



NGI
NORTHERN GULF INSTITUTE

Cooperative Institute Progress Report

Reporting Period: July 1, 2007 to June 30, 2008

Submitted July 30, 2008

by:
David R. Shaw, Director
E. Glade Woods, Co-Director

Northern Gulf Institute
Mississippi State University

www.NorthernGulfInstitute.org



The Northern Gulf Institute is a cooperative institute funded by
National Oceanic and Atmospheric Administration Award #A06OAR430264



Cooperative Institute Progress Report

Reporting Period: July 01, 2007 – June 30, 2008

Submitted by:
David R. Shaw, Director
E. Glade Woods, Co-Director
Northern Gulf Institute
Mississippi State University

Submitted on:
July 30, 2008

Award Investigator:
Denise Peoples
Mississippi State University

Submitted to NOAA via:
<https://www.GrantsOnline.noaa.gov>

Courtesy Copy to:
John Cortinas, OAR CI Program Manager
National Oceanic and Atmospheric Administration

This report was prepared under award NA06OAR4320264 06111039 to the Northern Gulf Institute by NOAA's Office of Ocean and Atmospheric Research, U.S. Department of Commerce.

Table of Contents

1. Introduction	1
1.1 Institute and Core Activities	1
1.2 NGI Vision, Mission, Goals and Organization	2
1.3 Executive Summary of Significant Research Activities	9
1.4 Distribution of NOAA Funding by Task and NGI Theme	11
1.5 Task 1 Activity with Distribution of Funding	12
2. Performance of NOAA/NGI Funded Projects	12
3. Relationships of NGI Projects to NOAA Goals	13
4. NGI Publications for Reporting Period	14
5. Personnel Supported by NGI Funding	15

APPENDIX

Summary of Performance of NOAA NGI Funded Projects

1. Introduction

1.1 Institute and Core Activities

The Northern Gulf Institute (NGI), a National Oceanic & Atmospheric Administration (NOAA) Cooperative Institute, develops, operates, and maintains an increasingly integrated research and transition program focused on filling priority gaps and reducing limitations in current Northern Gulf of Mexico awareness, understanding and decision support.

Partnering with five academic institutions and NOAA, the NGI is a collaboration led by Mississippi State University (MSU) that includes the University of Southern Mississippi (USM), Louisiana State University (LSU), Florida State University (FSU), and the Dauphin Island Sea Lab (DISL). The Institute develops, operates, and maintains an increasingly integrated research and transition program, the results of which fill priority gaps or reduce limitations in current Northern Gulf of Mexico awareness, understanding, and decision support. This is particularly true at the intersection of upland-watershed systems and coastal waters, habitats, resources and hazards; the NGI integrates the interaction and impacts of people and communities. The NGI contributes to NOAA's priority interests within four Research Themes: Ecosystem Management; Geospatial Data Integration and Visualization in Environmental Science; Coastal Hazards; and Climate Change and Climate Variability Effects on Regional Ecosystems.

The Institute was created in late 2006, and shortly thereafter the Council of Fellows, made up of the Senior Investigator from each of the member institutions, established an Executive Office at MSU in Starkville, Mississippi, a Program Office at Stennis Space Center, Mississippi, and began evaluation for funding of the various proposals. Funding for the various research initiatives began in February 2007 and significant efforts are being made to address important questions related to the NOAA goals of Ecosystem Management, Weather and Water, Climate Change, and Commerce and Transport.

The fundamental philosophy of the NGI is integration - integration of the land-coast-ocean-atmosphere continuum; integration of research to operations; and integration of individual academic institutional strengths into a holistic research and educational program specifically geared to the needs of Northern Gulf of Mexico users. This report encompasses the research and transition program of NGI through Year 2 of the NOAA award.

University partners are continuing collaboration in the development of education and outreach programs to educate the public on NGI research and to facilitate the transition of NGI research to NOAA operational centers. The NGI is working closely with the educational programs of the Gulf of Mexico Alliance and the Gulf Coast and Ocean Observing System to develop immediate communication and significant long term messaging campaigns to address identified priority issues.

1.2 NGI Vision, Mission, Goals, Organization

Vision

NGI will be a regional leader providing integrative research and education to improve the resiliency and conservation of the Northern Gulf of Mexico.

Mission

NGI conducts high-impact research and education programs in the Northern Gulf of Mexico region focused on integration - integration of the land-coast-ocean-atmosphere continuum; integration of research to operations; and integration of individual organizational strengths into a holistic program. The program shall measurably contribute to the recovery and future health, safety, resilience and

productivity of the region, through sustained research and applications in a geospatial and ecosystem context.

Goals, Strategies and Objectives

Goal 1: Develop high-impact regional research programs within the four NGI themes

Strategies:

- Develop Annual Science Plans that identify core regional issues framed by the four NGI themes that will guide allocation of research funding
- Establish and implement funding criteria to emphasize multi-organizational collaboration of projects
- Establish and implement funding criteria to emphasize regional impact of projects

Objectives:

- NGI Science Plan developed and adopted by Research Fellows and accepted by NOAA
- NGI Science Plan reviewed/modified annually and adopted by Research Fellows and accepted by NOAA
- Over the three to five year period, produce a major research finding in each of four themes
- All funded projects will be multi-organizational collaborations
- All projects will include an assessment of regional impacts, transferability, and potential to increase in scope

Goal 2: Develop high-impact regional education and outreach programs within the four NGI themes

Strategies:

- Adopt and implement funding criteria to emphasize student involvement in projects
- Involve students in the NOAA and Minority Fellowship programs
- Develop funding criteria to emphasize outreach activities for each project
- Conduct major regional outreach activities aligned with development and implementation of the NGI Science Plan
- Conduct speaker series, hold workshops, and develop training collaborations for core regional issues framed by the four NGI themes

Objectives:

- All funded projects will involve students
- Over the three to five year period,
 - 150 students will be funded by NGI
 - 20 NGI students hired into NOAA
 - 25 NOAA Minority Fellowships awarded
 - 25 NOAA Internships awarded
- All funded projects will include an outreach component or activity.
- Over the three to five year period,
 - At least one major outreach activity will be produced in each of the four theme areas
 - 9 to 15 talks will be sponsored
 - 9 to 15 workshops will be conducted
 - 6 to 10 training collaborations will be established
 - 600 people will have participated in workshops and collaborative training events

Goal 3: Create strategic partnerships with other organizations to enhance northern Gulf regional research and educational efforts

Strategies:

- Utilize the NGI Advisory Council composed of stakeholder organizations to provide strategic guidance to NGI and help create a vital regional community
- Establish formal relationships with Gulf of Mexico Alliance and the Sea Grant programs of Alabama/Mississippi, Florida, and Louisiana
- Create formal and informal strategic relationships with other organizations to address NGI's core regional issues framed by the four themes

Objectives:

- Bi-annual meetings of NGI Advisory Council
- Establish a formal tie to the Gulf of Mexico Alliance
- Establish formal ties with the Sea Grant programs of Alabama/Mississippi, Florida, and Louisiana
- Over the three to five year period,
 - 20 strategic relationships will be established
 - 10 to 12 other funding sources will be established from within the strategic relationships
 - \$15 million in additional funding will be developed
 - 160 scientists will be supported through the NGI

Goal 4: Transition research into new or enhanced products and operations

Strategies:

- Develop research transitions aligned with development and implementation of the NGI Science Plan
- Establish and implement funding criteria to emphasize transition activities for each relevant project
- Establish and implement funding allocation to develop research transition projects

Objectives:

- Over the three to five year period, produce four major research transitions within the 4 theme areas
- All funded projects will include a plan for transition into use
- Over the three to five year period, fund 5 transition projects

Goal 5: Communicate NGI research, activities, and opportunities through traditional and non-traditional channels

Strategies:

- Hold an annual conference of all NGI Principal Investigators, researchers, and students
- Support quarterly meetings of Research Fellows
- Participate in the Cooperative Institutes Annual Meeting
- Develop the NGI website to effectively communicate the program's messages, focusing on timely dissemination of information and completeness of content
- Develop an NGIgram to share critical information among strategic partners
- Initiate and encourage coverage of NGI activities and research in the Northern Gulf region media
- Establish and implement evaluation criteria to encourage publication and dissemination of research results

Objectives:

- Conduct Annual NGI Research Conference
- Conduct quarterly meetings of Research Fellows
- Attend annual Cooperative Institutes Directors & Financial Administrators Meeting
- Create NGI website and populate with NGI documents and research program information
- Prepare and disseminate 12 NGIgrams per year
- Over the three to five year period, outreach activities of the NGI will result in:
 - 30 Press releases
 - 30 Newspaper articles
 - 8 Television news stories
 - 50 mentions in media
- Over the three to five year period, research activities of the NGI will produce:
 - 75 refereed articles
 - 300 non-refereed articles and research reports
 - 150 professional conference presentations/posters

Goal 6: Build and maintain a NGI framework and culture that fosters collaboration and maximizes human potential

Strategies:

- Utilize meetings to foster NGI identity and collegiality
- Develop research infrastructure to facilitate research activities
- Maintain transparency in NGI activities and administration
- Establish mechanisms to encourage and recognize the participation of young researchers and students
- Establish mechanisms to encourage and reward innovation and excellence

Objectives:

- Over the three to five year period,
 - Host 30 NGI meetings
 - 750 attendees at the NGI meetings
- Annually review and update:
 - the NGI Strategic Plan
 - the NGI Science Plan
 - the NGI Implementation Plan
 - the NGI Web Page
- Over the three to five year period, 10-15 externally funded projects will be managed within NGI
- Over the three to five year period,
 - 5 Students will receive NGI Awards/Honors
 - 5 Researchers will receive NGI Awards/Honors
 - 15 Nominations for award
 - 25 NGI Student Internships will be awarded

NGI Organization

Figure 1.1 illustrates the NGI organizational structure and collaborative connections. The top row reflects the oversight role of MSU and location of the Director of NGI who reports directly to the MSU Vice President for Research. Located in Mississippi State University’s High Performance Computing Collaboratory, the NGI Administrative Office is led by a tenured faculty Director among whose responsibilities are to serve as primary liaison to NOAA’s Executive Council and as the principal point of contact for the Cooperative Institute Program Manager.

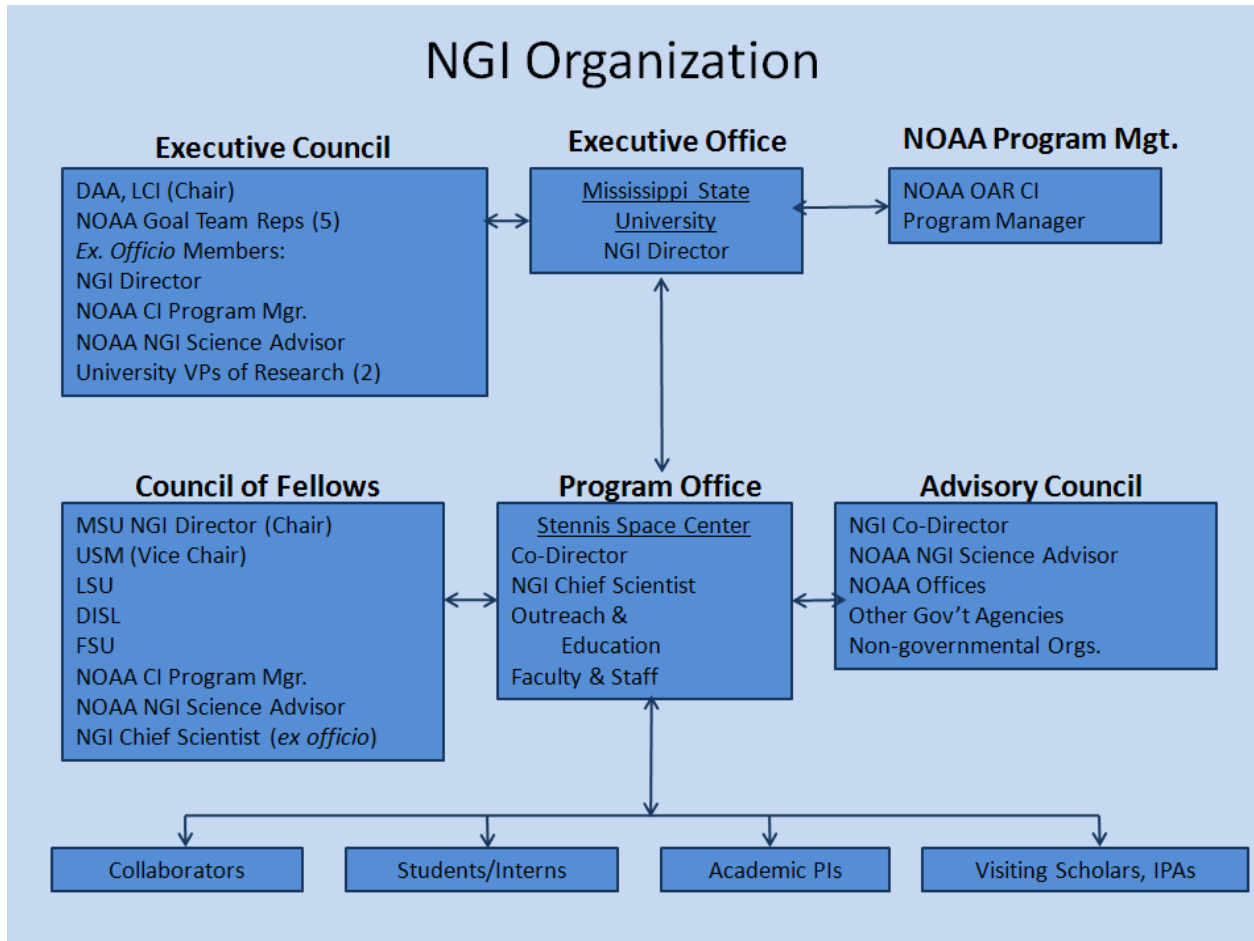


Figure 1.1 NGI Organizational Structure and Collaborative Connections

The NGI Program Office is located at the Stennis Space Center, Mississippi, and is led by the NGI Co-Director and supported by the Mississippi State University team at Stennis, including research and outreach faculty and the Chief Scientist. The NGI Program Office is responsible for maintaining regular interaction with the Council of Fellows, the lead academic body for the NGI, the Advisory Council and the NOAA NGI Science Advisor. The NGI Program Office has prime responsibility for the day-to-day operation of the Institute, with particular reference to Stennis-based and regional coordination, meetings of the Council of Fellows, the annual conference, and NGI students.

The NGI implementation builds upon the proposal submitted by the NGI consortium to NOAA on May 23, 2006, a number of interactions with NOAA and resulting clarifications after selection, the NOAA October 1, 2006 award, the preparation and review of a Memorandum of Agreement between MSU and NOAA, and reference to NOAA’s Cooperative Institute Interim Handbook. The NGI implementation

framework presents policy, program, and procedural guidance to the NGI, communications with NOAA’s CI Program and participating NOAA offices, and to the various review, advisory and working-level entities affiliated with NGI.

In the second year of operation, staff drafted institutional strategic and implementation plans and began the review and adoption process for the instruments.

Figure 1.2 combines the organizational arrangements with the key functions of the Institute. The roles of each functional unit are described.

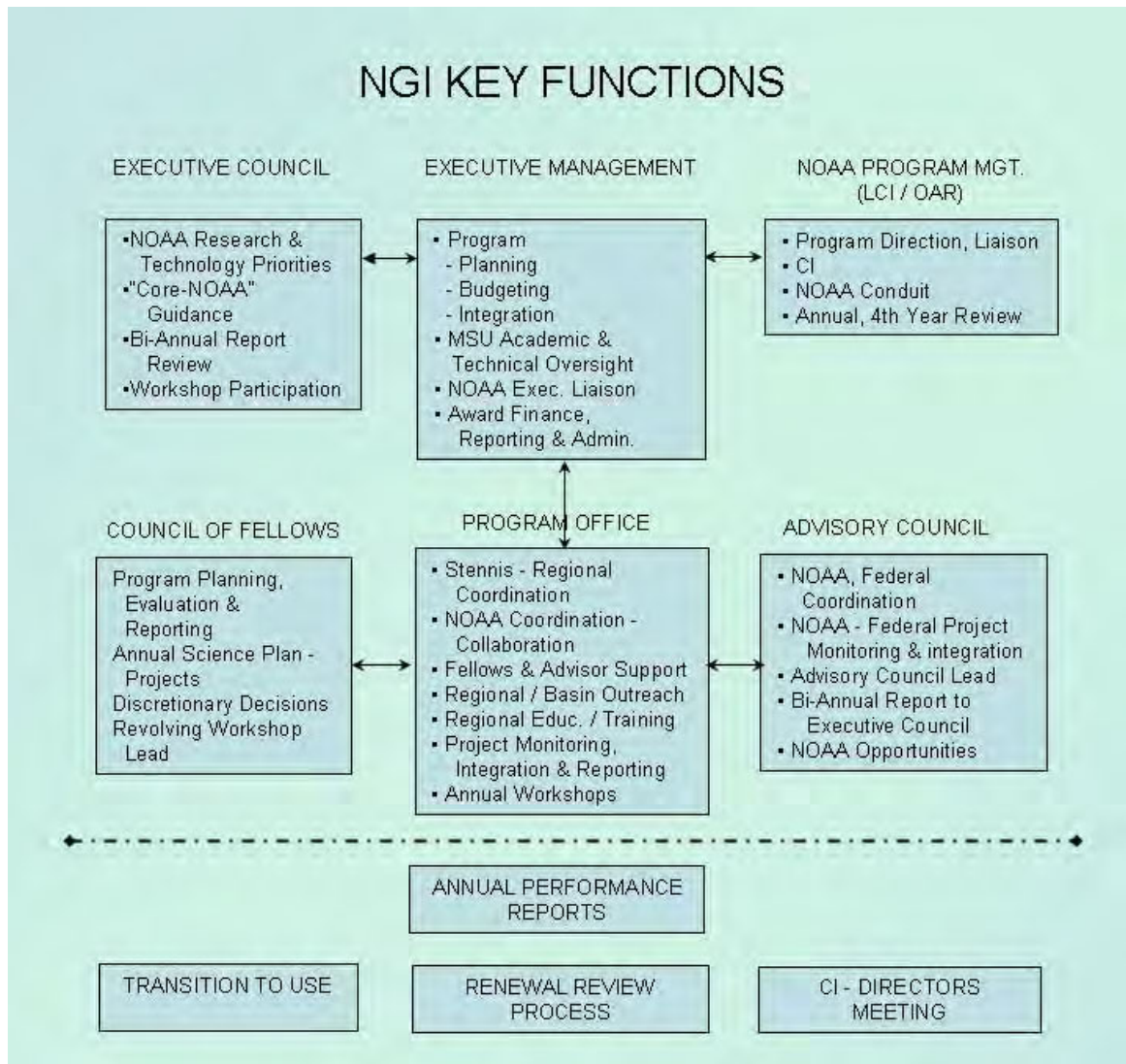


Figure 1.2 NGI Key Functions

Role of the Executive Council: The Executive Council is made up of five Senior NOAA officials, representing the four NOAA Goal Teams, vice presidents of two NGI academic partner institutions, and is chaired by the Deputy Assistant Administrator for Laboratories and Cooperative Institutes. The NOAA NGI Science Advisor, the NGI Director, and the NOAA Cooperative Institutes Program Manager will serve as ex-officio members of the Executive Council.

The Executive Council is primarily responsible for broad policy and program direction for the NGI. It will meet at least once yearly to review NGI programs and progress, and to transmit NOAA strategic plans and priorities to the NGI management in order to ensure program alignment with these priorities. In turn, the Executive Council will provide information regarding the NGI successes to the NOAA Administrator to justify inclusion of NGI funding in the NOAA core budget. The NGI is wholly committed to transparency, accountability, governance control, and effective integration through the Executive Council.

The NGI Executive Council members are:

Sandy MacDonald, Chair, NOAA Deputy Assistant Administrator for Laboratories & CIs
Robert Atlas, Director, NOAA Atlantic Oceanographic Meteorological Laboratory
Cecil Burge, Vice President, Research & Development, University of Southern Mississippi
Gary M. Carter, Director, NOAA Office of Hydrologic Development
Roy Crabtree, Regional Administrator, SE Region, NOAA Fisheries Service
Margaret Davidson, Director, NOAA Coastal Services Center
Louisa Koch, Director, NOAA Office of Education
Al Powell, Director, NOAA Center for Satellite Applications and Research
Kirk Schulz, Vice President, Research & Economic Development, Mississippi State University
Ex-officio:
David R. Shaw, NGI Director
John Cortinas, NOAA CI Program Manager
NOAA Science Advisor (To be determined)

The first meeting of the Executive Council will be held in October 2008 in Miami, Florida.

Role of the Council of Fellows: The Council of Fellows is comprised of senior scientific/technical representatives from each NGI partner academic institution, as well as the NGI Science Advisor, and the NOAA CI Program Manager. The Council is chaired by the NGI Director, and the Vice Chair is the USM representative. The Council of Fellows is responsible for development of the Implementation Plan and its bi-annual review by the Advisory Council. It will conduct an Annual Program Assessment and Report to NOAA, and oversee the Annual NGI Work Plan. It will receive overarching guidance from the Executive Council, and will build the Annual Work Plan based on needs assessments and recommendations from the Advisory Council. This group will also be responsible for ensuring the highest quality research is conducted, both through stringent project review prior to implementation and through monitoring progress of these projects once initiated.

The NGI Council of Fellows members are:

David Shaw, Chair, NGI/Mississippi State University
Steven Lohrenz, Vice-Chair, University of Southern Mississippi
Eric Chassignet, Florida State University
Robert Twilley, Louisiana State University
Scott Quackenbush, Dauphin Island Sea Lab
Ex-officio:
Michael Carron, NGI Chief Scientist
John Cortinas, CI Program Manager

Meetings of the NGI Council of Fellows for this reporting period were:
December 2007, Council of Fellows and Advisory Council, Florida State University
May 2008, Annual Meeting, Fellows and Advisory Council, Biloxi, Mississippi

Conference calls of the NGI Council of Fellows for this reporting period were:
August 2007, January 2008, and April 2008

Role of the Advisory Council: The Advisory Council serves as the principal interface to the regional stakeholder community of the NGI. It has broad representation from the entities listed in the organizational chart, and meets regularly to identify and prioritize research and educational needs in the Northern Gulf region. The Advisory Council will also provide input on the current research and education/outreach programs of the NGI. The Advisory Council provides a bi-annual report to the NGI Director and Executive Council on its findings and recommendations.

The NGI will support the formation and efforts of workgroups around each of the major themes of the NGI. The responsibility of these workgroups will be to develop research approaches that focus on the integration philosophy of the NGI in all aspects of the programs developed. These workgroups may hold workshops and meetings to foster a collaborative atmosphere across institutions, and will be used to generate innovative approaches to research and education by bringing together the often disparate viewpoints of the various disciplines involved.

The NGI Advisory Council members are:

Russ Beard, NOAA NCDDC
Bob Bendick, The Nature Conservancy
Miles Croom, NOAA-NMFS
Todd Davison, NOAA GCSC
Kristen Fletcher, Coastal States Organization
Mark Glorioso, ARTPO, NASA Stennis Space Center
Bryon Griffith, EPA Gulf of Mexico Program
Karl E. Havens, Florida Sea Grant College Program
Dawn Lavoie, USGS Gulf Coast & LMV
Paul Moersdorf, NOAA NDBC
David Reed, NOAA NWS LMRFC
Mathias Romkens, USDA National Sedimentation Lab
David Ruple, Grand Bay NERR
Martha Segura, NPS Gulf Coast Network
LaDon Swann, MS-AL Sea Grant Consortium
Bill Walker, MS Department of Marine Resources
Jeff Waters, US Army Corps of Engineers
Chuck Wilson, Louisiana Sea Grant College
Glade Woods, MSU/NGI Stennis Space Center, Chair

Meetings of the NGI Advisory Council for this reporting period were:
December 2007, Council of Fellows and Advisory Council, Florida State University
May 2008, Annual Meeting, Fellows and Advisory Council, Biloxi, Mississippi

NOAA Leadership: NOAA administration is responsible for ensuring that agency priorities are effectively represented to the NGI, through the NGI Director. Through the Executive Council, NOAA

will transmit these priorities, and will provide programmatic review annually. In addition, NOAA is responsible for integrating the NGI budget into the overall NOAA budget through effective advocacy based upon the merits of the program to the Executive Branch.

Academic Collaborators: The five collaborating academic institutions are responsible for providing primary input into and periodically reviewing and revising as necessary the Implementation Plan for the NGI. The Implementation Plan is the primary reference for the “Annual Work Plan” required by NOAA. Each collaborating institution will develop priority research areas that capitalize on the strengths of each university, promote a strong integrative and collaborative effort between institutions, NOAA line offices and NOAA scientists and ensure that the highest standards of quality in research are maintained.

NOAA Collaborators: NOAA line units (e.g. National Coastal Data Development Center, National Data Buoy Center, and Gulf Coast Service Center) are encouraged to provide input on programmatic directions and collaborative activities. Through the NGI Advisory Council, NOAA units will provide critical input into the prioritization of research requirements and thrusts for the NGI, review of research projects developed, and assessment of the research outcomes of these projects. In addition, since a portion of the funds associated with the NGI may be made available to NOAA units through an internal competition, and collaboration with the NGI is an important criterion for selection, the NOAA units receiving these funds are responsible for effective collaboration with the NGI research program through utilization of these funds.

Other Collaborators: A number of other federal agencies, (e.g. Environmental Protection Agency, National Air and Space Administration, U.S. Army Corps of Engineers, Department of Transportation, U.S. Geological Survey, Department of Agriculture, National Estuarine Research Reserve, Naval Research Laboratory, Minerals Management Service), state agencies (e.g. Departments of Marine Resources, Departments of Environmental Quality) and non-governmental organizations (e.g. Gulf of Mexico Alliance, Coastal States Organization, The Nature Conservancy) will play a substantial role in the activities of the NGI. This involvement will come from at least two paths: leveraged research activities and stakeholder requirements. Collaborators and stakeholders are responsible for providing input into the development of the NGI research program via participation in the Advisory Council. In addition, both the NGI leadership and the collaborating entities are expected to seek out opportunities to leverage resources in joint efforts, thus maximizing the benefits derived from those funded projects.

1.3 Executive Summary of Significant Research Activities

The policies and procedures of this initial IP are consistent with and expand upon the Memorandum of Agreement between MSU and NOAA, the NOAA notice of award to MSU of October 1, 2006, NOAA’s review of MSU administrative and grants processes (MSU, September 7, 2006), and the NOAA Cooperative Institute Interim Handbook (NOAA, OAR, Version 01, December 5, 2005). The NGI’s Executive Office is located at Mississippi State University’s High Performance Computing Collaboratory in Starkville, MS. A Program Office is located at Stennis Space Center, MS facilitating a link with NOAA’s NGI Science Advisor and many resident federal agencies. The academic facilities of the five NGI collaborating institutions host the research, technology, education, and transition-to-use program activities.

The NGI defines the Northern Gulf of Mexico region as the upland, watershed, coastal zone, and coastal ocean areas from the Sabine River in Louisiana east to the Suwannee River in Florida. This region is a rich and interdependent natural environment of great complexity vital to the Nation. The riverine-dominated Northern Gulf ecosystems are under pressure from increasing population and coastal

degradation, and many other factors. This is the geographic focus for the NGI. NGI has chosen an approach to Northern Gulf Region issues, problems and opportunities that is closely aligned with NOAA's strategic and research priorities and its user-community. This approach is science driven, regionally focused, and coordinated with other Gulf of Mexico Basin activities, and seeks whenever appropriate to promote the application of its results to support decision makers and policy development.

The Gulf of Mexico ecosystem encompasses 1.8 million square miles and is the receiving body for 66 percent of the rivers within the continental United States—including the Mississippi River, the largest river system in North America. A proposed partial solution to the loss of wetlands in the Mississippi River delta system requires periodic releases of fresh water (and silt) into these wetlands from the Mississippi River. Researchers at NGI academic partner, Louisiana State University, have recently begun four projects, all related to the health of the Mississippi River delta and related ecosystem by developing a series of linked simulation models that will allow tracking of the effects of pulsed freshwater inputs through the complex wetland environment in the Breton Sound and Barataria Basin estuaries. Related projects concern the relationship between available carbon, nitrogen, other physical oceanographic measurements and harmful algal blooms and *Vibrio* (*vulnificus* and *parahaemolyticus*) population dynamics in the two estuaries and an investigation of material exchange between the marsh and main channel to assess impacts of rising sea level and/or fluvial inputs on carbon and nitrogen budgets at the interface of a marine salt marsh environment between the Gulf of Mexico and a major river system. Related research at Mississippi State University involves the study of the impact of man-made protection structures on hurricane storm surge in areas away from the structures.

The Mobile River Basin is the fourth largest watershed in the United States. Our understanding of the flow of sediment and specific associated pollutants in the Mobile Basin will allow resource management decisions to be made in an informed manner which should ultimately result in quality environmental improvements. Mississippi State University researchers, working with the U.S. Army Corps of Engineers and researchers in Alabama, have begun field and modeling studies of the complete system to estimate the total reservoir and distribution of contaminated sediments, as well as to provide estimates for factors impacting changes in that distribution. Particular emphasis is being placed on modeling the distribution and movement of DDT and mercury in the system. The results of this modeling will be extended to other watersheds in the NGI region in the out years of this project.

The future health of the Northern Gulf region depends on knowledge of the biogeochemical and physical dynamics of a complex system of ecosystems and their interaction with both the large system of watersheds feeding the northern Gulf Coast littoral and the deep water processes of the Gulf of Mexico. NGI academic partners, University of Southern Mississippi and Florida State University, have begun a series of research projects addressing many of the significant issues related to fish population dynamics, harmful algal blooms (HABs), microbial source tracking, nutrient and pollutant fluxes and the interaction between near-shore and off-shore processes during extreme weather events. Both universities are working to correlate remotely sensed data with in situ measurements to decrease the uncertainty in remotely sensed data and develop and improve our regional HAB and hypoxia forecast capabilities.

The NGI through Mississippi State University is building a database to allow the study of the impact of extreme events on the economic health of the Northern Gulf region and to develop guidance for coastal managers to develop resilient communities and their associated ecosystems.

Many other research projects related to NOAA goals are in progress. Dauphin Island Sea Lab, Alabama's marine science education and research laboratory, is examining the potential benefits of

restoration of shallow sub-tidal oyster reefs on adjacent near-shore habitats. The objective is to determine whether the creation of shallow, near shore oyster shell breakwaters in the Northern Gulf of Mexico will result in the enhancement of oysters and other reef-associated species, facilitate the maintenance and expansion of the shoreline and enhance other productive biogenic habitats such as seagrass meadows.

1.4 Distribution of NOAA Funding by Task and NGI Theme

The following charts depict the NOAA Cooperative Institute funding by NGI Task and funding by NGI Research Theme.

Figure 1.4a depicts the ratios of Task I (Administrative/Education), Task II (Research with Significant NOAA involvement) and Task III (Research without significant NOAA involvement) activities.

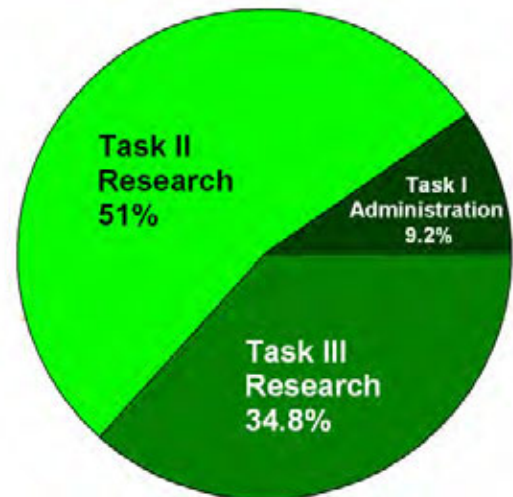


Figure 1.4a Distribution of Tasks I, II, and III Funding (includes NGI NOAA Projects)

NGI’s Research Themes follow and amplify the four themes presented in the NOAA Announcement of Opportunity. As NGI moves ahead on implementation it is important to reiterate and present several additional thematic guideposts.

First, an ecosystem-based approach to research and transition pervades the NGI program. Second, geospatial technology and applications are important “glue” that connects the four NGI Themes and NGI’s wider regional communities. Consistent with the ecosystem-based foundation of the program, geospatial research and products are guided by ecosystem principles, definitions and approaches. Third, climate effects are studied primarily from a regional perspective and in conjunction with ecosystem-based theory, observations and monitoring schemes. Fourth, both climate effects and hazard/resilience issues will incorporate social and economic elements and research endeavors.

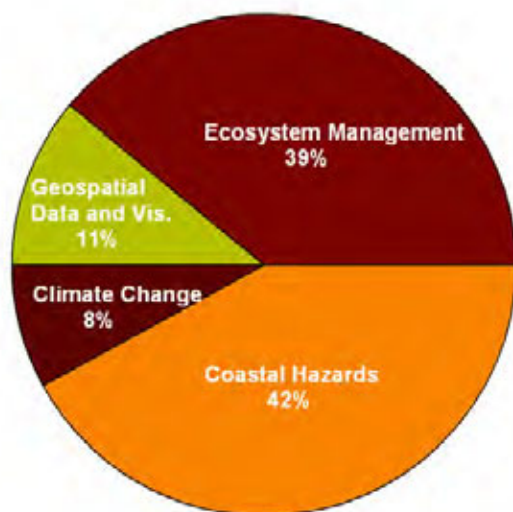


Figure 1.4b NGI Funding by Research Theme

Figure 1.4b illustrates the approximate distribution of NGI funding across the NGI research themes. Most NGI research projects have potential impact on two or more of these themes.

1.5 Task 1 Activities with Distribution of Funding

During this reporting period, NGI initiated the Task I administrative activities and program development, conducted program planning, and recruited and staffed the central program office as Stennis Space Center. NGI prepared operational budgets to remain flexible with the requirements of the contract and incorporated NOAA finance and budget procedures. The NGI Director worked with the NOAA CI Program office to develop the Memorandum of Agreement, in accord with the five universities' academic collaborators. Figure 1.5 depicts the relative funding of the administrative components of Task I activities.

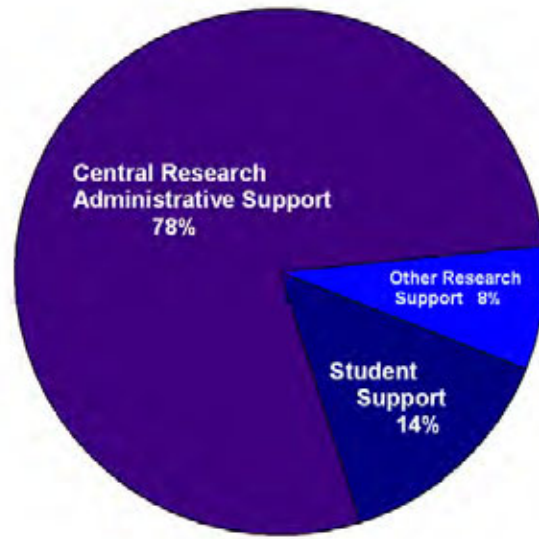


Figure 1.5 Distribution of Task I Administrative

The NGI Executive Office and Program Office worked with the NGI Council of Fellows to develop the first research plan and make the selection of first year funded research. NGI senior staff expended great effort developing collaborative relationships with other Federal and State partners within the region in order to leverage the base funding. NGI held its first annual conference in May 2007, to provide a forum for presentation of current research and activities to foster collaboration.

NGI staff initiated the Education and Outreach Program by facilitating topical workshops and presenting NGI program overviews to teacher groups. NGI hosted a student technology exposition and exercise and is currently working to extend existing NOAA outreach networks (e.g., Phytoplankton Monitoring Network) and facilitate collaboration and outreach with continuous institutional website development at www.NorthernGulfInstitute.org.

NGI staff working in concert with the Council of Fellows developed program review and evaluation processes. NGI has defined management leadership roles and established channels of communications to lay a good foundation for supporting this critical and much needed research in the Northern Gulf. NOAA provides four anonymous evaluators for all proposals.

2. Performance of NOAA/NGI Funded Projects

A full description of the 34 NGI projects (24 academic and 10 NOAA) funded by NOAA is provided in APPENDIX A: **NGI Year 2 Project Profiles**. The project profiles include project performance, with principal investigator(s) contact information. The primary NOAA contact on these projects to date is Dr. John Cortinas, Oceans and Atmospheric Research Office. Other technical contacts to NOAA personnel are developing, but are not officially listed as co-investigators at this time.

3. Relationship of NGI Projects to NOAA Goals

The following table (Table 1) lists the NGI research projects in a matrix with NOAA Goals from the NOAA Strategic Plan.

Table 1. NGI Research / NOAA Goals Matrix

NGI University Research Efforts		NOAA Goals			
		Ecosystem	Climate	Weather & Water	Commerce & Transport
MSU	07-MSU-01 Analysis of Disturbances to Coastal Economies	X		X	
	07-MSU-02 Assessing the Impact	X		X	
	07-MSU-03 Watershed Modeling	X		X	
	07-MSU-04 Spatial Technology	X		X	
	07-MSU-05 Modeling Mobile Bay	X		X	X
	07-MSU-06 Visualization			X	
	07-MSU-07 An Information Semantic	X	X	X	X
	07-MSU-08 NGI Outreach	X	X	X	X
	07-MSU-09 Improving Hurricane			X	
USM	07-USM-01 Microbial Source Tracking	X		X	
	07-USM-02 Utility of Ionosphere	X	X	X	X
	07-USM-03 Monitoring and assessment	X		X	
	07-USM-04 Interaction between off-shore circulation	X		X	
	07-USM-05 Optical Assessment of Algal Bloom	X		X	
	07-USM-06 Coordination of USM NGI	X	X	X	X
	07-USM-07 Quantifying Ecosystem Services	X		X	
	07-USM-08 Macrofaunal Indicators of Hypoxia	X		X	
LSU	07-LSU-01 Delta Ecosystem	X		X	
	07-LSU-02 Public Health and Stressors	X		X	
	07-LSU-03 Trophic Linkages	X		X	
	07-LSU-04 Investigating material exchange	X		X	
FSU	07-FSU-01 Integrated Research Big Bend Region	X	X	X	
DISL	07-DISL-02 Habitat Restoration Research at DISL	X		X	
	07-DISL-01 Marine Education and Outreach at DISL	X		X	

NOAA Goals addressed by NGI projects are: (1) Protect, Restore, and Manage the Use of Coastal and Ocean Resources through Ecosystem-based Management; (2) Understand Climate Variability and Change to Enhance Society’s Ability to Plan and Respond; (3) Serve Society’s Needs for Weather and Water Information; and (4) Support the Nation’s Commerce with Information for Safe, Efficient, and Environmentally Sound Transportation.

4. NGI Publications for Reporting Period

The NGI competed and awarded the first round of research projects in 2007. A summary of publications by type and quantity are provided in the table below (Table 2).

Table 2. NGI Publication Summary

Summary of Publications for NGI					
	Year 1	Year 2	Year 3	Year 4	Year 5
Peer Reviewed					
Institute Lead Author	4	18			
NOAA Lead Author		1			
Other Lead Author	4	0			
Total	8	19	0	0	0
	Year 1	Year 2	Year 3	Year 4	Year 5
Non-Peer Reviewed (not to include presentations)					
Institute Lead Author	2	51			
NOAA Lead Author		11			
Other Lead Author	1	0			
Total	3	62	0	0	0

In addition to the standard publication categories reported in the Table 2, an annual NGI newsletter, *The Portal*, was launched, and approximately 400 copies were distributed in Year 2 via conferences, workshops, and other meetings with collaborators. An NGI ListServe was established in order to communicate electronic announcements of Northern Gulf issues and opportunities via email and its subscriber list now contains over 250 email addresses; during Year 2 information was disseminated at an average rate of 4 messages per month.

5. Personnel Supported by NGI Funding

The NGI funding availability and support for NGI institutional staff began on October 1, 2006. Research proposals were evaluated in the fall of 2006, and funding was awarded in the winter of 2007. The summary table depicting the research and administrative personnel supported by NOAA Award Number NA06OAR4320264 is found below, Summary of NGI Personnel - Year 2.

Summary of NGI Personnel - Year 2				
Employees that receive > 50% NOAA Funding (not including students)				
Category	Number	B.S.	M.S.	Ph.D.
Research Scientist	5	0	1	4
Visiting Scientist	0	0	0	0
Postdoctoral Fellow	5	0	0	5
Research Support Staff	19	13	6	0
Administrative	6	1	2	3
Total	35	14	9	12
Students				
Undergraduate Students	13	13	0	0
Graduate Students	51	37	14	0
Total	64	50	14	0
Employees that receive < 50% NOAA Funding (not including students)				
Category	Number	B.S.	M.S.	Ph.D.
Research Scientist	126	0	9	117
Visiting Scientist	0	0	0	0
Postdoctoral Fellow	1	0	0	1
Research Support Staff	24	7	17	0
Administrative	1	0	0	1
Total	152	7	26	119
Located at Lab (include name of lab)	21	7	0	14
Obtained NOAA Employment within Last Year	0	0	0	0

NOAA Labs: CCFHR – 4, AOML – 9, Panama City Laboratory, NMFS – Woods Hole Laboratory, NMFS – Mississippi Laboratory – 3, NMFS – Estuarine Habitats and Coastal Fisheries Center, NMFS – Galveston Laboratory, Great Lakes Environmental Research Laboratory.

APPENDIX: NGI Year 2 Project Profiles

This appendix to the NGI Year 2 Project Report provides a full description of the 34 research projects (24 academic and 10 NOAA) funded under award NA06OAR4320264 06111039 to the Northern Gulf Institute by NOAA's Office of Ocean and Atmospheric Research, U.S. Department of Commerce.

Table of Contents:

4	Education and Outreach at the Dauphin Island Sea Lab 07-DISL-01
7	Restoring Estuarine landscapes in Alabama Coastal Waters through Creation of Oyster Reefs 07-DISL-02
12	Integrated Research for the Northeast Gulf of Mexico Big Bend Region 07-FSU-01
24	Developing a Foundation for Analysis of Natural and Human-Induced Disturbances to Coastal Economies 07-MSU-01
30	Assessing the Impact of Ordinances, Outreach and Enforcement on the Resiliency of Gulf Coastal Watersheds 07-MSU-02
43	Watershed Modeling Improvements to Enhance Coastal Ecosystems 07-MSU-03
66	Spatial Technology and High Performance Computing for Improving Prediction of Surface Water Quality 07-MSU-04
79	Modeling Mobile Bay Sediments and Pollutants with New Technologies 07-MSU-05
90	Visualization Techniques for Improving Public Understanding of Catastrophic Events 07-MSU-06
96	Information Semantic Approach for Knowledge Discovery in Integrated Ocean Observing System 06-MSU-07
104	Northern Gulf Institute Outreach Efforts – Year 2 07-MSU-08
110	Improving Hurricane Intensity and Landfall Estimation with Refined Modeling 07-MSU-09
116	Microbial Source Tracking 07-USM-01
121	Utility of Ionosphere and Troposphere Models for Extending the Range of High-Accuracy GPS 07-USM-02
127	Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf 07-USM-03
138	Interaction between Off-shore Circulation and Nearshore Processes during Extreme Weather Events 07-USM-04
143	Satellite and In Situ Optical Assessment of Algal Bloom Events in the Northern Gulf of Mexico 07-USM-05
151	Coordination and Educational Support for USM Northern Gulf Institute Activities 07-USM-06
156	Quantifying Ecosystem Services of Different Coastal Habitat Types in Support of Ecosystem-based Fisheries Management 07-USM-07
160	Monitoring and Assessment for Ecosystem Management -Macrofaunal Indicators 07-USM-08
164	DELTA Ecosystem Forecasting System 07-LSU-01
170	Public Health and Stressors 07-LSU-02
178	Trophic Linkages and Biomass Production in Estuarine Ecosystems 07-LSU-03
181	Investigating Material Exchange between the Marsh and Channel along an Estuarine Gradient 07-LSU-04
185	NOAA Ecosystems Data Assembly Center (EDAC) supporting the NOAA NGI 07-NOAA-01
190	Forecasting the Ecological Impacts of Hurricanes through the Integration of Retrospective Remotely Sensed Imagery with Hydrographic and Biological Data 07-NOAA-02
192	Habitat-linkages, Spatial Demographics and Food Web Components of the Northeastern Gulf Fisheries Ecosystem 07-NOAA-03
203	Mercury Bioaccumulation in Mobile Bay: a Model for Other of Gulf of Mexico Estuaries 07-NOAA-04
207	Northern Gulf Cooperative Institute: Development of Molecular Assays to Monitor Waters for Threats to Human Health 07-NOAA-05
216	Building a Comprehensive Database on the Early Life Stages of Fishes in the Northern Gulf of Mexico 07-NOAA-06
220	Determining the Relative Contributions of Ekman Transport and Other Meteorologically-Driven Flows and Astronomical Tides in Estuarine Recruitment 07-NOAA-07
224	Enabling and Initiating Observing System Simulation Experiments of a Coastal High Resolution Oceanographic Model in the Northern Gulf of Mexico 07-NOAA-08
228	Temperature and Salinity Effects on the Growth and Survival of Juvenile Penaeid Shrimps: Implications for the Influence of River Diversions on Production 07-NOAA-09
233	Estimating Air-Sea Carbon Dioxide Fluxes in the River Dominated Northern Gulf of Mexico 07-NOAA-10



*Northern Gulf Institute – Education and Outreach at the
Dauphin Island Sea Lab*

NGI Project File Number: 07-DISL-01

Dr. John Dindo, jdindo@disl.org

Dauphin Island Sea Lab, 101 Bienville Blvd, Dauphin Island, AL 36528

Personnel funded by this project (name, position, % salary from NGI, NOAA Lab):

Dr. John Dindo, Research Scientist, 4%, No

Dr. Tina Miller-Way, Research Scientist, 100%, NO

Ms. Mendel Graeber, Marine Science Educator, 100%, No

Mr. Orin Robinson, Graduate student, 10%, No

Ms. Lauren Showalter, Graduate student, 100, No

Key Scientific Question(s)/Technical Issues:

Given the nature of this project, the key scientific questions we are communicating are taken from other projects. With regard to technical issues, modification of existing pre- and post-assessments to determine what NGI-related information and concepts students are gleaned from the Discovery Hall educational programs at the Dauphin Island Sea Lab have begun.

Collaborators/Partners:

None

Project Duration:

Start Date: February 1, 2007 Estimated End Date: November 2009

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

Education and outreach span and help to integrate all of NOAA' mission goals. This grant specifically supports ocean literacy through outreach and education across all grade levels and for the general public.

Contributions to regional problems and priorities:

We are working directly with the Gulf of Mexico Alliance to address Gulf of Mexico Ocean Literacy.

Gaps (Describe how the project will narrow gaps in regional knowledge, data, model performance, geographic coverage, etc.):

This project is addressing gaps in Gulf of Mexico Ocean Literacy using a variety of approaches including various media and target audiences. NGI educators have interacted with a number of student groups (detailed below). Informational panels have been developed and displayed in the Estuarium, Dauphin Island Sea Lab's public aquarium. An educator has been posted in the Estuarium and is informing visiting educational groups and the general public about Gulf of Mexico topics and issues as well as NGI research. Webpages have been developed or modified to inform viewers, potentially nation-wide, of NGI, its mission and NGI research results using text, podcasts and short videos.

Project Abstract:

Establish a direct link between marine researchers and K-12 marine science education and provide a marine educator to enhance marine science education for school groups and the general public that visit the Estuarium at the Dauphin Island Sea Lab. The Ph.D. researcher/educator will assist in bridging the gap between research and K-12 education by interacting with researchers and their projects and educators at the Dauphin Island Sea Lab, the Southern Association of Marine Educators, and the National Marine Educators Association. In addition this person is working closely with the marine educator within the Estuarium to assist in relating marine research to

the general public. Included in the messages to the general public through our outreach project, Bay Mobile and the Estuarium, will be the priority issues of the Gulf of Mexico Alliance that overlap research efforts by scientists within the Northern Gulf Institute including 1) water quality for healthy beaches and shellfish beds; 2) wetland and coastal conservation and restoration, 3) environmental education, 4) identification and characterization of Gulf habitats and 5) reductions in nutrient inputs to coastal ecosystems.

