helped me logistically organize and plan for all of our parking issues;

Sam Hyde, who provided a wonderfully entertaining lecture on Thursday night as one of our key-note speakers. He spoke about environmental history in our area, and as usual, the audience loved him;

Our Turtle Cove staff: Hayden Reno—who helped showcase Turtle Cove on the Field Trip on Saturday, and Fred Stouder and our two Turtle Cove Graduate Students Logan McCordle and Matt Ripley. Along with Biology students Ashley Ross and Danielle Gomez (who arrived at 7:00am each morning to monitor the parking barricades!), their efforts throughout the Conference were so important;

And last but not least Simone Hamilton, our Turtle Cove Technical Communications Specialist (and recent Southeastern graduate student who graduated this past spring in English) who was so instrumental in helping me to keep all of this on track in terms of registrations, the Agenda and maps, and so many other things;

Again, putting on such a successful and well-received conference of this magnitude could not have been possible without all of these folks’ help, and I greatly appreciate their efforts. I have also copied Dr. Dale Manty (USEA and Southeastern PBRP Program Manager) and Dr. John Lopez (Acting Director of the Lake Pontchartrain Basin Foundation) who also express their gratitude and thanks to you and the Southeastern Administration and all of these people mentioned above for their efforts in hosting such a successful Basics of the Basin 2011 Symposium.

Rob Moreau

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Special thanks for assistance to printing of the proceedings to

Derek Boese
Associate VP
Atkins-Louisiana
Science Advisory Committee  
(SAC)

The Pontchartrain Basin Research Program (PBRP) is guided by an external Science Advisory Committee (SAC) that is comprised of 10 individuals representing academia, federal and state agencies, the local community, and the private sector. The SAC members advise the program director and, through a peer review system, critique submitted proposals for merit and compatibility with the PBRP mission. SAC recommends proposals worthy of funding to the director who then finalizes the ranking and dispersion of funds to the principal investigators. The program director is very appreciative of the unwavering commitment, dedicated support, and valued guidance that the members of SAC have provided PBRP over the years. Below is a list of current SAC members and their affiliation.

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<td>Mr. Carleton Dufrechou</td>
<td>Wetland restoration and community involvement</td>
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<td>Committee Chair</td>
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<td>General Manager, Lake Pontchartrain Causeway</td>
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<td>Dr. Dale Manty</td>
<td>Hazardous substances</td>
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<td>EPA, Washington DC</td>
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<td>Dr. Robert Reimers</td>
<td>Bioremediation</td>
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<td>Health Sciences Center Tulane University</td>
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<td>Dr. Kenneth Teague</td>
<td>Wetland restoration</td>
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<td>EPA, Region 6</td>
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<td>Mr. Dan Llewellyn</td>
<td>Wetland ecology</td>
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<td>Southeastern Louisiana University</td>
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<td>Mr. Gordon Austin</td>
<td>Treatment of sewage and waste water</td>
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<td>Sewerage &amp; Water Board of New Orleans</td>
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<td>Dr. Mike Livingston</td>
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<td>Dr. Marilyn Kilgen</td>
<td>Environmental microbiology</td>
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<td>Head of Biology Department, Nicholls State University</td>
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<td>Dr. David Constant</td>
<td>Environmental engineering</td>
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<td>Professor and Assistant Director of EPA HSRC</td>
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<td>Louisiana State University</td>
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<td>Mr. Bill Hawkins</td>
<td>Environmental toxicology</td>
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<td>Executive Director GCRL, University of Mississippi</td>
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