List major milestones completed and describe any significant research results and transitions:

- An informational panel on the mission of the Northern Gulf Institute has been developed and displayed in the Estuarium.
- An informational panel on the NGI supported research of Dr. Bill McAnally of Mississippi State University has been developed and displayed in the Estuarium.
- An informational panel on the NGI supported research at Florida State University is being developed for the Estuarium.
- An informational panel on the manatee research of Dr. Ruth Carmichael of the Dauphin Island Sea Lab has been developed and displayed in the Estuarium.
- An informational panel on the oysters and human health has been developed and displayed in the Estuarium.
- By application and review, the Discovery Hall Programs have earned AMSTI Affiliate status, resulting in potentially wider distribution of the content in our teacher workshops.
- A webpage featuring podcasts and short informational videos on research done by DISL scientists has been developed and will be going live shortly.
- A teacher has been recruited to participate in Dr. Kyeong Park's research cruise to the Gulf of Mexico continental shelf.
- The curriculum used by students visiting the Estuarium has been updated to include new NGI-related content.
- Information on NGI scientific themes have been infused into Discovery Hall programs (academic year K-12 classes, middle school summer camps, summer high school course, teacher workshops).
- NGI educators are developing a series of exercises using wave tables to demonstrate erosion control measures and the importance of land use planning for use in the classroom and in the Estuarium.
- We have partnered with Radio Dauphin Island to disseminate news and items of interest including Gulf of Mexico messaging.
- An NGI educator has developed a fishing activity for the Estuarium to instruct about local species, overfishing and sustainability based on the National Marine Fisheries catch quotas and federal restrictions.
- An NGI educator has collaborated with the Gulf Coast Exploreum on activities for the public and a project proposal in collaboration with the Mobile Bay National Estuary Program.
- An NGI educator has started a series of written research news briefs for educators for distribution to Discovery Hall educators and fact sheets for distribution in the Estuarium.
- NGI educators are developing an additional unit on watersheds and water quality to include with the activities offered by the BayMobile, our traveling marine science classroom.
- A number of proposals have been written to increase the dissemination of information on watershed concepts and issues as well as harmful algal blooms (HABs).
- The Gulf of Mexico Alliance Environmental Education priority issue team have contracted with the University of South Florida Center for Social Marketing to conduct a survey about how select audiences interpret the term 'nutrients', their understanding of the role of nutrients in the Gulf of Mexico and of coastal resiliency. The survey will use a variety of approaches (telephone surveys, focus groups, interviews) and will examine local, state and federal elected officials and over 750 coastal residents from various walks of life across the Gulf of Mexico region. The Environmental Protection Agency-Gulf of Mexico, Northern Gulf Institute, and NOAA Office of Education are supporting this effort.

General Description of Outreach Activities:

NGI educators have worked with several groups of students in the Mobile area. We have taught middle school students in the Pillans Leadership Academy, funded by 100 Black Men of Mobile (April 2008). We have taught

over 500 middle school students who are potentially matriculating into the engineering program at Davidson High School, about watershed and water quality concepts and issues, funded by the Mobile Area Education Foundation (March 2008). We will be teaching underserved high school students this summer as part of the USA 21st Century Community Learning School Summer Camp, funded by a 21st Century Grant (July 2008). NGI research is also being infused into both sessions of the Marine Applications of Science and Technology (MAST) teacher workshop this summer (~60 teachers). Additionally, information on NGI's scientific themes (specifically Coastal Hazards, Ecosystem Management) has been incorporated into DHP's residential high school summer course. One NGI educator is located in the Estuarium and interacts with visitors informing them on Gulf of Mexico topics and issues as well as NGI research.

Have you hosted speakers, workshops and/or any training?

- NGI educator-led field excursions to salt marshes, sandy beaches and the maritime forest for the general public have been implemented.
- NGI educators developed a display and engaged participants in environmental games that highlighted NGI at the Dauphin Island Sea Lab's annual open house, Discovery Day.



NGI DISL Principal Investigator, Dr. Tina Miller-Way, is developing a fishing activity to instruct on local species and sustainability, and is distributing research news briefs and fact sheets to educators at the Dauphin Island Estuarium.

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

None

List non-refereed articles and reports for this project.

None

List conference presentations and poster presentations for this project:

- What's in a watershed? Ms. Mendel Graeber, North American Association for Environmental Education, November 2007, Virginia Beach, VA. 2008.
- Marine Research meets Education at the Dauphin Island Sea Lab, Dr. John Dindo, Dr. Tina Miller-Way and Ms. Mendel Graeber, Northern Gulf Institute 2008 Annual Conference, May 2008, Biloxi, MS.
- Post-Katrina Impacts to Colonial Nesting Birds in Coastal Alabama. Dr. John Dindo and Mr. Orin Robinson, Northern Gulf Institute 2008 Annual Conference, May 2008, Biloxi, MS.



Restoring Estuarine landscapes in Alabama Coastal Waters through Creation of Oyster Reefs

NGI Project File Number: 07-DISL-02

Dr. K. L. Heck Jr., kheck@disl.org,
Dauphin Island Sea Lab and University of South Alabama

List all personnel funded by this project (name, position, % salary from NGI, NOAA Lab):

Dr. Ken Heck, Research Scientist, 0%, No
Karly Steeves, Research Support Staff, 100%, No
Dorothy Byron, Research Support Staff, 50%, No
Matthew Kenworthy, Undergraduate Student, 25%, No
Sharon Davis, Research Support Staff, 50%, No
Steven Scyphers, Graduate Student, 0%

Key Scientific Question(s)/Technical Issues:

Will the creation of shallow, near shore oyster shell breakwaters in the northern Gulf of Mexico result in the enhancement of oysters and other reef-associated species, facilitate the maintenance and expansion of the shoreline and enhance other productive biogenic habitats such as seagrass meadows?

Collaborators/Partners:

Name of collaborating organization: USA Fisheries Habitat Program, Alabama Department of Conservation and Natural Resources, Auburn University Shellfish Lab

Date collaborating established: At project initiation

Does partner provide monetary support to project? Yes for USA program.

Amount of support? \$35K. No for ALDCNR and Auburn Shellfish Lab.

Does partner provide non-monetary (in-kind) support? Yes, reduced vessel charges for USA, and reduced prices for oyster spat from the Auburn Shellfish Lab

Short description of collaboration/partnership relationship: Our NGI project is designed to provide proof of concept for the benefits of living breakwaters in coastal Alabama, a goal consistent with one of the aims of the Fisheries Enhancement Program at USA, and why they have provided financial and in-kind support for the project.

Project Duration:

Start Date: February 1, 2007 Estimated End Date: February, 2010

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

By restoring oyster reef habitat and monitoring parameters that involve the entire ecosystem, this project aims to protect and restore oyster reefs and shoreline, which are both habitats of special concern.

Contributions to regional problems and priorities:

This project addresses several regional priorities. One problem is the need to reverse the decline of near-shore essential fish habitats, such as salt marshes and submerged aquatic vegetation, and the consequent negative effects on the production of finfish and shellfish. Another is the need to restore lost oyster reef habitat in coastal Alabama, stemming from the catastrophic losses (nearly 80%) due to Hurricane Ivan that have not yet been reversed.

Gaps:

This project will add knowledge to the potential for artificial oyster reefs to attract and sustain juvenile oysters that may ultimately develop into self-sustaining oyster reef habitats. It will also help determine whether this type of “living breakwater” structure can successfully slow erosion and speed recovery of lost shoreline areas. In addition, It will show how likely it is that the development of beds of submerged aquatic vegetation can be facilitated by the presence of the living breakwater reefs.

Project Abstract

This project is designed to examine the potential benefit of restoration of shallow subtidal oyster reefs on adjacent near shore habitats located at Point aux Pines and in the vicinity of Alabama Port, by examining whether such habitats will (1) result in fisheries enhancement; and (2) facilitate the maintenance and expansion of other biogenic habitats, by addressing the following four objectives:

1. Documenting changes in the physical setting of study sites resulting from the addition of oyster reefs.
2. Quantifying oyster recruitment and adult density in created near shore reefs.
3. Quantifying primary and secondary producers within subtidal and intertidal habitats between created oyster reef and shoreline.
4. Quantifying juvenile and adult fish and mobile invertebrate utilization of created oyster reefs and adjacent habitats.

List major milestones completed and describe any significant research results and transitions:

Although overall the shoreline at Point aux Pins has continued to erode, the West reef has substantially slowed erosion compared to the control site, while at the East reef site erosion is only slightly less than that at the control site. See Figure 1, Shoreline Change from May 2007 to May 2008.

The created oyster reefs are attracting spat which are successfully growing into adult oysters (greater than 3cm in length). See Figure 2, Oyster Density.

Fish increasingly are utilizing the reefs, as shown by the trend for higher fish abundance at the reefs than at the controls, in Figure 3, Demersal Fish Abundance.

Figure 4 shows several pictures of the reefs during construction.

Outreach activities:

Scyphers, S. 2008. Applying Technology to Marine Research: Oyster Reef Habitat Restoration and Shoreline Stabilization in Coastal Alabama. Marine Applications of Science and Technology Workshop for High School Science Teachers. Dauphin Island Sea Lab. Dauphin Island, AL. June 2, 2008. Oral Presentation.

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

None

List non-refereed articles and reports for this project:

Oyster Reefs to the Rescue. NGI Research Spotlight.

List conference presentations and poster presentations for this project.

Scyphers, S., K. Heck, S. Powers. Oyster Reef and Estuarine Landscape Restoration. November 5-7, 2007. Oral Presentation. Mobile Bay Collaboration Network Workshop.

Heck, K., S. Powers. Oyster Reef and Estuarine Landscape Restoration. May, 2007. Oral Presentation. NGI Annual Conference.

Scyphers S., S. P. Powers, K.L. Heck Jr. and C. Steeves. 2007. Restoring Estuarine Landscapes in Coastal Alabama Through Creation of Oyster Reefs. November 4, 2007. Oral Presentation. NGI Mobile Bay Collaborative Meeting.

Scyphers, S., S. P. Powers, K. L. Heck Jr. and C. Steeves. 2008. Shoreline Stabilization and Fisheries Benefits of Oyster Reef Restoration in Coastal Alabama. April 6-10, 2008. Oral Presentation. 100th Annual National Shellfisheries Association Meeting.

C. R. Steeves, K. L. Heck, Jr., S. P. Powers, S. B. Scyphers. The effects of breakwater oyster reefs on coastal ecosystems in the northern Gulf of Mexico. April 9-13, 2008. Poster Presentation. Benthic Ecology Meeting.

K. L. Heck, Jr., S. P. Powers, C. R. Steeves, S. B. Scyphers. The effects of breakwater oyster reefs on coastal ecosystems in the northern Gulf of Mexico. Poster Presentation. NGI Annual Conference. May 12-14, 2008.

Figure 1: Shoreline Change from May 2007 to May 2008

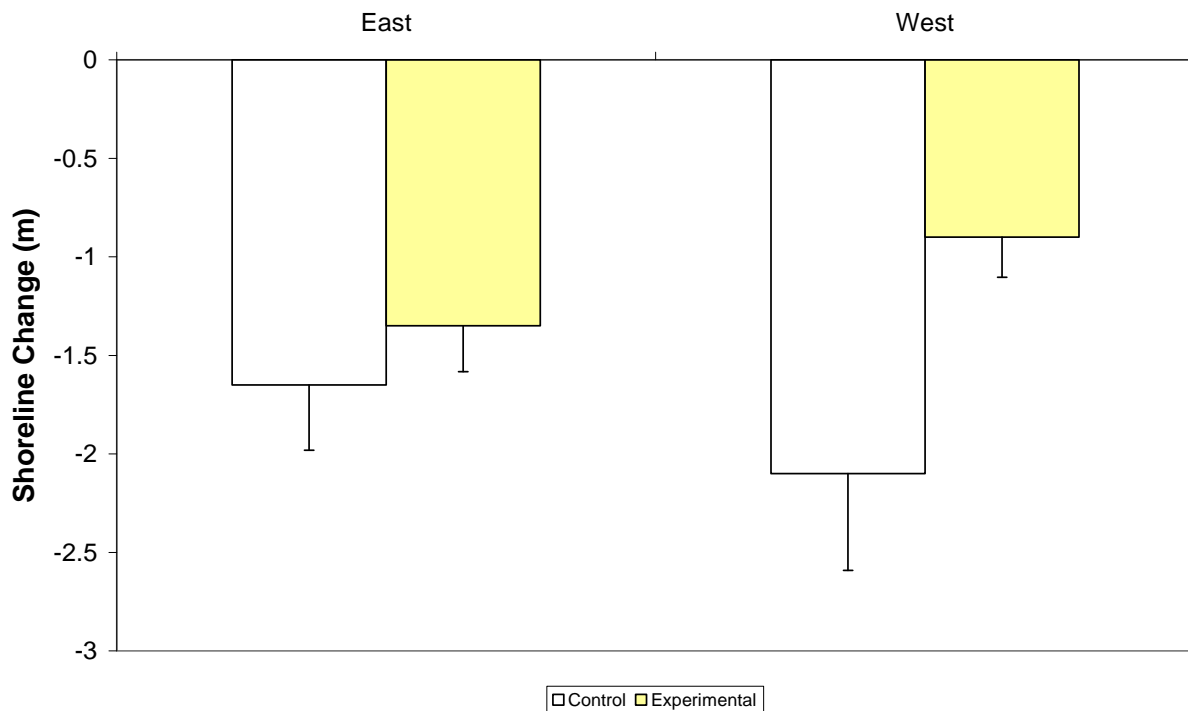


Figure 2: Oyster Density

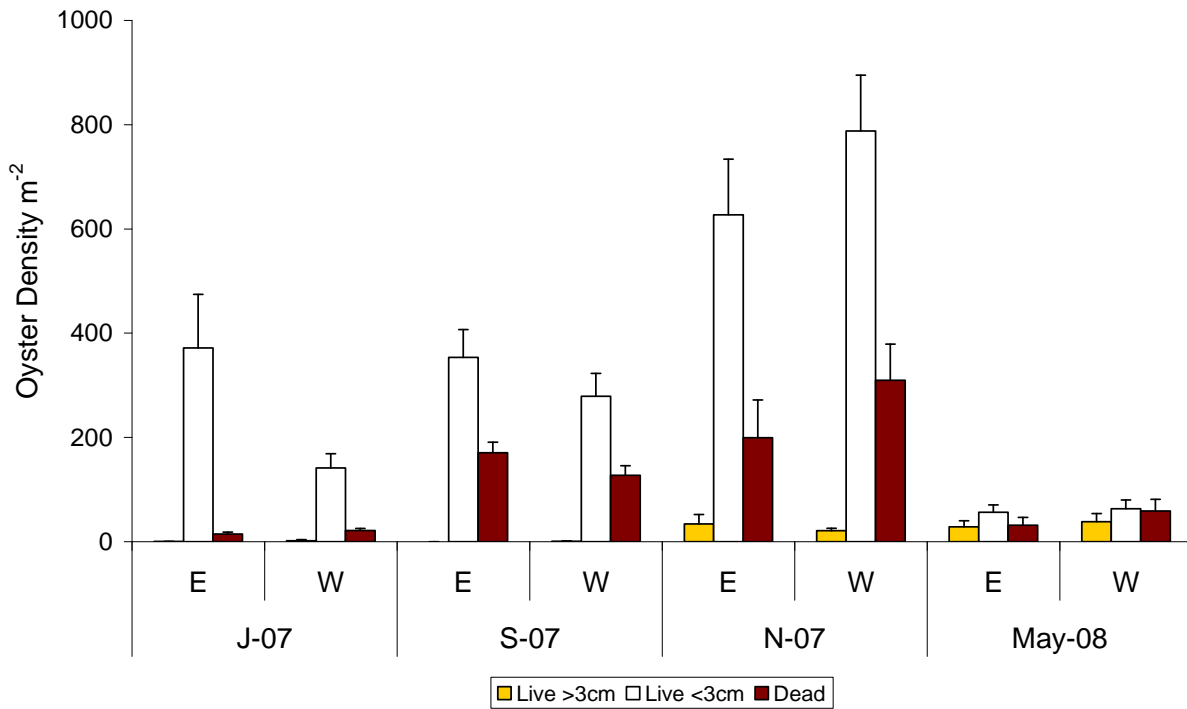
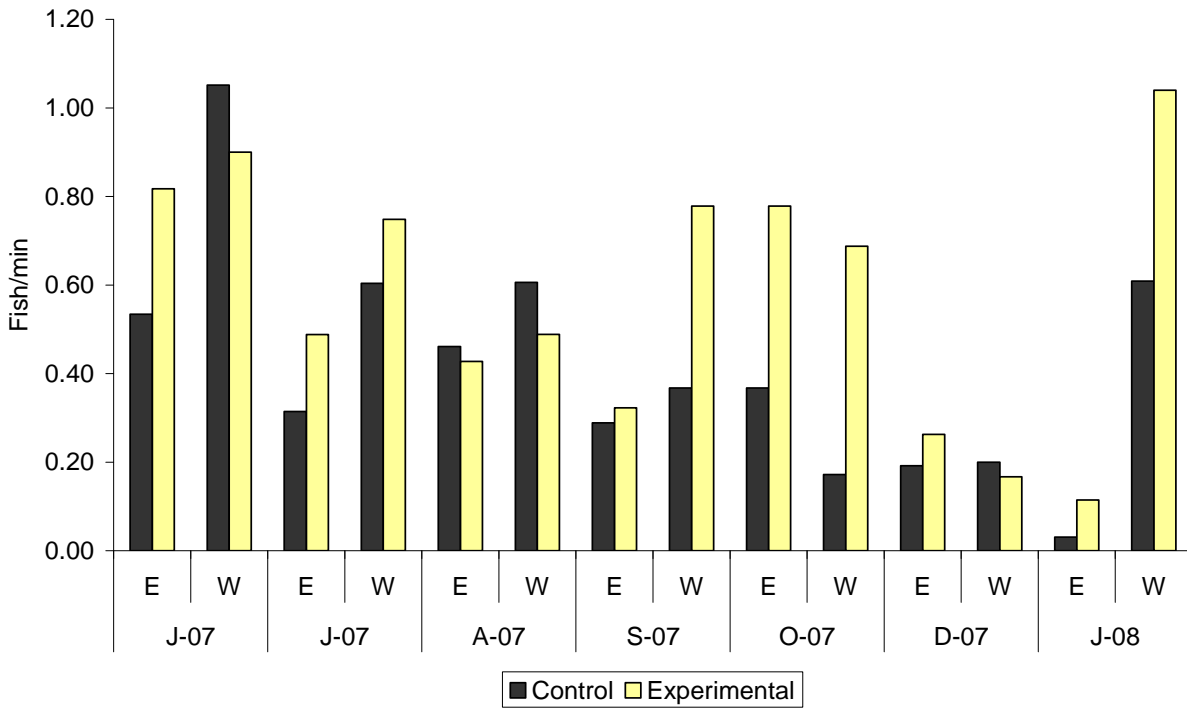


Figure 3: Demersal Fish Abundance





Reef Construction at Alabama Port



Completed Reef at Alabama Port



Reef Construction at Point aux Pines

Figure 4. Photos during reef construction



*The Florida State University Contribution to the Northern Gulf of Mexico
Cooperative Institute - [Integrated Research for the Northeast Gulf of Mexico
Big Bend Region] - Year 2*

NGI Project File Number: 07-FSU-01

PI: Prof. Eric Chassignet, Professor, Director, COAPS
Co-PI: Prof. WK Dewar, Professor, Chair, Dept. of Oceanography
Florida State University
Dept. of Oceanography, Florida State University
850-645-7288; 850-644-4099
echassignet@coaps.fsu.edu; dewar@ocean.fsu.edu

List all personnel funded by this project: (Name, Category, % of support by NGI, at NOAA Lab):

1. Stephanie Fahrny, research support staff, 100%, No
2. Tommy Van Horn, graduate student, 50%, No
3. S. Suryaputra, graduate student, 25%, No
4. Steve Morey, associate scientist, 40%, No
5. Dmitry Dukowsky, assistant scientist, 40%, No
6. Stephan Bourgoïn, graduate student, 100%, No
7. Jimmy Nelson, graduate student, 100%, No
8. Austin Todd, graduate student, 25%, No
9. Don Van Dyke, graduate student, 25%, No
9. Jesse Fields, high school student, 10%, No

No-cost faculty: Prof. E. Chassignet, Prof. W. Dewar, Prof. K. Speer, Prof. A. Clarke, Prof. G. Weatherly, Prof. M. Huettel, Prof. D. Thistle, Prof. T. Dittmar, Prof. J. Chanton, Prof. M. Bourassa, Prof. C. Clayson, Prof. P. Rusher, Dr. F. Coleman, and Dr. C. Koenig.

Key Scientific Question(s)/Technical Issues:

The overarching goals of the combined program are several, and motivated by the four tenets behind the establishment of the Cooperative Institute. We are interested in quantifying the on-shore and off-shore transport mechanisms of the Big Bend Region (BBR), documenting the basic regional physical oceanography and clarifying key aspects of the regional ecosystem and Gag grouper fishery. All three themes are drawn together within an overarching BBR modeling framework. The observations and modeling foci are directed at ecosystems based management, coastal hazards and the impacts of climate variability. The three components of our effort are (1) the transport project, (2) the gag grouper ecosystem project and (3) the modeling project. We outline the key scientific questions for each below.

Transport Project: We are interested in defining the cross-shelf transport mechanisms of the BBR with a view towards those processes that set the regional biological and chemical environment. We wish to:

1. Compare water column and sediment chlorophyll concentrations and productivity at three stations located at (4m, 10m, 20m) on the NGOM shelf and relate the productivity to water currents, nitrate and dissolved organic matter concentrations.
2. Estimate the transport of particles and chemical species in the water column due to wind, waves, tides, and buoyancy effects at these stations.
3. Assess the dynamics of dissolved organic carbon at the three stations and relate the DOC concentration to current characteristics.
4. Assess the dynamics of nitrate in the bottom water at the three stations and relate its dynamics to current directions, temperature and light.

Gag grouper ecosystem project: The objectives of the ecosystems research are to examine the role of benthic primary productivity in sustaining the regional ecosystems and the life cycle of the regionally important gag grouper. Relative to the latter, we focus on the effect of climate variability on (1) the growth rate and diet of early juvenile gag in seagrass bed nursery grounds; and (2) trophic linkages that occur between seagrass-bed-derived forage species and offshore production of gag in the shelf-edge environment.

Modeling project: We are interested in integrating all the above two components under a common numerical umbrella that will in turn provide us a consistent broader regional view. In addition, we are interested in the potential role of the riverine outflows in influencing the BBR environment as contrasted with that input from the deeper Gulf of Mexico. The wave's module of our existing model will also allow an examination of the importance of the wave driven on and off shore drifts of the BBR.

Collaborators/Partners:

Collaboration with NOAA-NMFS Panama City Laboratory: The collaboration was initiated in January 2007. Dr. DeVries (NOAA-NMFS Panama City) is providing tissue samples of gag, red grouper, vermilion snapper, and red porgy from his NGI sampling to us for stable-isotope analysis to elucidate trophic linkages between northeastern Gulf of Mexico seagrass beds and offshore reef fish communities. In January 2008, Dr. Jeff Chanton analyzed 150 specimens for Dr. DeVries of the key grouper and snapper species and the most abundant forage species (tomtate) for ^{13}C and ^{15}N for the NMFS study examining trophic linkages between inshore and offshore hard-bottom habitats off NW Florida. Dr. Chanton will also link his stable-isotope work on transfer of plant productivity to gag to their study on offshore trophic patterns by providing data on ^{13}C and ^{15}N ratios from estuarine specimens of juvenile gag and pinfish. The in-kind support from Dr. DeVries consists of ship time and labor collecting and grinding up the samples (~\$30,000). We also collaborate with the staff of Dr. David (NOAA-NMFS Panama City) from whom we hope to obtain specimens of early juvenile gag from three sites in St. Andrew Bay FL for comparison to our Turkey Point Shoals specimens. During the season that grouper are in the seagrass, Dr. David's technician (Ms. Stacey Hartner) samples 5 sites once each week and saves the grouper from three of those sites for us. We are supplying instruments to record temperature, light, and salinity at their sites.

Collaboration with NOAA/AOML: Since the establishment of the NGI, we have been collaboration with Drs. Goni and Atlas. Their comprehensive high resolution, three dimensional model that connects coastal to land and offshore hydrodynamics has been developed for the entire Northern Gulf of Mexico (NGoM) coastal region is based on the data assimilative HYCOM (Hybrid Coordinate Ocean Model). The NGoM-HYCOM is nested within the regional Gulf of Mexico HYCOM model (GoM-HYCOM), itself nested within the larger-scale, publicly-available HYCOM GODAE (Global Ocean Data Assimilation Experiment) product housed at FSU.

Collaboration with Dr. Clarke, FSU: The "Red Tide" project led by A. Clarke at FSU supports several cruises per year since 2006 as part of a collaboration with the NGI on the FSU NGI hydrographic section. This section is occupied on an approximately monthly basis. No monetary support comes from the Red Tide project.

Project Duration:

Start Date: February 1, 2007 Estimated End Date: February 1, 2010

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

Our project contributes directly to the NOAA goals/objectives on Ecosystem Management, Climate Variability and Coastal Hazards. With regards to Ecosystem Management, our efforts to clarify the on-shore/off-shore transport mechanisms of gag grouper will be of central importance to sustaining this fishery. We anticipate that a fundamental role is played by seagrass beds, thus stressing the need for seagrass bed protection when making management decisions. In addition, our attempts to quantify benthic primary productivity in the BBR are important to management decisions affecting regional water clarity. Riverine input to the chemical and biological structure of the BBR is essential to river management decisions. Knowledge of on and off-shore transport mechanisms will affect coastal hazards and management decisions. Sustained observations of the BBR current

system, its variability and structure, will be of critical importance to disaster management, as will modeling products produced in the presence of these data. We further expect climatic variability on a variety of timescales to impact the region, through stressing the shallow-water environments by floods, droughts, and extreme wind events as well as long-term modifications to riverine inflow. Generic regional warming can be expected to impact the utilization and population of the regional seagrass beds.

Our project contributes to the circulation monitoring goal of the NGI, by the sustained operation of three sites monitoring biophysical parameters for ecosystem studies, the assimilation of that data into the FSU modeling effort and integrating datasets produced by various agencies (Appalachicola Estuarine Reserve, Florida Fish and Wildlife, Florida Dept of Agriculture) involved in monitoring the coastal bays and oceans in our area.

Contributions to regional problems and priorities:

The maintenance of the grouper fishery is a regional issue as it is one of the, if not the, primary commercial and recreational fish stocks of the BBR. Water quality is also a significant regional issue, with the increasing attention being paid to the water wars of the regional concerns. The impact on several marine industries, like tourism and oyster farming, are potentially significant. Primary stakeholders include regional land use planners and fisheries managers.

Gaps: (Describe how the project will narrow gaps in regional knowledge, data, model performance, geographic coverage, etc.)

Our research investigating benthic primary production along a transect in the Northern Gulf of Mexico will quantify the contribution of microalgal communities inhabiting the sandy sediment to total ocean productivity in this area of the Northern Gulf of Mexico. The productivity data will be related to environmental parameters (nitrate and colored dissolved organic matter (C-DOM) concentrations, light climate, temperature, salinity, currents and pressure fluctuations) in order to elucidate the factors controlling regional primary production.

Our project will for the first time generate a database of dissolved organic carbon (DOC) and dissolved organic nitrate (DON) concentrations in the northern Gulf of Mexico. DOC, DON and inorganic nutrient data are essential for the interpretation and prediction of production processes in the water column and at the sea floor and for the assessment of the cycles of organic matter and nutrients on the shelf.

With nitrate, a key nutrient will be monitored for the first time continuously over long time periods and this data set will show the influence of this nitrogen carrier for the production dynamics in the NEGOM.

The data produced by this project are central to modeling efforts, interpretation of satellite data, prediction of ecosystem response, red tide prediction and will establish a reference database for future projects.

Our Gag project will define for the first time the offshore linkages to the onshore sea grass bed communities and their role in regards to the spawning of the next grouper generation. We will also define the physical characteristics responsible for carrying the fertilized grouper larvae to the inshore sea grass beds where they mature, and the possible role that climatological fluctuations in these beds will play in the maturation process of the cohort group.

List major milestones completed and describe any significant research results and transitions:

Major milestones of our experimental program are listed below:

- 11/06/2007 Tower transect cruise*
- 12/12/2007 Deploy Sea-Bird Temperature/conductivity loggers on K-tower
- 12/19/2007 Tower transect cruise*
- 01/23/2008 Tower transect cruise*
- 02/08/2008 Recon dive trip to K-tower for new placement of ADCP bottom mount
- 02/20/2008 Tower transect cruise*
- 02/28/2008 Deploy anchors for Site A mount
- 03/12/2008 Deploy YSI and ADCP at K-tower, and deploy YSI and AWAC at Site A
- 03/26/2008 Tower transect cruise; Deploy AWAC and CDOM at K-tower

- 04/16/2008 Site A cruise
- 04/23/2008 Tower transect cruise*
- 05/06/2008 Site A cruise
- 05/29/2008 Site A cruise
- 06/03/2008 Tower transect cruise*

*During each of the Tower cruises, vertical profiles of multiple parameters at 5 stations along a transect line are measured with a CTD and YSI. Also, the instruments deployed at the tower are downloaded and serviced.

Data Gathering: We show in Fig. 1 the primary observational transect of our NGI program.

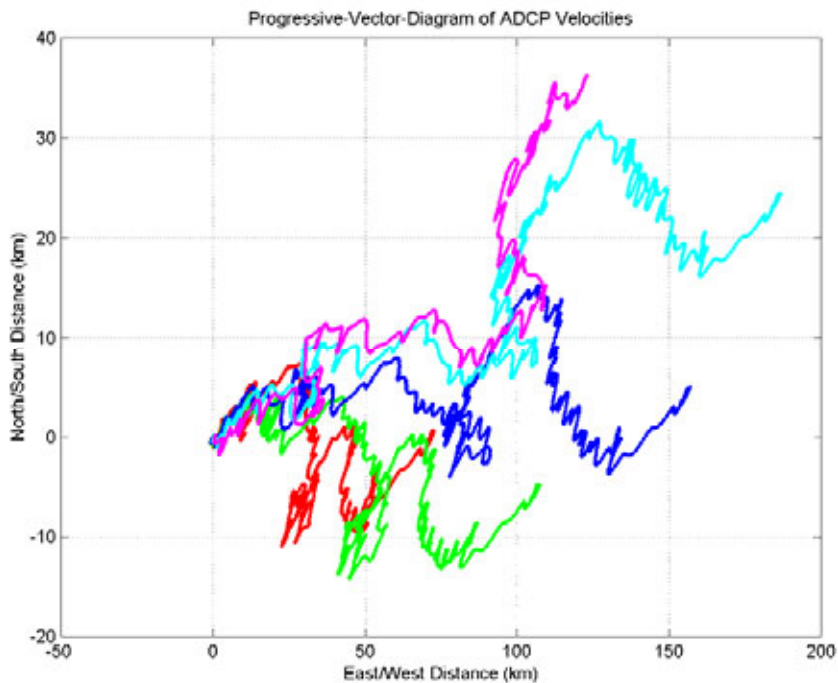
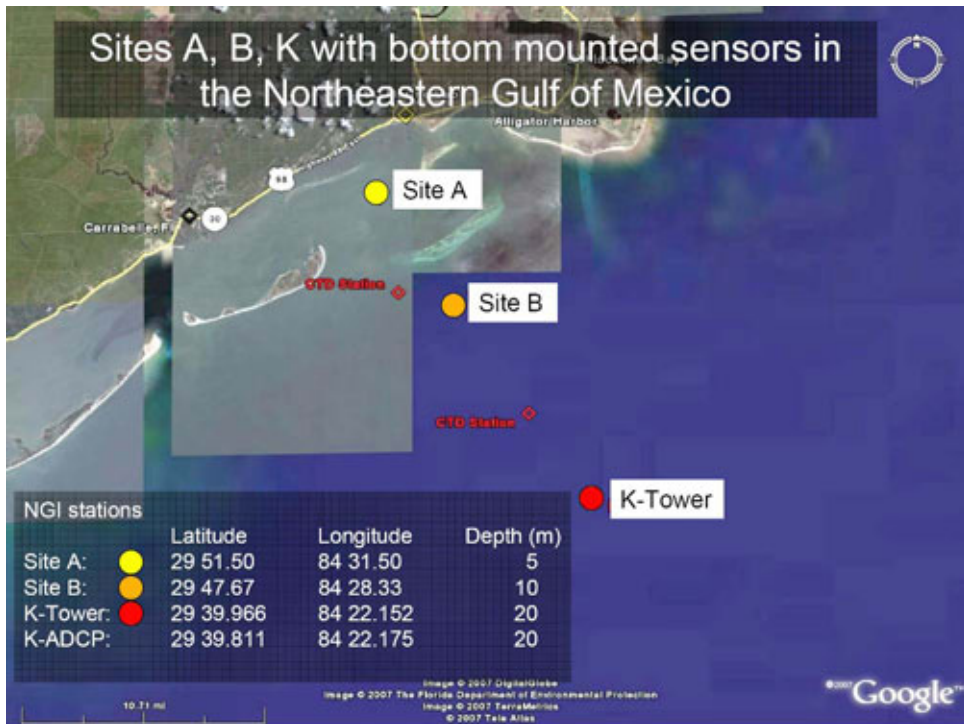


Figure 1. The transect in the Northeastern Gulf of Mexico with the stations where sensor systems are deployed. All three moorings are now in place and returning observations. In addition, on the monthly cruises to the moorings, CTD and YSI observations are obtained.

Gag grouper project: In regards to our gag grouper project, in the 2007 field season (April to October), we collected early juvenile gag in a seagrass meadow at Turkey Point Shoals in the northeastern Gulf of Mexico. To assess weather conditions, we deployed instruments that recorded temperature, salinity, and light at the site. So far in the 2008 field season (April to current), we have collected post larval gag at two separate seagrass meadows at in Appalachee Bay, ~100 km east of St. Andrews Bay in collaboration with NOAA investigators. At the beginning of the field season, we deployed instruments that recorded temperature, salinity, and light at the center of each site. At the end of the field season, we will begin counting and measuring the post larval gag in our samples. Ms. Stacey Hartner of NOAA NMFS in Panama City, FL, heads the St. Andrews Bay study. She will follow our methods for counting and measuring gag. At the end of the season, we plan to compare both the weather and growth rate data for post larval gag from the two regions. Data collected thus far suggests the post larval gags' preferential earlier ingress to one site in Appalachee Bay (Turkey Point Shoal) over the other. As of May 30th, 2008, no gag groupers have been collected at a second site, Lanark Reef. It is hypothesized this may be due to Turkey Point Shoal stretching further offshore, thus providing the first source of seagrass habitat for the young gag to settle.

James Nelson (Koenig/Chanton's graduate student) has determined with stable isotope techniques the maximum turnover rates for gag liver, gonad, and muscle tissue. He is currently sampling offshore gag grouper for stable isotopic composition on a monthly basis. We are also working in collaboration with NOAA NMF investigators to provide them with stable isotopic data on a variety of fish from a number of habitats that they are investigating to aid with determination of the overall offshore trophic structure.

Modeling: The Regional Ocean Modeling System (ROMS) has been configured at 30 arc second horizontal resolution for the northeastern Gulf of Mexico (Florida Big Bend) region (see Figure ?1). The model derives its lateral boundary conditions from the HYbrid Coordinate Ocean Model (HYCOM) near real-time simulations. The ROMS model has been successfully tested as a nest within the 1/12° global HYCOM simulation and is currently being nested within the newly developed 1/25° Southeastern U.S. HYCOM near real-time model. Nesting in this manner allows for the simulation of the local impacts of the offshore circulation (Loop Current and mesoscale eddies), propagating shelf waves, and advection of salinity anomalies from outside the model domain.

The atmospheric component of the Big Bend modeling system is based on the Weather Research and Forecasting (WRF) model. The Advanced Research WRF (ARW) is configured for a region covering the Big Bend ocean modeling domain at 1.33 km horizontal resolution (see Figure 2). This weather model is nested within a 4 km WRF-ARW domain covering the southeastern U.S., which in turn is nested within the NOAA NCEP North American Mesoscale (NAM) WRF model. The WRF-ARW Big Bend model is being developed for coupling to the Big Bend region ocean modeling component. The atmospheric model is being used to investigate cold air outbreaks over the marine area, and local diurnal variability (Figure 3). The coupled system will be used to investigate the role of sea breeze on the coastal circulation and wave field, and air-sea interactions during wintertime cold frontal passages.

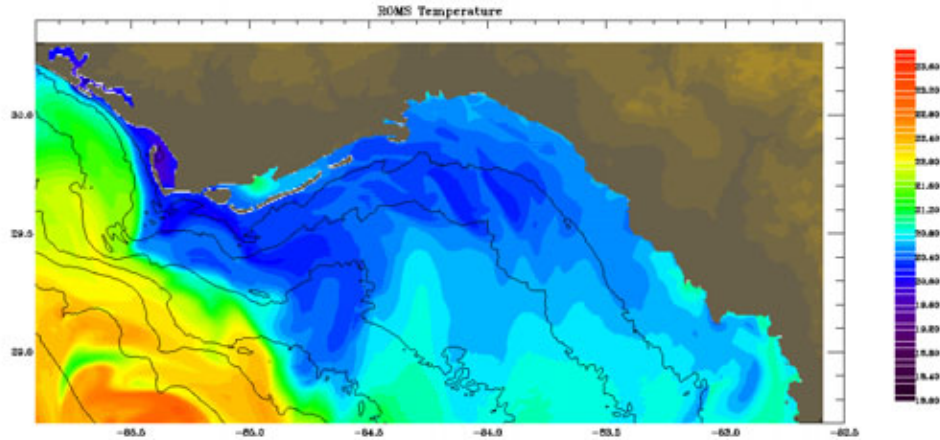


Figure 2. Surface temperature field from a ROMS Big Bend Region model hindcast of April, 2007, showing the influence of the Loop Current on the outer shelf.

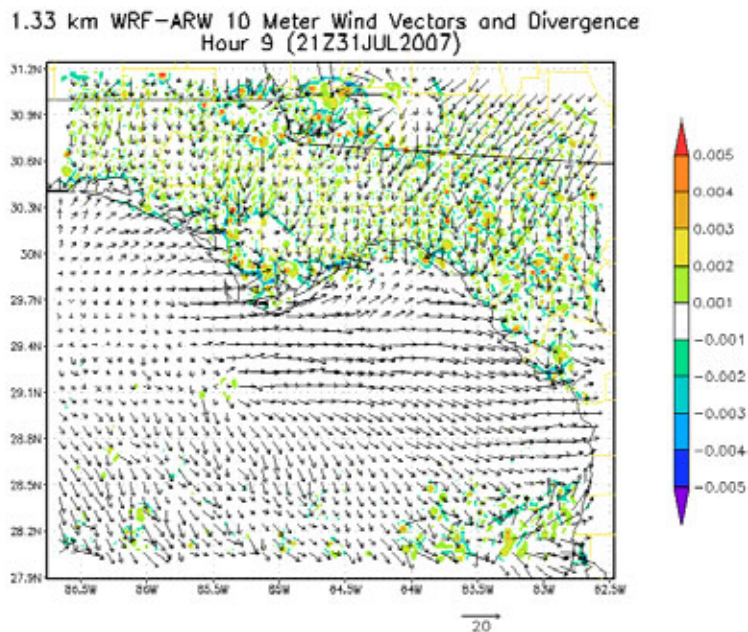


Figure 3. 10m winds from the 1.33 km WRF-ARW simulation for 31 July 2007 showing a well developed sea breeze convergence along the coastal area.

We are also interested in understanding the climatology of cold air outbreaks (CAOs) over the Gulf of Mexico, how the cold air outbreaks affect the sea surface temperature and mixed layer depth, and then how these oceanic changes feedback into the atmosphere and affect the return flow and weather in the region. We have first been exploring the climatology of these outbreaks using a combination of NCEP NARR model output and buoys. The importance of the CAOs to the surface heat budget in the region can be seen in Figures 4 and 5, in which the mean summer and winter latent and sensible heat fluxes are shown for the years of 1996 through 2000. The summer means and standard deviations are much reduced compared to the winter means. The largest values in the wintertime are along the northern and western coastlines, regions where the heat loss is greatest during a CAO. The mean values show also the influence of the Loop Current, with greatest losses in this region. It should also be noted that the resolution of this data is such that we lose a significant fraction of the coastal information, which will be remedied by running the high-resolution WRF-ARW.

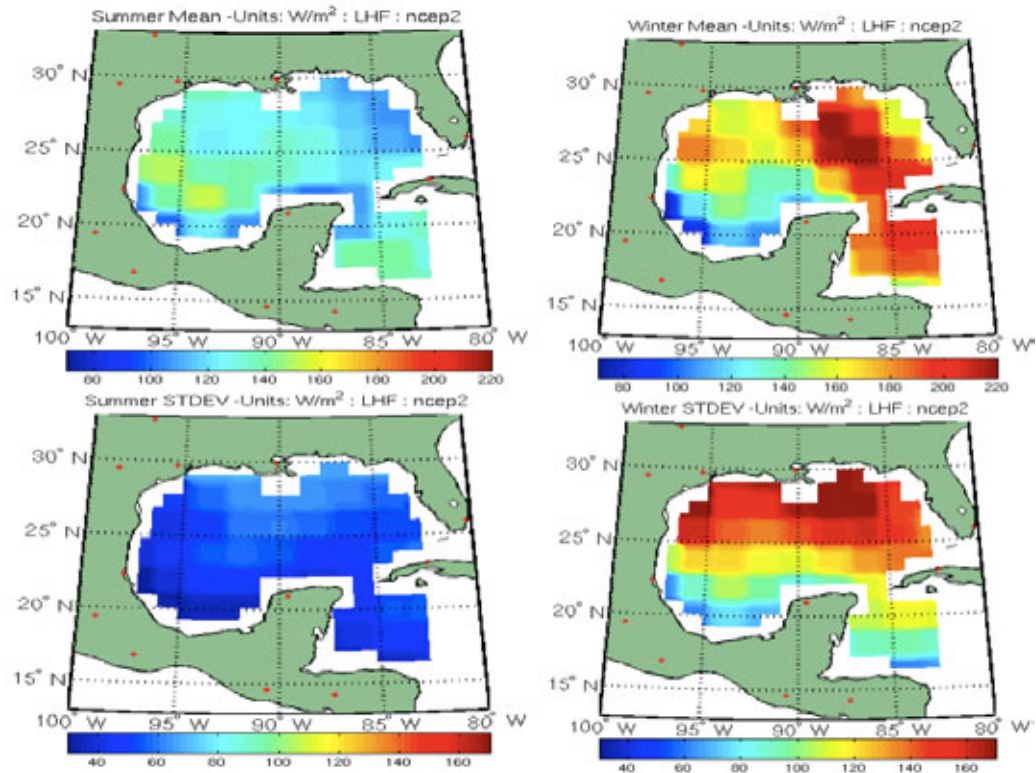


Figure 4. Mean summer and winter values (January 1996 through December 2000) of latent heat flux over the Gulf of Mexico. Also shown are the standard deviations of these values.

An EOF analysis of the fluxes shows that in the latent heat flux, roughly 65% of the variance is explained by seasonal variability. The principal component time series and variance map are shown in Figure 6. The time series demonstrates amply that significant variability in this region is associated with wintertime events. A spectral analysis of the data demonstrates that filtering out all variability but that occurring on the 5 – 10 day time scale provides an estimation that the CAOs provide roughly 25 – 30% of the variance in surface fluxes seen in the Gulf of Mexico region. We are currently finishing an analysis of a much longer time series (1979 – 2007) with a higher resolution model output (the NCEP NARR) and comparing to buoys for a complete climatology of these events. We have also been able to successfully simulate cold air outbreaks in this region.

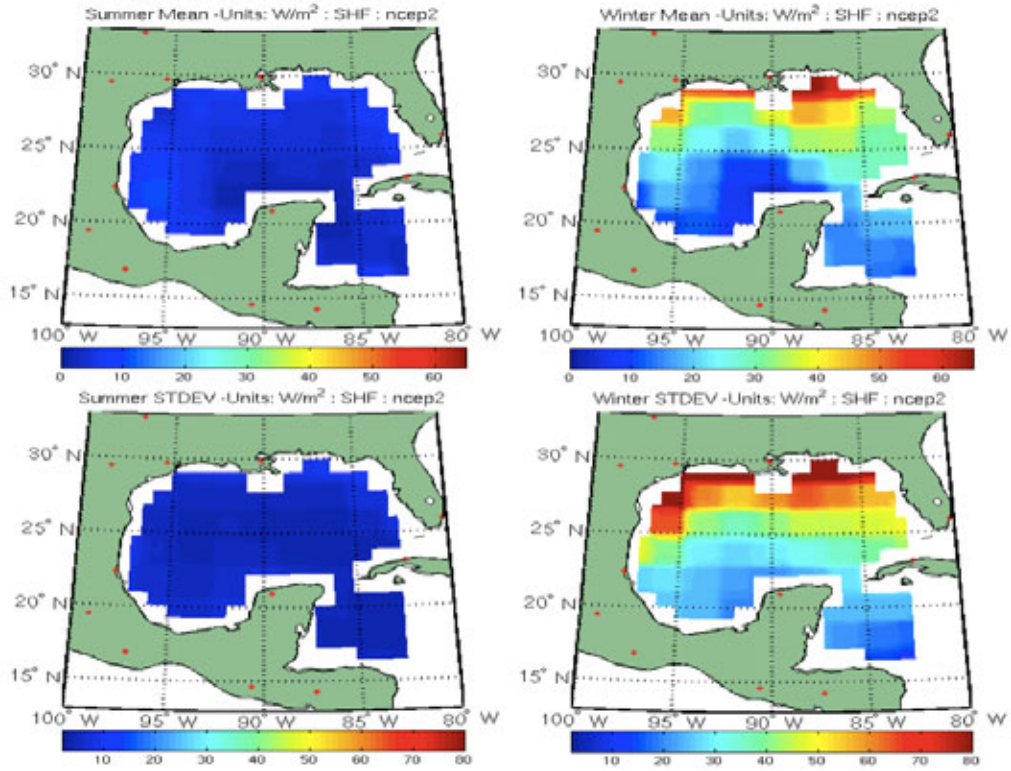


Figure 5. Mean summer and winter values (January 1996 through December 2000) of sensible heat flux over the Gulf of Mexico. Also shown is the standard deviation of these values.

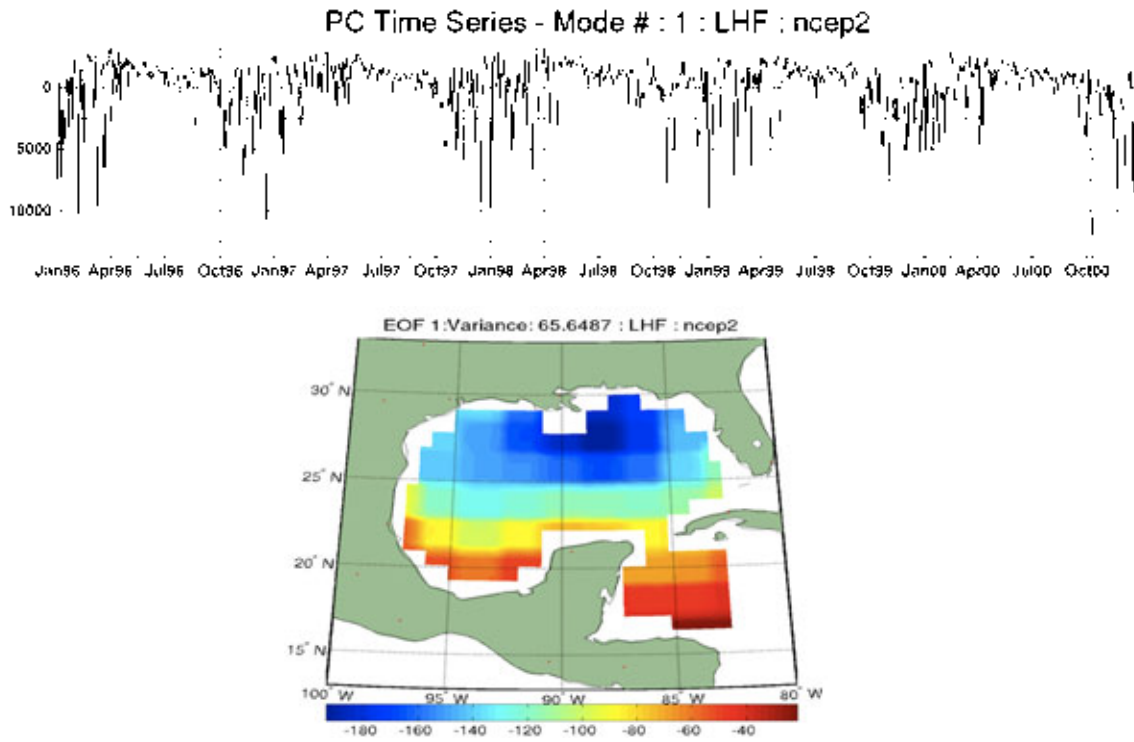


Figure 6. First EOF mode of variability in the Gulf of Mexico latent heat fluxes.

Monitoring: Monitoring centers on two major tasks, instrumentation and data management. We have purchased over \$55,000 of equipment and materials to provide instrumentation on a stationary tower (N7) in Apalachee Bay, 17 miles offshore from the FSU Coastal and Marine Laboratory (FSUCML). Due to operational delays at the FSUCML with the R/V Seminole and weather delays due to rough seas, we were unable to complete cruises for deployment of instruments during spring 2008 as we had anticipated. A total of six cruises were canceled during Spring 2008 due to unavailability of the ship, crew, or poor weather or seas. Figure 7 illustrates the tower array operated by the USAF in Apalachee Bay, and Figure 8 illustrates the instrumentation configuration for N7 tower. We will deploy multiple levels of instrumentation for standard meteorological observation and high-frequency flux measurements of parameters. Due to the limitations in the budget for year two, we will be unable to instrument a second tower, but will use year two equipment funds to complete the instrumentation of N7 tower (previously known as K tower). We have been given unlimited access to the tower by the USAF.

ACMI Range Layout

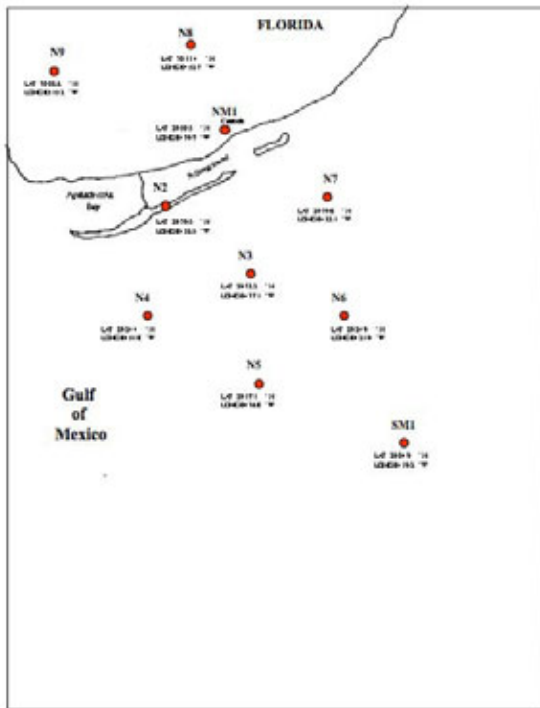


Figure 7. Range layout for Tyndall AFB tower array in Apalachee Bay.

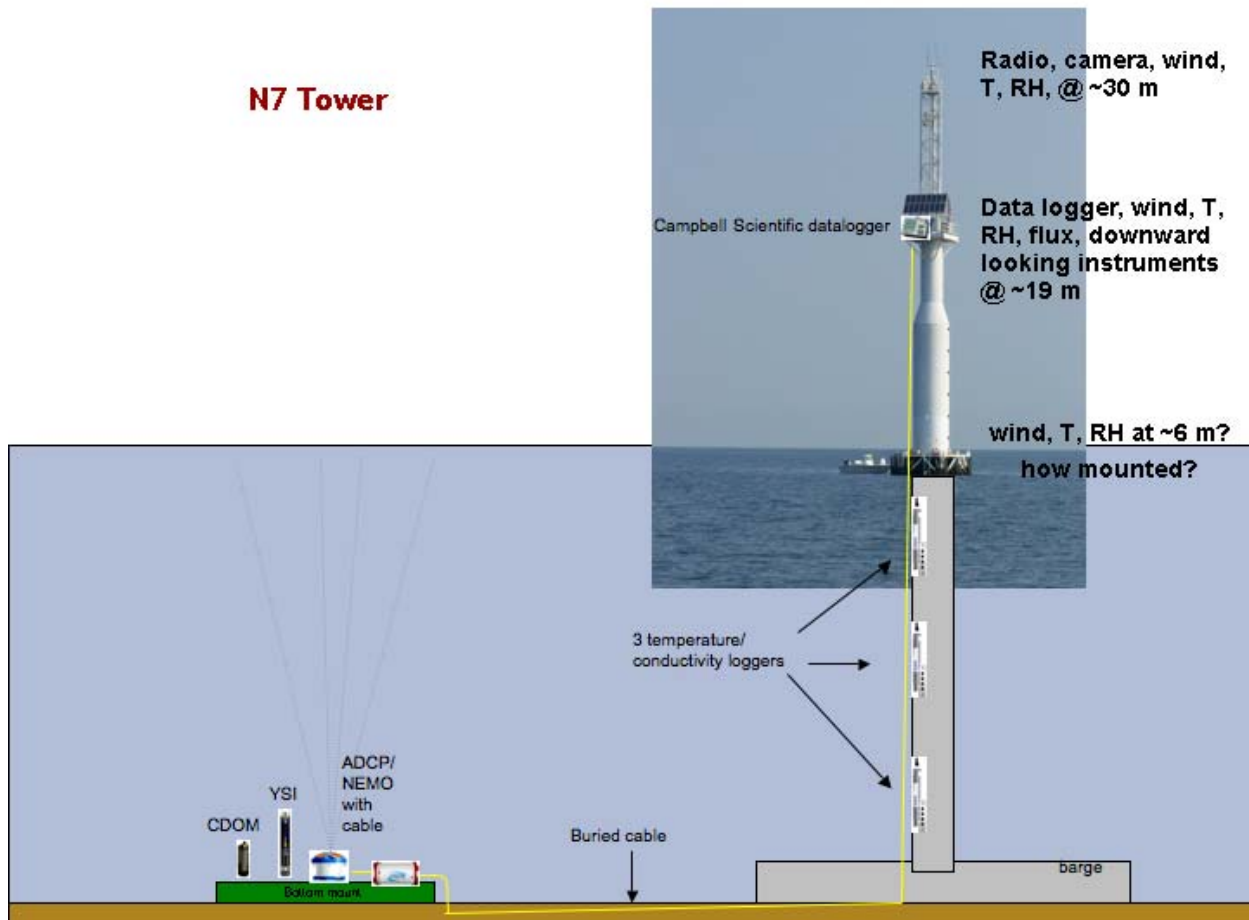


Figure 8. Proposed and USAF-approved instrumental configuration and cross-section for meteorological and subsurface oceanographic instrumentation at N7 tower.

The objective of our first deployment will be installing the radio communications antenna, data logger, solar and battery power, with a test instrument (thermistor). We will then follow with another full day mission to deploy additional instrumentation. The radio receiver and data collection computer have been installed and configured at the FSUCML. Data will be automatically transferred by the FSU network to COAPS for storage and processing to create various level datasets as described in the COAPS report below. A redundant data logger is being purchased to provide adequate ports and functionality to allow for eventual transmission of real-time oceanographic data to the FSUCML and COAPS. Prof. Ruscher leads this project and is assisted by several Meteorology staff.

Data Management: We have developed suitable formats and directory structures for near real time quality assurance of the observations. These plans are consistent with the data logger's capability, redundancy on the data logger and on the PC at FSUCML, and rapid transfer of these data files to COAPS for quality assurance. We have also determined the sampling rates required to support the science and operational needs of the several data streams. Meteorological data will be averaged and recorded every minute, and processed every ten minutes. Flux observations will be taken continuously, calculated on site, recorded every fifteen minutes, and processed every hour. We have obtained a methodology (M. Yelland, personal communication, 2008) for using our eddy covariance flux estimates to calibrate fluxes calculated with the eddy dissipation method. Oceanographic data will be sampled and processed every hour.

We have converted our quality assessment procedures into a form that will work with the tower observations. We have also nearly finished conversion of our automatic quality assurance system to a form that can be used as part

of our near real time quality assurance. This part of the project is led by Prof. Bourassa of COAPS/Meteorology, and incorporates the contributions of several other individuals at COAPS.

Outreach Activities:

General Description:

We employed Ms. Jesse Fields, a high school student in our lab in the summer of 2007 and again in 2008.

Jeff Chanton:

2008. Invited Speaker, Florida Electric Cooperative Association, Clearwater, Florida.

2008. Invited Speaker, Florida Chapter of the American Planning Assn, Tallahassee, Florida.

2008. Invited Speaker, Florida State University College of Law, Tallahassee, Florida.

2007. Invited Speaker, Florida Municipal Electric Association, Florida Municipal Power Association Annual conference, Palm Beach, Fl, July.

2007. Invited Speaker, International Baccalaureate Program, Rickards High School, March,

Have you hosted speakers, workshops and/or any training?

No

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

Carlson, D. F., and A. J. Clarke, 2008: Seasonal along-isobath geostrophic flows on the West Florida Shelf with application to *Karenia brevis* red tide blooms in Florida's Big Bend. Submitted to Continental Shelf Research.

Wilson, A. M., Huettel, M., Klein, S., 2008: Grain size and depositional environment as predictors of permeability in coastal marine sands. Estuarine, Coastal and Shelf Science, in press.

Morey, S.L., D.S. Dukhovskoy, and M.A. Bourassa, 2008: Connectivity of the variability of the Apalachicola River flow with the physical and bio-optical oceanic properties of the northern West Florida Shelf, *Cont. Shelf. Res.*, In Review.

List non-refereed articles and reports for this project.

None

List conference presentations and poster presentations for this project:

Carlson, D. F., and A. J. Clarke, March 4, 2008: "Seasonal along-isobath geostrophic flows and the transport of *Karenia brevis* red tide blooms into Florida's Big Bend." AGU Ocean Sciences 2008, Orlando, Florida.

Huettel, M., Kostka, J.E., Arnosti, C., Berg, P., Higgs, M., Laschet, M., Chipman, L., 2007: Oxygen dynamics controlled by advective pore water exchange in permeable Gulf of Mexico sediment. ASLO Meeting February 2007, Santa Fe

Huettel, M., Higgs, K., Laschet, M., Chipman, L., Cook, P.L.M., Wenzhoefer, F., 2008: Comparison of metabolic activities in permeable nearshore sediments, ASLO/Ocean Sciences Meeting, March 3-7, Orlando.

James, Nelson. Florida Chapter of American Fisheries Society, Ocala, Feb., 2008. Flux By Fen.

Chris Koenig. Florida Chapter of American Fisheries Society, Ocala, Feb., 2008. Demographic patterns of fish inside and outside of the Madison Swanson Fishery Reserve, Gulf of Mexico.

James, Nelson. NGI annual meeting, Biloxi, Mississippi, May, 2008. Flux By Fen. ****BEST STUDENT POSTER AWARD***

Morey, S.L., D.S. Dukhovskoy, D. Van Dyke, and E.P. Chassignet, 2008: Oceanic and atmospheric modeling of the Big Bend region, Northern Gulf of Mexico Institute Conference, Biloxi, MS.



Developing a Foundation for Analysis of Natural and Human-Induced Disturbances to Coastal Economies

NGI Project File Number: 07-MSU-01

Principle Investigator:

Daniel R. Petrolia, Assistant Professor
Department of Agricultural Economics, Mississippi State University
Box 5187
Mississippi State, MS 39762
Ph: 662.325.2888 Fax: 662.325.8777
Email: petrolia@agecon.msstate.edu

Personnel funded by this project:

No faculty receive any salary support from the NGI, nor located at a NOAA Lab. Thus, all faculty time devoted to the NGI's efforts is support in-kind from the Department of Agricultural Economics (names given below). Only the following personnel receive salary support from the NGI:

Dr. Sanjoy Bhattacharjee, Post-doctoral Research Associate, 100%, NOAA Lab (No)
Dr. Tae-goun "Teddy" Kim, Post-doctoral Research Associate, 100%, No
Dr. Guylain Ngeleza, Post-doctoral Research Associate, 100%, No
Ms. Kelly Schaefer (no longer employed), Research Associate, 100% (Sept 2007-May 2008)
Not located at NOAA lab

NGI Personnel not funded by NGI (i.e., providing in-kind time & support)

Dr. Barry J. Barnett, associate professor
Dr. Keith H. Coble, professor
Dr. Garen Evans, assistant extension professor
Dr. Terrill R. Hanson, associate professor
Dr. Andrew Muhammad, assistant professor
Dr. Al Myles, extension professor
Dr. Daniel R. Petrolia, assistant professor (principle investigator)
Dr. Benedict C. Posadas, associate extension professor, MSU-CREC

Key Scientific Question(s)/Technical Issues:

The overall objective of this project is to gain a better understanding of the value of coastal economic activity and ecosystems, the potential economic impacts of coastal hazards, and the unique economic drivers of coastal economies. This project is subdivided into 10 subprojects (referred to as "tasks"), each headed by a sub-PI(s), with a research associate attached. Each task addresses a particular scientific question/issue.

Task 1. What is the economic value of restoring the Mississippi Barrier Islands?

Task 2. What is the economic value of and what are the publically-preferred methods for restoring coastal Louisiana?

Task 3. What is the economic impact of alternative land-use practices in the Upper Mississippi River Basin as it relates to Gulf of Mexico hypoxia? What are the possible impacts on Gulf hypoxia of increased corn production in the Basin due to increased demand for biofuels?

Task 4. Coastal natural disaster risk and insurance research needs: What are the critical policy questions and how can they be addressed?

Task 5. What are the key factors of a tropical storm forecast that influence evacuation behavior?

Task 6. What are the population migration flows following Hurricane Katrina, and are they spatially correlated to the path of the storm's inland track?

Task 7. What is the status of economic recovery of seafood processors and dealers, marinas, commercial harvesters, and bait dealers in coastal Mississippi?

Task 8. The Port of New Orleans: What is the impact of tropical storms on lost revenue due to diversion of cargo and lost income due to port inactivity, and what is the impact of port disruption on prices of key commodities?

Task 9. Toward developing a coastal business resiliency index: Are coastal communities more economically vulnerable than other groups of counties?

Task 10. Before and after Katrina: What were the local market capture, loss, retail viability, population, and income shifts in the Gulf Coast counties of Mississippi between 2004 to 2006?

Collaborators/Partners

NGI Member Institutions

Louisiana State University

Collaborating Faculty: Dr. Rex Caffey (Task 2) and Dr. John Westra (Task 3)

Date collaboration established: May 2007

Partner provides indirect monetary support: a closely-related project, of which the collaborating LSU faculty member is the PI, provides NGI members research monies (\$28,529). Additionally, LSU provides in-kind support in the form of uncompensated faculty research time and facilities. NGI members and LSU collaborators are jointly carrying out Tasks 2 and 3.

University of Southern Mississippi Gulf Coast Research Lab – Gulf Coast Geospatial Center

Collaborating Faculty: Dr. Greg Carter (Task 1)

Date collaboration established: October 2007

Partner provides in-kind support in the form of uncompensated faculty and research staff time. Additionally, the collaborating faculty member and staff member provided all of the maps necessary to carry out Task 1.

Non-NGI Member Institutions

Florida A&M University

Collaborating Faculty: Dr. Michael Thomas (Task 5)

Date collaboration established: May 2007

Partner provides in-kind support in the form of uncompensated faculty research time. Collaborator is working jointly with NGI researchers to develop survey instrument for Task 5.

University of Miami

Collaborating Faculty: Dr. David Letson (Task 5)

Date collaboration established: May 2007

Partner provides in-kind support in the form of uncompensated faculty research time. Collaborator is working jointly with NGI researchers to develop survey instrument for Task 5.

USDA Agricultural Research Service – Conservation & Production Research Laboratory

Collaborating Individual: Dr. Prasanna H. Gowda (Task 3)

Date collaboration established: January 2008

Partner provides in-kind support in the form of research time. Collaborator is working jointly with NGI researchers to accomplish Task 3.

Project Duration:

Tasks	YR 1	YR 2		YR 3	
		Q1	Q2	Q3	Q4
Task 1	█	█	█	█	█
Task 2	█	█	█	█	█
Task 3	█	█	█	█	█
Task 4	█	█	█	█	█
Task 5	█	█	█	█	█
Task 6	█	█	█	█	█
Task 7	█	█	█	█	█
Task 8	█	█	█	█	█
Task 9	█	█	█	█	█
Task 10	█	█	█	█	█

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This work directly relates to several of NOAA’s broad societal goals. The proposed work has linkages to all of the goals specified in the National Ocean Service Social Science Plan. Specifically, it pertains to the following NOAA objectives:

- Enhance NOAA’s ability to monitor, understand, evaluate, and communicate socioeconomic benefits of NOAA/NOS information, services, and products.
- Provide more accurate and comprehensive decision-support tools for ecosystem management by integrating social science, natural science, and monitoring results.
- Improve models and methods for assessing the impact of human and natural disturbances to coastal and ocean resources and infrastructure.
- Increase the relevancy of NOAA efforts by improving understanding of the needs, knowledge, perceptions, and values of NOAA partners and constituents.

Contributions to regional problems and priorities:

First, this project contributes to NGI Themes I - Ecosystem Management (via Tasks 1-3) and IV- Coastal Hazards (via Tasks 4-10). Specifically, it contributes to Theme I by providing a better understanding and estimates of the economic value of coastal ecosystem resources allowing resource managers, government agencies, private citizens, and other stakeholders to make more informed management decisions. Additionally, it contributes to Theme IV by providing a better understanding of the relationship between economic activity on the Gulf Coast and coastal hazards and tools for predicting impacts of such hazards allowing decision makers the ability to make more informed decisions regarding management of hazards and their impact on the coastal economy.

Second, this project is important to US taxpayers because it directly addresses issues that impact them significantly. Estimates of the value of coastal resources is obtained directly from citizens, which means that these values directly reflect the needs, preferences, and opinions of taxpayers; and when combined with scientific coastal resource management knowledge, sound public policy on coastal ecosystem and economic development can result. Such policies and management decisions based on these estimates should also be reflective of taxpayer preferences. Additionally, because the coastal economy and coastal hazards directly impact the quality of life for coastal residents, obtaining a better understanding of the relationship between these two will be of direct benefit to taxpayers as the information gained will provide decision-makers with the opportunity to mitigate negative economic impacts stemming from coastal hazards.

Gaps:

Although the fields of regional development and natural resource economics are well-developed, they have not been widely applied to issues specific to the Northern Gulf. This project will address gaps in natural resource valuation for coastal ecosystems and the gaps that exist in the understanding of the impact of coastal hazards on coastal economic activity.

Project Abstract:

This project focuses on the relationship between people and the ecosystems, resources, and hazards of the Gulf Coast. Because almost all human decisions are dependent on time, uncertainty (risk), cost, and expected benefits, this project can shed light on how the choices of coastal residents, businesses, and other entities are influenced by those characteristics unique to the coast. Furthermore, because economic analysis is always geared toward understanding the value of things and how these values influence decisions, this project will provide a wide range of cost and benefit estimates that can be utilized by decision-makers at all levels to make choices that improve quality of life along the Northern Gulf Coast.

The overall objective of this project is to gain a better understanding of the value of coastal economic activity and ecosystems, the potential economic impacts of coastal hazards, and the unique economic drivers of coastal economies. In order to complete this objective, a two-dimensional approach will be followed. The first dimension will focus on ascertaining the value of key coastal resources that have been identified as both feasible tasks for the duration of the project and as resources that embody a host of amenities (value) including storm protection, recreation, historical and cultural amenities, and other ecosystem services. Because these natural resources are not market goods, it is necessary to undertake non-market valuation techniques, such as contingent valuation methods (surveying), to estimate these values.

The second dimension will focus on analysis of key coastal economic activity and their relationship to hazards unique to the Gulf Coast. Thus, this dimension focuses on human and market responses to coastal hazards: this includes an assessment of critical risk and insurance issues facing the Gulf Coast, analysis of demographic shifts and migration flows, analysis of evacuation behavior, assessment of marine resource activity such as marinas, seafood processors, and bait shops, assessment of interruption of trade flows through major coastal ports, analysis of retail shifts in coastal communities, and overall business resiliency in the face of tropical events.

Combined, this multi-faceted approach will yield a more clear understanding of key economic activity and estimates of the implicit value of the coast's natural resources. Furthermore, this approach will yield a combination of short- and long-term outputs that balance complex research with accessible outreach information of great value to the general public. Ultimately, this work will make it possible to develop a general framework that allows for accurate and timely forecasting of economic and demographic changes in the NGI area due to a variety of coastal hazards.

List major milestones completed and describe any significant research results and transitions

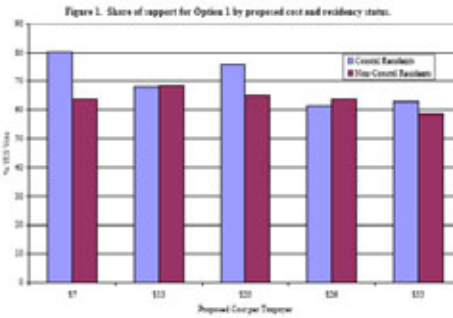
Task 1. Barrier-island restoration survey was administered, data collected, and results compiled. See Figure 1 for summary of findings. Results indicate that, overall, the probability of support for barrier-island restoration is higher for those who cite hurricane protection, environmental, or recreational benefits as the key driver of their decision-making. Of those that cited hurricane-protection benefits, coastal residents were more likely to support restoration relative to non-residents. However, of those that cited environmental benefits, coastal residents were less likely to support restoration. Although over half of respondents cited hurricane protection as their main concern, the marginal effect on probability of support was greater for those who cited either environmental or recreational benefits.

Figure 1. Summary of results from Task 1: Barrier-island restoration survey.

SUMMARY OF FINDINGS: Restoration Options

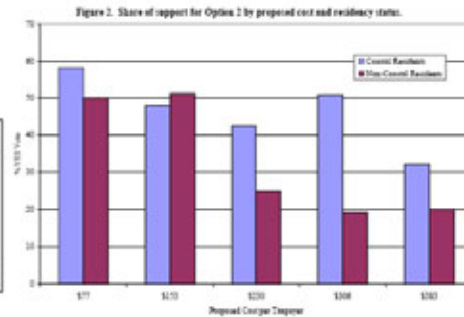
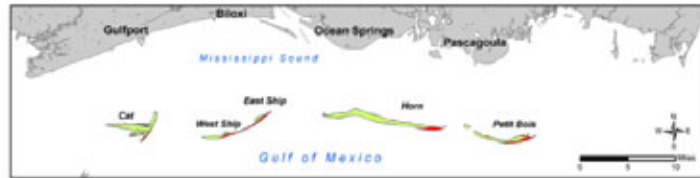
Option 1: Maintain the Barrier Islands in their Current State

Estimated Willingness to Pay (WTP): \$27-\$30 per Mississippi taxpayer
 Implied Aggregate WTP: \$31.7-\$34.7 million statewide



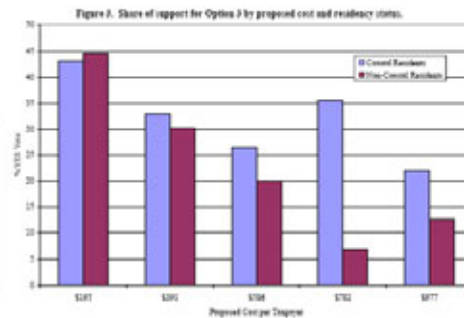
Option 2: Restore the Barrier Islands to their Pre-Camille State

Estimated Willingness to Pay (WTP): \$137-\$168 per Mississippi Taxpayer
 Implied Aggregate WTP: \$160.0-\$196.0 million statewide



Option 3: Restore the Barrier Islands to their Pre-1900 State

Estimated Willingness to Pay (WTP): \$240-\$312 per Mississippi Taxpayer
 Implied Aggregate WTP: \$280.1-\$364.5 million statewide



Seminars & Presentations / Outreach activities:

A seminar was hosted in the Department of Agricultural Economics for two experts on hurricane evacuation behavior on August 13, 2007, entitled “A Web-based Socio-Economic Analysis of Human Response to Hurricanes: The Case of Several 2005 Hurricanes in Florida.” The two presenters were Dr. Michael Thompson (Associate Professor, Economics Department, Florida A& M University) and Dr. David Letson (Associate Professor of Marine Affairs, University of Miami). There were approximately 20 attendees.

A seminar was hosted in the Department of Agricultural Economics for an expert on coastal economics and non-market valuation on November 2, 2007. The presenter was Dr. Craig Landry (Assistant Professor, Department of Economics and Assistant Director, Center for Natural Hazards Research, East Carolina University). There were approximately 25 attendees.

A presentation was made at to the Chief Economist of NOAA, Dr. Rodney Weiher, in his office in Silver Spring, MD, on June 4, 2008, by 5 project members and Dr. David Shaw, NGI Director, to outline NGI economics research goals and accomplishments, and to coordinate NGI economics research with NOAA priorities and those of the Office of the Chief Economist.

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles

None

List non-refereed articles and reports for this project

Evans, G. "Impact of Hurricane Katrina on County-to-County Migration Flows". Working paper.

Petrolia, D.R. and T. Kim. "What are Barrier Islands Worth to Mississippians? A Contingent-Valuation Approach to Estimating WTP for Restoration." Working paper.

Conference presentations and poster presentations for this project

Evans, G. "Shift-Share Analysis: Hurricane Katrina and Employment Change in Louisiana and Mississippi." Submitted for presentation at the 2008 Southern Agricultural Economics Association annual meeting.

Hanson, T.R., G. Evans, A. Myles, D.R. Petrolia, K.H. Coble, B. Posadas, S. Hodge and S.H. Sempier. 2007. "Developing a Foundation for Analysis of Natural and Human-Induced Disturbances to Coastal Economics." Poster, presented at the Center for Natural Resource Economics and Policy 2007 2nd National Forum on Socioeconomic Research in Coastal Systems, New Orleans, LA, May 20-22.

Petrolia, Daniel R., Garen Evans, Tae-goun Kim, Guylsain K. Ngeleza, and Andrew Muhammad. "The Economics of the Northern Gulf Coast." Poster, Presented at the 2008 Northern Gulf Institute Annual Conference, Biloxi, MS, May 13-15, 2008.

Petrolia, Daniel R. and Tae-goun Kim. "Mississippi's Barrier Islands: A Contingent-Valuation Approach for Estimating WTP for Restoration." Presentation at the 2008 Southern Natural Resource Economics Committee (SERA-30) Annual Meeting, Washington, DC, May 22-23.

Thomas, M.H., D. Letson, E. Mahoney, and T.R. Hanson. 2007. "To Evacuate or Not To Evacuate, That is the Question: A Review of the Hurricane Evacuation Choices for Residents of Several Urban Communities." Presentation at the Center for Natural Resource Economics and Policy 2007 2nd National Forum on Socioeconomic Research in Coastal Systems, New Orleans, LA, May 20-22.



Assessing the Impact of Ordinances, Outreach and Enforcement on the Resiliency of Gulf Coastal Watersheds

NGI Project File Number: 07-MSU-02

PI : Jason Walker
 Mississippi State University
 Box 9725, MSU, MS 39762
 662.325.4561
jwalker@lalc.msstate.edu

Co-PIs:
 Taze Fulford
ctf23@msstate.edu
 Timothy Schauwecker
tschauwecker@LALC.MsState.Edu
 Wayne Wilkerson
WWilkerson@LALC.MsState.Edu
 Robert Brzuszek
RBrzuszek@LALC.MsState.Edu
 Michael Seymour
MSeymour@LALC.MsState.Edu

List all personnel funded by this project:

Person’s Name, Category, Percent of Salary from NGI, and NOAA Lab

Name	Category	Yr 1 % Salary	Yr 2 % Salary	NOAA Lab
Jason B. Walker	Faculty	10%	0%	No
Robert Brzuszek	Faculty	0%	0%	No
Michael Seymour	Faculty	10%	10%	No
Taze Fulford	Faculty	10%	0%	No
Timothy Schauwecker	Faculty	0%	0%	No
Wayne Wilkerson	Faculty	10%	0%	No
Kenny Langley	Grad Student	75%	0%	No
Mark Levy	Grad Student	25%	0%	No
Hall Roberts	Grad Student	25%	0%	No

Key Scientific Question(s)/Technical Issue(s):

The NGI mission requires the establishment of baseline data and geographical distribution of current regional watershed management approaches. The division of political boundaries along the Northern Gulf of Mexico (NGM) range from federal, state, county /parish down to municipal governances, and requires a holistic approach to understand and compare current watershed regulations and codes. Coastal community long-term resiliency can only occur by the full implementation and public acceptance of regulatory codes and ordinances that ensure wise management practices that directly affect regional watersheds and NGM water quality. There is an expressed need for a comprehensive central database that lists all regulatory codes for each strata of government for all lands and communities within coastal watersheds directly bordering the NGM.

Numerous NGO's are active along the NGM that directly impact the public's education and understanding of water quality issues. Currently, there is no central database that tracks NGO's that provide a water quality focus in their outreach. NGO's are identified by level of watershed education involvement and their geographic focus. GIS database is being created to locate ordinance and NGO data, and correlate them to water quality data. With the regulatory ordinances and NGO's compiled by location, spatial analysis will reveal how the existing land and water regulations and education efforts of localized watershed areas link to the water quality data of the region. Spatial analysis findings will be paired with activities that focus on data collection and analysis from local stakeholders in the identified study watersheds.

This approach provides a holistic methodology for assessing governance and stakeholder's effectiveness by establishing a base line in which coastal watersheds resiliency can be measured. Our hypothesis is that the most ecologically resilient watersheds are those with well-defined ordinances and regulations that include established enforcement and are supplemented with active and effective NGO's involvement. If the research data supports this argument, the information gained from successful watershed approaches could serve as a model for improving communities or governance in other watersheds of the region. This effort will also serve as input to other NGI research initiatives, especially the ones associated with best management practices and watershed modeling.

Collaborators/Partners

We are collaborating with the following individuals and institutions:

Scott Phipps, Research Coordinator, Weeks Bay National Estuarine Research Reserve

Michael Shelton, Coastal Training Program Coordinator, Weeks Bay National Estuarine Research Reserve

Lee Edmiston, Research Coordinator, Apalachicola National Estuarine Research Reserve.

Rosalyn F. Kilcollins, Coastal Training Program Coordinator, Apalachicola National Estuarine Research Reserve

Weeks Bay and Apalachicola Bay National Estuarine Research Reserves are providing non-monetary support. These partners are aiding in the coordination and planning of outreach/training workshops to disseminate findings and to collect additional local stakeholder data. Collaboration began in the later half of 2007.

Project Duration

Start date of February 1, 2007 Estimated end date February, 2010

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This project satisfies NOAA Mission Goal 3: Serve Society's Needs for Weather and Water Information, through informing society on the role of watersheds and water quality. This project also contributes to *NOAA Mission Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources through an Ecosystem Approach to Management.*

Contributions to regional problems and priorities:

With the implications of a changing climate and a growing population, the landscape of the Northern Gulf of Mexico (NGM) and its ecological and social processes require analysis and understanding in order to promote and ensure their stability and resilience. Human activity has an impact on the environment. Because the human population is increasing and because trends show much of this increase occurring in coastal areas, it is important to understand the affects of growth on water quality (Baird, 1996). In response, the partnership between the Northern Gulf Institute (NGI) and the National Oceanographic and Atmospheric Administration (NOAA) is an opportunity to establish baseline data and geographical distribution of current regional watershed management approaches within the NGM.

The division of political boundaries along the NGM range from federal, state, county/parish down to municipal governances, and thus requires a holistic approach for understanding watershed regulations and codes. Coastal community resiliency can only occur through wise management and public responsibility in regards to regional watersheds and NGM water quality. Enacting a code or ordinance and its subsequent enforcement is important, but may be difficult to due to budget, equipment, and well-trained personnel (Kilcollins, 2007). A need exists for a database that compiles regulatory codes for communities within coastal watersheds.

Similarly, numerous NGO's are active along the NGM that directly affect the public's education and understanding of water quality issues. NGOs often use federal monies to fund their projects in an effort to bring target water bodies into accord with established federal pollution levels and water quality standards. Currently, there is no central database that tracks NGO's that provide a water quality focus in their outreach.

This study explores the link, if any exists, between ordinances and regulations and NGO's (non-governmental organization) compared to water quality. GIS is used to map the codes and regulations, NGO's and water quality spatially. This allows for data analysis that can reveal relationships between watershed regulation and water quality. The spatial data gathered in Year 1 will inform the development of focus group topics and questionnaires as the study continues.

Gaps:

This project fills a stated NOAA *Gap* by providing a jurisdictional baseline for coastal watersheds and water quality issues and will reveal differences in governance structures that may influence water quality. In addition, this project addresses the goals and mission of the *NERR Coastal Training Programs (CTP)* "to share current science regarding coastal watersheds, estuaries and nearshore waters with decision-makers, increase understanding of the environmental, social and economic consequences of human activities and decisions on coastal ecosystems, and help Coastal Decision-Makers make and implement better informed decisions affecting coastal ecosystems and coastal resources". Likewise, this project contributes to the NGI theme of Ecosystem Management by assessing regulatory policies and non-governmental activities that impact water quality in coastal watersheds. The goal for the project is to allow stakeholders to participate in addressing water quality issues within their governance structure through informed decision-making concerning regulatory codes and NGO involvement.

Project Abstract:

The goal of this research is to test the hypothesis that the most ecologically resilient watersheds are those with well-defined ordinances and regulations that include established enforcement and are supplemented with active and effective NGO (non-governmental organization) involvement. The development of a GIS database to map and analyze relationships between watershed regulation and water quality by compiling regulatory codes, ordinances, enforcement actions, and NGO outreach efforts for coastal watersheds establishes a spatial methodology for analyzing coastal watersheds. Coupling the spatial data with local stakeholder data, collected via focus groups and questionnaires, establishes a holistic methodology for assessing the resiliency of Gulf Coastal watersheds. Conclusions from the study watersheds relating to ecology, governance, NGO activity, and community resilience will test the assumption that water quality, sound management, and involved communities lead to resilient systems. The study will establish a methodology in which the effectiveness of regulatory action and NGO outreach on water quality and community resiliency can be assessed, while simultaneously improving the data available to other NGI researchers. It is expected that results from this effort can serve as input for policy recommendations at state, county, and municipal levels.

List major milestones completed and describe any significant research results and transitions:

Task 1. Identify study watersheds and related political boundaries:

The first task was to identify the study watersheds and related political boundaries. A spreadsheet was developed that identified the coastal watersheds (within the NGI service area) for Florida, Alabama, Mississippi, and

Louisiana using criteria including watershed area, water quality data, does not cross state borders, contained basin, contained 3rd order streams or less, and so on were used in the selection of the study watersheds. This approach established the following drainage systems in the study:

- Louisiana – Upper and Lower Tchefuncte and the Bogue Falaya Rivers
- Mississippi - Biloxi River
- Alabama – Fish River
- Florida - New River

Two of the study watersheds are NOAA National Estuarine Research Reserve (NERR) sites, Weeks Bay Reserve and the Apalachicola Reserve. The NOAA NERR sites offer many opportunities for further collaboration and data sharing.

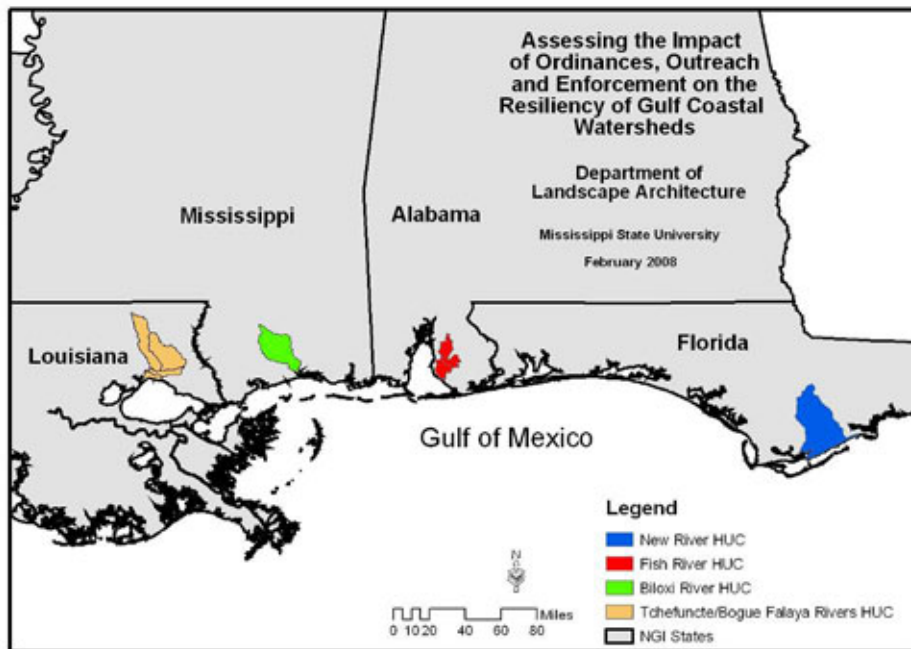


Figure 1: Map of NGI and study watersheds

Task 2. Compile water quality data

Objective: Compile water quality data from statewide water monitoring databases, EPA databases, government agencies databases, and available non-government organization (NGO) databases.

Background

Water quality standards represent the basis for evaluating controls on human activity associated with the Clean Water Act (EPA 2006). These standards are for the protection of designated uses within a given watershed. Our evaluation of water quality ordinances is based on these standards provided by the four states in which the study watersheds are located. In particular, water quality criteria to protect designated uses for each of the states in question.

Dissolved oxygen levels are particularly important to the biota of streams and serve as an indicator of increased nutrient levels. Increased nutrient levels lead to algae blooms, many of which die, leading to oxygen-robbing decay of the dead material (NOAA 2004). Dissolved oxygen levels of 5 mg/l are considered to be borderline, and levels below that, particularly often or for sustained periods of time, are detrimental to the biota of a stream.

Increased temperatures in streams are harmful to stream biota (NOAA 2004), and are an indicator of a loss of streamside buffer structure and unsustainable increases in impervious cover within a watershed (Poole and Berman 2001). Temperatures above 32.2 degrees Celsius (90 degrees Fahrenheit) are harmful to stream biota (ADEM 2007, FDEP 2006, LDEQ 2007). There are caveats for drought and periods of extreme temperature written into discussions of the effects of temperature written into the state parameters.

Bacterial presence in a stream, including Fecal coliform and *E. coli*, can lead to infection of humans who come in contact with polluted waters while recreating in the water (Wymer et al. 2005), drinking the water, or eating shellfish species that live in the water. This parameter has the widest range of acceptable levels depending on the designated use of the water body in question. Acceptable levels of fecal coliform for recreational contact range from 200 to 400 colonies per 100 milliliters of water. During the fall and winter months, when recreational contact is less likely, acceptable levels rise as high as 4000 colonies per 100 ml. For the enterococcus bacteria (and Fecal coliform), shellfish harvesting areas have the most stringent guidelines, with acceptable maximums for the State of Alabama of 104 colonies per 100 ml. The water quality evaluations are based on the lower acceptable levels and spikes in fecal coliform.

Conductivity values are measures of specific conductance, or the ability of water to carry an electrical charge. High conductivity values indicate high levels of salts and other solids in the samples. Salts and solids are associated with high nutrient content and high total dissolved solids. The State of Florida is the only study watershed state that lists a parameter for conductivity, and is the metric used for all of the states. Florida permits a maximum of 1275 micromhos per centimeter, or a 50% increase in the background reading of a water body.

Turbidity is highly correlated with conductivity and is a measure of the clarity of the water body, and thus represents the amount of nutrients and solids in suspension in the sample. In general, the upper limit of 50 Nephelometric turbidity units (NTU) is a common maximum, but measurements of 10% above natural background are also mentioned.

Other water constituent data such as nutrients, chemicals and metals are available for some of the study watersheds, but those data were sporadic and taken for short periods of time. For this reason, the data in this study uses the parameter listed above.

Method

Compilation of water quality data consisted of contacting various state and national agencies or acquiring resources from online databases. The United States Geologic Service (USGS) and United States Environmental Protection Agency's (USEPA) water quality and streamflow databases were queried by watershed. The available USGS and USEPA data were evaluated for completeness and usefulness, as was data from other sources.

Complete and useful USGS and USEPA datasets had the following characteristics:

1. A long-term record of water quality data through the time periods that corresponded to the enactment of programs associated with the USEPA's Non-point Pollution Discharge Elimination System (NPDES). In general, datasets that included sampling in the mid-1990's through the early 2000's were preferred.
2. Data are consistent in the method of sampling and evaluation for the parameter of concern.
3. Sampling locations lay within the watershed of concern.

In addition to the national databases, data from the State of Louisiana Ambient Water Quality sampling program, the Weeks Bay and Apalachicola National Estuarine Research Reserves, and the Alabama Department of Environmental Management Water Quality Division were obtained.

Data were sorted by latitude and longitude and by parameter. The most complete and useful parameters were Fecal coliform, *E. coli*, temperature, conductivity, dissolved oxygen, and turbidity. In some cases, other

parameters were included in the evaluation. All data were formatted for inclusion in the Geographic Information System (GIS) that houses all data collected for this study. Graphs for each parameter at each of the sampling sites were generated and are presented in Appendix A – Water Quality Graphs. The graphs represent summaries of water quality data by parameter, and were evaluated according to observed changes in water quality parameters as sampling progressed downstream (and past municipalities) and/or over time. Water quality parameters were evaluated based on published acceptable levels for each parameter by state. These state water quality levels are summarized in Table 1. The goal was to discuss the data according to reasonable levels of water quality by each parameter.

STATE & WATERSHED	Water Quality Parameter				
	Turbidity (NTU)	Temperature (max)	Dissolved O2 (min)	Fecal coliform (density)	Conductivity (mmhos/cm)
Louisiana - Tchefuncte R.	50	32.2 Deg C	Fresh water: 5 mg/l	400 col./100 ml	NL
Mississippi - Biloxi River	NL	NL	Appropriate levels	400 col./100 ml	1000
Alabama - Fish River*	50 above background	32.2 Deg C	5.5 mg/l	200 col./100 ml	NL
Florida - New River	29 above background	32.2 Deg C	4 mg/l min	800 col./100 ml max.	1275

* - Represents parameters for the Outstanding Alabama Water designation
 NL – Not listed

Table 1. Water quality parameters used for comparisons of spatially distributed water quality sampling locations along each of the water bodies within the study watersheds. Sources: Louisiana Environmental Regulatory Code December 2007, State of Mississippi Water Quality Criteria for Intrastate, Interstate and Coastal Waters June 2003, Alabama Department of Environmental Quality Water Division Water Quality Criteria April 2007, Florida Department of Environmental Protection Criteria for Surface Water Quality Classifications December 2006.

Findings

We have completed the research of information about 4 different watersheds. Please refer to this project at the NGI website for more details of this work: www.NorthernGulfInstitute.org.

Task 3. Compile ordinance/regulation data by state, county, and/or municipality:

Objectives: Compile the governing state, county and municipal codes and ordinances for each coastal watershed and compile the enforcement measures and procedures outlined in the regulations.

We have completed a Summary of the Role of the Federal and State Governments in Environmental Laws and Regulation during this reporting period. The summary includes a brief overview of the federal and state roles in the creation, implementation and enforcement of laws and regulations affecting water quality. As federal and state laws and regulations have a significant impact upon county and municipal ordinances and are sometimes the impetus for such regulations, it is critical to understand the responsibilities of each layer of government. Understanding each authority’s role requires a brief history of water quality regulation that is covered in this section. Please refer to this project at the NGI website for more details of this work: www.NorthernGulfInstitute.org.

Task 4. Compile outreach efforts using 501c3 and other sources:

Objective: Compile the major outreach efforts undertaken by non-governmental organizations in each coastal watershed.

Background

Numerous NGO’s are active along the NGM that directly affect the public’s education and understanding of water quality issues. Currently, there is no central database that tracks NGO’s that provide a water quality focus in their outreach.

Method

To understand the role of NGO's in coastal watersheds requires identifying and documenting the various groups and their actions. For this study, the approach to compiling and documenting NGO information was as follows: 1) identify relevant non-profit groups within the four identified watersheds, 2) develop a survey and interview all NGO representatives via telephone, 3) compile organization information into a spreadsheet, 4) develop a model for organization categories and, 5) summarize the data into a report.

1) Identify relevant non-profit groups within the four identified watersheds:

Objective: To research and compile the Federal, State, and Local NGO's within the four identified study watersheds.

Face to face and telephone interviews with water quality educators revealed the primary groups and contacts working within the specified watersheds. Also, an internet search was conducted to reveal other NGO's not listed. An Excel spreadsheet was created with NGO's by watershed and contact information. Through this process, twenty-two environmental organizations were identified.

2) Develop a survey and interview all NGO representatives:

Objective: To survey organizations that advocate watershed education and to determine the goals and objectives of each organization.

A survey of questions regarding the structure, goals and programs of each organization was written and submitted to the Mississippi State University IRB for approval. Categories were developed that reflect the scope of watershed monitoring, education, and conservation. Approval was granted for the survey in May 2007. Telephone surveys were conducted from May to August 2007.

3) Compile organization information into a spreadsheet:

Objective: Compile all identified non-profit organizational groups within the target area and rank the efforts and information into a report format.

Survey information was compiled into a Word document and Excel spreadsheet.

4) Developed a model for organization categories:

Objective: Utilize CANOCO 4.55 to run de-trended correspondence analysis for category information gained from survey.

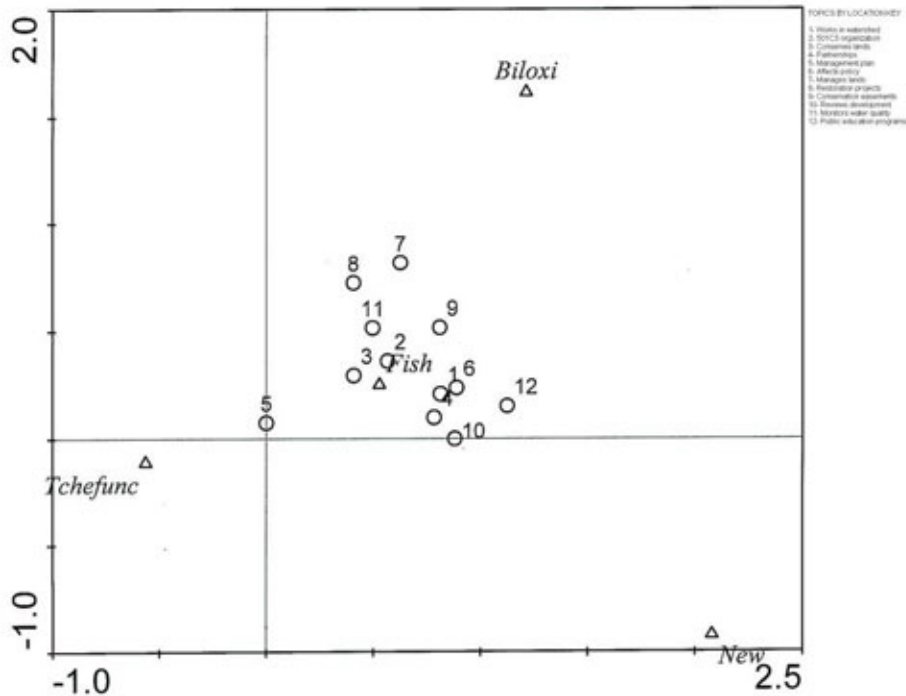
Analysis revealed tendencies of organizations to watershed type.

5) Summarize data into a report:

Objective: Compare averages of responses by organizations to watershed.

A report that identifies all available non-profit organizations with relevant outreach to watershed education within the selected watersheds was generated. This includes contact information, examples of education programs, analysis and a listing of all efforts and activities. The study identified twenty-two environmental organizations that work directly within the four watersheds. Each NGO completed and submitted the survey information. Please refer to this project at the NGI website for more details of this work: www.NorthernGulfInstitute.org.

Results from survey responses for this study was entered into an Excel spreadsheet, with positive responses from organizations to a question entered as a 'one', and negative responses entered as a 'zero'. The spreadsheet data was entered into the CANOCO software, and the response data was evaluated against watershed locations (sites), to reveal which data inputs were most closely located to location sites. It is important to note that due to the small number of organizations surveyed, that this information is not statistically relevant. It does display trends however, which are supported by the survey results.



For the Tchefuncte and Bogue Falaya watersheds (Louisiana), the analysis shows stronger associations for conserving land. The New River in Florida, displays tendencies for reviewing development plans, developing or assisting in policies and ordinances, and education. The Biloxi watershed (Mississippi), efforts tend toward managing lands, restoration projects, water quality monitoring, and conservation easements. The Fish River in Alabama is more centered to all survey responses, and is closely associated to conserving lands, policies, education, reviewing development, land conservation, water quality monitoring, and conservation easements.

The New River (Florida) watershed contains large portions of the Apalachicola National Forest and the Tates Hell State Forest. Because of these national and state lands, efforts in regards to restoration, conservation, and management may be precluded within that watershed, allowing for more development and policy foci. Similarly, in Alabama the Weeks Bay National Wetland Estuarine Reserve lies within the Fish watershed, perhaps providing more central focus for broadly diverse education and development review efforts. In the rapidly growing population areas within the Tchefuncte and Bogue Falaya (LA) watersheds, conserving land may be a higher priority issue. With the large amount of lands in private holdings within the Biloxi watershed (MS), land management and conservation easements may be one avenue of working with landowners to improve water quality and riparian habitat.

The trends revealed from these survey results appear that watersheds with predominantly private lands focus upon site related conservation and management issues, whereas watersheds with conserved lands allow for more diverse education, policy, or development standard issues. Further research is needed to better establish these

tendencies, and to add other parameters to watershed data, including impermeable paving footprints, population data, and demographic changes over time.

Task 5. Categorize pilot data:

Objective: Categorize the data compiled in Tasks 2-4

(Water quality, Ordinances/Regulations, and Outreach Efforts)

Background

Kauffman et al. (2006) utilized GIS to evaluate New Castle County Water Resources Protection Area ordinances' effectiveness in protecting water quality. The WRPA ordinance limits new development to less than 20% impervious cover. Using GIS to analyze the 138 new developments since the ordinance went into effect shows that impervious cover in New Castle County ranges from 7 to 41%. Research recommended that new development comply with the WRPA ordinance of less than 20% impervious cover in order to protect water quality. This research provides a similar approach to this study in that it evaluates water quality ordinances with ordinance enforcement using GIS. Trauth and Adams (2004) developed a strategy to incorporate the impact of site-specific watershed characteristics into storm water ordinances. This effort was undertaken to provide a rational means for a community to differentiate the sediment contributions from alternative scenarios at alternative locations. The California State Water Resources Control Board noted that a higher percentage of impervious cover was highly correlated with greater pollutant loading (SWRCB 2003). Regulations associated with mitigating the effects development and redevelopment have on water quality are governed by this state organization. The United States Environmental Protection Agency (USEPA) identified the importance of zoning ordinances in dictating what amounts to poor development practices (www.epa.gov/watertrain/). They stated that "ordinances must be changed in order to facilitate mainstreaming of innovative alternatives". Rola and Tabien (2001) found that in the Philippines, sufficient governmental policy exists, but that local implementation is lacking to protect surface water resources in that country. Local government units did not have the needed ordinances for effective river management. Xiang (1993) utilized GIS to model riparian buffer widths in terms of local physical conditions and expected effectiveness. This research demonstrates GIS's capability as a decision support tool for facilitating environmental policy formulation, evaluation, and effectiveness.

Method

Water quality sampling data for the project were formatted into GIS for each state, variables tested per site and the name of each .SHP files created are summarized in Table 9. A total of one hundred and sixty four .SHP files have been created at this time. A map of each selected watershed may be found below.

Findings

Louisiana

The Tchefuncte/Bogue Falaya HUC has a total of twenty-eight sampling stations, which is the largest number of any of the four states involved in the study. All twenty-eight sampling stations were tested for conductivity, dissolved O₂, fecal coliform, temperature C, and turbidity. Twenty-one out of the twenty-eight sampling stations were also checked for E coli. All the collection sites are located inland, with the exception of one located at the mouth of the Tchefuncta River. The data was collected in either 2004 or 2003. See Figure 2 for the Louisiana sampling locations.

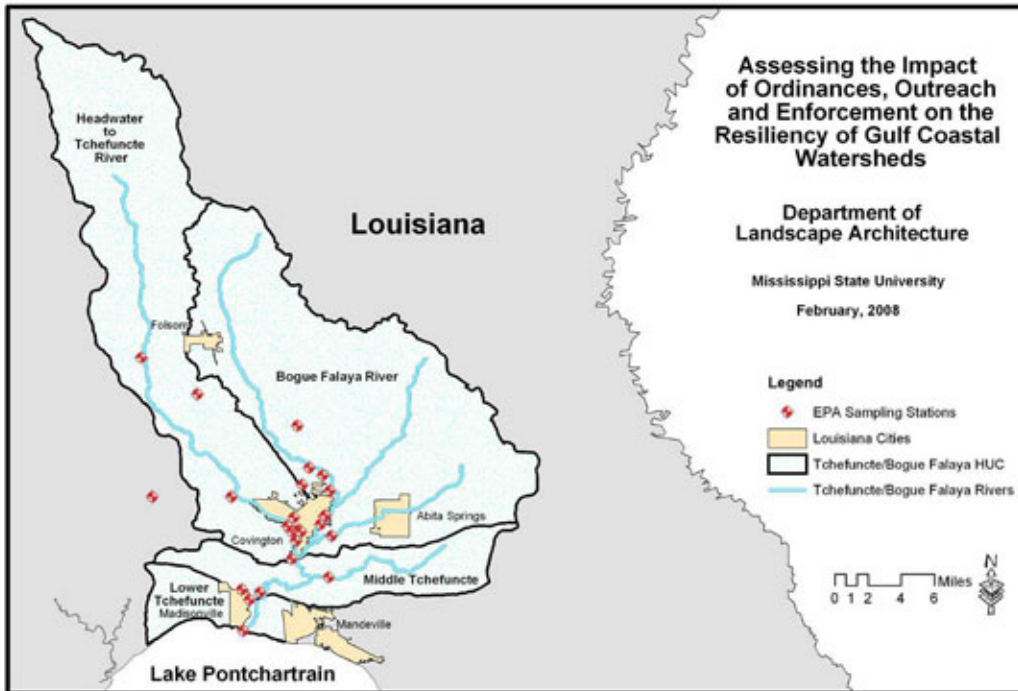


Figure 2: Louisiana Tchefuncte River Watershed Map

Florida

Florida had six water quality-sampling locations, which are all located in the Gulf of Mexico. See Figure 3. The only variable that was tested at all six sampling locations was dissolved oxygen. Other variables tested included fecal coliform, total nitrogen, total phosphorus, temperature C, E coli, and turbidity.

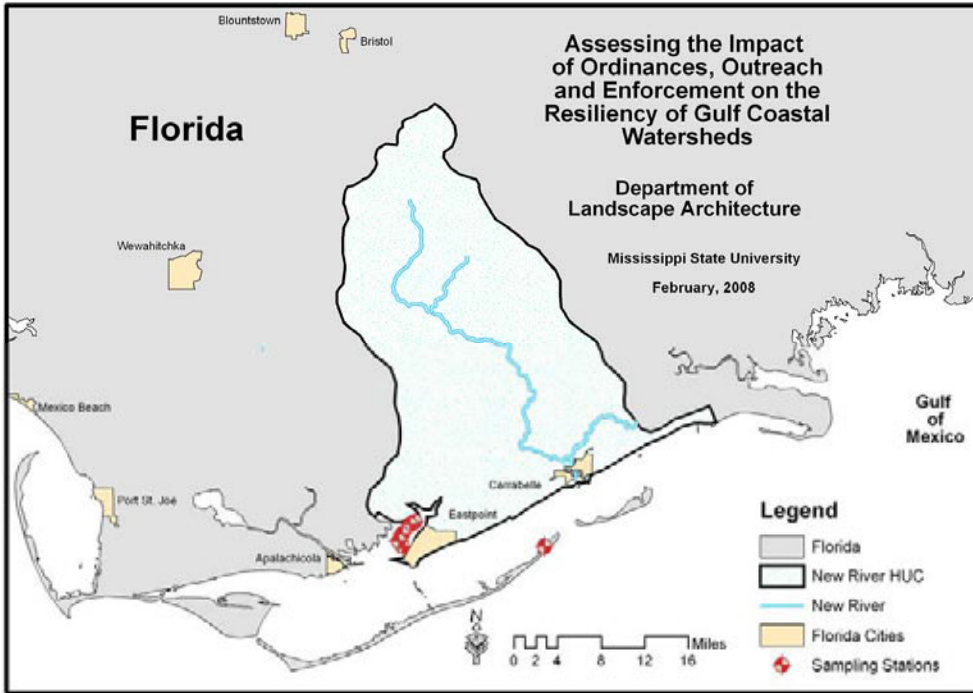
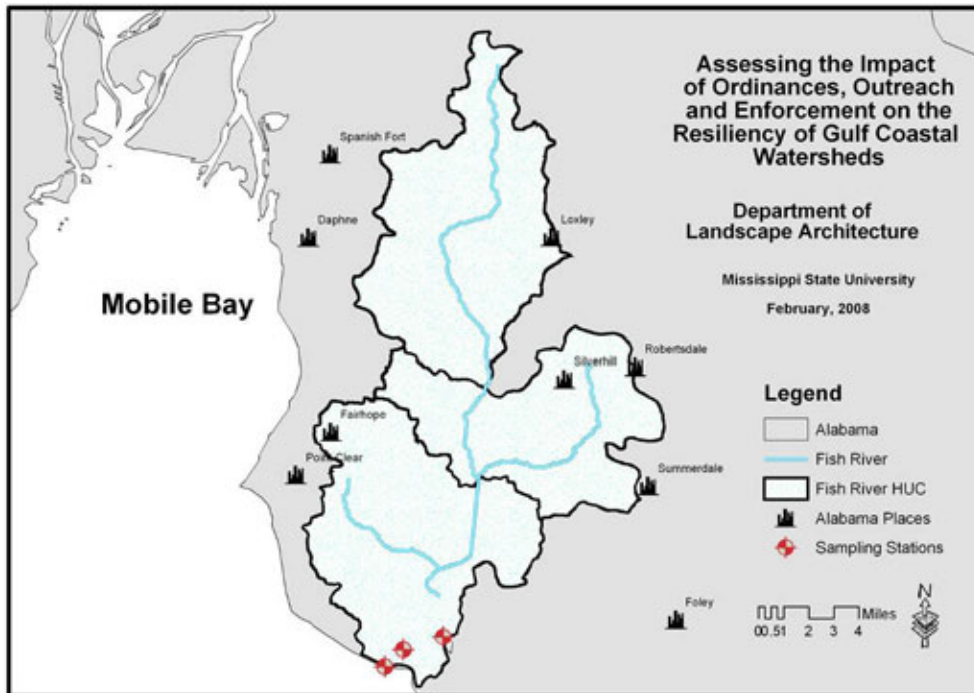


Figure 3: Florida, New River Watershed Map

Alabama

Two sampling stations were located at the mouth of the Fish River. Both sampling stations tested for E. coli.

Figure 4: Alabama, Fish River Watershed Map



Mississippi
Mississippi had only one sampling station, located in Biloxi.

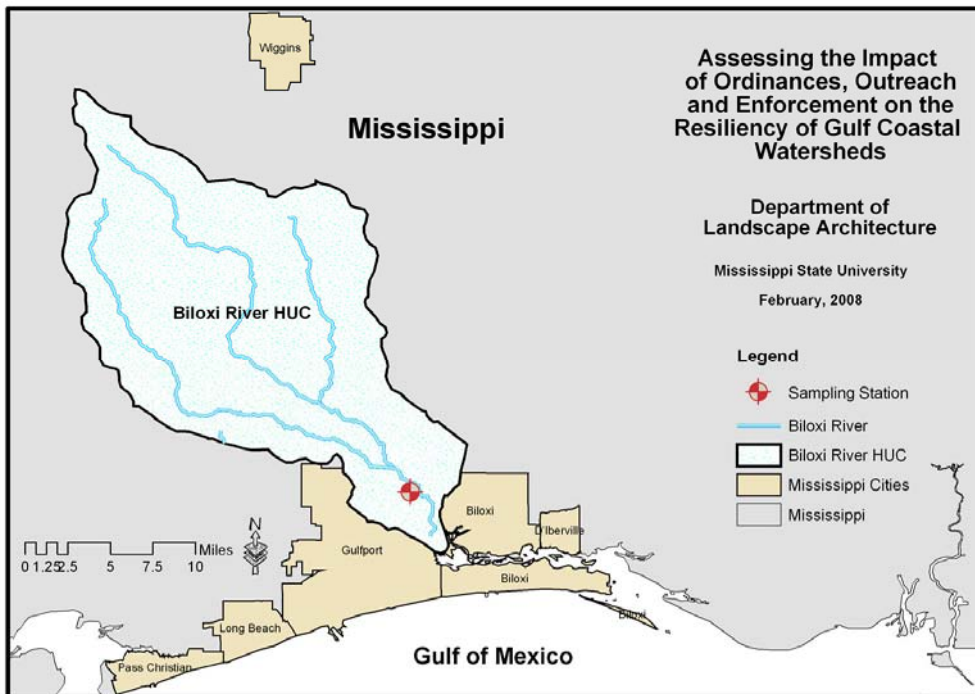


Figure 5: Mississippi, Biloxi River Watershed Map

Task 6. Analyze pilot data. Task on-going

Data analysis of compiled data is on-going and is aiding in the development of focus group topics and questionnaires for Year 2.

Task 7. Expand research area. Task on-going

**Outreach Activities:
General description**

Outreach

Organize a workshop to communicate data to identified stakeholders. The stakeholders of interest are elected officials, planners, developers, NGO personnel, Coastal Training Program Coordinators from Weeks Bay NERR and Apalachicola NERR, and other NGI researchers.

Workshops will have a training component associated with topics of interest, i.e. model ordinances, stream assessment, Best Management Practices (BMPs), Low-Impact Development (LID) strategies, and stream restoration.

Focus Groups and Questionnaire(s) Conduct Focus Groups and administer Questionnaires to stakeholders. A facilitator will run the focus groups. The questionnaires will be administered pre- and post-workshop.

Assessment-Coupling Year One Spatial data with Year Two stakeholder data can provide a basis for assessing the effectiveness of regulatory action and outreach on water quality in Gulf coastal watersheds.

Additional Outreach

Working with Joby Prince to develop an educational message about NPS pollution to be printed on hotel keycards for hotels along the Mississippi gulf coast.

Working with Sharon Hodge on a coordinated outreach effort to present results to identified stakeholders, media and general public. The workshops are tentatively scheduled for October and/or November 2008. The dates and times are in the process of being finalized.

Has anyone on this project been hired by NOAA:

No

Peer Reviewed Articles:

Peer reviewed articles are in progress.

List non-refereed articles and reports for this project:

N/A

List conference presentations and poster presentations for this project:

Schauwecker, T., Seymour, M., Walker, J.B., and M. Levy. 2008. Ordinances and water quality in the Northern Gulf of Mexico: comparisons and correlations. Presented at the Environmental Design and Research Association (EDRA) Annual Conference. Boca del Rio, Veracruz, Mexico.

Brzuszek, R., Fulford, C.T., and Roberts, H. 2008. The role of non-governmental organizations and their efforts concerning regional water quality within the Northern Gulf of Mexico. Presented at the Environmental Design and Research Association (EDRA) Annual Conference. Boca del Rio, Veracruz, Mexico.

Walker, J.B., Schauwecker, T., Seymour, M., Wilkerson, G.W., Fulford, C.T., and Langley, K. 2008. Assessing the impact of ordinances, outreach and enforcement on the resiliency of gulf coastal watersheds. Presented at the Annual Northern Gulf Institute Conference. Biloxi, Mississippi.

For more information about the progress on this project including Water Quality Graphs, Codes and Ordinances, NGOs and Bibliography, Please refer to this project at the NGI website: www.NorthernGulfInstitute.org.



Watershed Modeling Improvements to Enhance Coastal Ecosystems

NGI Project File Number: 07-MSU-03

W. H. McAnally and J.N. Diaz-Ramirez; mcanally@cee.msstate.edu; jd216@msstate.edu; MSU Civil and Environmental Engineering; Box 9546, MSU, MS 39762

List all personnel funded by this project (Person's Name, Category, Percent of Salary Funding from NGI, Individual located at a NOAA Lab?)

J. N. Diaz, Post-Doc, 50% NGI, No
W. H. McAnally, Assoc Prof, 8% NGI, No
G. Ervin, Assoc Prof, 10%, No
C. Brooks, Asst Prof, 10%, No
V. Alarcon, Asst Prof, 25% No
W. Wilkerson, Assoc Prof, 8%, No
J. McKee, Grad. Student, 100%, No
R. Taylor, Undergrad, 25%, No
N. Sonderman, Undergrad, 25%, No
T. Johnson, Undergrad, 25%, No

Key Scientific Question(s)/Technical Issues:

Improved watershed-wide decision support for resource management agencies

Collaborators/Partners:

U. S. Army Corps of Engineers, Mobile District
Begun March 2007
Provide in-kind support
Nature: sharing of data and models, interlocking tasks

U. S. Army Corps of Engineers, Engineer R&D Center
Begun June 2007
Part reimbursed support, part in-kind support (signed agreements)
Nature: Shared models, training on Corps' models

U. S. Department of Agriculture, National Sediment Lab
Begun Dec 2007
Planned reimbursable and in-kind support (agreement under negotiation)
Nature: Shared models, data, training on models and field operations

Project Duration:

Start date: February 2007 Estimated end date: January 2010

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This project satisfies NOAA Mission Goal 1: Protect, Restore, and Manage Use of Coastal and Ocean Resources Through Ecosystem-Based Management. It also contributes to Mission Goal 4: Support the Nation's Commerce

for Safe, Efficient, and Environmentally Sound Transportation through increased use of environmental information in management of the Tenn-Tom and Black Warrior Waterways.

Contributions to regional problems and priorities:

This project will contribute generally to improved watershed management decisions by demonstrating the best use of new data and modeling technologies for ecosystem management and specifically to improved management of the Mobile Basin, with benefits to the Alabama-Mississippi coastal zone and Mississippi Sound.

Gaps:

Relationships between coastal ecosystem responses and watershed-scale inputs will be quantitatively defined with improved integrated models of the entire watershed. Data compiled from multiple sources and generated by the models will be available to all stakeholders in the basin.

Project Abstract:

The goal of this project is improved watershed-wide decision support for resource management agencies. Previous NASA-funded work verified and validated NASA data products for routine use in the EPA BASINS Decision Support System tool through a systems engineering approach. For this project, we will investigate additional data products from NOAA and others for improving the performance of the BASINS model HSPF by improved parameters, forcing, and initial conditions. The initial evaluation process has identified HSPF as the critical link in the BASINS Decision Support System and thus amenable for possible improvements through the infusion of additional data and data products. These include: improved parameters (i.e., topography, land use, buffer zones, etc.); improved forcing (i.e., spatially distributed precipitation, evaporation, wind, solar radiation, etc.); and improved initial conditions (i.e., snow cover, soil moisture, etc.). This project will evaluate new or enhanced data streams for improving modeling performance of HSPF and the EPA BASINS decision support system and test the sensitivity of results to use of more sophisticated models, such as the Corps' distributed hydrologic model, Gridded Surface Subsurface Hydrologic Analysis (GSSHA) model. In preliminary studies, HSPF simulations tended to improperly estimate peak events and exhibited seasonal abnormalities between wet and dry seasons. The efforts of this project will incorporate the use of existing and new data streams to better estimate various inputs to hydrologic models as a means of improving model parameterization. Improved data sources will provide better boundary conditions and event-based inputs for rainfall-runoff components of model simulations.

List major milestones completed and describe any significant research results and transitions.

This section shows results of the following tasks:

- a. Basin and Data Testing: Hydrologic Simulation Program FORTRAN (HSPF)
- b. Basin and Data Testing: Gridded Surface Subsurface Hydrologic Analysis (GSSHA)
- c. Basin and Data Testing: Grid-Based Mercury Model (GBMM)
- d. Data Collection and Analysis: Water Budget of Tombigbee River - Tenn-Tom Waterway from Headwaters to Heflin Lock and Dam
- e. Data Collection and Analysis: Best Management Practices
- f. Wetland and Riparian Buffers
- g. Ecosystem Responses

- a. Basins and Data Testing: Hydrologic Simulation Program FORTRAN (HSPF)

1. HSPF Model Set Up

The objective of this sub-task was to generate a second-tier watershed model for the Mobile river watershed and selected streams around the Mobile estuary. The project region was divided into two sectors for simplifying the modeling task: an upland watershed (that included streams not draining directly to the Mobile Estuary), and

several watersheds of selected streams that drain directly to the Mobile estuary (namely: Fish River, Magnolia River, and Chickasaw Creek).

1.1 Topographical Data

Using the BASINS interface, topographical DEM data covering all the project area were downloaded. Please refer to this project at the NGI website for more details of this work: www.NorthernGulfInstitute.org

ArcGIS was used to mosaic the individual DEMs into comprehensive DEMs for covering, both, the upland region and the region surrounding the Mobile estuary. To further enhance the quality of the DEMs and preprocessing them for hydrological modeling, ArcInfo was used to produce hydrology-friendly seamless DEMs. Figure 1 summarizes the process.

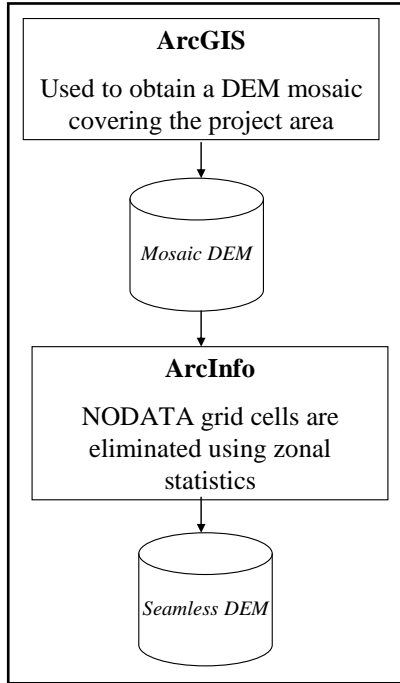


Figure 1. Generation of seamless topographical datasets for hydrological modeling.

Due to the geographical extension of the upland watershed, USGS DEMs (300 m spatial resolution) were used for the “mosaicking” process. Higher resolution National Elevation Datasets (NED, 30 meter spatial resolution) were used for the region surrounding the Mobile Estuary.

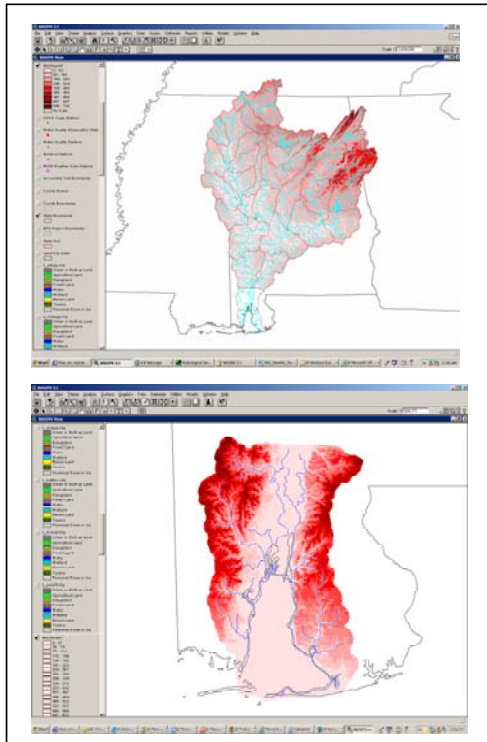


Figure 2 shows the resulting DEMs already input into the BASINS interface. The Figures also show the stream network used for subsequent watershed delineation (RF1).

The topographical datasets shown above do not contain “no data” value. Several datasets that are downloaded from public-domain topographical-data repositories contain cells with non-existent values. For this project, the correction of the datasets was done using zonal averaging algorithms appropriate for the subsequent watershed delineation process.

Figure 2. “Mosaicked” DEMs for the project area

1.2 Land Use Data

For the model set-up of the upland watershed the USGS-GIRAS land use dataset was used. Figure 3 shows the land use coverage of the project area. Notice the faulty land use characterization near Mobile Bay.

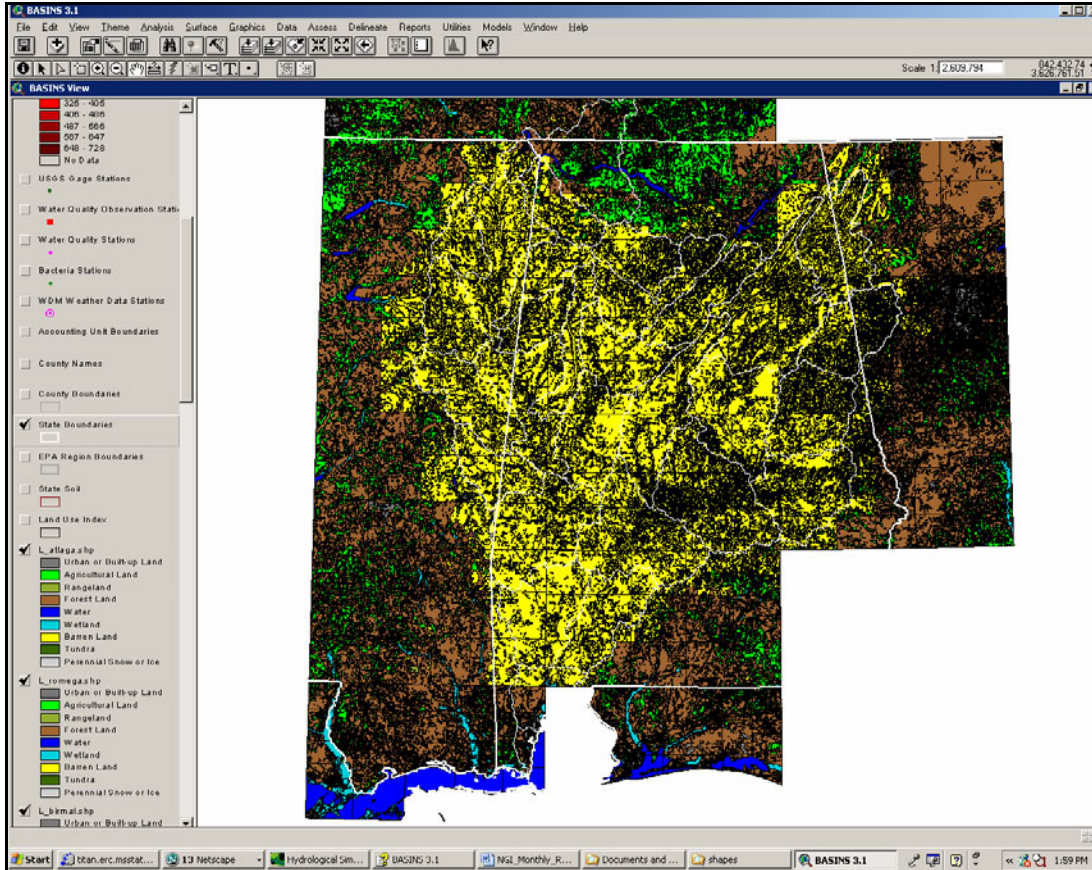


Figure 3. GIRAS land use dataset for the upland watershed project area.

Since the USGS-GIRAS land use dataset does not provide a complete characterization of the areas surrounding the Mobile Estuary, the National Land Cover Dataset (NLCD) was used for the watershed models of the coastal watersheds.

Figure 4 shows the NLCD characterization for those areas. Due to the higher-resolution of the NLCD dataset, the land use specification is much better than GIRAS and also completely covers the project area. Besides being more geographically complete, NLCD provides more updated land use information. The NLCD dataset used in this project corresponds to 2001.

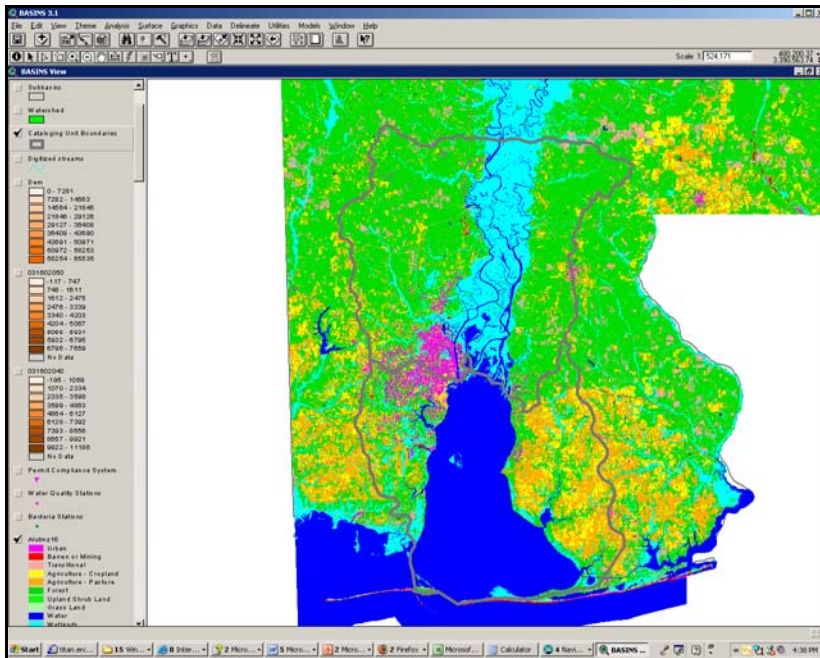


Figure 4. NLCD land use dataset for the coastal project area.

1.3 Delineation

Delineation was performed using the “mosaicked” DEMs grid. The DEM pre-processing (fill, flow direction, etc.) was set-up to be burned-in to the RF1 stream network. The threshold area for delineation was specified as 300000 ha for the upland watershed and 1000 ha for the coastal watersheds. Several outlets were inserted manually to avoid the creation of “large” sub-basins and to provide outlets near USGS stream gages. Figures 5 and 6 show the delineated watersheds. Black lines represent the delineation achieved with BASINS. Light gray lines show HUC boundaries.

In Figure 5, notice that the five sub-basins located in the upper left corner of the delineated area (sub-basins 1 to 5) drain northwards. All other streams drain southwards in the direction to Mobile Bay.

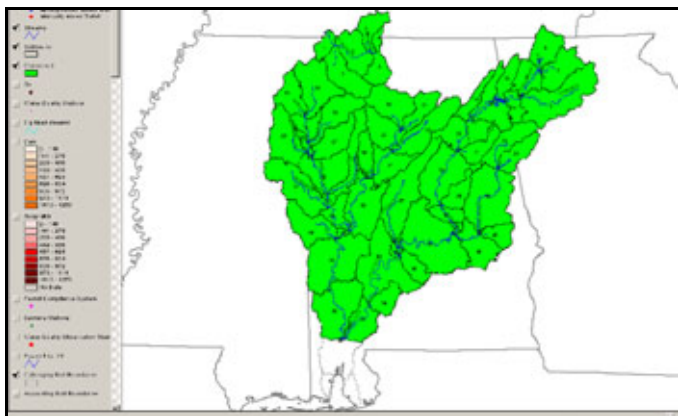


Figure 5. Delineated watershed in the upland region.

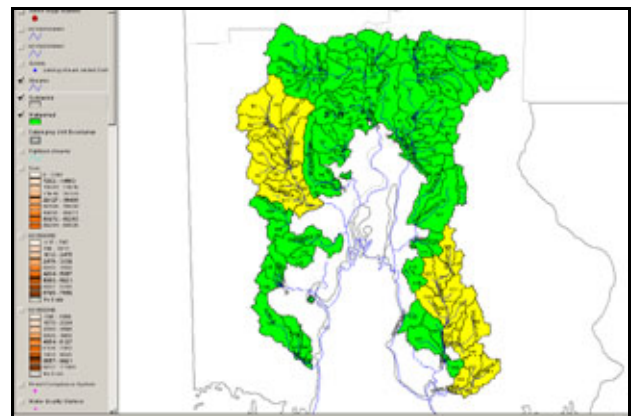


Figure 6. Delineated watersheds in the coastal region. The catchments for which HPSF applications were produced are shown in yellow: Chickasaw Creek (left), Fish River (upper bottom left), and Magnolia River (lower bottom left)

2. HSPF Applications

2.1 Upland Watershed

The HSPF project corresponding to the upland watershed was set up such that the “Individual” option was specified in the Model Surface Segmentation section. This option assigns to each sub-basin individualized land use categories. In this way, each sub-basin has its own table for land use. Having an HSPF model with this characteristic also allows specifying other model parameters per sub-basin.

2.1.1 Meteorological Stations

Thiesen polygons were used to assign meteorological stations to the sub-basins within the HSPF options for meteorological stations assignment (Figure 7). In cases where sub-basins were segmented by two or more polygons, majority area criteria was used to perform the assignment.



Figure 7. Meteorological stations and Thiesen polygons for assigning meteorological data to sub-basins. Weather stations were changed during the calibration process by comparing rainfall patterns with measured hydrographs. This comparison helped in deciding what weather station was more representative for a particular sub-basin (hence, the initial weather station assignment done according to Thiesen polygons was modified during calibration).

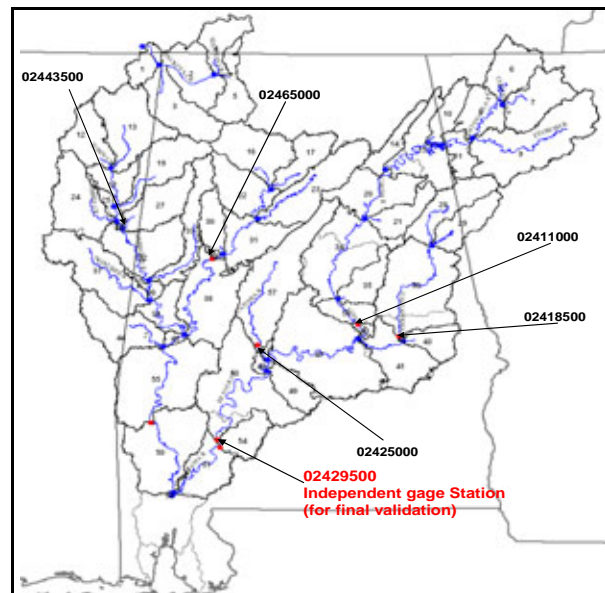


Figure 8. USGS stream flow gage stations used in the calibration and validation of the HSPF model for the upland watershed. Stations numbered in black were used for calibration and initial validation. Station 02429500 (numbered in red) was used for an independent validation of the whole model.

2.1.2 Stream Flow Gage Stations

The USGS stream flow gage stations that were used for calibration and validation are shown in Figure 8. The stations were chosen based on the extensive period of measured data that they have. The periods of calibration and validation are in most cases from 1970 to 1985, and 1986 to 1995, respectively. However, the meteorological stations near gage stations 02443500 and 02425000 do not provide as extensive rainfall record as in the rest of the area. For that reason, the stream flow calibration period in those cases is shorter. See Table 2 for more details.

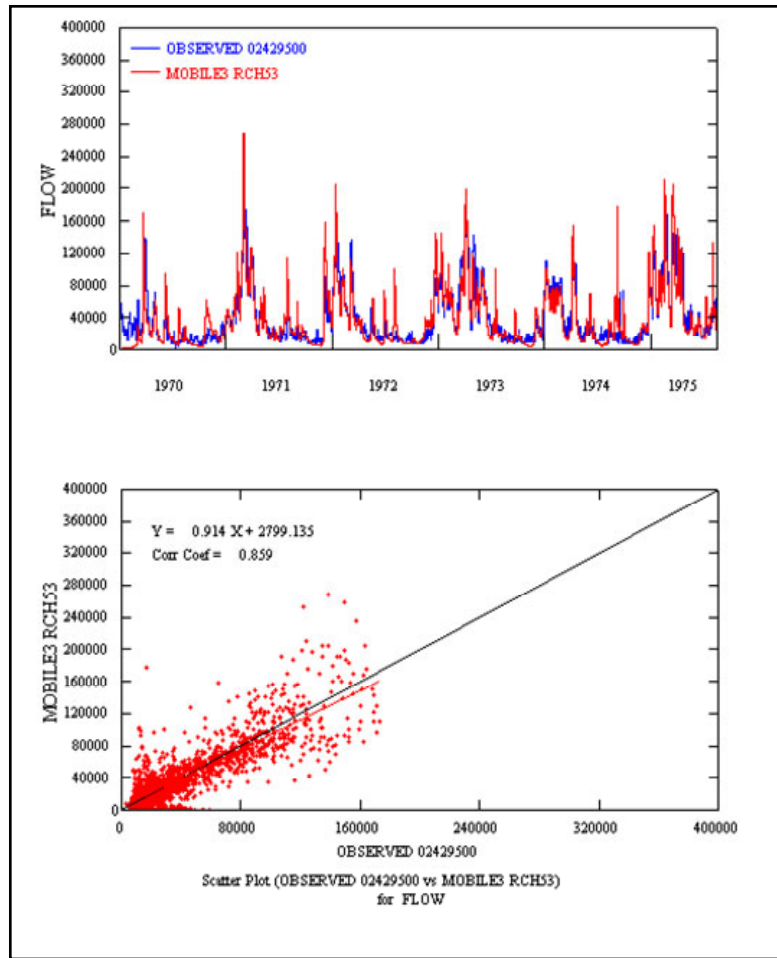


Figure 9. Final validation of the upland HSPF model. Statistical fit tests are performed at an independent gage station (02429500). Daily stream flow simulated values show good fit with measured flows ($R=0.859$, $R^2= 0.74$, $NS=0.73$). The upland HSPF model is considered validated.

2.1.3 Calibration and Validation Results

We conducted calibration and validation process status for the stream flow gage stations above mentioned.

2.2 Coastal Watersheds

Figure 10 shows the locations of the USGS stream flow gage stations and the meteorological station used in the calibration/validation process. Figure 11 shows the corresponding HSPF projects. The calibration of the coastal watersheds included in this project has not yet been as successful as the calibration and validation of the upland watershed.

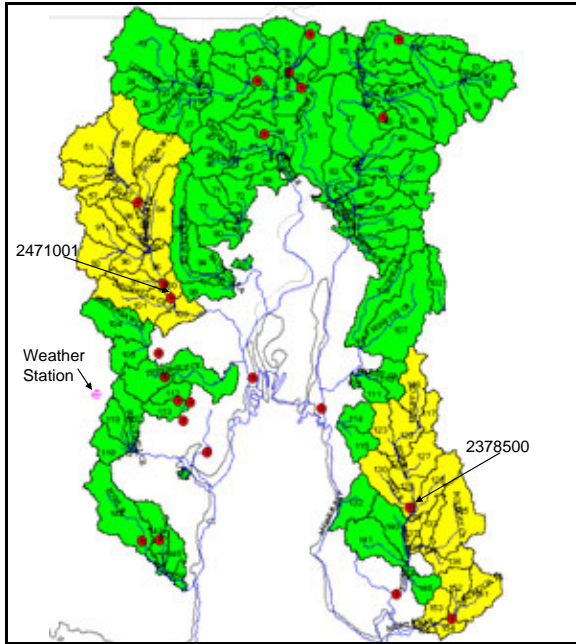


Figure 10. USGS gage stations and meteorological stations used in calibration of the coastal watersheds

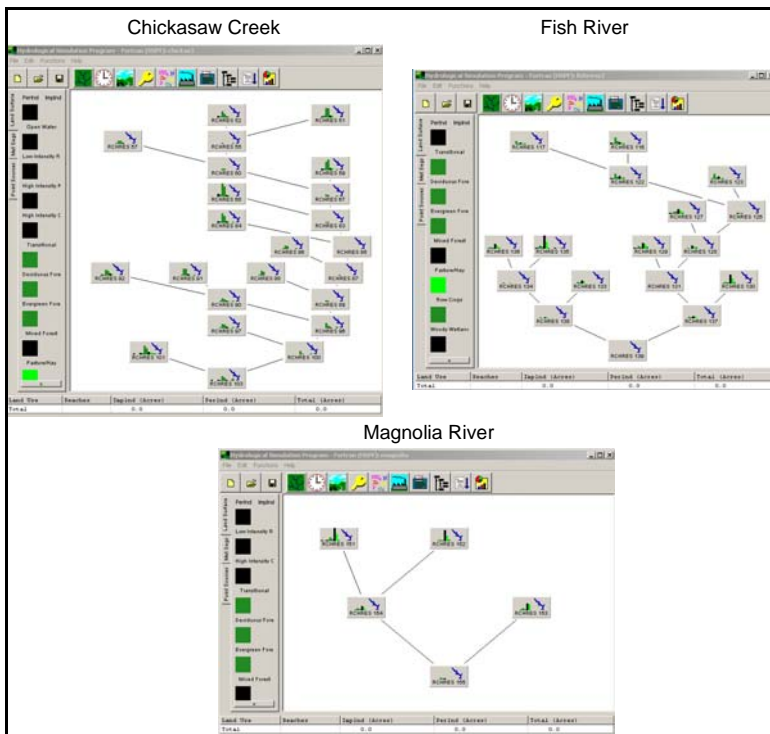


Figure 11 HSPF models for the coastal watersheds.

We created tables depicting calibration and validation of the models. It should be noted that the calibration of Fish River watershed is still in process. Please refer to this project at the NGI website for more details of this work: www.NorthernGulfInstitute.org.

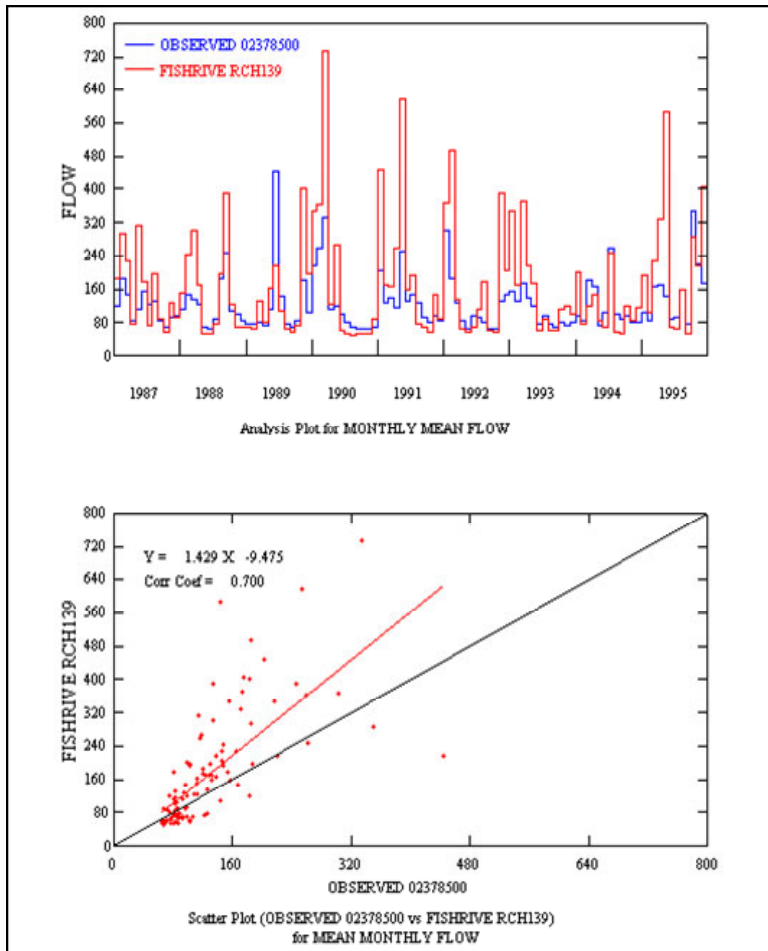


Figure 12. Partial calibration of Fish River HSPF model. Statistical fit indicators are not optimal for the watershed. Calibration for Magnolia River was not possible because there are no USGS gage stations in the area.

b. Basin and Data Testing: Gridded Surface Subsurface Hydrologic Analysis (GSSHA)

1. Objective

Apply USACE's GSSHA distributed model. Generate model meshes with task W1c, coefficients, and input data streams for periods to be modeled. Validate models to available field data using standard and innovative techniques and criteria. Please refer to this project at the NGI website for more details of this work: www.NorthernGulfInstitute.org.

2. Deliverables

(1) Validated model. (2) Modeling Report chapters on input data, meshes, and validation.

3. STATUS

A GSSHA model, Figure 13, has been set up for the Luxapillila basin and initial calibration simulations, Figure 14, have been made. Figure 15 shows the current land use grid and Figure 16 shows the current soil texture grid. There are three precipitation gages: a) Millport; b) Halleyville; and c) Sulligent. Meteorological data at Columbus, Mississippi was received from the U.S. Air Force Meteorological Data Center and is currently being used in the calibration simulations. After making initial model runs it was determined that the model outlet was not in the proper location and thus the model is currently being extended down to Steen, MS. Upon completion of the model extension, calibration and validation of the GSSHA model will be resumed and completed.

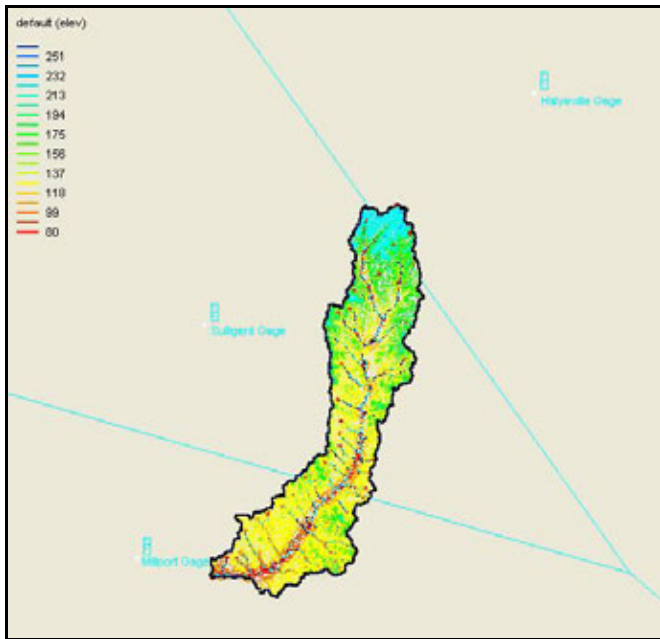


Figure 13. Luxapallila Watershed

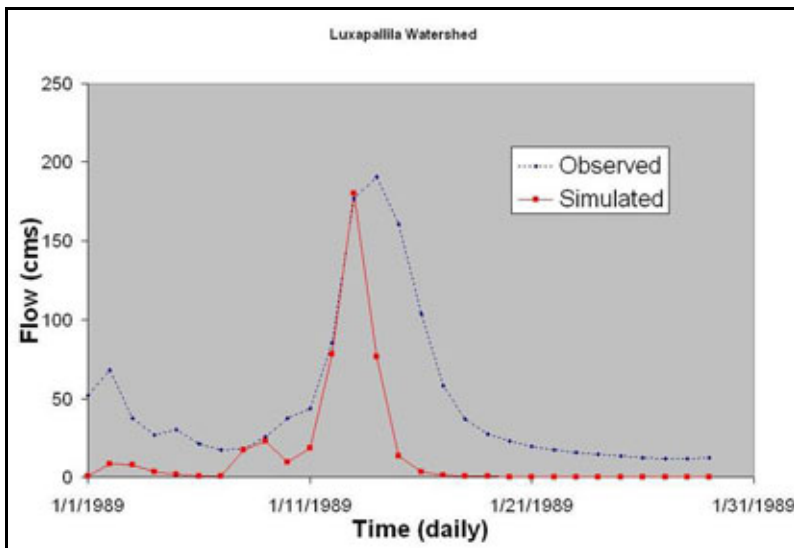


Figure 14. Initial Model Results

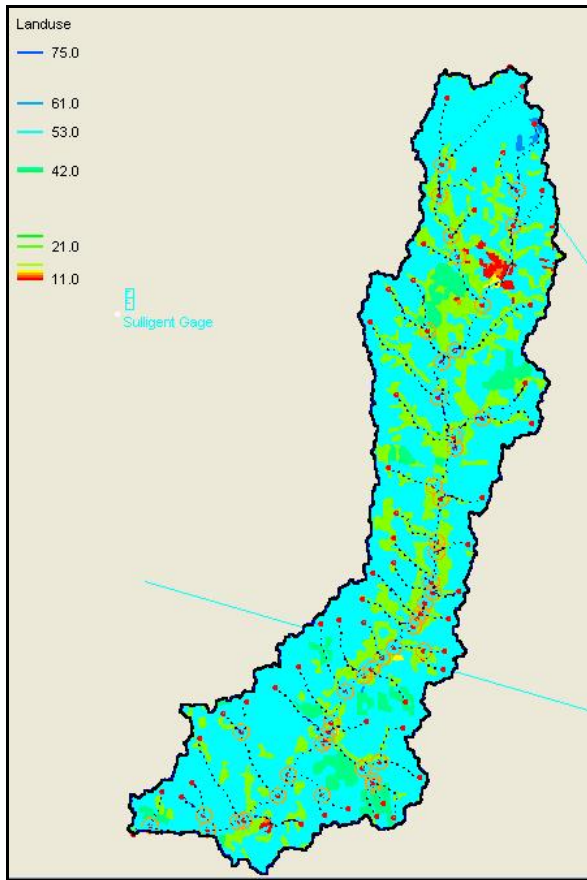


Figure 15. Landuse Grid

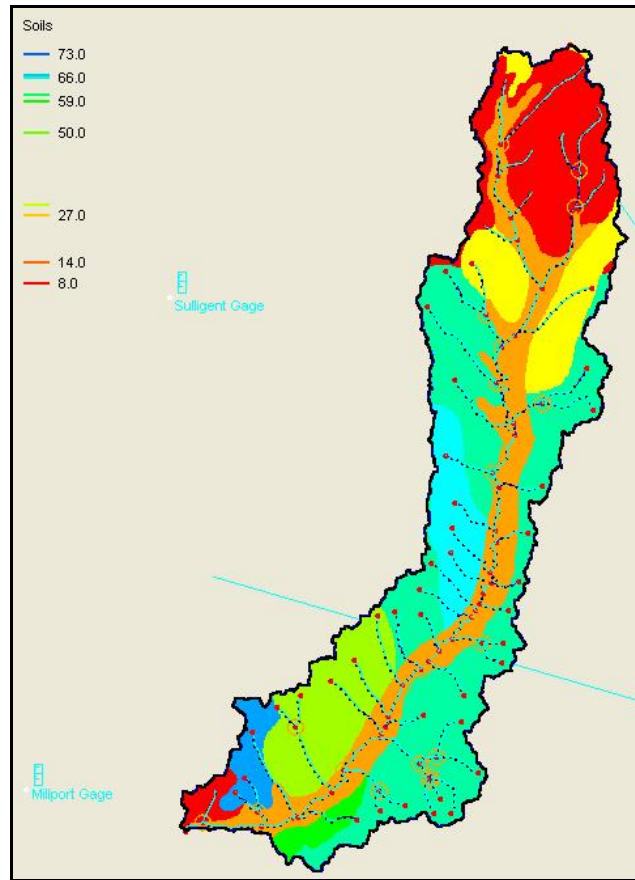


Figure 16. Soil Texture Grid

c. Basin and Data Testing: Grid-Based Mercury Model (GBMM)

1. Introduction

One of the objectives of the “Watershed Modeling Improvements to Enhance Coastal Ecosystems” project is to evaluate new grid based watershed models. The EPA’s Grid-Based Mercury Model – GBMM v2.0 (USEPA, 2006) was selected to simulate daily mercury at the watershed level. The software was installed in Fall 2007. The model was set up with physiographic data from the Luxapallila Creek watershed. During the model setup process, the program crashed because selected GIS layers were not in the same projection system; however, all of the GIS layers were set up with the same projection system. After several trials re-projecting the GIS layers and contacting EPA developers, Robert Ambrose and Heather Golden, we did not generate acceptable results. We concluded that GBMM was not appropriate for this study. EPA Region 4 (AL, GA, FL, KY, MS, NC, SC, TN) has developed a watershed characterization tool called Watershed Characterization System – WCS (<http://wcs.tetrattech-ffx.com/>). This tool has an extension to calculate annual soil mercury loads from pervious and impervious areas. Our next step will be set up the annual mercury tool using data from the Luxapallila Creek watershed.

This report contains information about the GBMM model, model application in the Luxapallila Creek watershed, and model errors.

2. Overview of the GBMM

Table 7 depicts selected characteristics of the GBMM model. The three major components simulated by the model are hydrology, sediments, and mercury. The model runs in a daily basis for every grid cell within a simulated area. GBMM requires the ArcGIS software on data pre-processing and Excel on data post-processing.

Table 7. Characteristics of the GBMM model

Characteristic	Comment
General	Gridded, 1D
Released	2006
Supported	USEPA/TETRA TECH
Programming Language	C++
Pre/Post Processor	ArcGIS/Excel
Scale	Small/Large Watershed
Simulation Period	Continuous
Simulation Time Step	Daily
Hydrology/Infiltration	NRCS Curve Number
Flow Routing	Manning's equation
Erosion	MUSLE/SDR
Sediment Transport	Mass balance
Mercury	Methyl/Divalent

3. Model Application

The GBMM model application focused on the Luxapallila Creek watershed located in Alabama and Mississippi. Runoff from this watershed discharges in the Tombigbee waterway. The Luxapallila Creek watershed is a sub-watershed of the Mobile River basin.



Figure 17. Location of the Luxapallila Creek watershed

Table 8 depicts the GIS map layers and input tables developed for the Luxapallila model. This table provides also a description and source on the GIS map layers and input tables.

Table 8. GIS map layers and input tables for the Luxapallila model

Data	Description	File Name	Source
Soil Map	STATSGO	AlabamaAlbers	www.essc.psu.edu/soil_info
Land Use	NLCD 1992	58237946	http://seamless.usgs.gov/website/seamless/viewer.php
DEM	Digital Elevation Model (30m resolution)	DEMAIbers	http://seamless.usgs.gov/website/seamless/viewer.php
Climate Station	Millport2E	Millport_Project	http://www.ncdc.noaa.gov/oa/climate/stationlocator.html
NHD_Streams	Reach data	routeAlbers.rch (nhd folder)	ftp://nhdftp.usgs.gov/FOD_Data/ (HUC: 03160105)
NHD_RFlow Table	Stream connection information	nhd.rflow (nhd folder)	
Land Use Lookup Table	NLCD land cover code and land cover parameters	lulookup	Default table
Land Use CN Lookup Table	Soil hydrologic group and NLCD land cover code	lucode_cn	Default table
Climate Data Table	Daily precipitation and temperature	climate	http://www.ncdc.noaa.gov/oa/climate/stationlocator.html
Soil Property Table	Linked to U.S. soil map through soil group lookup IDs	SoilData	Default table

4. Model Errors

The GIS layers of this model were set up to USA_Contiguous_Albers_Equal_Area_Conic_USGS_version coordinate system, but the program stopped with the following error: “All input layers are not in the same Projection Systems.”

After several trials re-projecting the GIS layers we contact EPA developers, Robert Ambrose and Heather Golden. Heather Golden suggested we re-project the layers with USA Contiguous Albers Equal Area Conic coordinate system, but this did not work. We have terminated this effort as it appears to be unproductive.

d. Data Collection and Analysis: Water Budget of Tombigbee River -Tenn-Tom Waterway from Headwaters to Heflin Lock and Dam

Abstract

The purpose of this project is to develop a water budget tool for rivers and demonstrate it for the Tombigbee River-Tenn-Tom Waterway. The Tenn-Tom Waterway was completed in 1984, linking the Tennessee River to Mobile Bay via the Tombigbee River. Water from the Tennessee River watershed flows through Whitten Lock near Bay Springs, Mississippi, and merges with flows from the Tombigbee Watershed. Although the primary authorized purpose for the Waterway is navigation, now it is being looked to for surface water supply for current and future water demands in Northeast Mississippi. Before watershed managers can make well-informed decisions about permitting withdrawals, the amount of water available must be quantified – a water budget. This was attempted through the compilation of data into a spreadsheet schematic of the Tombigbee River and Tenn-Tom Waterway. Data were acquired through various methods and sources including Geographical Information Systems, USGS stream flow Data, MDEQ and USACE personal communication, and the MDEQ EnSearch

Engine. A meld of these data into the spreadsheet format transforms them into the volumetric discharges for different flow situations at locations along the river and waterway.

2. Approach

The overall approach consisted of compiling public water surface flow records and tabulating them in a Microsoft Excel spreadsheet, performing basic statistical analyses, and formatting the results.

The first step was to develop a conceptual understanding of how water moves through the system and to draw a schematic flow chart of the study area. Using maps from the Corp of Engineers Mobile District Office and Google Earth, a flowchart of significant tributaries was developed. Meetings with Waterway managers refined the flow chart and improved our intuitive understanding of physical processes along the waterway, particularly issues with minimum flow structures and bypasses along the upper part of the Waterway.

In order to begin to quantify the water budget, inflows and outflows from the watershed had to be gathered. Inflows to be gathered in the data collection included: tributary and in-stream flows, lockages, and permitted discharges in the study area, such as Publicly Owned Treatment Works (POTW). The data for streamflow were obtained from the United States Geological Survey water data webpage (<http://waterdata.usgs.gov/nwis/rt>) and analyses were conducted on an average annual basis. There were over 40 stream gaging stations located within the watershed, although not all gages were utilized. Stations having a very short period of record and upstream stations where there were multiple stations along a tributary were the most common reasons for omission. Surface water withdrawals in the Mississippi portion of the watershed were obtained through communication with Mississippi Department of Environmental Quality. This data was a collection of surface water withdrawal permits with the pertinent data being the maximum volume of water a permit site could remove, in acre-feet per year, as well as latitude and longitude positioning. The majority of water taken from the Tenn-Tom Waterway is used in industrial water supply, public drinking water supply, and irrigation.

Figure 18 displays the spatial and relative location of the permitted sources and sinks of water in the study area. These flows plus the gaged river flows were compiled into a spreadsheet which calculates the water budget for various standard statistical measures.

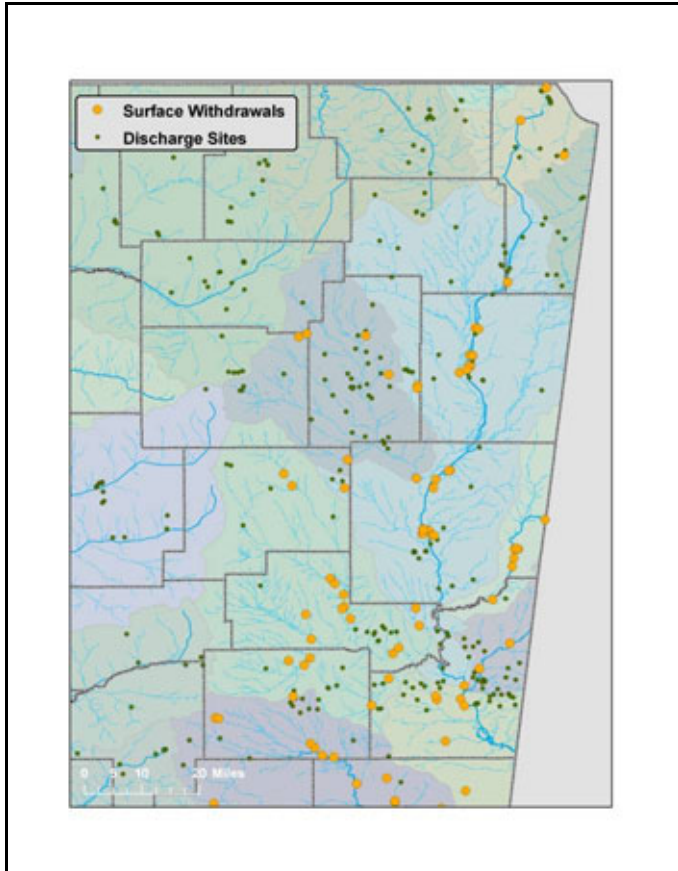


Figure 18. Withdrawals and Discharges

After all of the data had been gathered and arranged and ordered in a geographically, several statistical analyses were performed by changing the streamflow conditions. Three cases were analyzed: Mean, Low, and High Flow.

3. Results

A primary end product of this work is the spreadsheet described in the preceding section. The spreadsheet is shown in a sample screen shot in Figure 19. Please refer to this project at the NGI website for more details of this work: www.NorthernGulfInstitute.org.

In the spreadsheet, yellow cells represent withdrawals, pink cells stand for discharges, light blue cells signify a tributary, and dark blue cells indicate the run of the river or waterway. Some cells in the river and waterway are green. This connotes a measured flow in the river or waterway. Most of the dark blue cells values are derived through addition or subtraction of water from the system, but the green cells are measured flows. This can appear to cause some incongruence but this is just an artifact of limited statistical information and differences in the period of record for stream gages throughout the system. An example initially occurred at the Tombigbee River Gage near Cochrane Alabama. The volumetric flow as measured by the gage was lower than it should have been. The period of record for this gage was from 1938 to 1978. This means that the gage could not capture the hydrologic conditions of the river after the construction of the Tenn-Tom Waterway. The addition of Tennessee River water to the system must have caused an increase in flow of the system and therefore this gage is expected to provide a statistical flow which is less than the actual flow at that point of the waterway. It is for these reasons and the fact that there are gages located closely upstream and downstream of the Cochrane gage that the gage was excluded from the study.

One of the issues with the study is the use of a 7Q10 analysis over the entire watershed. A 7Q10 event over that large of an area is extremely unlikely to occur because of the sheer size of the watershed and low probability of occurrence for each stream within the area. It is more likely that only a portion of streams will be experiencing a 7Q10 type of flow while other streams maybe just a little below average. Of course, the possibility of a widespread drought situation could occur, as witnessed by the droughts across the Southeast is the past few years. Another problem encountered during the statistical analysis was lack to data. The stream gages from Mantachie, Rock, and Bull Mountain Creek did not have enough data in order to perform the statistical flow analysis. They all had a long enough period of record but the data was not continuous throughout the lifetime of the gage and therefore it was not advisable to try to calculate the high and low flow events. These two considerations should be recognized when examining the low and high flow scenarios of the study.

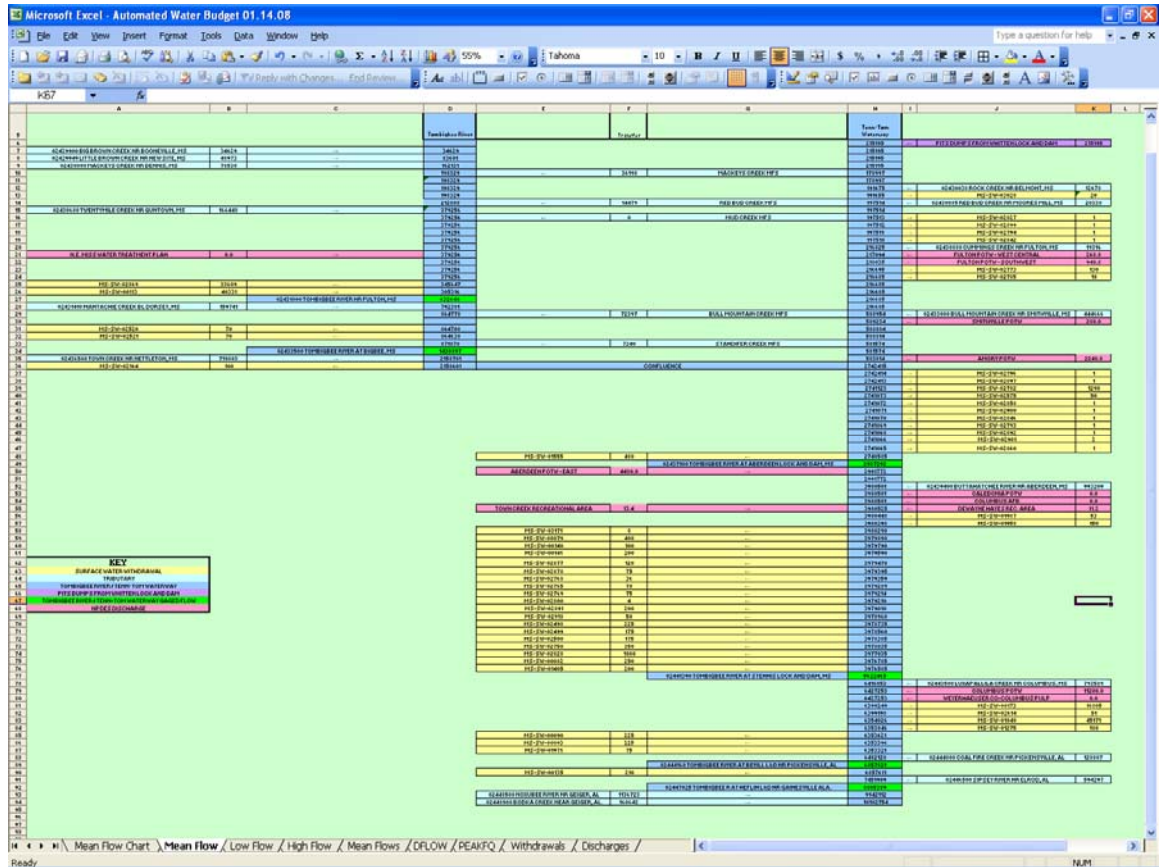


Figure 19. Water Budget Spreadsheet Sample Screenshot

Improvements to be implemented to better characterize the system include information for ungaged streams and creeks. There are several considerable inputs to the system, which are not gaged by the USGS. An estimation of the contributions of these streams would be helpful in assembling a more complete picture of the water budget in the study area. These ungaged flows could be estimated by finding the average flow contribution per acre for the streams with data in the watershed and applying that average to the ungaged streams and their contributing areas. This should provide a ballpark estimate of the water contributed by streams for which we have very little information. Another improvement to the study will be the use of a probability function to determine a portion of streams in the area which would be experiencing low or high flows and thereby giving use a better characterization of the activity of the entire system.

e. Data Collection and Analysis: Best Management Practices

1. Summary

A survey was prepared that will be e-mailed to design and construction professionals in the NGI service area. Questions in the survey include participant demographics, understanding of BMP and LID, utilization of BMPs, and utilization of technology. This survey will be the foundation for a thesis to complete a master of Landscape Architecture degree at Mississippi State. Surveys will be implemented through a WEB site. The graduate student, Austin Moore, is also working on designing a spreadsheet that will house BMP data previously collected at MSU. Information collected as part of this survey will also identify the potential for linking this spreadsheet to a CAD or GIS interface. The survey will be mailed out the latter part of June, 2008. The results should be complete by the end of August, 2008.

(https://www.surveymonkey.com/s.aspx?sm=rx1BnnWXrCkyE_2b9Oyt2RZQ_3d_3d), as well as a draft copy of the survey instrument itself. The final draft has been submitted to IRB for review prior to disseminating to the general public.

f. Wetland and Riparian Buffers

1. Data Assembly

1.1 Goals and Progress

The objective of this subtask was to assemble the most temporally appropriate land cover, water quality, and biological data for use in advancing studies of interactions among those factors towards a watershed management-focused application. Land cover data clearly can be used in deriving estimates of wetland and riparian vegetated zone parameters (percent of watershed comprised of riparian buffer, percent of stream length adjacent to buffers, etc.), which ultimately could be used as correlates of water quality (i.e., sediment or nutrient transport).

Previously, we assembled information on USGS gaging stations in the Mobile Basin for which data were available on water quality parameters that could be readily and logically linked with land cover and physical watershed models developed under other components of this Watershed Modeling Improvements research program. During this period, we further refined our investigation to determine the number and distribution of those USGS stations for which data are temporally matched with available land cover and biological data. This specifically focused on stations with sediment or turbidity data collected during the years 1999-2003, the period during which imagery were collected for developing the NLCD 2001 land cover data, and the years 1975-1983, the period during which imagery were collected for the GIRAS land cover data. Results from these investigations are discussed under section g: Ecosystem Responses.

1.2 Next Steps

Once we complete the initial evaluations described under section g (Ecosystem Responses), we will proceed to evaluations of the relationship of water quality and aquatic biota with wetland and riparian vegetated zone parameters (e.g., percent of watershed comprised of riparian buffer, percent of stream length adjacent to buffers, as mentioned above). Thus, it will be necessary to derive additional land use data for those studies which will be derivations of land cover and stream networks within the Mobile Basin or sub-basins thereof.

2. Correlation of Buffer Zone Characteristics with Water Quality

2.1 Goals and Progress

The objective of this subtask is to conduct statistical analyses of correlations between derived data on wetland and riparian buffer zones (part 1, above) and water quality and biotic data assembled as part of this NGI project (see, e.g., section g, below). These analyses will be performed after we have completed work under section g, described below. Those analyses will be executed first in order to best evaluate biotic parameters that appear correlated with water quality in a general sense, and which should thus best correlate with the presence or absence of riparian buffers on the landscape.

This work has not yet begun because we are still executing section g.

3. Recommendations for Buffer Zones as BMPs

3.1 Goals and Progress

The objective of this subtask is to use the above statistical analyses to make recommendations as to buffer requirements for maximizing water quality benefit in the Mobile Bay Watershed, specifically with respect to minimizing sediment inputs to the system. Those recommendations will be incorporated to the extent possible into modeling systems developed through the various NGI projects.

This work will begin once parts 1 and 2 are complete. This will not begin until late in 2008 or possibly early 2009 and will be coordinated with other BMP research within the NGI.

g. Ecosystem Response

This Task Area originally was named “Coastal Habitat Responses.” However, in keeping with the broader basin-wide approach of the *Watershed Modeling Improvements* research program, we have broadened the scope of this work to encompass *Ecological Responses*, potentially anywhere in the Mobile Basin. Our initial approach, described below, focuses on sub-basins within the uppermost reaches of the Mobile Basin, but plans are underway to incorporate coastal sub-basins (e.g., Fish River) in the next phases of research.

1. Predicted biotic response to water quality, sediment load, and land cover change

The objective of this subtask is to use results of analyses from multiple Task areas in combination with available biological data as the basis for formulating hypotheses as to how aquatic ecosystems will respond to human-induced changes in water quality, especially sediment loading (Figure 20). These responses also will be incorporated into studies of the potential role of riparian buffers in water quality improvement (section f, above).

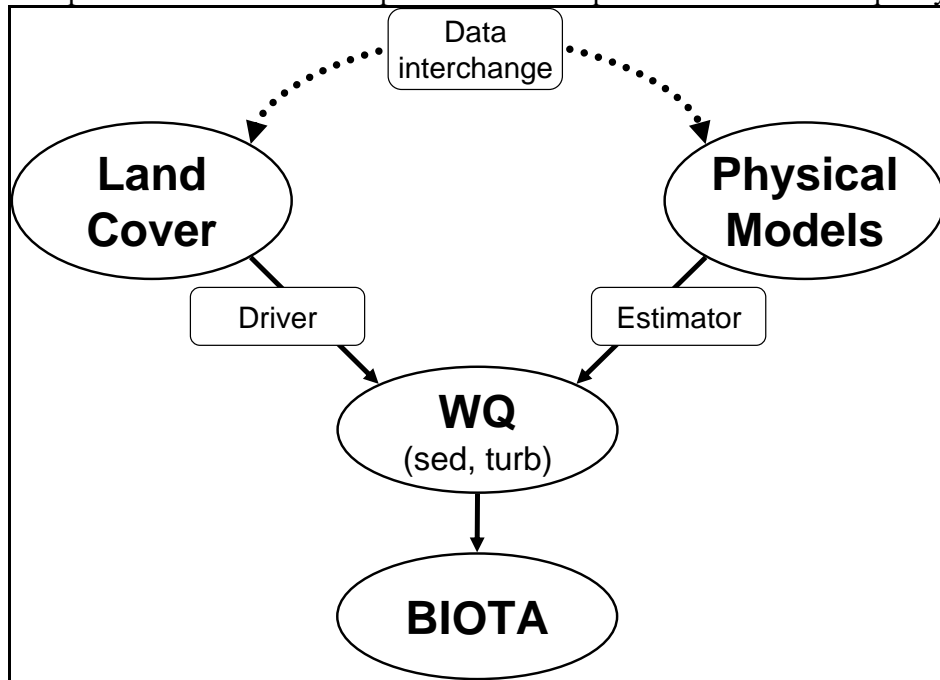


Figure 20. Conceptual relationships among potential data streams for biological responses modeling. We will be evaluating whether output from hydrologic and water quality models (Physical Models) may be adequate in some cases for use as predictor variables for biotic responses.

Based on existing literature on responses of biota to human land use-induced changes in water quality, we expect to find negative relationships between level of human land use within sub-basins and biotic responses. Similarly, we anticipate negative relationships between human land use and water quality. Thus, the hypothesized causal relationship among these interactions is the negative effect of water quality degradation on aquatic species, particularly those of conservation interest. This is the reason for the direct link between water quality (WQ) and biota in Figure 20.

2. Assessment of Predicted Biotic Responses

The objective of this subtask is to evaluate the adequacy of statistical models developed under Task 1, above. The initial intent was for these analyses to take advantage of water quality data provided through the US Geological Survey gaging station network. Those stations potentially provide a rich source of water quality data from across the Mobile Basin – all of which should be collected with the same methodology and which are housed in publicly available databases with open online data access. However, we found quickly that there were two significant barriers to use of these data for these purposes. The first difficulty was the coverage of the Mobile Basin with gaging stations that provided the type of data in which we were interested. The second difficulty was that even among the stations that provided the data in which we were interested, the temporal match between USGS water quality data collection and land cover data collection made joint analysis of these two data types essentially impossible.

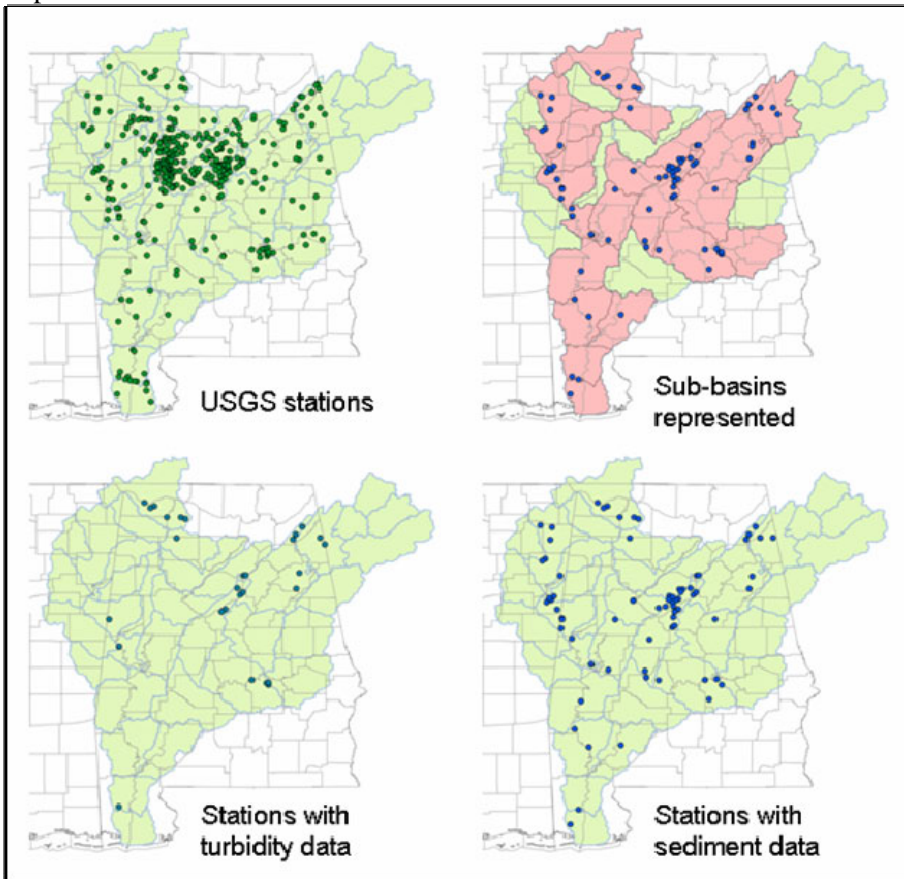


Figure 21. Deficiency of USGS gaging stations for providing data for these modeling activities. Stations with sediment or turbidity data are poorly represented across the Mobile Basin, but the physical models thus far have focused primarily on sediment transport modeling. Nutrient data are even more poorly represented in the USGS database.

These investigations provided very few stations that could be used for these analyses (Figure 22). For these reasons, we must rely on predictive output from physical models as the source of water quality data for correlational analyses in comparison with land cover patterns within the Mobile Basin.

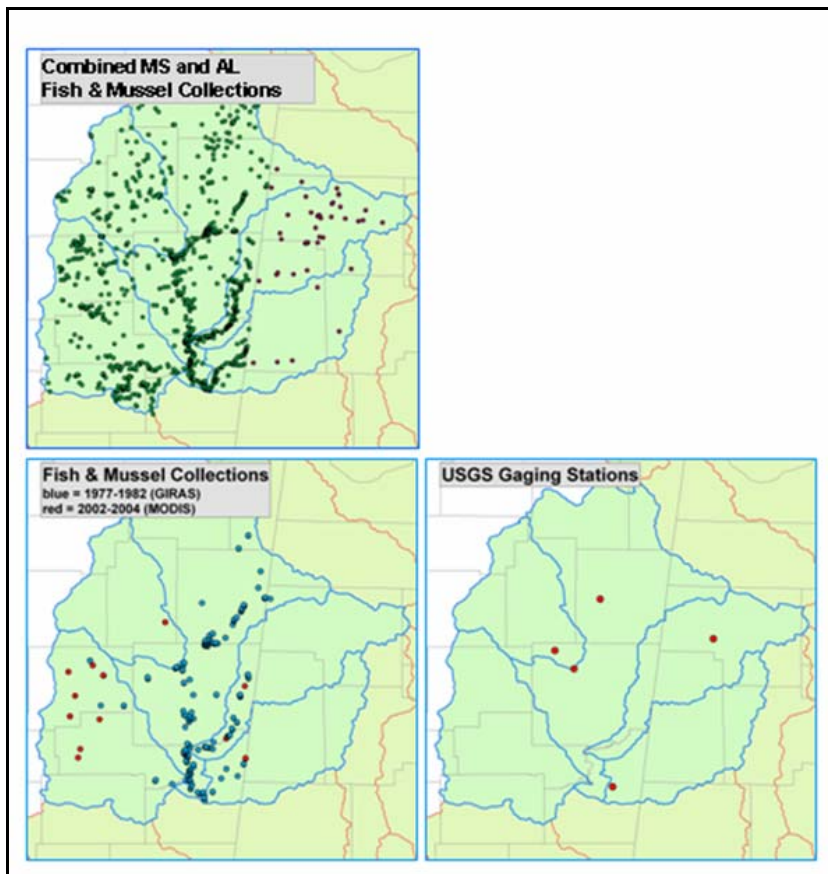


Figure 22. Biotic collections in MS matched well with the timing of land cover data, but USGS gaging station data did not. Lower left indicates the temporal match between biota and land cover in two time periods (GIRAS – blue and MODIS – red). Only five gaging stations had appropriate data during these time periods.

In an effort to conduct those analyses, we have begun to develop a system to initiate analyses of interactions depicted in Figure 31. Biological data obtained from MMNS and the ANHP will be combined with output from water quality models on a sub-sub-basin level in the upper Tombigbee portion of the Mobile Basin to determine which of those biological data are informative in terms of indicating relationships with land cover and water quality output generated via physical watershed models that have been developed for the upper Tombigbee region. This work initially will focus on sub-sub-basins in two sub-basins draining into Aberdeen Pool of the Tennessee-Tombigbee Waterway (TTW) – that is, subdivisions of the Town Creek and Tibbee Creek watersheds.

3. Effects on Exotic Invasive Species (*to become* Effects on Aquatic Biota)

The objective of this subtask was to expanded upon Tasks 1 and 2, with the specific objective of determining whether water quality or land cover parameters are correlated with presence or abundance of exotic species within the Mobile Bay Watershed, and whether those correlations are sufficiently strong to permit accurate prediction of when and where non-native species might be expected establish and spread – and at what scale those predictions are most accurate. A particular goal here was to determine whether human-induced changes in landscape features or water quality accurately predict invasive species distribution within the watershed.

We are pursuing two lines of research to develop an accurate metric of health in the Mobile basin watershed. The first is to use published allometric relationships that can be used to identify mussel glochidia (the parasitic life stage of Unionid mussels) on existing samples from the East Fork and Buttahatchie Rivers in Mississippi. The second is to modify an existing model of mussel dynamics that is based on flow models already being used by our

colleagues on this project. This model will be used to project the dynamics of the native mussel community through time

3.1 Reconstructing Mussel Abundances

The manner in which a community of Unionid mussels interacts with local fish communities is diverse. Generally mussels will employ one of two types of strategies for parasitizing fish. The first is to simply cast their spawn into the current, typically either attached to mucus nets or freely floating in the river current. Fish that swim through these areas pick up the glochidia on their gills allowing for the immature mussels to develop. The second strategy is for the female to display some sort of lure which includes the immature mussels. When a benthic fish eats the lure they become parasitized by the mussel glochidia. The former strategy is one in which the number of glochidia per infected individual should vary positively with the density of mussels in the river because contact depends solely upon the density of mussels in the system. As a result, we should be able to use historical fish collections to re-construct the relative abundances of different mussel species in a riverine system in the past. We have developed cooperative and collaborative relationships with the Mississippi State Museum of Natural Sciences to obtain fish specimens as well as mussel abundance measurements for the East Fork and Buttahatchie Rivers in order to develop these empirical relationships. Colleagues at the USDA Center for Bottomland Hardwood Forests have also agreed to train Brooks and a student on their techniques to take measurements necessary to identify glochidia to species. These relationships are one of the two foci of our work on this component this year.

3.2 Modeling Mussel Abundances

Once we have developed our empirical relationships we can use them to help parameterize (or calibrate, depending upon your preferred terminology) an existing model for mussel population dynamics. This model is based on existing hydrodynamic models and can be used to predict the spatial distribution of mussel beds in the river (Figure 23). By adapting this model and parameterizing it based on what we discover in our empirical work, we will develop an approach that can then be used to predict future mussel dynamics as a function to alterations in river hydrodynamics, and watershed land use.

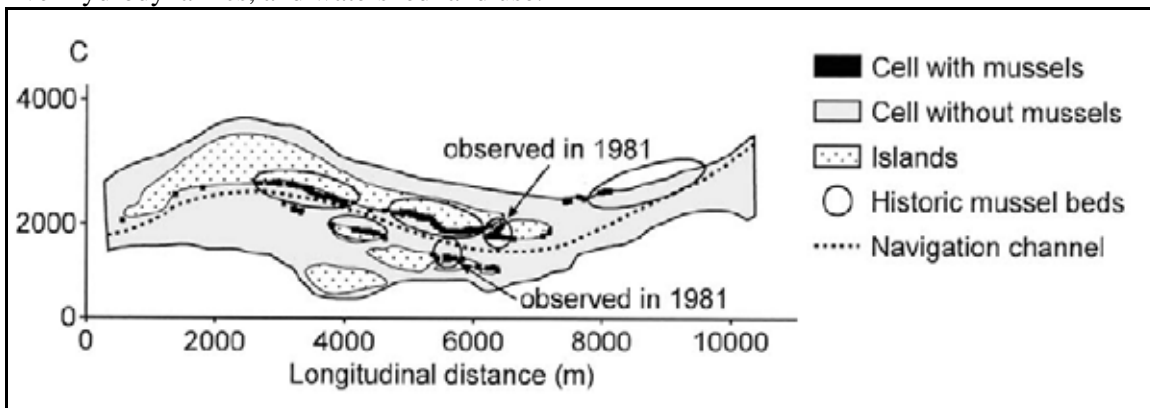


Figure 23. . Comparison of predicted (black dots) and actual (ovals) location for mussel beds based on the model. Taken from Morales et al. (2006).

Outreach activities

General Description:

Project staff made multiple presentations at state (e.g. Mississippi and Alabama Water Resources Associations and American Society of Civil Engineers conferences), regional (e.g. Gulf Alliance Monitoring Forum), and national meetings (e.g., Environmental and Water Resources Conference) to showcase our NGI work and solicit feedback on the technical merits. In addition, this project, in concert with two other MSU projects, has conducted extensive outreach to stakeholders and potential collaborators. The outreach effort has been documented in a report (Tagert et al. 2008).

Have you hosted speakers, workshops and/or any training?

Type: Workshop

Name of event: Mobile Bay Collaboration Network Workshop

Date: November 5-7, 2007

Location: Dauphin Island Sea Lab, Alabama

Description: to create mutually beneficial interactions among researchers working on collaborative projects and resolve selected questions about data and models.

Approximate Number of Participants: 47

Type: Training

Name of event: GSHHA Training

Dates: August 2007

Location: MSU

Description: B. E. Johnson of USACE taught two project staff how to apply USACE watershed runoff model.

Approximate Number of Participants: 2

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

Diaz-Ramirez, J.N., V.J. Alarcon, Z. Duan, M.L. Tagert, W. H. McAnally, J. L. Martin, and C.G. O'Hara. 2007. Impacts of Land Use Characterization in Modeling Hydrology and Sediments for the Luxapallila Creek Watershed, Alabama/Mississippi. Accepted for publication in Transactions of the ASABE. (partially supported by sources other than NGI)

List non-refereed articles and reports for this project:

Diaz-Ramirez, J.N., W.H. McAnally, and J.L. Martin. 2008. Parameter Uncertainty Propagation on Streamflow Simulations and Parameter Sensitivity Evaluation of a Lumped Watershed Model: A Case Study. World Environmental & Water Resources Conference, Honolulu, HI, May 13-16. Meeting of the Environmental & Water Resources Institute of ASCE, Reston, VA.

Tagert, M.L., K.A. Collins, W.H., McAnally, and J.N. Diaz-Ramirez. 2008. Mobile Basin Stakeholder Needs and Assessment: Year One Report. NOAA - Northern Gulf Institute, MSU, MS. (in press)

List conference presentations and poster presentations for this project.

Diaz-Ramirez, J.N., W.H. McAnally, and J.L. Martin. 2008. Parameter Uncertainty Propagation on Streamflow Simulations and Parameter Sensitivity Evaluation of a Lumped Watershed Model: A Case Study. World Environmental & Water Resources Conference, Honolulu, HI, May 13-16. Meeting of the Environmental & Water Resources Institute of ASCE, Reston, VA.

McAnally, W.H., and J.N. Diaz-Ramirez. 2008. Watershed Modeling Improvements to Enhance Coastal Ecosystems. Northern Gulf Institute Annual Conference, Biloxi, May 13-14. Meeting of the Northern Gulf Institute, MSU, MS.

Diaz-Ramirez, J.N., V.J. Alarcon, W.H. McAnally, and J.L. Martin. 2008. The Mobile River Basin: A Review of Physiographic, Climatic, Water Quantity, and Water Quality Characteristics. Annual Mississippi Water Resources Conference, Jackson, MS, April 15-16. Meeting of the Mississippi Water Resources Research Institute, MSU, MS.

McKee, J.K., W. H. McAnally, and J. A. Sharp. 2008. Water Budget for the Tombigbee River in Mississippi and Alabama. Annual Mississippi Water Resources Conference, Jackson, MS, April 15-16. Meeting of the Mississippi Water Resources Research Institute, MSU, MS. (Won Best Student Paper Award)

McAnally, W., J.N. Diaz-Ramirez, V. Alarcon, L. Wasson, B. Johnson, G. N. Ervin, and C. P. Brooks. 2007. Watershed Modeling Improvements to Enhance Coastal Ecosystems. Mobile Bay Collaboration Network Workshop, Dauphin Island Sea Lab, Alabama, November 6.

Diaz-Ramirez, J.N., W. H. McAnally , J. L. Martin, J. H. Cartwright, V. Alarcon, and M.L. Tagert. 2007. Watershed Modeling for Improved Surface Water Predictions in the Tennessee and Mobile Bay Basins. Alabama Water Resources Conference, Orange Beach, AL, September 6-7.



Spatial Technology and High Performance Computing for Improving Prediction of Surface Water Quality

NGI Project File Number: 07-MSU-04

W. H. McAnally; MSU Civil and Environmental Engineering; Box 9546, MSU, MS 39762;
mcanally@cee.msstate.edu; 662-325-9848

Vladimir Alarcon, MSU GeoResources Institute, alarcon@gri.msstate.edu; John H. Cartwright, MSU GeoResources Institute, johnc@gri.msstate.edu

Personnel: (name, title, % funding, located at NOAA)

- V. Alarcon, Asst Prof, 50% NGI, No
- J. Cartwright, Rsch Assoc, 50% NGI, No
- W. H. McAnally, Assoc Prof, 8% NGI, No
- M. Remotigue, Asst Prof. 5% NGI, No
- R. Jackson, Rsch Assoc, 20% NGI, No
- J. Sharp, Rsch Assoc, 25% NGI, No
- W. Aziz, Grad Student, 100% NGI, No

Key Scientific Questions/Technical Issues:

Develop and demonstrate the use of advanced spatial technology and high performance computing capabilities in the prediction of surface water quality

Collaborators/Partners:

U. S. Army Corps of Engineers, Engineer R&D Center
Begun June 2007

Part reimbursed support, part in-kind support (signed agreements)

Nature: Shared models, training on Corps' models

U. S. Army Corps of Engineers, Mobile District
Begun March 2007

Provide in-kind support

Nature: sharing of data and models, interlocking tasks

NASA Marshall Space Flight Center, Huntsville
Begun May 2008

Provide in-kind support

Nature: Informal agreement to share data and models

Project Duration:

3 years, Feb 2007 – Jan 2010

Project Baselines:

Contributions to Specific NOAA Goals/Objectives:

This project satisfies NOAA Mission Goal 1: Protect, Restore, and Manage Use of Coastal and Ocean Resources Through Ecosystem-Based Management. It will also contribute to Mission Goal 4: Support the Nation's Commerce for Safe, Efficient, and Environmentally Sound Transportation through increased use of environmental information in management of the Federal and state channels and Port of Mobile.

Problems and Priorities:

This project will contribute generally to improved coastal management decisions by demonstrating the best use of new data and modeling technologies for ecosystem management. It will specifically lead to improved management of Mobile Bay, with benefits to the Alabama-Mississippi coastal zone and Mississippi Sound.

Gaps:

Relationships between coastal ecosystem responses and watershed-scale inputs will be quantitatively defined and displayed using state-of-the-art geospatial tools and advanced numerical models running on high performance parallel-computing platforms. Data compiled from multiple sources and generated by the models will be available to all stakeholders in the basin

Project Abstract:

The goal of this project is to develop and demonstrate the use of advanced spatial technology and high performance computing capabilities in the prediction of surface water quality. The use of advanced spatial data analysis and high performing computing capabilities for development of input for surface water quality models, enhancing model performance, and demonstrating and displaying model results will be investigated. Surface water quality models are routinely used by various agencies for water quality management and control. Modern models of surface water quality typically consider not only in-stream hydraulic and kinetic processes and the influence of point sources, but the influence of landscape features (e.g. land uses, soils, hydrology) in order to assess water quality and evaluate alternative management strategies to improve or maintain water quality (e.g. BMPs, etc.) or biologic integrity.

Implementation strategies to achieve acceptable water quality or biologic integrity often focus primarily on the opportunities and constraints inherent in a basin. As such, much of the data required to drive these integrated models is geospatial in nature and model accuracy is often directly impacted by the availability and accuracy of those geospatial data. In addition, the application of an integrated model approach is typically computationally intensity and results in potentially enormous quantities of output that are often difficult to interpret. However, recent advances in spatial technology and high performance computing can be used to aid in the development and application of integrated modeling systems and the interpretation of model predictions. Through more accurate modeling, effective policy decisions can be made or developed by the responsible agencies.

List major milestones completed and describe any significant research results and transitions.

This section shows results of the following tasks:

Task H2: Spatial Data Tools:

- H2a. Geospatial processing of NEXRAD data: Vladimir Alarcon, Louis Wasson
- Objectives: Incorporate geospatial data to aid in the development and application of surface water quality models. Generate precipitation time-series for models.

More than 70000 NEXRAD precipitation data files, in zipped XMRGS format and HRAP coordinates (for the period 1997-2005), were used to generate precipitation time series to be used by the models in this project and other NGI projects. Figures H2.1 through H2.3 detail the methodology used for the generation of the precipitation time series.

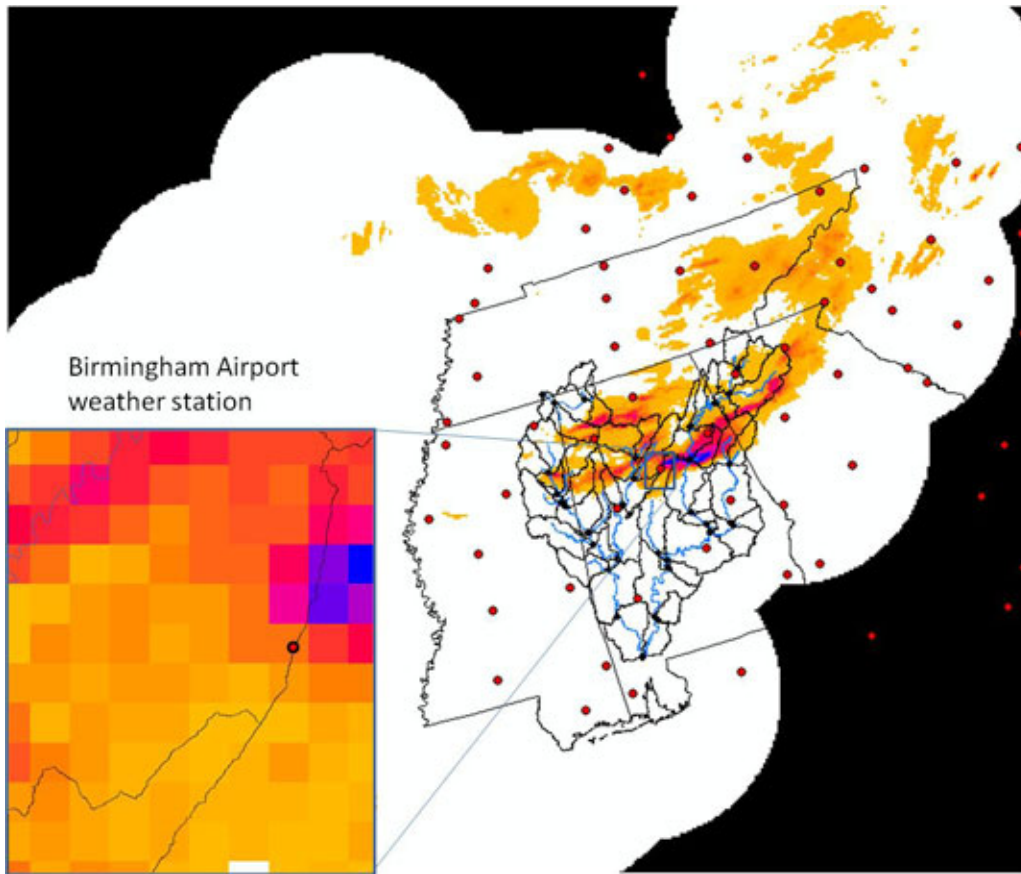


Figure H2A.1 NEXRAD raster layer (HRAP projection) showing precipitation values for 6/14/1997, 11: AM. The zoomed area shows precipitation distribution near the Birmingham, AL, Airport weather station. Notice that this particular storm covers a number of other weather stations (red dots).

Figure H2A.1 shows one-instance of hourly NEXRAD precipitation for the mobile watershed area. Precipitation stations that collect precipitation data at the ground are also shown. Notice that for the particular case of the Birmingham Airport weather station, exactly one pixel of the NEXRAD data coincides in geographical location. More than 70000 raster files of the type shown above (containing hourly precipitation for the period 1997-2005) were processed to generate precipitation time series. Figure H2.2 shows a summarized flowchart of the process. A program in C language (precip.c) was generated to read XMRGS binary data and produce ASCII text values of precipitation. The program was compiled for SunOS 5.10 Unix system. To generate the actual time-series in text format (not only one value per hour), this program was sequentially applied to all files using Shell scripting (see Figure H2A.2) in a four-processor machine. The hourly time-series for the whole period 1997-2005 were produced.

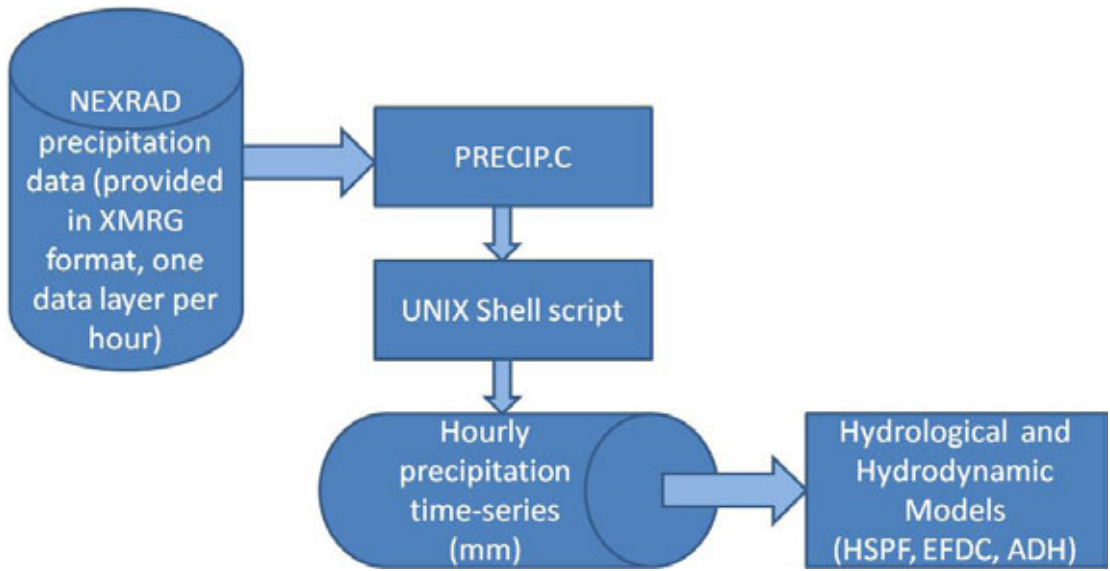


Figure H2A.2. Methodology for generating precipitation time-series from NEXRAD layered data in XMRGS format. The data generated could be used directly and indirectly by a number of models used in this and other NGI projects.

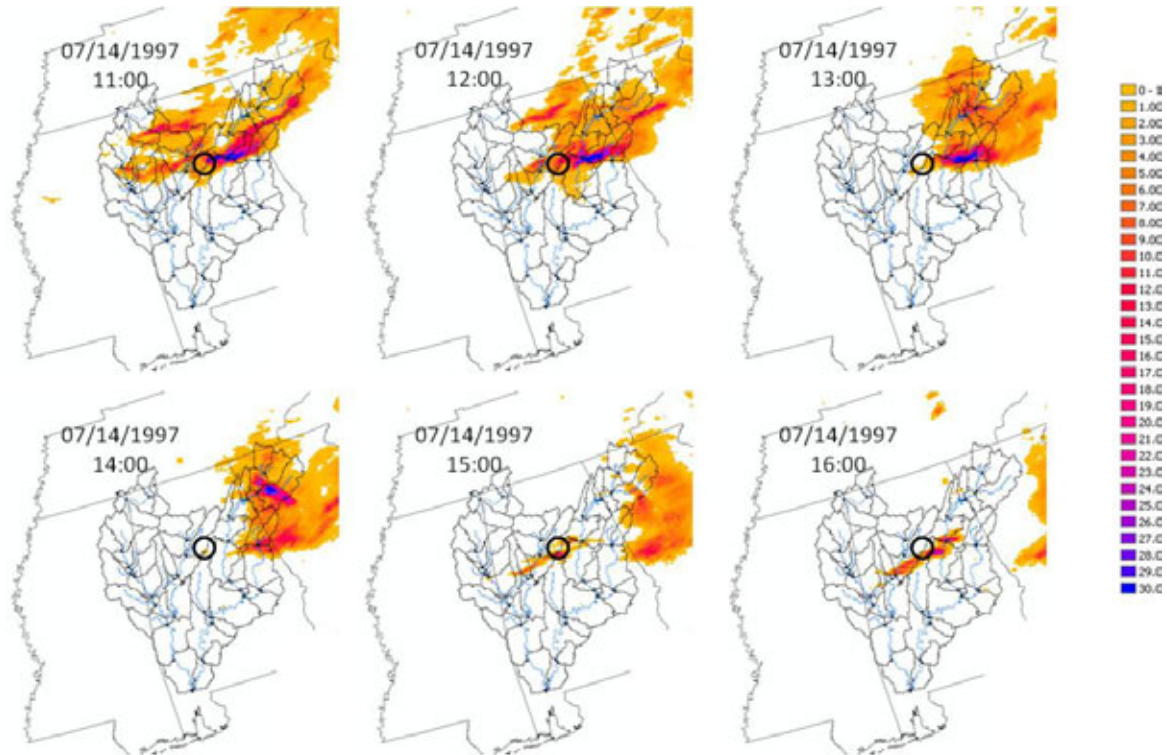


Figure H2A.3. Several instances of a 6/14/1997-storm in the Mobile watershed area as shown by NEXRAD. To validate the precipitation data extracted from the NEXRAD layers, time-series were generated for locations coinciding with weather stations that contain at least some (sparse) ground data. An example of this validation is shown in Figures H2A.3 and H2A.4. Figure H2A.3 shows several instances of the 6/14/1997-storm in the Mobile watershed area. Figure H2A.4 examines more closely the time-series corresponding to this particular day for several weather station locations.

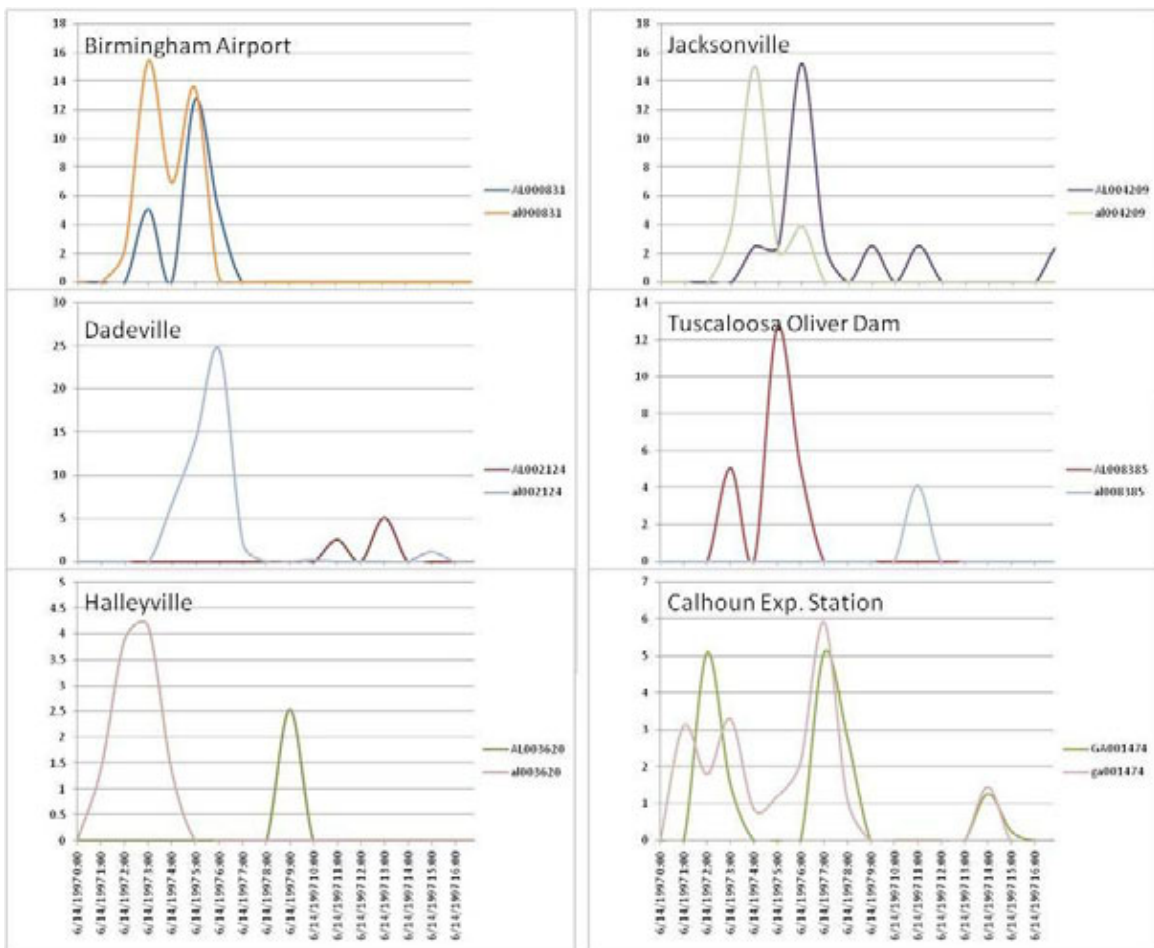


Figure H2A.4. Hourly precipitation for several stations in the Mobile watershed area. Ground weather-station data (uppercase) is compared to NEXRAD generated data (lower case).

In particular, data at Birmingham Airport, Jacksonville, and Calhoun Experimental Station, show consistency, if not in value at least in the location of peaks and order of magnitude of precipitation. Jacksonville data seem to be off by 2 hours but the trend of the curves is similar. Comparisons such as this are on their way to validate further the time series generated by the methodology shown in Figure H2A.2. Moreover, a methodology for generating precipitation per sub-basin, for the NGI watershed project, is being also developed.

Figure H2A.5 shows final results of the precipitation time-series for years 1997 and 2004, covering the Mobile watershed area (weather stations are shown in Figure H2A.1).

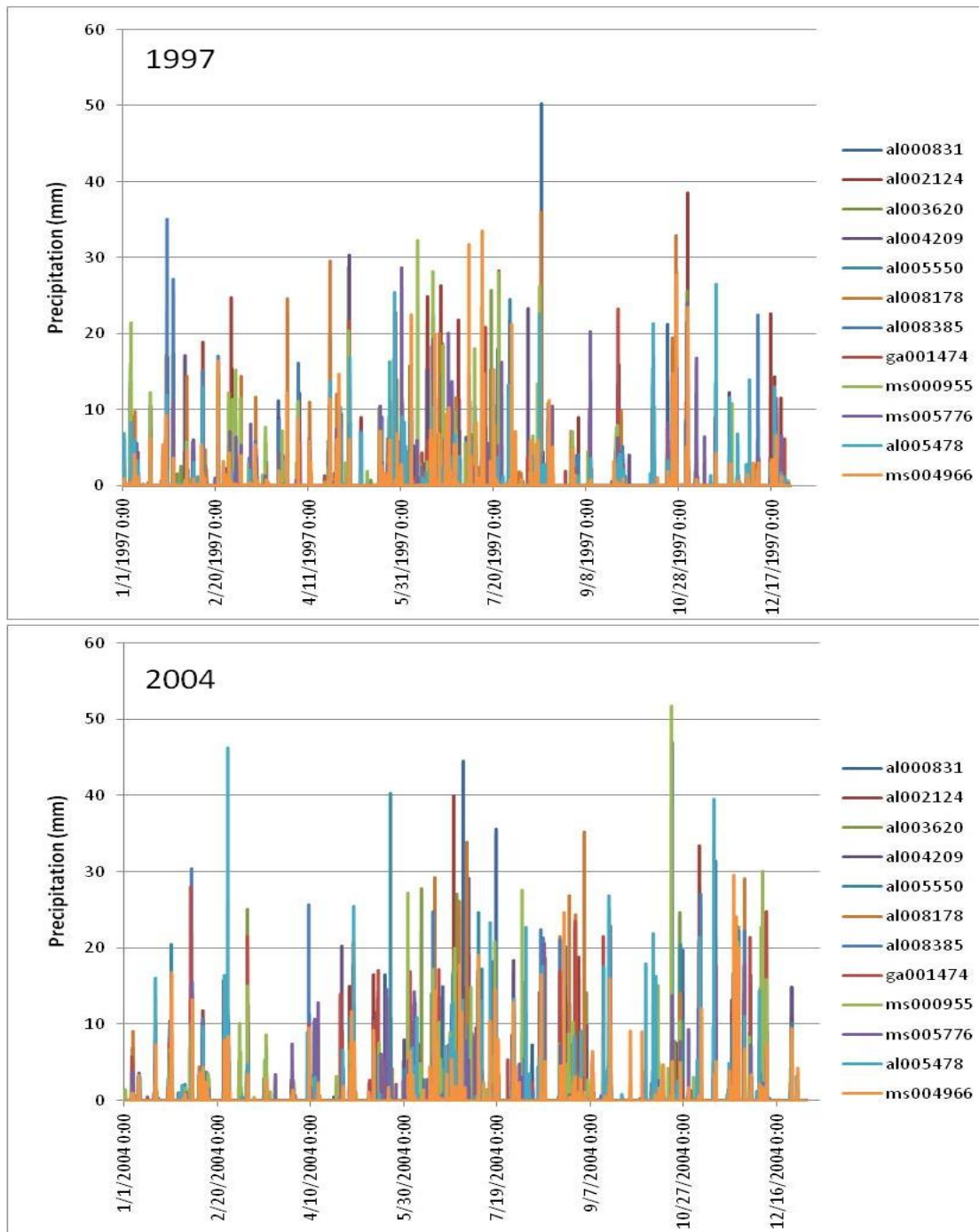


Figure H2A.5. Hourly precipitation time-series at weather stations locations covering the Mobile watershed area. Data for other years are not shown for brevity.

The time-series extracted from NEXRAD will be input to existing HSPF, EFDC, and ADH model applications for Mobile Bay.

▪ H2b. Grid Generation

- Objectives: Determine user requirements and evaluate mesh capabilities of selected models and user interfaces. Determine spatial data interface needs and develop and demonstrate a hexahedral approach established from current algorithms, software, and user input.
- Training has been received at the Corps of Engineers, Engineering Research and Development Center (Vicksburg) on the Surface water Modeling System (SMS) grid generator and the Adaptive Hydrodynamics (ADH) model for utilization and for providing a frame of reference for this subtask.
- A grid generation tool, called the Mesh Generation and Refinement Tool (MGRT), is being developed to output ASCII text files in the format required by ADH (*.3dm). The coordinates of the boundaries for an alternative Mobile Bay grid have been established. Figures H2B.1 and H2B.2 show the current capabilities and status of this tool.

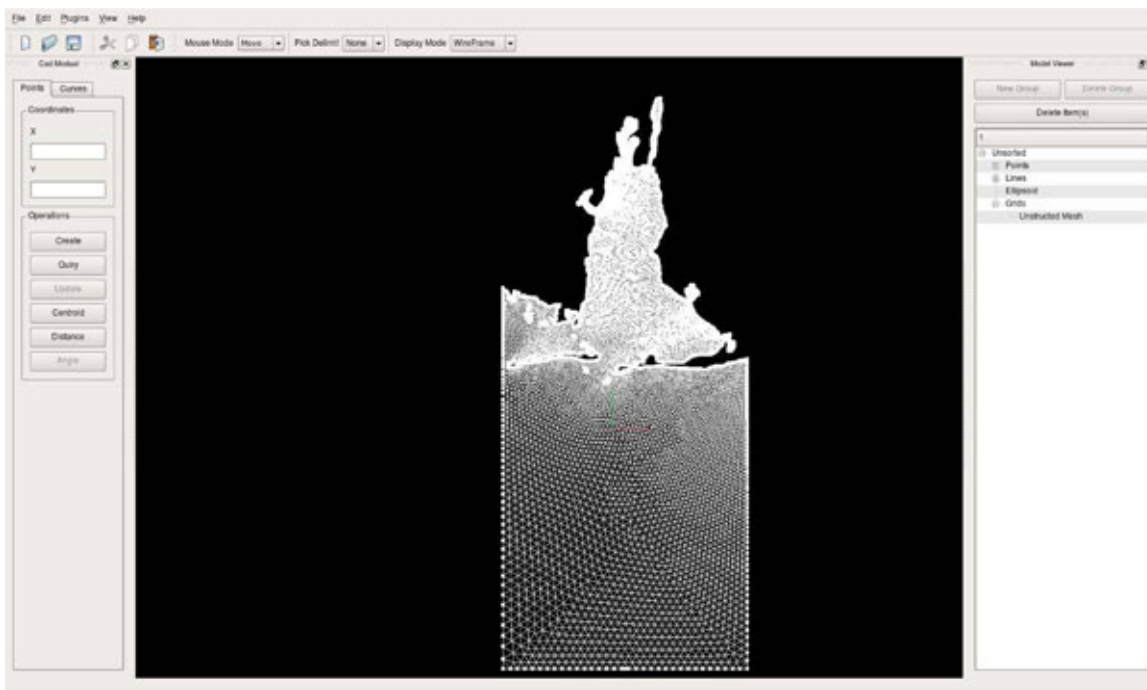


Figure H2B.1 General view of the Graphical User Interface of the grid generation tool under development. The Figure also shows an alternative grid for Mobile Bay.

The Grid generation tool that is being developed is implemented using the Qt scheme. Qt is a comprehensive C++ application framework from Trolltech that includes a class-library and tools for cross-platform development and internationalization. The intuitive Qt API and tools are consistent across all supported platforms, enabling platform-independent application development and deployment. The algorithm used for the grid show in figures H2.1 through H2.2 is the currently implemented in the Advancing-Front/Local-Reconnection (AFLR) grid generator developed by Marcum (1998) and Marcum and Weatherhill (1995). The environments in which this grid generator was implemented are: UNIX (HP-HPUX, SUN-Solaris, and SGI-IRIX), PC-Linux, PC – Solaris.

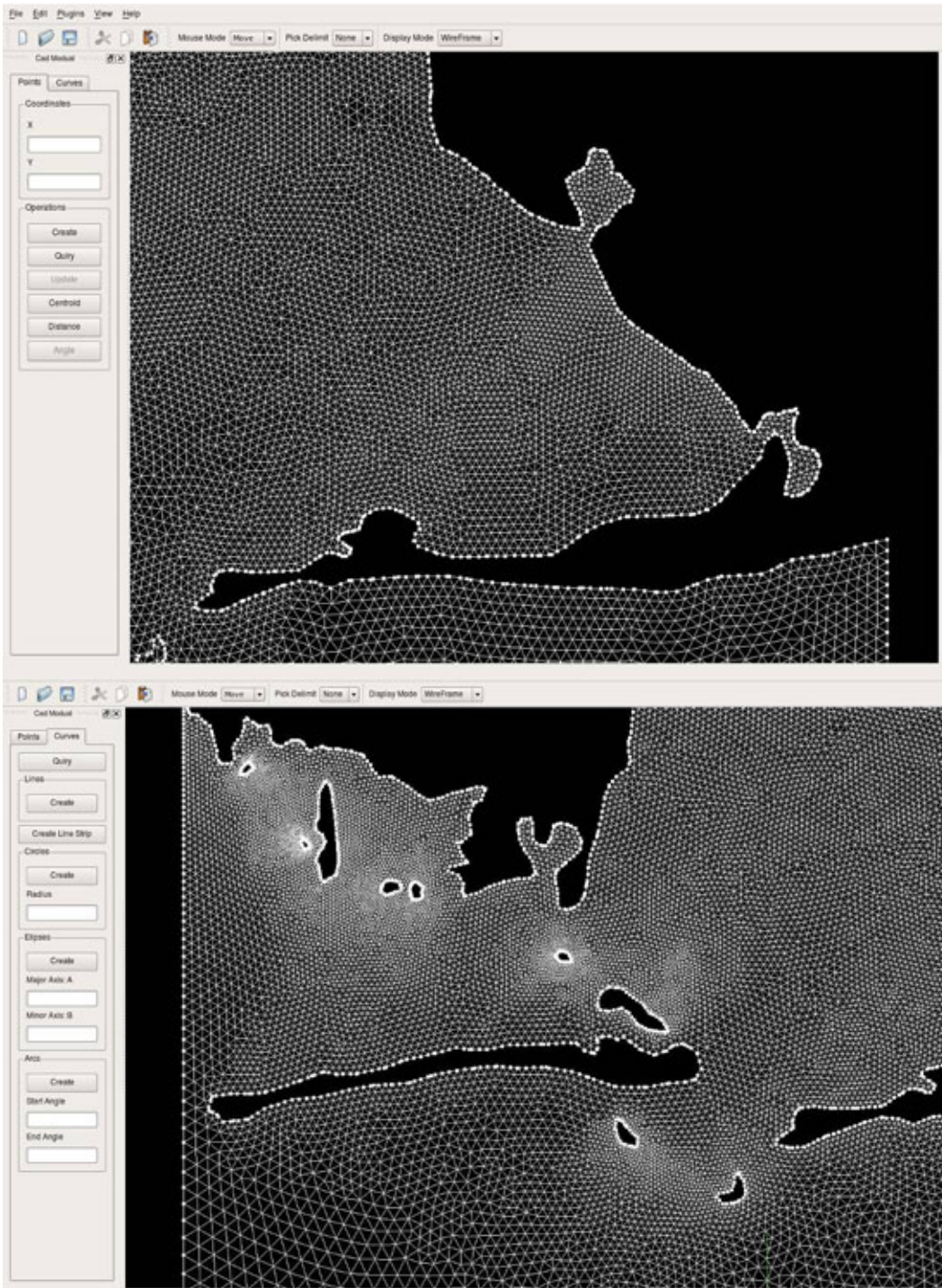


Figure H2B.2. Two views of the grid at locations near the south of Mobile Bay. Notice that the grid provides a more detailed characterization of the geometry of the bay than the ADH grid (shown in H4.1) for Magnolia and Fish rivers coastal areas.

Efforts are on the way for implementing this interface fully into the Windows PC environment.

- H2c. Model Interface and Visualization:
 - Objectives: Evaluate model interfaces for ease of use and technical rigor, including the Corps of Engineers Surface Water Modeling System (SMS), Dynamics Solutions' EFDC Explorer, and others as selected in consultation with our CI partners and advisors. Choose interface(s) based on evaluation and model(s) selected in Task H2. Obtain visualization tools from NGI Project "Visualization Technologies".
 - Conducted a seminar on SMS for NGI project personnel and assisted users with setup and application of the system.
 - Began collaboration with the NGI Visualization project on improved displays of models and model results. Provided sample model data outputs for trials.
- Plans
 - Continue coordination of task activities with subtask W2b for the refined development of landscape metrics with hydro network development for use in a watershed parameter/characterization database reporting system. Continue with the validation of NHD data for the Mobile Basin and associated watersheds for network accuracy.
 - Code the grid generation software and revise the survey per IRB requirements. Additionally a list of survey participants will be established.

Task H3. Model Identification and Enhancement:

- H3a. Select Models
 - Objectives: Evaluate commonly used modeling frameworks for hydraulics, surface water quality, and landscape processes (e.g. HSPF, GSSHA, RIV1, EFDC, ADCIRC, ADH, WASP and others). Select a subset of these models for use. Identify input requirements and output format.
 - The following selections were made:
 - EFDC for standard 3D modeling.
 - WASP for 3D water quality modeling
 - ADH as the research 3D hydrodynamic and sediment model.
- H3b. Enhance Model Physics and Chemistry:
 - Work began on improved linkage between the EFDC hydrodynamic driver and WASP.
 - Work began on improved fine sediment settling and deposition modules using a probabilistic conceptual framework. ERDC partners have begun inserting the sand transport modules and standard fine sediment modules.
 - Discussions began with Dr. K. McNeal of MSU on creation of a sediment diagenesis model. A collaborative effort is planned.

Task H4: Model Applications.

A developed ADH grid, a boundary conditions file, and miscellaneous charts for the Northern Gulf of Mexico were received from the Corps of Engineers (see Figure H4.1)

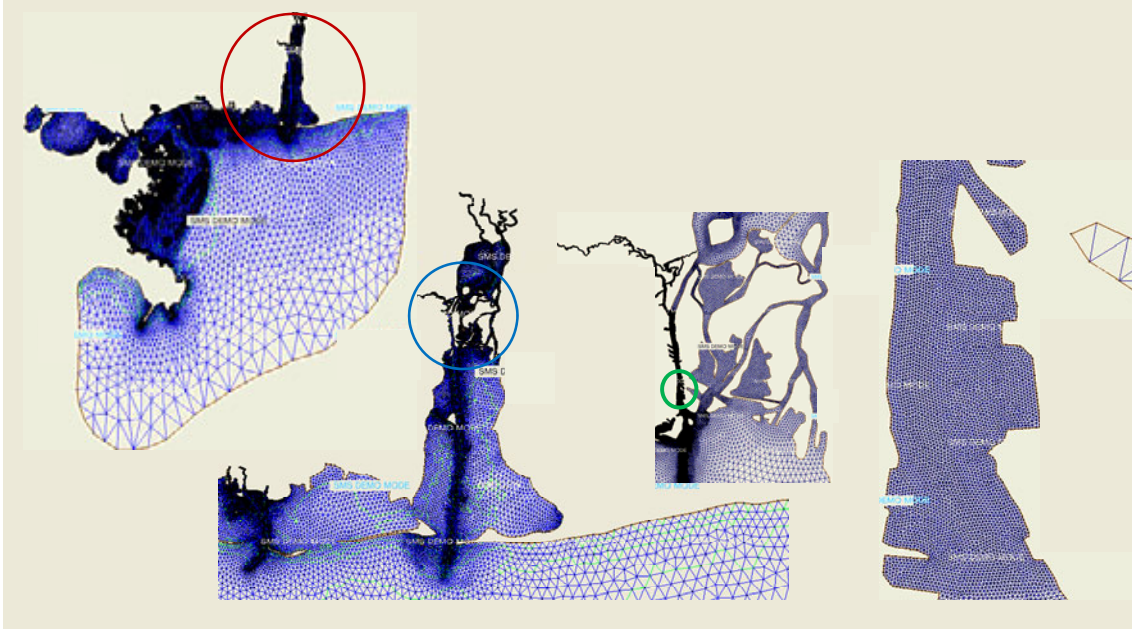


Figure H4.1. ADH grid from the Corps of Engineers. The grid is being used for simulating the hydrodynamics of Mobile Bay and surrounding ocean waters.

Exploratory runs of the ADH application were performed to get to know the SMS and ADH programs and the performance of the model, in terms of running times, visualization, boundary conditions, and initial conditions. The ADH model boundary conditions are set up as: open boundary (water stage) at southern nodes. Two inflow boundaries at the confluence of Mobile River with Mobile Bay (northern streams).

Figure H4.2 shows color-maps of water velocity magnitude for the entire northern Gulf of Mexico. Velocity magnitudes after 4 hours of simulation time increase substantially in areas near the open boundary (southern section).

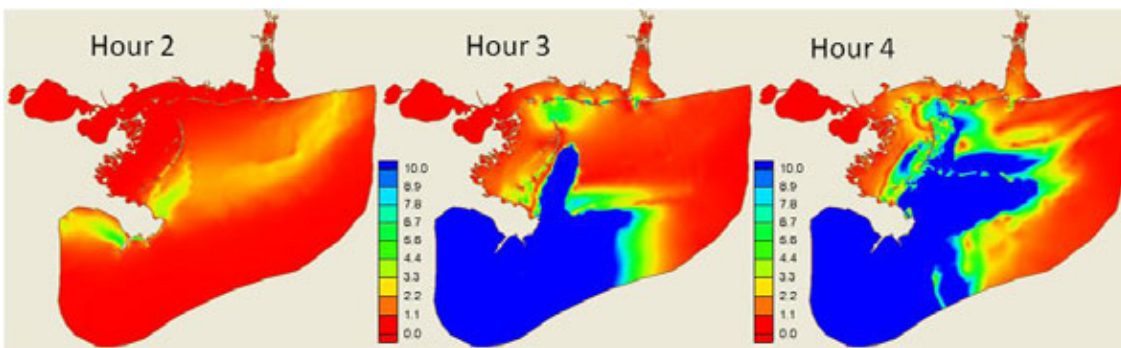


Figure H4.2. Velocity magnitudes calculated by the ADH model; simulation time: 2, 3 and 4 hours.

To explore the direction and distribution of velocity vectors after four hours of simulation time, SMS was used to create vector fields. Figure H4.3 shows directional velocity vectors in the bay and surrounding areas.

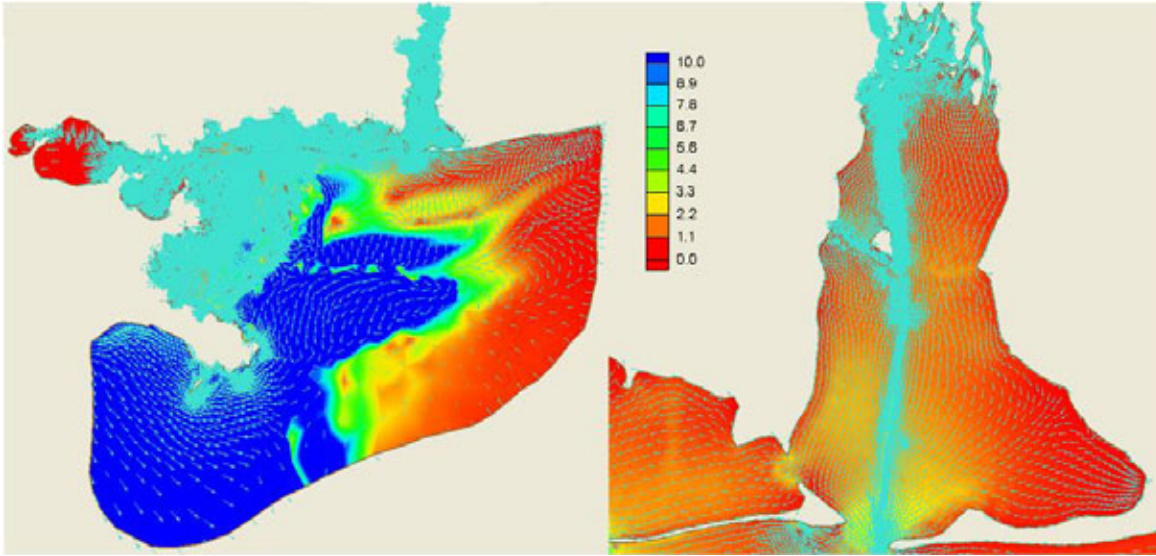


Figure H4.3. Water velocity vectors superimposed on color-map of velocity magnitudes after four hours of simulation time. The left picture shows zoomed velocity vectors in Mobile bay.

Processing time for generating these simulations is a critical factor. The current model seems to converge to solutions faster at the beginning of the simulation period and slow down substantially as simulation progresses. Figure H4.4 shows the increase of processing (running) times against simulation times. The processing times correspond to a dual-processor 2 GB RAM , 2.16 GHZ PC performing only the task of running the model. For four hour of simulation, 43 hours of processing time is required (Figure H4.4).

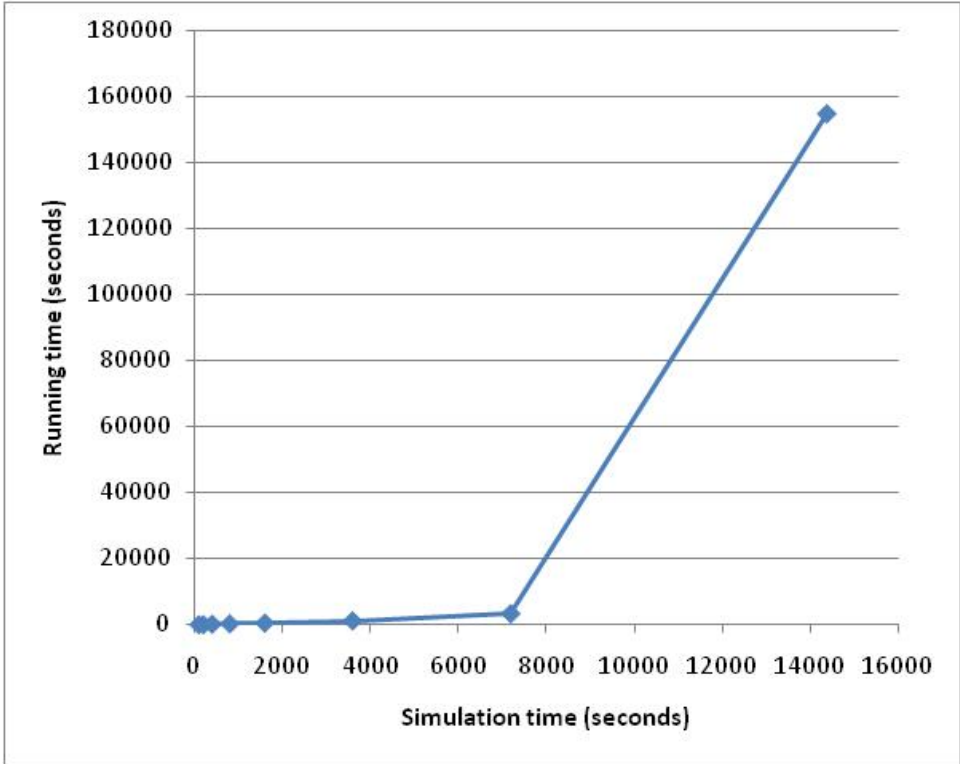


Figure H4.4. Processing (running) times against simulation times for the current configuration of the Mobile Bay ADH model. For 4 hours of simulation time, 43 hours of processing (running) time are required.

The exploratory results shown above demonstrate unquestionably that the ADH model application for Mobile Bay requires including high-performance computing for optimizing processing. Efforts are on the way for compiling the ADH code in local mainframes for this purpose.

An alternative approach is focusing the grid to areas of interest by reducing its size or generating new grids.

Outreach activities

General Description:

Project staff made multiple presentations at state (e.g. Mississippi and Alabama Water Resources Associations and American Society of Civil Engineers conferences), regional (e.g. Gulf Alliance Monitoring Forum), and national meetings (e.g., Environmental and Water Resources Conference) to showcase our NGI work and solicit feedback on the technical merits. In addition, this project, in concert with two other MSU projects, has conducted extensive outreach to stakeholders and potential collaborators. The outreach effort has been documented in a report (Tagert et al. 2008).

Have you hosted speakers, workshops and/or any training?

Type: Workshop

Name of event: Mobile Bay Collaboration Network Workshop

Date: November 5-7, 2007

Location: Dauphin Island Sea Lab, Alabama

Description: to create mutually beneficial interactions among researchers working on collaborative projects and resolve selected questions about data and models.

Approximate Number of Participants: 47

Type: Training

Name of event: SMS and ADH Training

Dates: Jan, Apr, and June 2008

Location: MSU

Description: J. Pettway, B. Donnell, and C. Berger of USACE taught project staff how to apply USACE SMS and ADH.

Approximate Number of Participants: 12

Type: Seminar

Name of event: 3D Modeling

Dates: 13 Feb 2008

Location: MSU

Description: K. Park of DISL and U South Alabama presented his work in modeling Mobile with the EFDC code

Approximate Number of Participants: 20

Type: Workshop

Name of event: e-Coastal GIS

Dates: Nov 2007

Location: MSU

Description: R. Dopsovic of USACE demonstrated the e-Coastal GIS system and provided hands-on workshop in applications.

Approximate Number of Participants: 14

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

None

Non-refereed articles and reports for this project:

Tagert, M.L., K.A. Collins, W.H., McAnally, and J.N. Diaz-Ramirez. 2008. Mobile Basin Stakeholder Needs and Assessment: Year One Report. NOAA - Northern Gulf Institute, MSU, MS. (in press)

List conference presentations and poster presentations for this project:

Cartwright, J. H., William H. McAnally. 2007. NGI Mobile Research Activities and Initial Efforts. Alabama Department of Environmental Management, Montgomery, AL, August 20.

Cartwright, J. H., 2007. Spatial Technology and High Performance Computing for Improving Prediction Surface Water Quality. Mobile Bay Collaboration Network Workshop, Dauphin Island, AL, November 2007.

Cartwright, J. H. 2007, Geospatial Tools in Water Resources. USACE Meeting on NGI, Vicksburg, MS. August 2007.

Cartwright, J. H., W. Aziz, V. Alarcon, W. H. McAnally, and J. L. Martin, Spatial Technology and High Performance Computing in Water Resources, Poster at NGI Annual Conference, May 2008.



Modeling Mobile Bay Sediments and Pollutants with New Technologies

NGI Project File Number: 07-MSU-05

W. H. McAnally and J. I. Martin; mcanally@cee.msstate.edu; jmartin@cee.msstate.edu; MSU Civil and Environmental Engineering; Box 9546, MSU, MS 39762

List all personnel funded by this project (Person's Name, Category, Percent of Salary Funding from NGI, Individual located at a NOAA Lab?):

W. H. McAnally, Assoc Prof, 15% NGI, No
J. K. Martin, Prof, 10%, No
J. A. Sharp, Rsch Assoc, 40%, No
Y. Xiong, Grad Asst, 100%, No
C. Hall, Grad Asst, 100%, No

Key Scientific Question(s)/Technical Issue(s):

Provide insight into the flow of sediment and specific associated pollutants in the Mobile Basin and similar coastal basins so that resource management decisions can be made in an informed manner and the Basin's environmental quality improved

Collaborators/Partners:

U.S. National Oceanic and Atmospheric Administration, Center for Coastal Fisheries and Habitat Research (NGI project) and Air Resources Laboratory

Begun May 2007

Providing mutual in-kind support

Nature: sharing of field and model data

U. S. Army Corps of Engineers, Mobile District

Begun March 2007

Provide in-kind support

Nature: sharing of data and models, interlocking tasks

U. S. Army Corps of Engineers, Engineer R&D Center

Begun June 2007

Part reimbursed support, part in-kind support (signed agreements)

Nature: Shared models, training on Corps' models

U. S. National Aeronautics and Space Administration, Stennis Space Center and Marshall Flight Center

Begun Nov 2007

Reimbursable and in-kind support

Nature: Shared imagery and ground truth data on sediment and mercury

Alabama Department of Environmental Management

Begun Nov 2007

In-kind support

Nature: Shared data on water quality

U. S. Environmental Protection Agency, Region 4
Begun June 2007
In-kind support
Nature: Shared models and data, advice on modeling

Project Duration:

3 years, Feb 2007 – Jan 2010.

Project Baselines:

Contributions to Specific NOAA Goals/Objectives:

This project satisfies NOAA Mission Goal 1: Protect, Restore, and Manage Use of Coastal and Ocean Resources Through Ecosystem-Based Management.

Problems and Priorities:

This project will contribute generally to improved coastal management decisions by demonstrating the best use of new sediment and contaminant data and modeling technologies for ecosystem management and specifically to improved management of sediments in Mobile Bay and adjacent waters, with benefits to the Alabama-Mississippi coastal zone and Mississippi Sound.

Gaps:

Source(s) and fates of sediment and associated contaminants will be identified. Data compiled from multiple sources and model results will be available to all stakeholders in the basin

Project Abstract: The overall goal of this proposed investigation is to provide insight into the flow of sediment and specific associated pollutants in the Mobile Basin and similar coastal basins so that resource management decisions can be made in an informed manner and the Basin's environmental quality improved. The proposed work will develop a management-oriented model of sediment, and mercury for Mobile Bay and the major tributaries to the Bay. The study will first synthesize available data in order to obtain mass budget estimates for water and sediments. This budget is a necessary first step to any water quality model for strongly sorbed contaminants, since the transport and fate of the contaminant is strongly associated with the transport and fate of the solids to which the contaminant is sorbed. The available data will then be synthesized to estimate the total reservoir (storage) and distribution of sediments, as well as provide initial estimates for factors impacting changes in that distribution. Mathematic models previously applied to the system will be refocused, and/or converted, to simulation of sediments and mercury. The models, along with available data and data analysis tools, will be used in the assessment of factors impacting the fate and transport of sediments and mercury in the Basin. Estimates will be made, wherever possible, as to the uncertainty of assessments based upon data and/or model results. Estimating uncertainties is of particular importance since, for example, some of the processes impacting the transformations of mercury, such as methylation, are poorly understood and quantified. The available data and model predictions will be used to evaluate potential management strategies (e.g. no action and action alternatives) using a weight of evidence approach. The modeling and data analysis tools will also provide a basis for a "living model" of the Basin that can be continually updated to address other management questions as they arise.

List major milestones completed and describe any significant research results and transitions.

This section shows results of the following tasks:

Task S1. Information Assembly:

- Objectives of this task include identifying stakeholders and engage them in defining sediment – contaminant issues, data, and information needs. Identification of sources (and format) of available data

in the Mobile Basin and other appropriate locations, compilation of available data related to factors impacting the fate and transport of sediments, DDT, and mercury, including quality assurance information.

- Stakeholder needs and inputs have been leveraged with similar tasks in NGI projects 06-MSU-03 and 06-MSU-04 for the development of an overlapping pool of interested agencies. A series of meetings were held with the Alabama Department of Environmental Management (ADEM), Mobile Bay National Estuary Program (MBNEP), and the Alabama Technical Interagency Committee (TIC) for input on stakeholder needs for an assessment of research focus areas. Include as a co-participant with these meeting was David Evans (NOAA) and his NGI project on “Mercury Accumulation in Mobile Bay.” Results from stakeholder meetings and surveys were assembled into a final report on stakeholder needs in terms of water resources in the Mobile Basin. (Tagert et al. 2008)
- The data assembly process within Mobile Bay was initiated with water quality data from ADEM (Jeff Davies, Mobile Branch). Efforts have continued with prototype data collection and modeling efforts on the Tenn-Tom waterway, Aberdeen Pool, in order to compute downstream flows and loadings. The Tenn-Tom data assembly includes bathymetric data utilized for the generation of cross sectional river profiles. Efforts continued with field studies initiated within Mobile Bay and the near-shore Gulf as a collaborative project with NASA. Data collected will be used to support remote sensing methods to estimate TSS and chlorophyll-a concentrations in Mobile Bay and the Mobile Bay plume in Mississippi Sound (collaboratively with NGI Mobile studies) and used to validate numerical models of the sediment plume.

Task S2. Sediment Budget:

- Objectives of this task include estimation of the quantities of sediments that enter the estuary by tributary and from direct point and non-point sources as well as changes in those loadings over time. Evaluation of sediment records to identify the distribution of sediment material bulk properties, associated sediment erosion rates, and dredging records (for the identification of quantities and locations/fate of materials removed). Provide estimations of depositional losses (external and internal), redistribution (resuspension and transport due to events and prevailing currents), and stability or balance of sediments within the Basin by representative zones or applicable areas.
- Sediment budget analysis was initialized and completed for the Aberdeen Pool and the determined the approximant deposition and sediment flux in the pool. HEC-RAS model was successfully run for the Aberdeen Pool and followed with a SIAM run based on the HEC-RAS model and findings were presented to Coastal and Hydraulics Lab at ERDC in December. These findings were used to generate the Sediment Budget Template (SBT) which will be used at future project sites and this work was used as graduate student thesis. The secondary study site of the Fish River and Weeks Bay was selected and data were identified from the USGS and ADEM. These data were used to create sediment rating curves and a conceptual sediment budget with a Tier-1 program and validated with a Tier-2 program, allowing for the initialization of a Weeks Bay sediment budget report. Figure 1 shows the sediment budget template.
- Obtained an initial Mobile Bay and Gulf of Mexico model mesh from ERDC and began running it for trials. Began generating a project-specific mesh for the model and consulted with ERDC on planned model simulations.

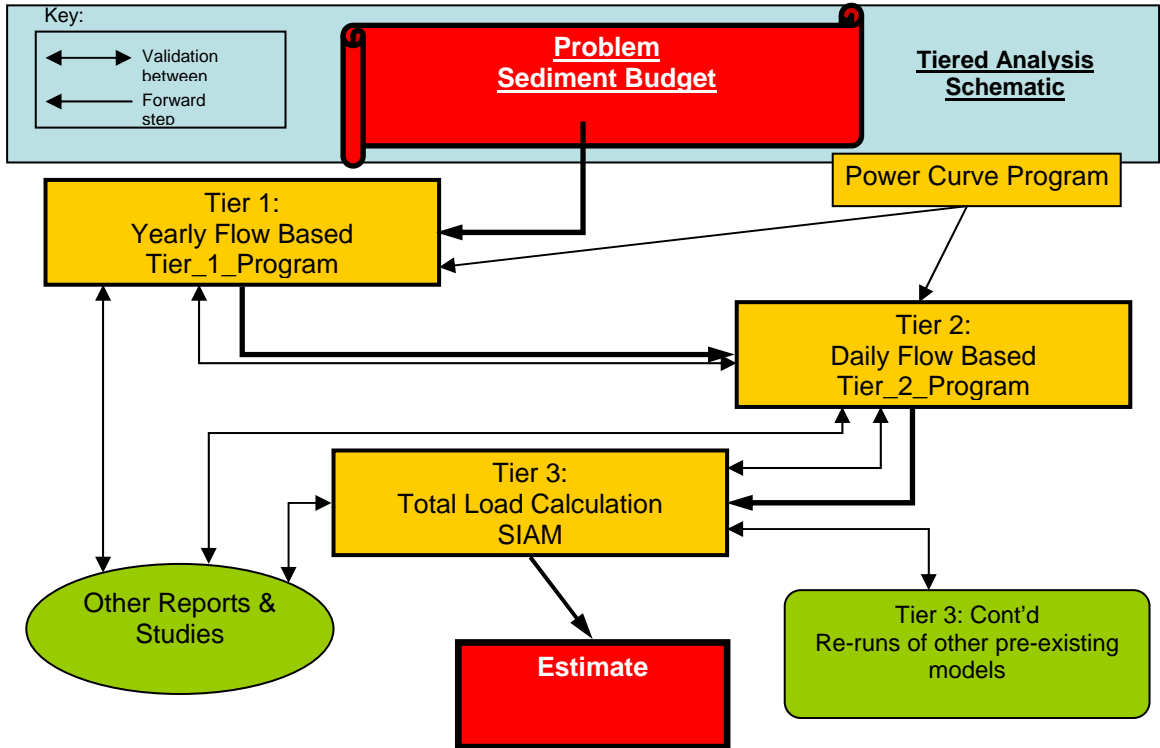


Figure 1. Sediment Budget Template Schematic

- Weeks Bay sediment budget finalized for Tier 1 and Tier 2
- Compared the sub-watersheds in the Weeks Bay watershed by using a LULC map provided by “Spatial Technology and High Performance Computing”
- Started running Mobile Bay grid in ADH
- Visit Fish River to survey cross sections for Hec-RAS
- Collaborated with NASA funded project to collect sediment and water quality samples in lower Mobile Bay and offshore. Data stations are shown in Figure 2.

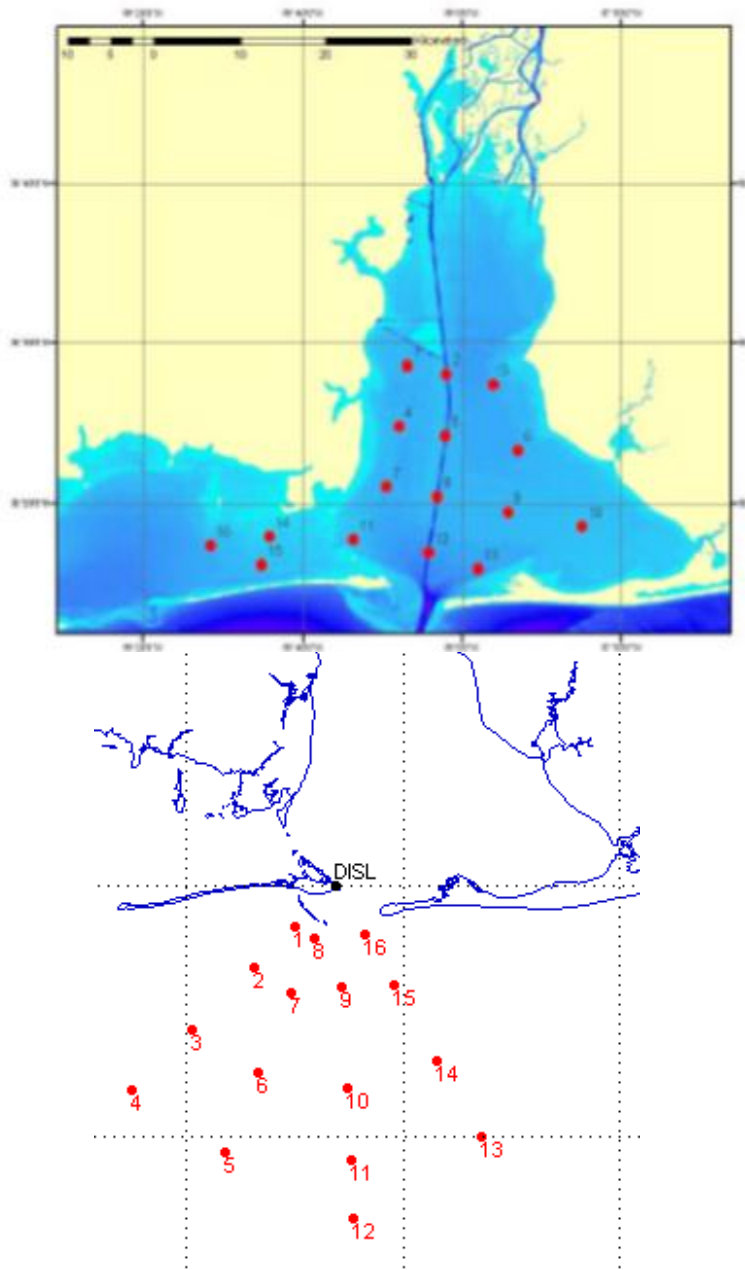


Figure 2. Data stations for sediment and water quality measurements in Mobile Bay.

Task S3. Pollutant Budget:

- Objectives of this task include assembly of available data and literature to estimate the source, mass and duration of mercury and DDT loadings to the Basin from point and non-point sources. If sufficient data are available and, if possible, construct a loading function for a long-term hind-cast simulation of mercury and DDT in the Basin. Generate estimations of rates for atmospheric deposition of mercury, existing and historical reservoir (storage) and distribution (spatial and temporal) of mercury and DDT in the sediments and biota within the Basin. Establish available data on other factors (e.g. sediment organic content as related to DDT sorption, data to estimate volatilization losses for mercury and DDT, etc.) impacting the transport and fate of mercury and DDT. Finally, determine uncertainties associated with measurement data, reservoir, and loading estimates.

- Efforts have focused on continuing to locate and catalog literature and reports on mercury levels in Mobile Bay including water column, sediment, and fish tissue concentrations. Site-specific mercury deposition data from multiple locations adjacent to Mobile Bay overseen by National Atmospheric Deposition Program (NADP) were located. Additionally communications were established with Mark Cohen of NOAA's Air Resources Laboratory (ARL) about collaborating on mercury deposition data from a planned monitoring site at Grand Bay NERR.
- A draft report on this task is being peer reviewed by David Evans of NOAA.

Task S4. Model and Data Analysis

- Objectives of this task include the assembly of models and model components for hydrologic/sediment yield, hydrodynamic, sediment transport, biogeochemical, and bioaccumulation. Expand with the design of model applications for the development and evaluation of period and extent simulation (short-term events, long term trends) and assemble/format/evaluate data/results for these applications. Results will provide identification of scenarios for evaluation of management strategies (e.g. no action and action alternatives) and perform simulations. Additional data analyses (e.g., analyses of data characteristics, statistical evaluations, graphical analyses, methods for finding empirical relationships, etc...) will be performed for comparison with model predictions and as independent analysis of factors impacting the fate and transport of mercury and DDT in the Basin, allowing for model algorithm updates with new technology to ensure reliability and accuracy.
- Development and testing of models for the Tenn-Tom waterway are being utilized to estimate flows and loadings to Mobile Bay and for the assessment of model algorithms for hydrodynamics, sediments, and water quality. Two parallel efforts are underway including development of 3-D hydrodynamic and sediment transport model for Aberdeen Pool and development of a 1-D hydraulic model of the Aberdeen Pool and the remaining Tenn-Tom waterway using the Corps of Engineers HEC-RAS model. This model was set-up and tested during this period and used to support the sediment budget calculations. 3-D efforts continued with the collection of data to support and set-up the 3-D Environmental Fluid Dynamics Code (EFDC) on Aberdeen Pool.
- Based upon input received during the Mobile Bay Collaboration Network Workshop (06 November 2007) efforts were initiated to extend the open boundary condition of the EFDC model further into the Gulf and more westerly portions of Mississippi Sound (extended – 50 km southern extent; at least to Tensaw and Mobile River split for northern extent; Horn island for western extent). Collaborative efforts and the use of EFRDC model developed by Dr. Kyeong Park of the Dauphin Island Sea Lab were discussed and initiated development of a hydrodynamic model of Mobile Bay based upon the Adaptive Hydraulic model (ADH) developed by the USACE ERDC.
- Completed an initial set up of Water Quality Analysis Simulation Program (WASP7), coupled with the EPA's application of EFDC, for Mobile Bay. This prototype will be the first fully functioning model to be used to predict mercury transport and fate in the Bay. As the NGI project continues and more Mobile Bay mercury data is collected, the model will be modified as needed. A summary paper was completed on mercury transport and fate in a water body, specifically, Mobile Bay. The paper will include four sections: 1) An overview of mercury including mercury forms, processes, and transportation; 2) Mercury in Mobile Bay (known and available concentrations, sources, etc); and 3) A review of different mercury models and modeling techniques specifically for mercury transport, and 4) the data requirements for the WASP mercury sub-model.
- Training was provided by the Corps of Engineers (Vicksburg) on the Surface water Modeling System (SMS) which will be used to assist developing model grids for this application.
- Boundary and Forcing data were compiled for the three-dimensional EFDC model of Mobile Bay for a 10-year simulation period. The model was run piecewise for 2.5 years to complete the simulation, with computational times of approximately 14 hours per year of simulation. The model mesh is shown in Figure 3.

Task S5. Basin-wide Evaluation:

Work began on a water resources management decision support system in collaboration with the Corps of Engineers. A conceptual framework is shown in Figures 3 and 4. Using the stakeholders needs report as a base, we began defining usability requirements with a Tombigbee River review group of local, state, and federal water management.

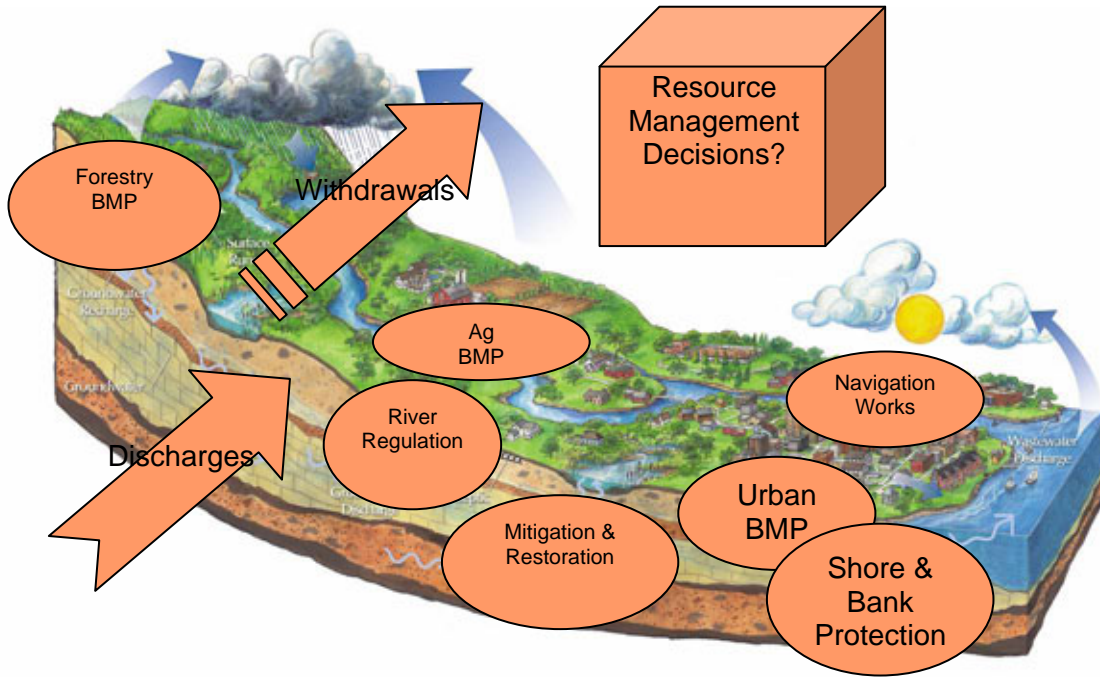
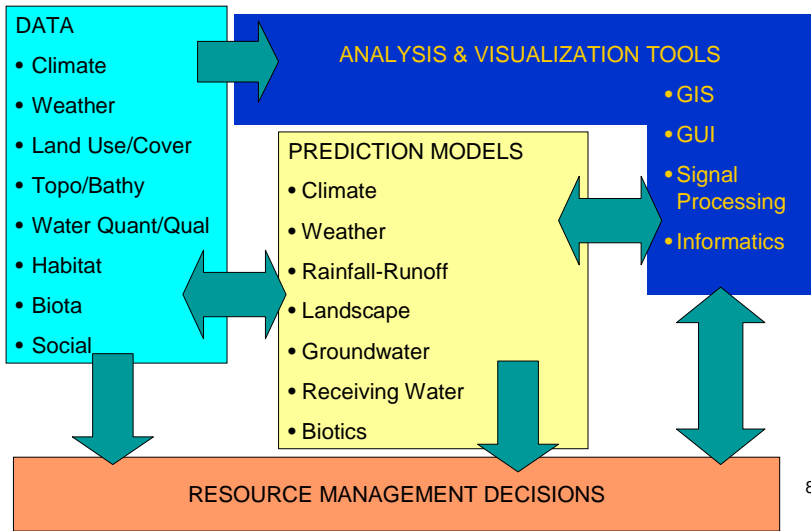


Figure 3. Watershed management actions and decision support



8

Figure 4. Decision Support Framework

Task S6. Morphologic Framework: William McAnally

A draft dissertation (Savant 2008) was prepared on a major new morphological prediction method employing empirical orthogonal analysis and stochastic modeling. Figures 5 and 6 show tentative projections for Mobile Bay. A full description will be given in the year three report.

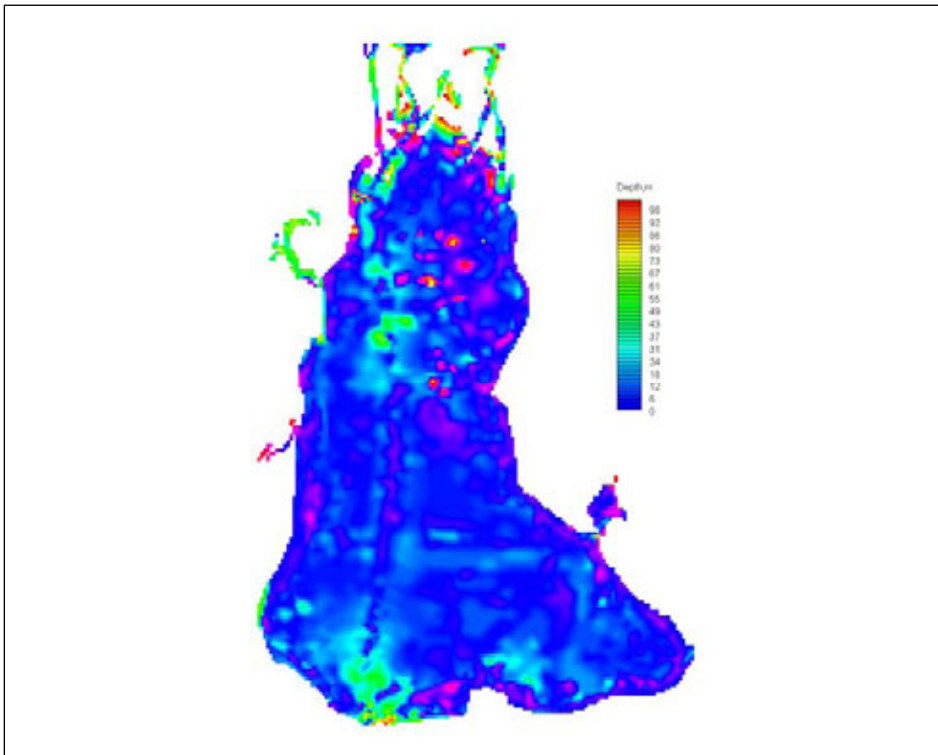


Figure 5. Projected bathymetry of Mobile Bay in Year 2100 for Plus 1 Standard Deviation in River Discharges.

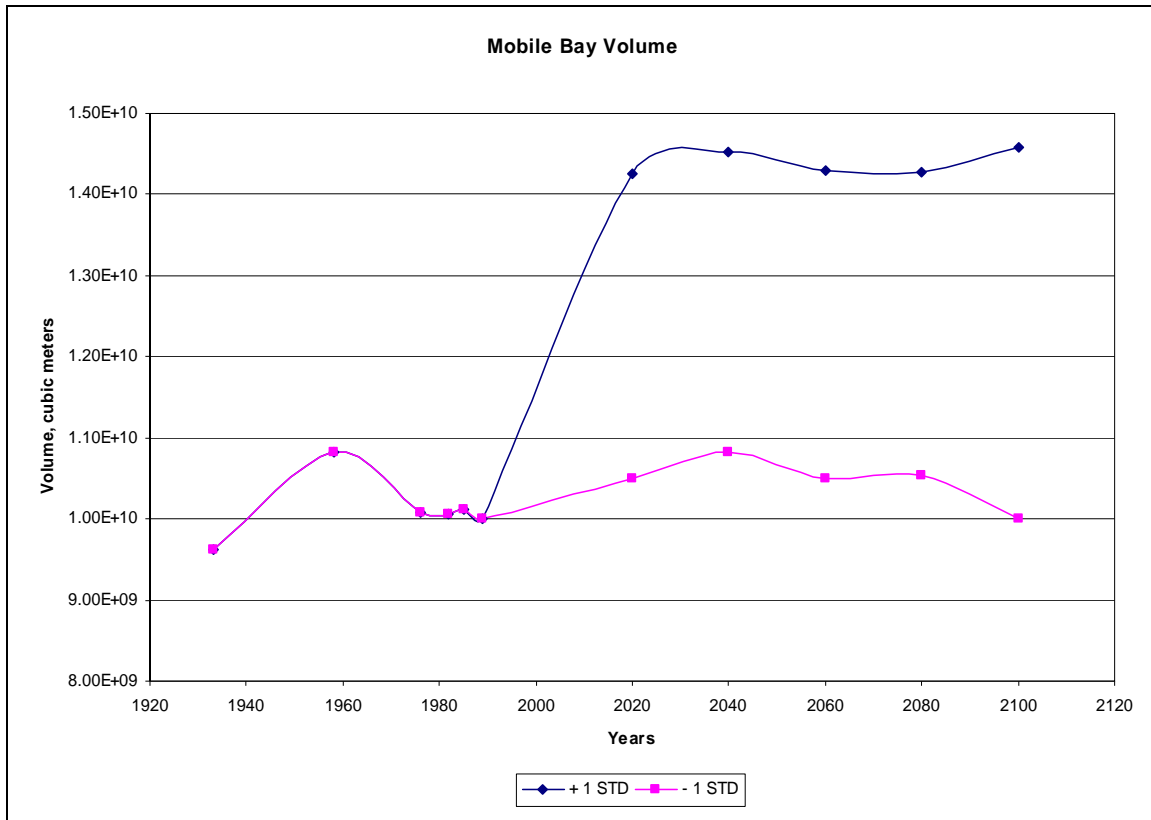


Figure 6. Predicted change in Mobile Bay volume for year 2100 with plus and minus one standard deviation in river discharge.

Task S7. Technology Transfer: See Outreach Activities

Task S8. Reporting and Coordination:

Objectives of this task include close coordination and communication between Mississippi State University investigators, our Cooperative Institute partners, and resource agencies will be required for the study to be completed in a rigorous and timely manner. A minimum of three project meetings is anticipated over the course of the study. Draft and final reports of the study will be developed upon the completion of each phase of the proposed study.

The leveraging of efforts with NGI projects 06-MSU-03 and 06-MSU-04 has resulted in several successful meetings with investigators, CI partners, and resource agencies. A procedure for quarterly reporting was developed using the NGI Project Profile Template and executed during the first year. A kick off meeting was hosted at Mississippi State University with all involved researchers associated with MSU NGI Mobile Basin projects. In November a workshop was coordinated to establish a Mobile Basin Collaboration Network, hosted at the Dauphin Island Sea Lab. An eCoastal workshop was successfully hosted at Mississippi State University with the USACE for numerous NGI researchers.

Coordination efforts were established with MSU NGI visualization researchers during the last quarter of the year for assistance in visualization of 3-D model results. A research link was established with NASA-Stennis researchers for land use – land cover studies in the Mobile Bay area and Mobile Bay sediment plume mapping. We are continually coordinating research efforts with NGI Outreach for maximum project visibility.

Outreach Activities:

The objectives of this task are overlapping with similar tasks in NGI projects 06-MSU-03 and 06-MSU-04 for an efficient leveraging of efforts. These tasks include collaboration with NGI outreach efforts and generation of technical reports, technical notes, and identification of possible peer reviewed journal publication opportunities and outlets. Additionally this task is to build a strong effort for quality professional presentations and workshops in collaboration with other projects and partners. This work is to provide a mechanism for incorporation of these new technologies in undergraduate and graduate curriculums at Mississippi State University. Efforts are to be guided toward establishing a web portal for data and publication availability and set up protocols with NOAA EDAC for transferring data.

Initial efforts of the technology transfer have focused on identification of needed resources and applications for data delivery at all levels. A website for all NGI Mobile projects has been developed and is currently in the testing stage, providing a gateway to Mobile Basin research efforts. Google Earth has been the start off platform as an available geospatial data application for data interaction and visualization. An overview of the Mobile Basin was generated as a Google Earth application for general stakeholder use as a means of project description and objectives.

The enterprise GIS eCoastal of the USACE has been selected as a data framework for the transfer of project specific data. The NOAA EDAC has been identified as one resource for the storage of model results and specialized data generated from the project. Additionally efforts are underway for standard metadata generation for all project developed data. Efforts have been established for incorporating Mobile Basin project work with the NGI online mapping applications with plans for a test deployment during the first half of year two.

Have you hosted speakers, workshops and/or any training?

Type: Workshop

Name of event: Mobile Bay Collaboration Network Workshop

Date: November 5-7, 2007

Location: Dauphin Island Sea Lab, Alabama

Description: to create mutually beneficial interactions among researchers working on collaborative projects and resolve selected questions about data and models.

Approximate Number of Participants: 47

Type: Training

Name of event: ADH Sediment Training

Dates: June 2008

Location: MSU

Description: G. Brown and K. Barry of USACE taught five project staff how to apply USACE sediment transport model.

Approximate Number of Participants: 5

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

Sharp, J. A. and McAnally, W. H., 2008 Sediment Budget Tool, Journal of Environmental Engineering, Inderscience, submitted.

List non-refereed articles and reports for this project:

Savant, G. 2008, Prediction of Estuarine Morphological Evolution, draft dissertation, Mississippi State University

Tagert, M.L., K.A. Collins, W.H., McAnally, and J.N. Diaz-Ramirez. 2008. Mobile Basin Stakeholder Needs and Assessment: Year One Report. NOAA - Northern Gulf Institute, MSU, MS. (in press)

Sharp, Jeremy Allen. 2007. "Sediment Budget Template for the Aberdeen Pool," Master of Science Thesis, Department Civil and Environmental Engineering, Mississippi State University, submitted as NGI report

Horton, Matthew. 2007. "Evaluation of the Factors Affecting the Fate and Transport of Mercury in a Coastal Estuary," Master of Science Project Report, Department Civil and Environmental Engineering, Mississippi State University.

List conference presentations and poster presentations for this project.

Martin, J. L. and W. H. McAnally. 2007. The Mobile Bay Sediment Studies. Mobile Bay Collaboration Network Workshop, Dauphin Island Sea Lab, Alabama, 06 November 2007

Ramirez-Avila, J., J.N. Diaz-Ramirez, J.L. Martin, and W.H. McAnally. 2008. "Sediment Transport using HEC-RAS 4.0." Presented at the April 15-16, 2008 Mississippi Water Resources Conference, Jackson, MS.

Sharp, Jeremy and W.H. McAnally. "Sediment Budget Template Applied to Aberdeen Pool," Presented at the April 15-16, 2008 Mississippi Water Resources Conference, Jackson, MS.

Sharp, J. A. and W. H. McAnally, 2008, Northern Gulf Institute, Three Watershed Perspective Projects, Corps of Engineers Regional Sediment Management Workshop, June.



Visualization Techniques for Improving Public Understanding of Catastrophic Events

NGI Project File Number: 07-MSU-06

Robert Moorhead

rjm@gri.msstate.edu

Mississippi State University

List all personnel funded by this project (name, position, % funded by NGI, at NOAA Lab):

Song Zhang, Assistant Professor, 10%, No
Phil Amburn, Research Associate Professor, 20%, No
Jean Mohammadi-Aragh, Research Associate, 30%, No
Derek Irby, Research Associate, 30%, No
Jibo Sanyal, Graduate Student, 50%, No
Keqin Wu, Graduate Student, 50%, No

Key Scientific Question(s)/Technical Issues:

The objectives of this project are:

1. Develop a hardware/software system which allows analyst with access to many and large data sources to see those many datasets in the viewing “environment” which allows them to extract the maximum amount of information and then knowledge from the datasets. (figure 1)
2. Study and deploy the optimum methodologies to communicate that information and knowledge to operational personnel (e.g., NHC, FEMA) and the general populace. For normal operations and daily deployment to operational personnel, images and animations will be put on a website (figure 2). For catastrophic events, animations will be pushed to television stations for broadcast and to emergency management personnel for their targeted use.
3. To accomplish the first 2 objectives, we will utilize existing software (e.g., Amira, vGeo (figure 3) and extend an existing visual analysis system, Triton II (figure 4), to allow examination of multiple datasets that are co-located in space and time. The extensions will allow Triton II to:
 - Ingest more data formats and types,
 - Perform data fusion in more automated ways, and
 - Display the data in more ways (e.g., 2D fields as contours, points, filled surfaces, glyphs) to allow us to accomplish objective #4.
4. Study the optimal method to display various sets of multiple co-located datasets (topography, bathymetry, coastline, oceanography, and atmosphere) in the same view volume. For example, if the topography and the bathymetry disagree on sea level, what is the best method to represent the information and the discrepancy? Most hurricane models contain a multitude of variables; what display method best demonstrates the weakening of a hurricane due to an influx of dry air (e.g., Hurricane Lili)?



Figure 1: The large physical proportions of a 3D virtual environment, combined with stereo, aids researchers in successfully identifying anomalies or peculiarities in their results.



Figure 2: Users select which data sets, variables, and visualization techniques they would like included in their KML. After selecting “Build KML”, the system generates their custom KML file which is previewed in Google Maps before loading into Google Earth.

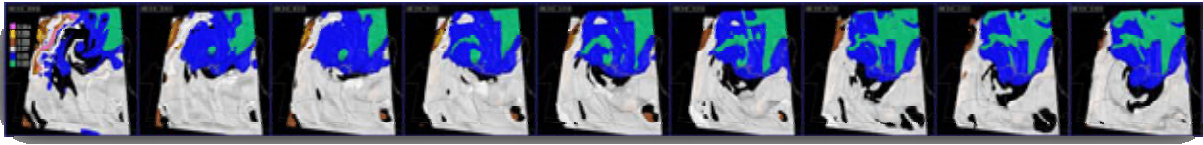


Figure 3: A series of small multiples showing the dry air impinging on Hurricane Lili and thus weakening it.

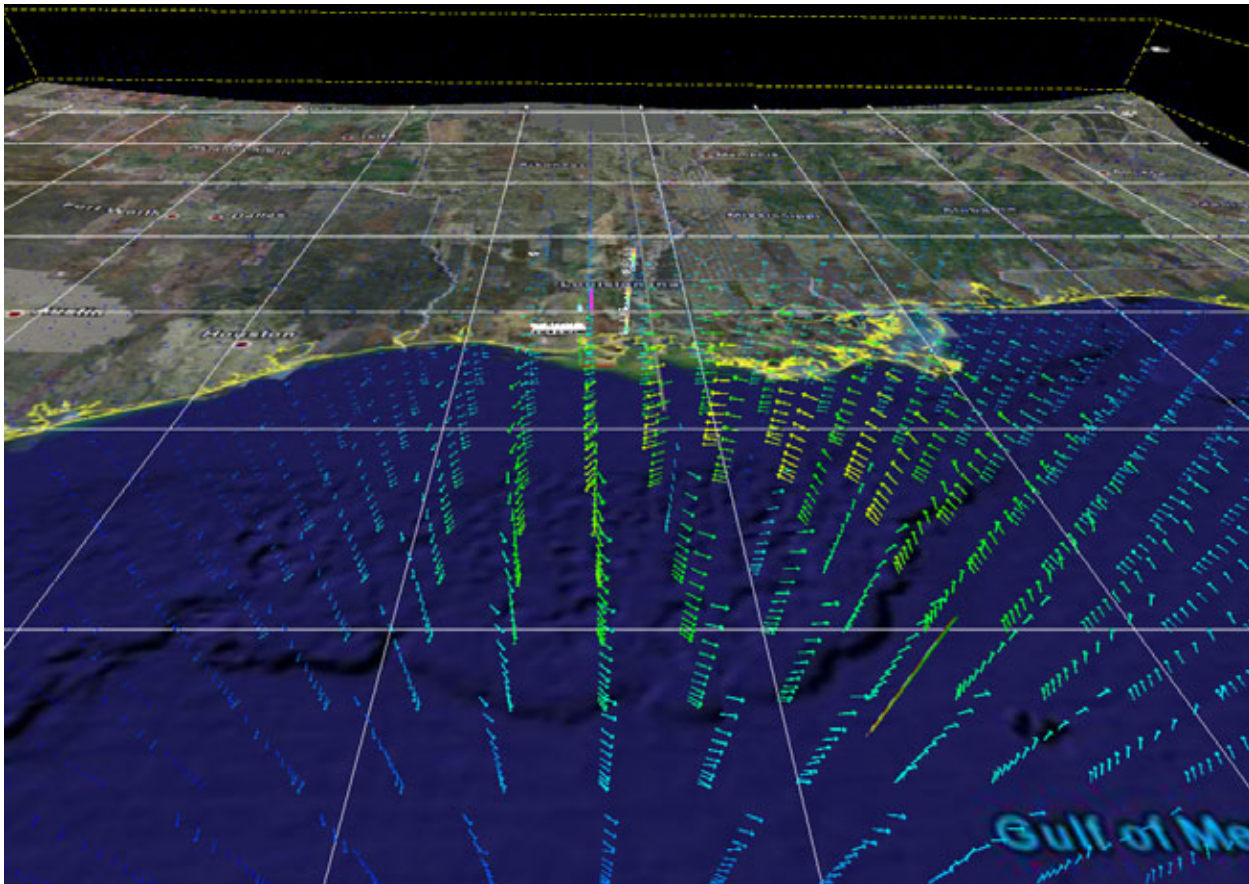


Figure 4: Triton II is a virtual reality system that allows visualization of data on different grids to combine meteorological and oceanographic data in one view, allowing for the exploration of storms as they progress from the ocean to the land.

Our objectives can be summarized in another way:

1. Help scientists study and predict hurricane dynamics.
2. Improve the quality and timeliness of *information* for decision makers along the Northern Gulf of Mexico.
3. Help citizens of the Northern Gulf of Mexico properly react to an approaching severe storm.

By fusing disparate datasets into a composite 3D visualization, one can see interactions, allowing a better understanding of severe storms and the forces that drive them.

Collaborators/Partners

Name of collaborating organization: NCDDC

Date collaborating established: May 2007

Does partner provide monetary support to project? Amount of support? No.

Does partner provide non-monetary (in-kind) support? No.

Short description of collaboration/partnership relationship.

NCDDC told us what they were trying to do; we are trying to help them accomplish that by providing effective visualization tools and visualization results.

Project Duration:

Start date: Feb 1, 2007

Estimated end date: February 2010

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This research will advance NOAA's leadership in applied scientific research.

Contributions to regional problems and priorities:

This work will allow emergency management personnel and people along the NG to better understand how to prepare for and response to catastrophic events.

Gaps:

The visualization will impress the pertinent information upon people better. People will better understand the way in which flooding will occur, how objects will fail, how exit/escape routes will be impaired, etc.

Project Abstract

One of the greatest challenges to an appropriate public response to emergencies is accurate and easily understood information. The general populace can readily become so overloaded with information that individuals will either not realize the magnitude of the crisis and thus not prepare or respond adequately, or overreact and evacuate when such is not warranted. As modeling and forecasting improve, one important facet of public awareness that has not been sufficiently addressed is visualization of the data in such a way that the information is easily understood, and provides an accurate spatial depiction of the threat. This project will focus on developing improved 2D and 3D visualization tools which produce visualization products that can be made publicly available, are easily interpreted by the non-technical public, and can be viewed on personal computers or used in television coverage. The initial efforts will focus in two elements of severe storms: storm surge and hurricane intensity/direction. One key research question is "Can a three-dimensional, time-varying visualization of a hurricane better elucidate the structure and evolution of hurricanes?" This project will capitalize on the high performance computing and visualization capabilities at MSU, but will be closely linked to the severe weather modeling activities at MSU, and with partner activities at several NOAA units. It will focus on using HPC for both modeling and development of the visualization of model output, and will then create visualization products that can be produced as simple animations or static images.

List major milestones completed and describe any significant research results and transitions:

We have the VERTEX (room size virtual environment) up and running with Triton II and vGeo – we can show lots of 3d time-dependent NOAA-related data.

Outreach Activities**General Description:**

Presented poster and powerpoint slide show at NGI Annual Conference
Traveled to NCDDC to discuss transferring our work to them (May 2008)
Working with StormCenter (www.stormcenter.com) to disseminate work.

Have you hosted speakers, workshops and/or any training?

No

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

Joel P. Martin, J. Edward Swan, Robert J. Moorhead II, Zhanping Liu, and Shangshu Cai, “Results of a user study on 2D hurricane visualization,” *Computer Graphics Forum*, vol. 27, no. 3, pp. 991-998, May 2008. Presented at the EuroVis conference held May 26-28, Eindhoven, Netherlands.

Qian Du, Nareenart Raksuntorn, Shangshu Cai, and Robert J. Moorhead, “Color Display for Hyperspectral Imagery,” *IEEE Transactions on Geoscience and Remote Sensing*, vol. 46, no. 6, June 2008, pp. 1858-1866.

Ikuko Fujisaki, David L. Evans, Robert J. Moorhead, Derek W. Irby, Mahnas Jean Mohammadi-Aragh, Scott D. Roberts, and Patrick D. Gerard, “Stand Assessment Through LiDAR-Based Forest Visualization Using a Stereoscopic Display,” *Forest Science*. 54(1):1-7.

Zhanping Liu and Robert J. Moorhead II, "Interactive View-Driven Evenly Spaced Streamline Placement," *IS&T/SPIE Electronic Imaging Conference on Visualization and Data Analysis (VDA'08)*, San Jose, CA, Vol. 6809, paper #0A, pp. 1-12, 2008.

S. Cai, Q. Du, and R. J. Moorhead, “Hyperspectral Imagery Visualization Using Double Layers,” *IEEE Transactions on Geoscience and Remote Sensing*, vol 45, no. 10, Oct. 2007, pp. 3028 – 3036.

Zhanping Liu and Robert J. Moorhead II, “An Effective, Robust, and Fast Loop Detection Strategy for Interactive Placement of Evenly-Spaced Streamlines,” *IEEE Computing in Science and Engineering*, Vol. 9, No. 4, July/Aug 2007, pp. 86-91. (invited)

Song Zhang, Stephen Correia, and David H. Laidlaw. Identifying white-matter fiber-bundles in DTI data using an automated proximity-based fiber-clustering method. *IEEE Transactions on Visualization and Computer Graphics*, 2008, In Press

Wei Chen, Song Zhang, Stephen Correia, and David S. Ebert. Abstractive representation and exploration of Hierarchically Clustered Diffusion Tensor Fiber Tracts. *Computer Graphics Forum (EuroVis 2008 Special Issue)*, 2008, In Press

Stephen Correia, Stephanie Y. Lee, Thom Voorn, David F. Tate, Robert H. Paul, Song Zhang, Stephen P. Salloway, Paul F. Malloy, and David H. Laidlaw. Quantitative Tract-of-Interest Metrics for White Matter Integrity Based on Diffusion Tensor MRI Data. *NeuroImage*, 2008, In Press

List non-refereed articles and reports for this project:

Jean Mohammadi-Aragh, Derek Irby, Song Zhang, and Robert Moorhead, “Visualization Techniques for Improving Public Understanding of Catastrophic Events,” *IEEE Visualization Poster Compendium*, October 2007.

List conference presentations and poster presentations for this project:

Robert Moorhead, Visualization Techniques for Improving Public Understanding of Catastrophic Events, Robert Moorhead, Visualization Techniques for Improving Public Understanding of Catastrophic Events, NGI Annual Meeting, Biloxi, May 2008



Information Semantic Approach for Resource and Knowledge Discovery in Integrated Ocean Observing System

NGI Project File Number: 06-MSU-07

Roger L. King, PhD
Professor and Interim Director
Center for Advanced Vehicular Systems (CAVS)
Mississippi State, MS 39762
rking@cavs.msstate.edu

Surya S. Durbha, PhD
P.O. Box 9627
GeoResources Institute (GRI)
Department of Electrical and Computer Engg.
Mississippi State, MS 39762
suryad@gri.msstate.edu

List all personnel funded by this project (name, title, % funding, located at NOAA):

Faculty:

Roger L. King, PhD, Research Scientist, 25%, No
Surya S. Durbha, PhD, Research Scientist, 50%, No

Students:

Balakrishna Gokaraju, PhD, Graduate Student, 100%, No
Santosh K. Akamanchi, MS, ECE, Graduate Student, 100%, No
Shruthi Bheemireddy, MS, ECE, Graduate Student, 100%, No

Key Scientific Question(s)/Technical Issues:

The goal of this project is to develop an IOOS compliant pilot that uses semantic web technologies and web services to enable resource and knowledge discovery among private and public data sets within the Northern Gulf of Mexico. The IOOS consists of three subsystems:

- Observing Subsystem (remotely sensed and *in situ* measurements and their transmission from platforms);
- Modeling and Analysis Subsystem (evaluation and forecast of the state of the marine environment based upon measurements); and
- Data Management and Communications Subsystem (DMAC) (the integrating component)

IOOS is a measurement, prediction, and integration system for the ocean systems. The proposed research addresses the data management and communications network subsystem or integration. The recent disaster caused by the hurricanes (Katrina, Rita etc.) necessitates an urgent need for the exploration of technologies which can provide knowledge instead of just information to act upon and can trigger decisions based on that knowledge automatically/semi-automatically. Also the identification of the types of models to be used and model inputs depending on the problem at hand, diverse data sets that could be used as inputs to these models and dynamic chaining of the above tasks that enables the exploration of solutions at various levels of granularity- the first steps to facilitate intelligent decision making. The key focus areas of this project are:

- Development of Coastal Sensor Web Enablement (CSWE) framework using OGC sensor description models such as Sensor Model Language (SensorML) [<http://vast.nsstc.uah.edu/SensorML/>], service models such as Sensor Observation Service (SOS), and Sensor Alert Service (SAS). This task would provide the necessary syntactic standardization of Coastal sensors.
- Use of real or near real time data derived from coastal sensor networks (e.g., NDBC, GoMOOS etc). Dynamic selection and aggregation of multiple meteorological and oceanographic simulations and other decision support systems in web services based environment.
- Heterogeneous coastal sensor data sets integration through ontology-based approaches, and intelligent reasoning over the acquired knowledgebase that enables to access content instead of just keyword based searches.
- Content-based remote sensing and in situ data extraction and integration.
- Involve partner institutions and expert groups to propose and evolve a Coastal Sensors Semantic Metadata Standard (CoSeM).

Collaborators(s)/Partners:

We have embarked upon several collaborations both within U.S and abroad as a part of this project. We envision that the problem of seamless integration of coastal data streams goes beyond regional needs and should be addressed in a more holistic perspective. It is necessary for several stake holders to come to a shared understanding of the domain of interest and then standardize and convert that understanding into reusable entities. As a result of this vision the following collaborations have been established:

- Open geospatial consortium (OGC) level participation to evolve the sensor web framework, and development of GeoSemantics.
- Participation in the OGC initiative on Oceans Interoperability Experiment. We are representing Mississippi State University (MSU) on this experiment and are one of the six participating institutions around the world in this endeavor. We will provide Sensor Observation Service (SOS) from sensors in the Gulf of Mexico and other sensor web tools developed as a part of this NGI project to the OGC initiative.
- We are involved with the Marine Metadata Initiative (MMI) in the development of Marine Devices Ontology along with about 30 participating individuals representing several organizations both from U.S and Europe.

Date collaborating established: Various before and during life of project

Does partner provide monetary support to project? Amount of support? No

Does partner provide non-monetary (in-kind) support? Yes

Short description of collaboration/partnership relationship:

We are working closely with ESA to develop a common Semantics driven data and resource discovery framework that is applicable to both the Gulf of Mexico and Mediterranean (see Figure 1). Dr. King represents MSU on the scientific committee of Image information mining working group. (http://earth.esa.int/rtd/Events/ESA-EUSC_2008/)

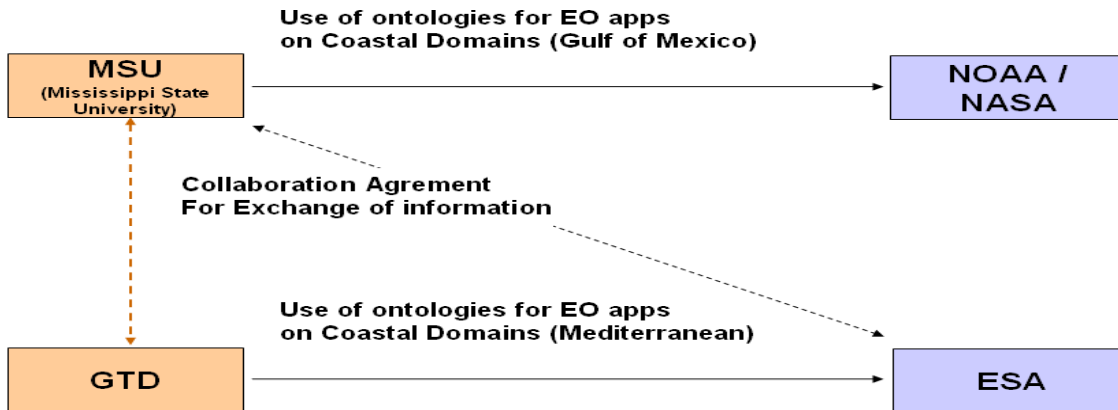


Figure 1. Collaborative development of shared semantics-driven application framework with ESA

Project Duration:

Start Date: 1/1/07 Estimated End Date 12/31/09

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

The proposed project is addressing some important NOAA goals that the IOOS data management & communications subsystem (DMAC) system has identified such as [http://www.ocean.us/dmac_subsystem]:

- IOOS-wide descriptions of data sets (metadata)
- Ability to search for and find data sets of interest (Data Discovery)
- The ability to access the data in an interoperable manner from client applications (data Transport)
- The ability to evaluate the character of the data through common web browsers and
- The ability to securely archive data and metadata and retrieve them on demand

While addressing some of the above goals in their entirety, the scope of this project is however limited to the Northern Gulf of Mexico region.

Contributions to regional problems and priorities:

The building blocks of the Gulf Coast Ocean Observing System (GCOOS) consists of three sub regions; Texas, Louisiana/Mississippi/Alabama, and Florida. This project is focused on the Louisiana/Mississippi/Alabama region, and seeks to foster regional representation to the overall GCOOS initiative and also fill in the gaps in the existing data management system. The emphasis would be on the reconciliation of disparate data streams in this region and provide consistent data discovery mechanism which is particularly relevant after the recent hurricanes/storms that affected this region. The close collaboration with NCDDC and NDBC and development and refinement of the prototype would be based on the understanding of their requirements in the data discovery and dissemination areas.

Gaps:

Currently, the data provided by the heterogeneous buoy sensors/ networks is not amenable to the development of integrated systems dues to conflicts arising in the data representation at syntactic, structural and semantic levels; this project seeks to fill in these gaps through the emerging Information technologies. The integration of remote sensing imagery through the content-based retrieval of knowledge is an important contribution of this research effort. Current systems are limited to searching archived coastal imagery based only on the syntactic metadata (lat/lon, sensor type, etc) which limits the discovery of actual knowledge, particularly after a coastal disaster event where it is required to rapidly retrieve affected regions. The project’s Rapid image information mining (RIIM)

component provides such a capability. This considerably reduces the gaps in the integration of in situ data and remote sensing imagery.

Project Abstract

The goal of this project is to develop an IOOS compliant pilot that uses semantic web technologies and web services to enable resource and knowledge discovery among private and public data sets within the Northern Gulf of Mexico. This project uses a scientific approach that utilizes an open source and standards-based approach for developing the middleware necessary for facilitating data sharing from the disparate and heterogeneous data providers of the region. It is conducted by a multi-disciplinary team and research methods that encompass computer science and engineering expertise at Mississippi State University and domain expertise resident at our federal, state, and private collaborators. The project also features an education and outreach element that reflects the multi-disciplinary modes of inquiry and increases the diversity of the workforce and a strong, but flexible management plan that supports collaborative research and delivers an ontology driven, and OGC standards-based Sensor web system for northern Gulf of Mexico data sets. The project is expected to provide IOOS with the functionality to begin to address three of its seven societal goals within the three year scope of the project. These goals are to provide more timely predictions of natural hazards and their impacts; to sustain, protect, and restore healthy marine and estuarine ecosystems; and to sustain, protect, and restore marine resources.

List major milestones completed and describe any significant research results and transitions:

- Sensor Web Enablement based on Open geospatial Consortium (OGC) framework is under development and the following components have been developed:
 - Describing the coastal sensors and observation processes with general models and XML encodings through *SensorML* this facilitates the dynamic retrieval of their capabilities and quality of measurements;
 - Sensor Observation Service (SOS) has been developed and deployed. It can handle several requests such as *GetCapabilities*, *DescribeSensor*, *GetObservation* etc.
 - Sensors database has been populated with data from NDBC. The user can subset and filter the data via the SOS. Some of the functionalities include spatial subsetting (*bounding box*, *overlap*, *containing*, *intersection*), temporal subsetting (*after*, *before*, *during*, *TEquals*, *Past N sec/min/hrs/days*) filtering based on comparison such as (*Between*, *EqualTo*, *NotEqualTo*, *LessThan*, *GreaterThanEqualTo* etc).
- A preliminary sensor web demonstration for buoys in the Northern Gulf of Mexico has been given to the partners at NDBC and NCDDC on Aug 07. The system has been significantly enhanced since then.
- Knowledgebase has been developed by the instantiation of the ontological models with the data from Buoys. A-Box (assertion box) based querying based on Sparql query language has also been integrated in the CosemWare application
- The development of the CosemWare client for the Sensor web is nearly complete it was developed using asynchronous Java scripting and XML (AJAX) technology using Google web toolkit API. Figures 2-4 illustrate the results from the project:

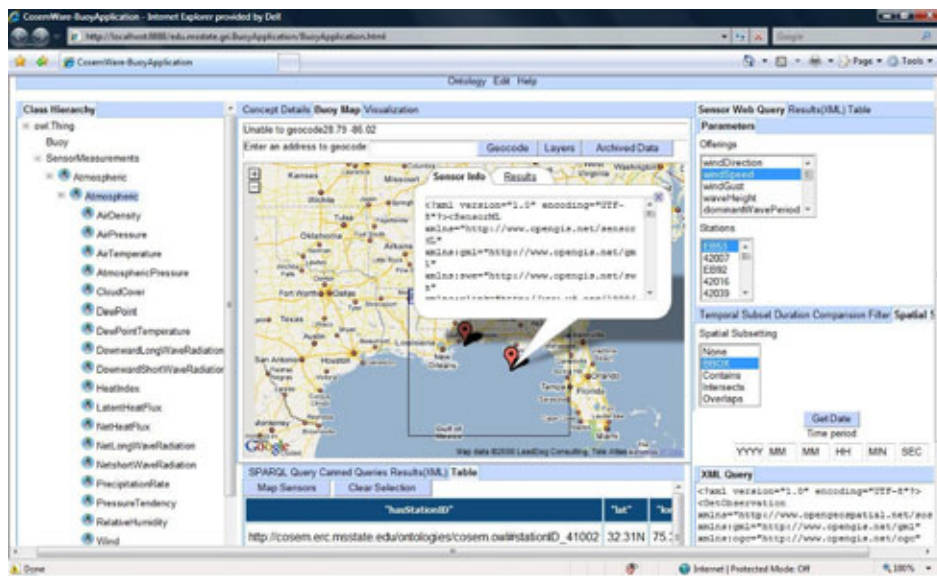


Figure 2. CosemWare sensor web client depicting the results of a *BBOX* query. The Sensor web developed in this project enables Spatio-temporal querying in addition to resolving semantic heterogeneities between different networks.

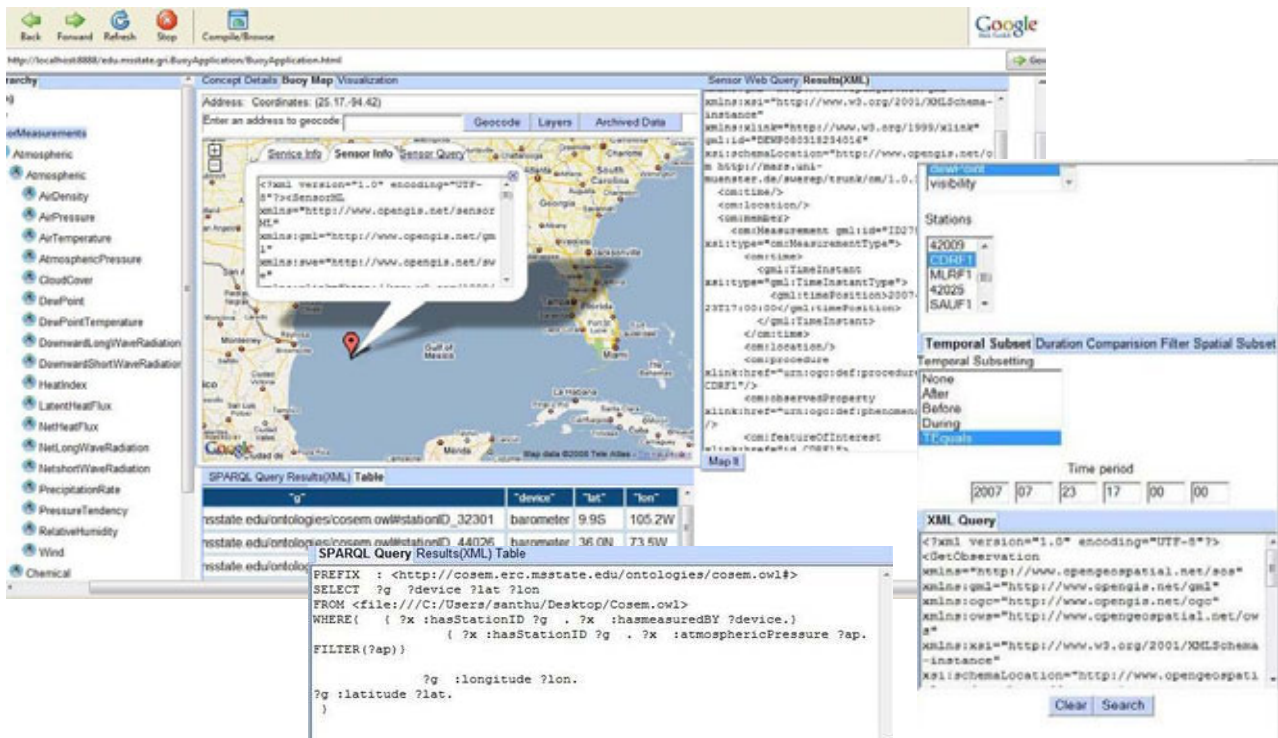


Fig. 3(a). Example SPARQL Query (Scenario: “Find devices that can produce certain output variables”) & Results. SPARQL is a protocol and query language for semantic web data sources. (b). Sensor Observation Service (SOS) query to retrieve measurements of *Dewpoint* at a particular *TimePeriod*.

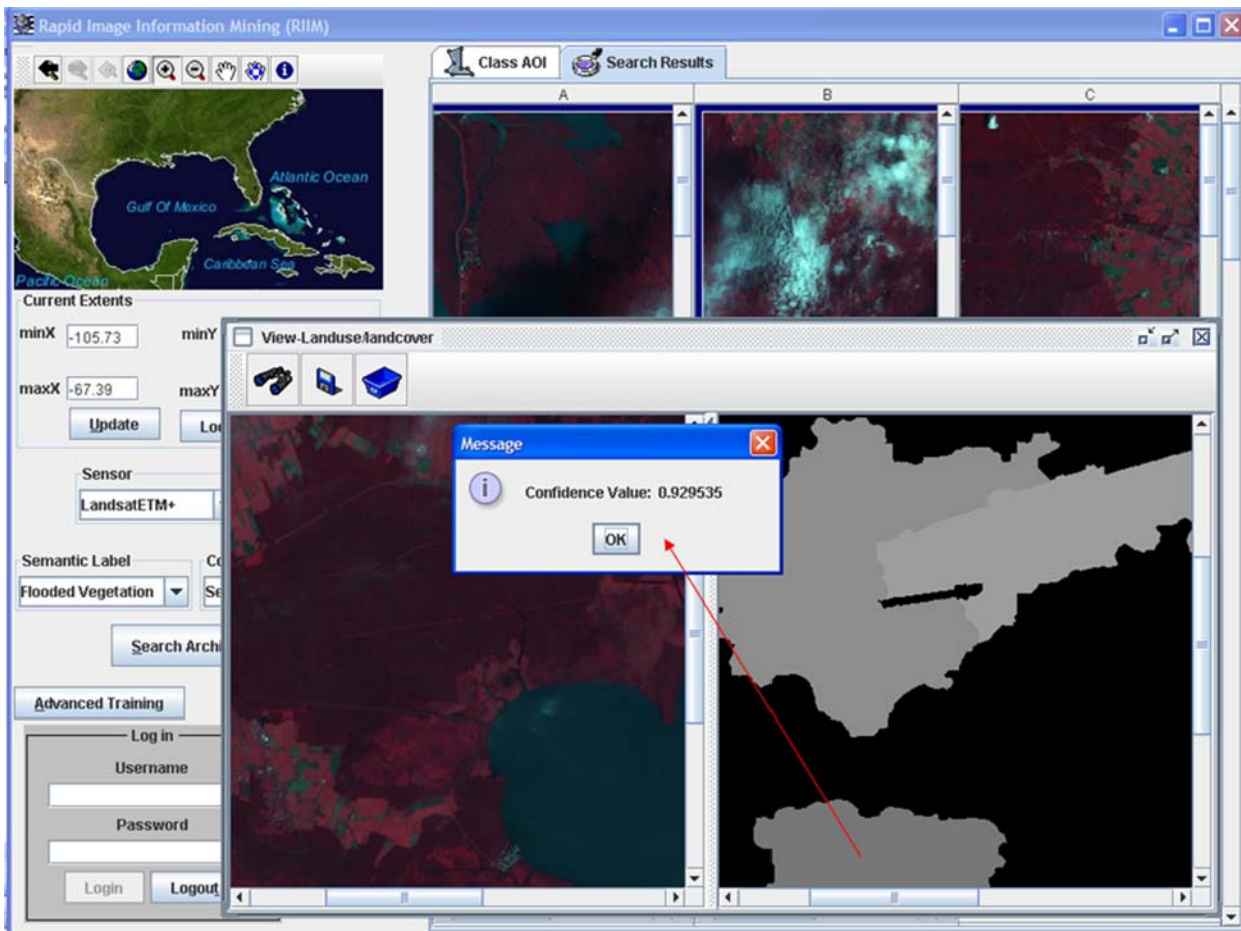


Fig 4. Rapid Image Information Mining (RIIM) system depicting the results of a query on “flooded Vegetation”. The above results are from the Landsat TM Imagery of post-Katrina Hurricane.

Remote sensing imagery is not amenable to automated methods of query and knowledge discovery. At present, information about an image is limited to queries on structural metadata (lat/lon, time, sensor type, etc). In an emergency response scenario it is required to explore images from different sensors in real or near real time. The Rapid Image Information Mining (RIIM) (Fig 4)component is being developed to respond in near real time after a coastal disaster event. The systems is developed based on :

- Primitive features extraction based on wavelets and color, texture and shape.
- Feature selection, and feature generation using Genetic Algorithms (GA).
- Predictive models generation through Support Vector Machines (SVM)

Outreach activities

General Description:

We are working with Sharon Hodge of NGI to coordinate with her outreach project efforts. We have contributed to a flyer that was distributed at the recent NGI conference and is part of large compilation of regular feeds to media outlets in the region. We will also assist in the future outreach efforts as appropriate.

Have you hosted speakers, workshops and/or any training?

No.

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

Journal Articles

2008

S. S. Durbha, R. L. King, V. P. Shah and, N. H. Younan, "A Framework for Semantic Reconciliation of Disparate Earth Observation Thematic Data" *Computers and Geosciences* 2008. (In press).

S. S. Durbha, R. L. King and N. H. Younan, "An information semantics approach for knowledge management and Interoperability for the global Earth observation system of systems", *IEEE Systems*, 2008 (In press)

2007

Vijay P. Shah, Nicolas, H. Younan Surya S. Durbha, and Roger L. King. "A Systematic Approach to Wavelet Decomposition Level Selection for Image Information Mining from Geospatial Data Archives", *IEEE Transactions on Geosciences and Remote Sensing*, Vol. 45, No. 4. (2007)

List non-refereed articles and reports for this project.

None

List conference presentations and poster presentations for this project:

2008

S.S. Durbha, R. L. King, and N. H. Younan, and B. Gokaraju. "A Proposal for the Standardization of Image Information Mining Systems via OGC Web Services Framework", *IGARSS 08, Boston*, 2008.

S.S Durbha, R. L. King, N. H. Younan, S. Bheemireddy, S. Amanchi. "Information Semantic Tools for Knowledge Discovery In Integrated Ocean Observing System", *IGARSS 08, Boston*, 2008.

S.S. Durbha, R. L. King, and N. H. Younan. "Coastal Buoy Sensors Data Integration: A Need for Syntactic and Semantic Standardization", *AAAI/SSSKI Workshop*, March 26-28, 2008, Stanford U., CA

S.S. Durbha, R. L. King, N. H. Younan, S. K. Amanchi, S. Bheemireddy "Information semantic approach for interoperability in an integrated ocean observation system , *NGI conference, Biloxi* , 2008

2007

S. S. Durbha, Y. Ling, R. L. King, N. H. Younan, "Coastal sensor web enablement: syntactic standardization and semantic enrichment", *Coastal Geotools*, Myrtle beach, SC, 2007.

S. S. Durbha, R.L. King, V. P. Shah, N. H. Younan. "Image information mining for coastal Disaster events", *IEEE Geoscience and Remote Sensing Symposium*, Barcelona, Spain.2007

Shah, V. P., N. H. Younan, S. S. Durbha, R. L. King. 2007. Application of the Contourlet Transform for Image Information Mining in Earth Observation Data Archives. *Proceedings of IEEE Geoscience and Remote Sensing Symposium*, Barcelona, Spain.2007.

R. L. King, S. S. Durbha, N. H. Younan, "Shared ontologies to facilitate semantic interoperability in Earth Observation Archives" *PV International Conference*, Paris, 2007,

V. Shah, N. Younan, S.S. Durbha, R. King, "Image Information Mining from Geospatial Archives based on Combination of the Wavelet Transform and Fourier phase Descriptor," *Proc. of SPIE on Data Mining, Intrusion Detection, Information Assurance, and Data Networks Security Conference, SPIE Defense and Security Symposium*, vol. 6570, Orlando, FL April 2007

S.S. Durbha, R.L King, N. Younan, S.K. Rajender, S. Bheemireddy, "Information Semantic Tools for Coastal Data Management", *AGU Fall meeting*, San Francisco, 2007



Northern Gulf Institute Outreach Efforts – Year 2

NGI Project File Number: 07-MSU-08

Sharon Hodge, JD
Mississippi State University
shodge@ngi.msstate.edu
228-688-3099

List all personnel funded by this project (Person's Name, Category, Percent of Salary Funding from NGI, Individual located at a NOAA Lab?):

Sharon Hodge, Research and Administrative, 49.28%, No
Joby Prince, Research Assistant , 75%, No

Key Scientific Question(s)/Technical Issues:

Can dissemination of NGI research results and other NGI outreach bolster stewardship in the Northern Gulf ecosystem and alter behavior towards that end?

Collaborators(s)/Partners

Name of collaborating organization: DISL Education and Outreach Program, USM Outreach Program, Gulf of Mexico Alliance Environmental Education Network

Date collaborating established: February 1, 2007

Does partner provide monetary support to project? Not to date, DISL and USM are NGI funded activities.

However, the GOMA EEN brings technical support and can fund travel to GOMA EEN meetings and workshops to develop Gulf of Mexico educational materials and programs. Amount of support? None to date.

Does partner provide non-monetary (in-kind) support? Yes, all partners bring institutional support and draw in expertise from their networks.

Short description of collaboration/partnership relationship. DISL provides an important public forum (The Estuarium) and personnel to promote research results of the NGI. USM publicizes the research performed by USM NGI PIs and assists MSU NGI Outreach with implementation of institute wide outreach. GOMA EEN provides content and direction of the GOMA educational webpage support which addresses Gulf wide issues relevant to the NGI mission.

Project Duration:

Start Date: February 1, 2007 Estimated End Date: January 31, 2010

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

Contributions to regional problems and priorities: The NGI Outreach project supports programs such as the GOMA educational program by hosting webpage development and implementation and the National Sea Grant Legal Program with participation in the Coastal Resiliency symposium. Those efforts will promote the ecosystem approach to the management of the Northern Gulf region. The contributions to the coastal resiliency symposium will contribute to enhancing society's ability to plan and respond to climate change's impacts and providing information for safe, efficient, and environmentally sound transportation.

Gaps:

This project disseminates results of research that was selected to fill gaps in knowledge.

Project Abstract:

The goal of this project is disseminate NGI research results in a manner understandable by general public, stakeholder community and potential collaboration partners. This project will evaluate new, existing and enhanced education and outreach approaches to help grow stewardship philosophy and behavior in the Northern Gulf region.

A number of outreach-oriented educational activities are planned for the second year NGI Outreach program. These include community workshops that will identify high-impact federal and state program integration opportunities, and set the stage for future actions to address States’ priority issues; ecosystem assessments and process research characterizing coastal and marine habitats and developing regional landscape restoration planning strategies related to transitioning the research; community risk and vulnerability assessments to identify mitigation strategies and tools; development of next-generation storm surge, coastal and inland flood, and erosion products and services; participation in Department of Homeland Security resiliency certification pilot for the northern Gulf region (Gulfport, MS) as a continuation of the current program efforts; and train coastal and watershed managers in the application of data and technology such as remote sensing and Geographic Information Systems, employment of best management practices, and collaborative processes in watershed management.

The NGI proposes to continue to work with, among others, the NOAA Gulf Coast Services Center and the National Coastal Data Development Center to identify and support activities that serve the coastal and watershed management needs of Gulf communities.



NGI Outreach Project, with additional support from the National Marine Sanctuary Foundation and leveraging partners, launched the NGI Keycard Project in 2008. NGI Outreach research associate Joby Prince coordinated coastal hotel involvement, ecotourism activity teamings, artwork and message development and distribution of the keycards along the Mississippi coast. The project is currently following up with additional education on the related NGI webpage, metrics collection and plans for expanding the keycard project to Northern Gulf coast hotels in Alabama, Louisiana and Florida. This project fulfills the goals of hitting the target audience of current consumers with significant carbon footprints in the Northern Gulf ecosystem, and captures the captive audience. www.northerngulfinstitute.org/keycards/

Priorities include: 1) hazards, coastal storms, navigation and ports; 2) integrated ocean observing systems; 3) mapping and change analysis; 4) spatial positioning and vertical control; and 5) hydrodynamic and other physical and watershed modeling. The NGI will also continue as a contributing partner in the development of a Gulf of Mexico Central Regional Ocean Information System (GCOOS) and Sea Grant programs in the region to foster collaboration, as well as address the Gulf Alliance needs for spatial data for the six priority issue areas of water quality, wetland restoration, habitat characterization, nutrient loading, environmental education, and coastal hazards.

List major milestones completed and describe any significant research results and transitions

<i>TASK</i>	<i>LEVEL COMPLETE</i>
<i>1. Needs assessment for Outreach</i>	<i>85%</i>
<i>2. Raise Ecosystem focus/NGI publicity</i>	<i>On going</i>
<i>3. Public education of natural resource programs</i>	<i>On going</i>
<i>4. Map Storm Surge Innovatively</i>	<i>30%</i>
<i>5. Resiliency Outreach/Coastal Storms – completed law journal piece and participated in symposium</i>	<i>100%</i>
<i>6. Geospatial outreach activities – coordinated support to</i>	<i>100%</i>
<i>7. Community led monitoring projects – coordinated Mississippi Phytoplankton Monitoring Network training workshop (held July 8, 2008)</i>	<i>75%</i>
<i>8. Develop Stewardship Products; Contributions to Earth Gauge 500 message feed</i>	<i>60%*</i>



Outreach activities - General Description:

Outreach is the central thrust of this activity intended to help build a citizenry informed of the natural resources and anthropogenic factors within the Northern Gulf ecosystem. Activities have included organizing and hosting other coastal and marine education professionals in this region, hosting and participating in teleconferences, developing publicity and educational materials (see “NGI Research Spotlights”), participating in outreach events for the public and coordinating media coverage.

Have you hosted speakers, workshops and/or any training?

(1) Type: Workshop with Lee Yokel and Sharon Hodge as lead
 Name of event: Gulf of Mexico Coastal Region Resiliency Messaging Efforts

Date: August 6, 2007

Location: MSU Coastal Research and Extension Center, Biloxi, MS

Description: Gathering of outreach professionals to review NGI plan for resiliency relevant messages.

Approximate Number of Participants: 14

(2) Type: Workshop reception with Tina Shumate and Heidi Recksick as leads for GOMA working group

Name of event: GOMA Resiliency Workshop

Date: September 17, 2007

Location: DMR Offices and Schooner Pier, Biloxi, MS

Description: Gathering of professionals throughout the Gulf region to develop action plan for resiliency efforts.

Approximate Number of Participants: 30

(3) Type: Joby Prince led team in student field workshop

Name of event: GIS Day

Date: November 13, 2007

Location: Starkville, MS

Description: MSU NGI research associates and staff involve students in fun hands-on use of geospatial instruments, technology and approaches.

Approximate Number of Participants: 80

(4) Type: Kathy Martinolich leads workshop on Metadata principles hosted by NGI Outreach project.

Name of event: Metadata training for students

Date: November 3, 2007

Location: JSU's eCenter, Jackson, MS

Description: NOAA NCDDC's metadata expert provides hands on instruction to graduate and undergraduate students on the concepts and details of making metadata records.

Approximate Number of Participants: 20

(5) Type: NGI hosted Gulf Coast Chapter of the American Institute of Architects in meeting of NGI and Stennis Space Center technologies

Name of event: AIA/Gulf Coast Special Monthly Meeting

Date: December 13, 2007

Location: Bldg 1103, Stennis Space Center, MS

Description: Members of the Gulf Coast chapter met at Stennis Space Center and Mike Carron presented research of NGI and Dr. Supreya Miller of IHL presented the storm surge visualization.

Approximate Number of Participants: 25

(6) Type: Dawn Lavoie, John Brock, and John Barras of USGS

Name of event: NGI Speaker Series

Date: January 8, 2008

Location: Rouchon House, Stennis Space Center, MS

Description: 3 speakers provided NGI researchers resident at Stennis Space Center with information about USGS Northern Gulf coast resiliency program.

Approximate Number of Participants: 27

(7) Type: Todd Davison, Director, NOAA Gulf Coast Service Center

Name of event: NGI Speaker Series

Date: February, 2008

Location: Bldg 1100, Stennis Space Center, MS

Description: Speaker provided a presentation about the recently completed needs assessment for the Gulf of Mexico.

Approximate Number of Participants: 30

(8) Type: Paul Moersdorf, Director, NOAA National Data Buoy Center

Name of event: NGI Speaker Series

Date: April 2008

Location: Rouchon House, Stennis Space Center, MS

Description: Speaker provided details of the history, evolution and current operations of the National Data Buoy Center

Approximate Number of Participants: 27

(9) Type: Oceans 09 Marine Technology Society IEEE Planning

Name of event: Planning meetings led by conference chair, Laurie Jugan

Date: Numerous, beginning in August 2007 and continuing monthly and semi-monthly

Location: Bldg 1103, Stennis Space Center, MS

Description: Host and attend meetings for 2 committees to plan the publicity, marketing and high school activities for the upcoming Oceans 09 Conference

Approximate Number of Participants: 5 to 30

(10) Type: Internship to teach metadata and develop a diverse NOAA workforce

Name of event: NCDDC NGI Metadata Diversity Internship

Date: May 28 – July 31, 2008

Location: Jackson, MS and Stennis Space Center, MS

Description: Administer the internship program and supervise the students in metadata publication development.

Approximate Number of Participants: 6

(11) Type: Provided logistical support and program development for GOMA EEN webpage development workshop led by NOAA NOS Alison Hammer and Davida Remer (with direction by GOMA Lee Yokel)

Name of event: GOMAEEN Webpage Storyboarding Workshop

Date: June 18-19, 2008

Location: MSU Coastal Research and Extension Center, Biloxi, MS

Description: GOMA EEN members worked together to storyboard the GOMA educational webpages. NGI coordinated the meetings and connections to the IT support personnel.

Approximate Number of Participants: 14.

(12) Type: Logistical support and program development for math and science teacher workshop led by Lynn Eiland of MSU

Name of event: Industry to Education Workshop – 08

Date: Planning occurred in March, April and May of 2008, workshop will occur on July 10-11, 2008

Location: Bldg 1103 and Bldg 3205, Stennis Space Center, MS

Description: 35 k – 12 teachers from all over the country come to Stennis Space Center for a week of hands-on activities to learn how math and science are used in the workplace. NGI coordinated the visits with the NOAA resident agencies at Stennis Space Center.

Approximate Number of Participants: 35 teachers and 5 workshop leads.

(13) Type: Phytoplankton Monitoring Network – Mississippi Training

<http://www.chbr.noaa.gov/PMN/> Mississippi Gulf Coast Community College

Jackson County Campus, Gautier, MS http://www.mgccc.edu/Documents/Campus_Maps/JC_Map.pdf

Estuarine Education Center, Natural Resources and Environmental Studies – Biology Lab

Planning was April, May and June 08 – training July 8

(14) NOAA Integrated Ecosystem Assessment Workshop, New Orleans, November 29, 2007

Has anyone on this project been hired by NOAA?

No.

Peer Reviewed Articles:

Government and Academic Institutional Involvement in Gulf Coast Resiliency, Sharon H. Hodge, J.D. , Sea Grant Law and Policy Journal, Vol 1.1, MASGC # 08-016-01

<http://www.olemiss.edu/orgs/SGLC/National/SGLPJ/Vol1No1/vol1no1.pdf>

List non-refereed articles and reports for this project:

NGI Research Spotlights – 12 projects highlighted

List conference presentations and poster presentations for this project.

NGI Outreach Program provided an “interactive poster” at the NGI 08 Conference with a quiz for attendees to identify the common name of the important commercial fisheries species FSU is conducting life cycle and ecosystem research on – Gag grouper; and presented at the following 3 events:





**Improving Hurricane Intensity and Landfall Estimation
with Refined Modeling**

NGI Project File Number: **07-MSU-09**

PI – Pat Fitzpatrick, Mississippi State University, BLDG 1103, Room 233, Stennis Space Center, MS, 39529, fitz@ngi.msstate.edu, 228-688-1157

Personnel funded:

Name	Category	Percent of salary funded by NGI	Located at NOAA lab?
Pat Fitzpatrick	Research Professor	16%	No
Yee Lau	Research Associate	16%	No
Yongzuo Li	Research Associate	16%	No

Key Scientific Questions/Technical Issue(s): Address the fundamental physics of storm surge, as well as the impact of levee configurations and the loss of wetlands resulting from hurricane events; develop a new Saffir-Simpson scale for storm surge based on bathymetry, storm size, storm speed, and intensity

Collaboratory(s)/Partners: NOAA’s Meteorological Development Lab as of March 2007. The partner does not provide monetary support, but assists with the SLOSH grid. They provided a grid which replaces the Mississippi River levee with its natural ridge

Project duration: Two years; Started 2/07, and is estimated to end on 1/09

Project Baselines:

Contributions to specific NOAA Goals/Objectives: Storm surge prediction and research has been identified as a deficient area requiring improvements. Specifically, the NOAA document *Interagency Strategic Research Plan for Tropical Cyclones: the Way Ahead* states it is a Top 5 priority (Table 4-1) and an important component of NOAA’s future hurricane prediction system (Section 4.4.2) in which ADCIRC will be coupled to HWRF. Storm surge research has also been identified as a high priority action item in the National Science Foundation document *Hurricane Warning: The Critical Need for a National Hurricane Research Initiative*

Contributions to regional problems and priorities: This research provides three primary benefits. First, it will provide an improved understanding of hurricane wind structure on the storm surge so that emergency preparedness officials can anticipate widespread storm surge events better. Second, it will quantify the impact of the Louisiana wetlands and levee system on storm surges. Third, it will provide a new Saffir Simpson scale which accounts for bathymetry and storm structure variability.

Gaps: This study will address the fundamental physics of storm surge, as well as the impact of levee configurations and the loss of wetlands in Louisiana, all of which contributed to the most expensive and the fourth-most fatal hurricane in the nation's history. It will also replace the current Saffir Simpson scale, which only lists storm surge by intensity.

Project abstract:

The storm surge of Hurricane Katrina (2005) is unprecedented in the U.S. for its elevation, area coverage, and levee breaches in New Orleans. This research seeks to address recent Mississippi and Louisiana storm surge issues using the finite element model ADCIRC. This research will facilitate answers to the sensitivity of the storm surge in Mississippi to wind profiles of major hurricanes, as well as to eye size.

An additional issue involves the impact of the Louisiana wetlands and the Mississippi River. It is widely believed that wetland erosion has increased storm surge vulnerability in southeast Louisiana. Grids will be created based on historical wetland data, and new ADCIRC run will be performed to examine the impact of wetland loss in the last 65 years. Specifically, we will investigate: 1) a hurricane moving over the less-eroded marsh of Louisiana in 1970 and 1940; 2) a weaker hurricane due to more marshland; and 3) a simulation without the Mississippi River levee system.

A prototype Saffir Simpson scale will also be developed, where storm surge will be a function of storm intensity, storm size, storm speed, and basin bathymetry. The current Saffir Simpson scale only related storm surge to storm intensity.

Major milestones and significant research results:

Katrina's surge was 2-3 feet higher east of river within 15 miles of levees due to the Mississippi River levee system.

Katrina's surge was 1-3 feet lower west of river due to levees (north of landfall) due to the Mississippi River levee system. The surge also arrives later.

SLOSH suggests less overtopping (no overtopping) of parish levees if river levees did not exist. ADCIRC contradicts this result.

The Louisiana levee system did not alter the surge impact on the Mississippi coast

SLOSH and ADCIRC suggest 2 feet reduction in surge every 3 miles of wetlands (twice as much as other research suggests). But, near levees, where water becomes trapped, wetland erosion does not reduce surge, although it may arrive sooner without wetlands.

A revised Saffir Simpson scale based on tropical cyclone size, intensity, storm speed, and continental shelf slope/depth is underway. A draft of this scale has been developed (see accompanying Powerpoints) but are being modified based on additional bathymetry scenarios. There is some potential that Integrated Kinetic Energy can be used which combines storm size and intensity.

Ongoing work:

Simulations in Barataria Bay and Terrebonne Bay with wetland loss for Hurricane Rita

Simulations with slightly weaker hurricane with 1930 land mass

Sensitivity to vegetation parameters, 1930 land height

Comparison of wind input in for levee forcing runs

Examination of levee heights in model runs

Comparison to 1D storm surge equations (bathystrophic equations)

Outreach activities:

General description.

Presentations to rotary clubs and other invited talks (See Section N.). Reviewed several journal articles, a book chapter, and proposals. In addition:

Magazine interviews:

"The business of risk: Katrina, what modelers do, and a look at catastrophe bonds." *Ahead Investment Magazine*. Edition 4, 2007. Published by Clariden Leu Bank, Zurich, Switzerland 5-12, 27-30.

Radio interviews:

WWNO New Orleans, October 2007.
WGSO, 990AM, New Orleans, 3/28/08

Conference assistance:

Continuing education:

IMSL presentation and PV-WAVE workshop. MRC Research Symposium. September 6-7, 2007.

Short course on “Methods and Software for Hurricane and Tropical Storm Prediction.” 88th Annual Meeting of the American Meteorological Society. January 20, 2008.

Some relevant meetings and attended presentations:

July 2007: UAS Gulf Region Stakeholder Workshop, Mississippi State University, Starkville, MS
February 2008: Hurricane Modification Workshop, Boulder, CO (3/18-3/19)
March 2008: Interdepartmental Hurricane Conference, Charleston, SC (3/3-3/6)
March 2008: Meeting with Kea Beiningen of Intermap (3/11)
March 2008: Meeting with Mineral Management Services (3/25)
April 2008: Gulf Region Unmanned Aircraft Systems Applications Conference, Biloxi, MS (3/31-4/2)
June 2008: Gulf of Mexico Alliance First Annual Monitoring Forum, St. Petersburg, FL (6/3-6/5)
Numerous teleconferences on UAS and OSSE work

Hosted speakers, workshops, or training? Yes, Hosted speaker Kea Beiningen, Intermap (3/11/08)

Anyone hired by NOAA?: No

Peer reviewed articles:

Steed, C. A., P. J. Fitzpatrick, T. J. Jankun-Kelly, A. N. Yancey, and J. E. Swan, 2007. An interactive parallel coordinates technique applied to a tropical cyclone climate analysis. *Computers and Geosciences* (submitted). [This journal is ranked 2099 on <http://www.journal-ranking.com>, 75 out of 100 in the category “Geosciences Multidisciplinary,” and 15 out of 90 in the category “Computer Science Multidisciplinary Applications”]

Non-Peer reviewed articles:

Fitzpatrick, P. J., 2008: The debate over tropical cyclones and anthropogenic climate change. *World History Encyclopedia*. ABC-CLIO.

Fitzpatrick, P. J., 2008: Global warming. *World History Encyclopedia*. ABC-CLIO.

Masutani, M., E. Andersson, J. Terry, O. Reale, J. C. Jusem, L. P. Riishojgaard, T. Schlatter, A. Stoffelen, J. Woollen, S. Lord, Z. Toth, Y. Son, D. Kleist, Y. Xie, N. Prive, E. Liu, H. Sun, D. Emmitt, S. Greco, S. A. Wood, G.-J. Marseille, R. Errico, R. Yang, G. McConaughy, D. Devenyi, S. Weygandt, V. Anantharaj, C. Hill, P. Fitzpatrick, F. Weng, T. Zhu, and S. Boukabara, 2007. Joint OSSEs. 18th Conference on Numerical Weather Prediction, June 25-29, Park City, UT.

Lim, E., Q. Xiao, J. Sun, P. J. Fitzpatrick, Y. Li, and J. L. Dyer, 2007. The impact of Doppler radar data on rainfall forecast: a case study of a convective rainband event in Mississippi Delta using WRF 3D-Var. 22nd Conference on Weather Analysis and Forecasting, June 25-29, Park City, UT.

Presentations and posters

Posters:

Lim, E., Q. Xiao, J. Sun, P. J. Fitzpatrick, Y. Li, and J. L. Dyer, 2007. The impact of Doppler radar data on rainfall forecast: a case study of a convective rainband evening in Mississippi Delta using WRF 3D-Var. 18th Conference on Numerical Weather Prediction, June 25-29, Park City, UT.

Majure, L. C., G. N. Ervin, and P. J. Fitzpatrick, 2007. Storm-driven maritime dispersal of prickly pear cacti (*Opuntia* species). International *Cactoblastis cactorum* Conference, May 7-10, Phoenix, AZ.

Lim, E., Q. Xiao, J. Sun, P. J. Fitzpatrick, Y. Li, and J. L. Dyer, 2007. The impact of Doppler radar data on rainfall forecast: a case study of a convective rainband event in Mississippi Delta using WRF 3D-Var. 22nd Conference on Weather Analysis and Forecasting, June 25-29, Park City, UT.

Steed, C. A., P. J. Fitzpatrick, T. J. Jankun-Kelly, A. N. Yancey, and J. E. Swan, 2007. Practical application of parallel coordinates to hurricane trend analysis. Posters Compendium: IEEE Visualization 2007, October 28-November 1, Sacramento, CA.

Anantharaj, A., G. Mostovoy, and P. J. Fitzpatrick, 2008. Impact of soil moisture initialization on numerical weather forecasting over the Mississippi Delta region. 88th Annual Meeting of the American Meteorological Society, January 20-24, New Orleans, LA.

Xiao, Q., X. Zhang, C. A. Davis, J. D. Tuttle, G. J. Holland, and P. J. Fitzpatrick, 2008. Impacts of airborne Doppler radar data assimilation on the forecasts of Hurricane Katrina (2005). 88th Annual Meeting of the American Meteorological Society, January 20-24, New Orleans, LA.

Hill, C. M., P. J. Fitzpatrick, H. Karan, and Y. Lau, 2008. An examination of COSMIC in the tropical cyclone environment. 28th Conference on Hurricanes and Tropical Meteorology, April 28-2 May, Orlando, FL.

Fitzpatrick, P. J., C. M. Hill, Y. Lau, Y. Li, J. Corbin, and H. Karan, 2008. A theory on the expansion of Hurricane Katrina's wind field. 28th Conference on Hurricanes and Tropical Meteorology, April 28-2 May, Orlando, FL.

Fitzpatrick, P. J., N. T. Tran, Y. Lau, C. M. Hill, H. Karan, and W. A. Shaffer, 2008. A sensitivity study of the storm surge from Hurricane Katrina. Annual Northern Gulf Institute Conference, May 16-17, Biloxi, MS.

Presentations:

Majure, L. C., P. Fitzpatrick, and G. N. Ervin. 2007. Storm-driven maritime dispersal of prickly pear cacti (*Opuntia* species). USDA, Animal and Plant Health Inspection Service, International *Cactoblastis cactorum* Conference, Phoenix, AZ, May 7-10.

Fitzpatrick, P. J., C. M. Hill, Y. Li, S. Bhate, Y. Lau, and Q. Xiao, 2007. A numerical study of the wind field expansion with Hurricane Katrina during a period of rapid intensification. 18th Conference on Numerical Weather Prediction, June 25-29, Park City, UT.

Hill, C. M., P. J. Fitzpatrick, J. Corbin, Y. Lau, S. Bhate, and P. G. Dixon, 2007. An analysis of the Northern Gulf of Mexico sea/land breeze and associated convective precipitation. 22nd Conference on Weather Analysis and Forecasting, June 25-29, Park City, UT.

Fitzpatrick, P. J., C. M. Hill, Y. Lau, Q. Xiao, X. Zhang, and D. Stettner, 2007. Hurricanes and climate. CloudSat/CALIPSO Joint Science Team meeting, June 11-14, San Francisco, CA [invited].

Fitzpatrick, P. J., 2007. Meteorology and oceanography computational work at HPC2. MCSR Research Symposium, University of Mississippi, September 6, Oxford, MS.

Fitzpatrick, P. J., Y. Lau, C. Hill, N. Tran, Y. Li, B. Jelley, and E. Valenti. 2007. Storm surge and wind issues of Hurricane Katrina, September, Metairie, LA. Continuing education lecture for the Independent Insurance Agents of Greater New Orleans [invited].

Hill, C. M., P. J. Fitzpatrick, Y. Lau, and H. Karan, 2007. An examination of COSMIC in the tropical cyclone environment. 2nd FORMOSAT-3/COSMIC Data Users Workshop, Oct. 22-24, Boulder, CO.

Fitzpatrick, P. J., C. M. Hill, Y. Lau, Y. Li, J. Corbin, and H. Karan, 2008. The impact of Louisiana's levees and wetlands on Katrina's storm surge. 28th Conference on Hurricanes and Tropical Meteorology, April 28-2 May, Orlando, FL.

Blackwell, K. G., A. Wimmers, C. Velden, P. J. Fitzpatrick, and B. Jelley, 2008. Hurricane Katrina's eyewall replacement cycle over the northern Gulf and accompanying double eyewalls at landfall: A key to the storm's huge size and devastating impact over a three-state coastal region. 28th Conference on Hurricanes and Tropical Meteorology, April 28-2 May, Orlando, FL.

Fitzpatrick, P. J., and A. Fernandez, 2008. Some lesser-known hurricane events which impacted society. 88th Annual Meeting of the American Meteorological Society, January 20-24, New Orleans, LA.

Fitzpatrick, P. J., C. Hill, Y. Lau, and D. Stettner, 2008. Analysis of the tropical cyclone environment using COSMIC data. 88th Annual Meeting of the American Meteorological Society, January 20-24, New Orleans, LA.

Fitzpatrick, P. J., Y. Li, C. Hill, H. Karan, E. Lim, and Q. Xiao, 2008. The impact of radar data assimilation on a squall line in Mississippi. 88th Annual Meeting of the American Meteorological Society, January 20-24, New Orleans, LA.

Masutani, M., J. S. Woollen, R. Errico, Y. Xie, T. Zhu, H. Sun, J. Terry, R. Yang, S. Greco, N. Prive, E. Andersson, T. W. Schlatter, A. Stoffelen, F. Weng, O. Reale, L. P. Riishojgaard, G. D. Emmitt, S. J. Lord, Z. Toth, G. J. Marseille, V. Anantharaj, K. Fielding, G. McConaughy, S. J. Worley, C. F. Shih, M. Yanaguchi, J. C. Jusem, C. M. Hill, P. J. Fitzpatrick, D. Devenyi, S. S. Weygandt, S. A. Wood, Y. Song, E. Liu, D. N. Groff, M. Hart, G. Gayno, A. Da Silva, M. J. McGill, D. Kleist, Y. Sato, and S. A. Boukabara, 2008. Progress in joint OSSEs – Three joint OSSE nature runs and simulations of observations. 88th Annual Meeting of the American Meteorological Society, January 20-24, New Orleans, LA.

Fitzpatrick, P. J., Y. Li, C. M. Hill, S. Bhate, Y. Lau, B. Jelley, E. Valenti, and B. Jacobsen, 2008. ADCIRC research activities at the Northern Gulf Institute. 2008 ADCIRC Model Workshop, April 16-17, Naval Research Laboratory, Stennis Space Center, MS.

Fitzpatrick, P. J., Y. Li, C. M. Hill, S. Bhate, Y. Lau, B. Jelley, E. Valenti, and B. Jacobsen, 2008. Storm surge research at Mississippi State University. Presentation to Army Corps of Engineers, February 21, Vicksburg, MS.

Lim, E., Q. Xiao, J. Sun, P. J. Fitzpatrick, Y. Li, and J. L. Dyer, 2008. The impact of Doppler radar data on rainfall forecast: a case study of a convective rainband event in Mississippi Delta using WRF 3D-Var. 88th Annual Meeting of the American Meteorological Society, January 20-24, New Orleans, LA.

Xiao, Q., X. Zhang, Z. Liu, W. Wang, C. A. Davis, G. J. Holland, P. J. Fitzpatrick, Y. Li, C. Hill, and H. R. Winterbottom, 2008. Experiments on WRF Hurricane Initialization (WRF-HI) --- An approach based on WRF variational data assimilation of remote sensing and synthetic observations. 88th Annual Meeting of the American Meteorological Society, January 20-24, New Orleans, LA.

Anantharaj, A., U. S. Nair, A. Song, L. Wasson, S. Christopher, P. J. Fitzpatrick, and R. King, 2008. Numerical model simulations of regional weather and climate impacts due to changes in historical land use in lower Mississippi river valley. 88th Annual Meeting of the American Meteorological Society, January 20-24, New Orleans, LA.

Fitzpatrick, P. J. 2008. Hurricanes and global warming. Rotary talk, Stennis Space Center, MS, January 15 [invited]

Fitzpatrick, P. J., Y. Li, N. Tran, Y. Lau, C. Hill, B. Jelley, and E. Valenti 2008. Storm surge research at the Northern Gulf Institute. Presentation to the U.S. Army Corps of Engineers, Vicksburg, MS.

Fitzpatrick, P. J., Y. Li, N. Tran, Y. Lau, C. Hill, B. Jelley, and E. Valenti 2008. Storm surge research at Mississippi State University. Presentation to the U.S. Army Corps of Engineers, March 19, Vicksburg, MS, and to Wil Laska (DHS).

Fitzpatrick, P. J., Y. Li, N. Tran, Y. Lau, C. Hill, B. Jelley, and E. Valenti 2008. ADCIRC research activities at the Northern Gulf Institute. ADCIRC Workshop 2008, March 17, Naval Research Laboratory, Stennis Space Center, MS.



Microbial Source Tracking

NGI Project File Number: 07-USM-01

USM Project Supervisor:

Dr. Steve Lohrenz

Department of Marine Science
University of Southern Mississippi
Stennis Space Center, MS 39529
228-688-3177
Steven.Lohrenz@usm.edu

Specific Project Investigators : Drs. R.D. Ellender (Research Scientist), Shiao Wang (Research Scientist); Christopher Flood (Graduate Student; 10% funding). No collaborators are involved in thY2 project.

Key Scientific Questions / Technical Issues:

During Y1, we analyzed library independent methods to identify human fecal pollution at coastal sites in Mississippi and Florida. We developed SOPs for each candidate method and select coastal sampling sites. We compared methods and selected the *Bacteroides* method for further study. This summer we will work with collaborating federal and state laboratories to confirm value of selected method.

Y2 has been committed to the refinement of the *Bacteroides* method (*Bacteroides* H183-B708 PCR protocol) with specific studies committed to a) alternate methods of DNA extraction from estuarine waters, b) alternate methods of marker analysis, c) development of *Bacteroides* internal control, d) application of the method in MS coastal waters, e) comparison of *Bacteroides* marker and enterococcal counts in coastal waters, and f) the preparation of a SOP for the state and local user community. To date, all of the objectives have been completed with the exception of f.

Collaborators/Partners:

None

Project Duration: January 31, 2007 / January 31, 2010

Project Baselines:

Contributions to NOAA Goals and Objectives: This project is linked with the NOAA Goals and Objectives in that it: a) allows regulatory agencies to improve the monitoring of human fecal pollution entering coastal waters (Ecosystem Management), b) will create a clearer understanding of the interaction between the land (drainage) and the near shore environment, and c) can improve the understand of how climate, tidal fluctuation and other physical conditions effect coastal recreational and shellfish waters.

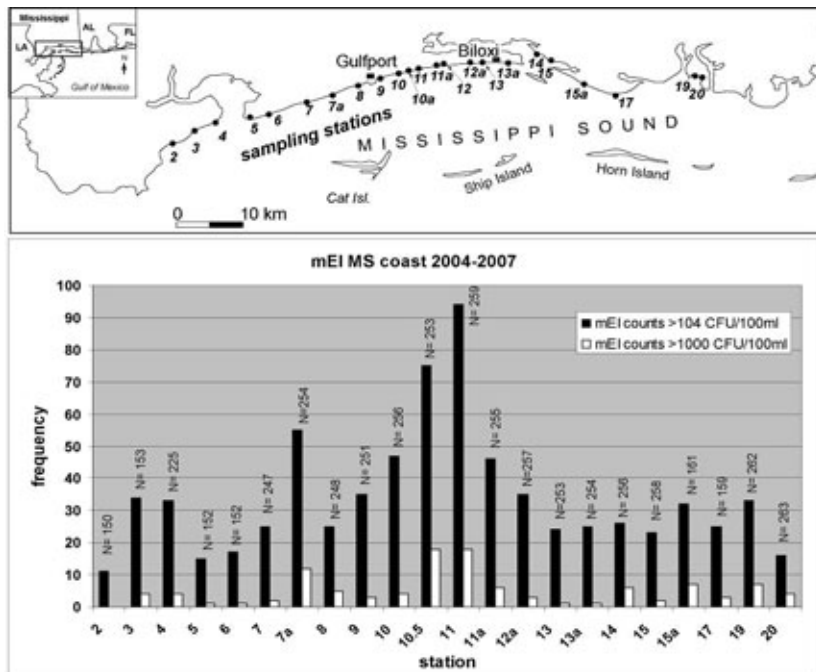
Contributions to regional problems and priorities: This study developed a practical strategy and methodology to determine the source(s) of a human marker to coastal beach and shellfishing areas. The objective is to protect public health by improving risk assessment through knowledge of the contamination source and then indicating locations where remediation of human or stormwater contamination can occur. This knowledge can be used not only for pollution mitigation but also for accurate risk assessment. In turn, these activities will result in cleaner environmental waters and better protection of the health of fisheries workers, consumers of seafood, and recreational water users. The *Bacteroides* marker is readily transferred to the public sector for common use in state and federal laboratories.

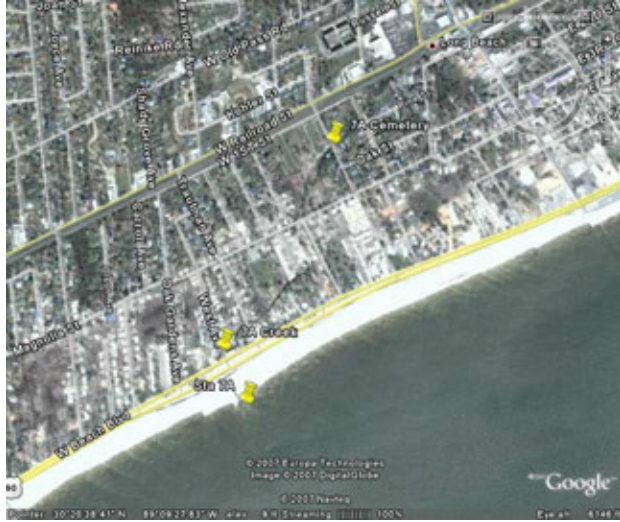
Gaps in knowledge: No present coastal data set exists that contains the information created by this project. Our MS database should be expanded to include other critical sites of pollution along the Northern Gulf.

Project Abstract

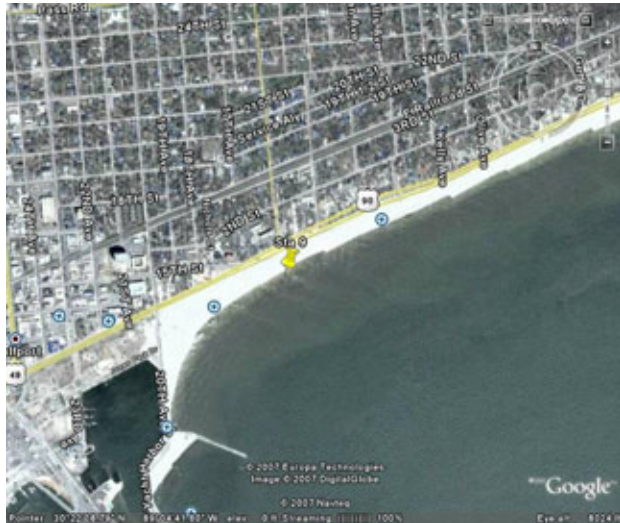
a) Major milestones: A summary of the sensitivity and specificity testing of the human markers compared in Y1 included the following: 1) the human markers were always detected in sewage by the the collaborating laboratories (USF, USM, UWF). Bacteroides was consistently found at a 10⁻⁴ - 10⁻⁵ sewage dilution. Methanobrevibacter smithii was found at a dilution of 10⁻³. Human polyomavirus was detected in dilution from 10⁻² – 10⁻³; 2) Bacteroides experienced a low percentage of cross reactivity with other animals. M. smithii and human polyomavirus did not cross reach with other animals.

b) Major milestones: Enterococcal (hot spot) data from sampling stations along the MS coast is shown in the following figure. As a consequence of these data, sampling sites tested during the last 10 months for human markers include stations 7A and two adjacent creek (7ACC, 7ACT), sites, 9, 10 and adjacent creek sites (CC1, CC2), 10A, 11 and adjacent creek sites (Condo and AO) and 12A.

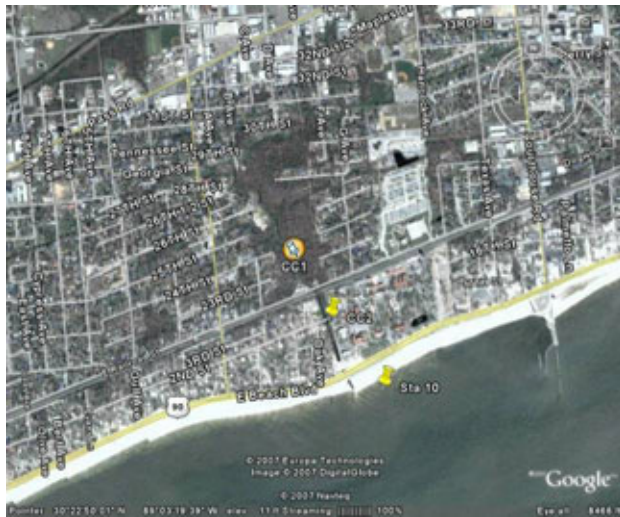




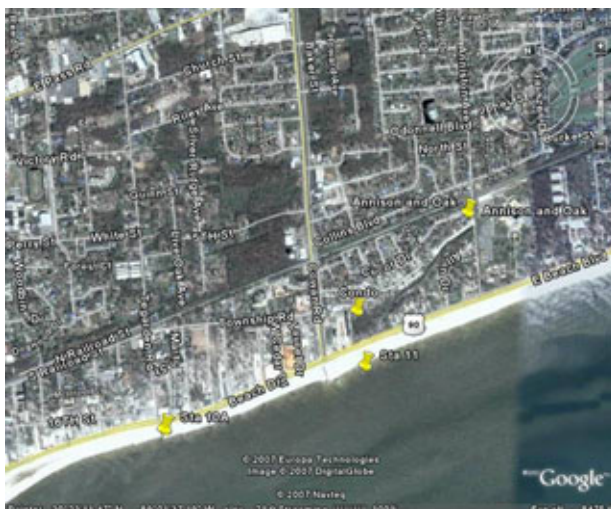
Sites 7A, 7ACC, 7ACT



Site 9



Sites 10, CC1, CC2



Sites 10A, 11, Condo, AOC (12A not shown)

Samples were taken from each location on 20 dates between 8/21/07 and 3/17/08. The samples were tested for the presence of the *M. smithii* and *Bacteroides* markers. The results of this study are shown in the two tables below (\checkmark = positive marker, blank = no marker, nd = not done). Of the 219 samples processed, 57 (26%) were positive for *M. smithii* and 83 (38%) positive for *Bacteroides*. The presence of the markers appears a random event, although the greatest number of positive hits occurred at the CC1 and CC2 creek stations leading into coastal station 10. Appropriate studies are now underway to clarify these results including the addition of supplementary samples near each creek and a greater focus on sediment associated markers. The markers appear to be more prominent during the winter months rather than the warmer months. This may relate to the temperature of the water (marker survivability) at the time of sampling.

For more information about the progress on this project including tables of Presence of *M. smithii* and *Bacteroides* markers in MS Coastal samples, Enterococci counts vs. *Bacteroides* markers, please refer to this project at the NGI website: www.NorthernGulfInstitute.org.

A synopsis of the significant data from Table 3 shows that the locations exhibiting the highest average enterococcal count (CC1 and CC2) also show the highest percentages of the *Bacteroides* marker (63 and 72 %, respectively). Creek associations with coastal beach water sites show a close relationship. For example, the percentages of the marker found at sites 7A, 7ACC and 7ACT demonstrate a close relationship, 37-47%. The same trend is seen at sampling sites 11, AOC and Condo, exhibiting 25 -27% marker percentages. The creek sites which drain to beach site 10 (CC1 and CC2) do not show the same relationship (21% at site 10; 63 and 72 % at CC1 and CC2).

As we continue to analyze these sites, we intend to focus more closely on the influence of creek effluent on coastal site, especially the relationship between 10, CC1 and CC2. These data will be important as we get into the summer recreational period when beach closures generally occur.

Outreach Activities:

Website developed for public presentation (www.usm.edu/bst)

Presentation to MSDEQ Water Quality Division – Library Independent Indicators of Surface Water Quality, September 24, 2007, Jackson, MS.

NOAA hires:

None

Peer Reviewed Articles:

None this reporting period.

Non-refereed articles or reports:

None this reporting period.

Conference Presentations:

None this reporting period.



Utility of Ionosphere and Troposphere Models for Extending the Range of High-Accuracy GPS

NGI Project File Number: 07-USM-02

Investigators

David Dodd
Research Scientist
Department of Marine Science
The University of Southern Mississippi
1020 Balch Blvd.
Stennis Space Center, MS 39529
228-688-7127
David.dodd@usm.edu

8% funded through NGI
Not located at NOAA Lab

Sunil Bisnath
Research Scientist
Dept of Earth & Space Science & Engineering, Faculty of Science & Eng
York University
Petrie Science and Engineering Building, 129
140 Campus Walk
Toronto, ON M3J 1P3 Canada
416-736-2100 ext. 20556
sbisenath@yorku.ca

1% funded through NGI
Not Located at NOAA Lab

Key Scientific Questions and Technical Issues:

The key question is: Does the use of NOAA generated ionosphere and troposphere models improve the vertical accuracy of long-range GPS to the sub-decimeter level? The Global Position System (GPS) is used extensively in many applications around the world. Different applications require different accuracies and processing methods. One of the most challenging applications is high-accuracy real-time positioning in the maritime environment, where users can expect high dynamics, variable weather patterns and long ranges to GPS reference stations and tidal stations. To understand the challenges in GPS positioning in these environments it is necessary to understand some of the concepts of GPS processing. This section begins with an overview of GPS, which is followed by a discussion on some of the uncertainties associated with GPS positioning. It looks into the position processing techniques used for the evaluations, such as sequential least-squares and fixed and float ambiguity solutions.

GPS Overview

There are several types of real-time GPS positioning modes, which require different equipment and result in different accuracies. Code point positioning, which is the simplest and least accurate mode, requires only one GPS receiver and antenna. Code Differential GPS (DGPS) positioning, which is more accurate than code point positioning, requires two receivers, antennae and a communication link for real-time applications. There are services that provide the differential corrections, in which case only a single rover station is required, along with a system to receive the correctors (usually a satellite or radio link). Precise Point

Positioning (PPP), which can achieve high precision, requires a dual-frequency receiver and antenna, advanced processing algorithms and a subscription to a satellite based correction service. Real-Time Kinematic (RTK) positioning, which can achieve very high precision (sub decimeter), over short ranges (< 20 km), requires two dual-frequency receivers and antennae as well as a communication link [Hofmann-Wellenhof, 2001]. This dissertation looks at the RTK positioning mode, but without the communication link. The processing methods have been developed to simulate a real-time environment, however all data were post-processed (Post-processed Kinematic or PPK).

The theory behind three-dimensional positioning using GPS is based on the fact that a unique solution can be derived from measuring the distances between an unknown location (roving receiver) and at least three known locations (satellites). The measured distance is computed from the time-of-travel of radio waves transmitted from each of the satellites to the roving receiver. A three-dimensional position (three unknowns x,y,z) can be computed from the three range observations. Because radio waves travel at the speed of light (299,792,458 m/s), extremely accurate time-of-travel estimates are necessary in order to compute a reasonable position (1 ms time uncertainty translates to a 300 km range uncertainty). To alleviate the need for precise clocks in receivers, the receiver clock uncertainty can be included as a fourth unknown in the position computation algorithm, in which case a minimum of four ranges are required for a solution. Other uncertainty sources include:

- Satellite clock and position uncertainties
- Multipath uncertainties
- Atmospheric uncertainties
- Residual receiver clock uncertainties

Two of the public services available for enhanced GPS positioning are the US Coast Guard's Nationwide Differential GPS (NDGPS) and the Federal Aviation Administration's Wide Area Augmentation System (WAAS). NDGPS is a land based system where differential corrections are transmitted via medium-wave radio frequencies, from towers at reference station sites. WAAS is a satellite based augmentation systems (SBAS) where corrections are delivered via communication satellites. The WAAS service provides correctors for GPS satellite orbits and clocks as well as corrector grids for the ionosphere and troposphere. Currently, both the NDGPS and WAAS services are intended for single-frequency users and can provide horizontal accuracies at the meter level.

Several private sector services are also available that can provide a variety of accuracies. Some of the high precision options include wide area SBAS (Space Based Augmentation Service) services that can provide RTK-type solutions with 10 cm vertical positioning (1σ) within a network of base stations. These systems provide ionosphere, troposphere, orbit and clock corrector estimates determined from the network of base stations. Another high precision SBAS option is a Precise Point Positioning (PPP)-type solution that can achieve 20 cm vertical positioning (1σ). The SBAS provides precise orbit and clock correctors and the PPP algorithms use ionosphere-free carrier observations to smooth the ionosphere-free code observations. The troposphere, for the PPP solution, is generally dealt with by using a zenith propagation delay term as another unknown in the least-squares position solution. One drawback to these long-range systems is the convergence time needed to achieve high precision result.

The processing methodologies used in the studies for this dissertation were developed based on the assumption that the information necessary for high-accuracy, long-range positioning would be transmitted from the NDGPS reference stations to users at sea. Users would expect to receive dual frequency code and carrier observations for the base station as well as ionosphere and troposphere information. They would also expect to use the broadcast ephemeris for satellite clock and orbit computations, and rely on information from a single base station.

Ionosphere

GPS signal refraction occurs as the waves travel through the ionosphere. The ionosphere is a region that covers from ~50 to ~1500 km above the earth's surface. It is an area that is characterized by electrically charged atoms known as ions. These charged particles interact with radio signals, such as GPS transmissions, as the signals pass through the region. The effect of this interaction on GPS signals is equal and in the opposite direction for the carrier and the code (advance of the carrier and delay of the code). The effect of the ionosphere is dispersive, meaning that it varies with the frequency of the signal.

The ionosphere affects the L1 and L2 GPS signals differently – there exists a frequency-dependent relationship; as a result the L1 and L2 signals can be combined to create an “ionosphere-free” signal that compensates for the effects of the ionosphere. However, the resulting combined signal has a greatly increased noise level. The L1/L2 combination also removes the integer nature of the ambiguity. This, and the increased noise, makes ambiguity resolution difficult. As a result, the ionosphere-free combination is useful in an ambiguity float solution for long baseline distances (greater than ~20 km), and for initial ambiguity estimates.

Troposphere

The troposphere is the section of Earth's atmosphere extending from the surface to approximately 10 to 20 km. It is generally characterized by a constant decrease in temperature with increasing height of approximately 6.5 °C/km, on average [Mendes, 1999]. Both the hydrostatic or “dry” and wet constituents of the troposphere refract (reduce speed and alter direction of) electromagnetic waves, such as those of GPS. Unlike the ionosphere, the troposphere is not a dispersive medium, therefore additional GPS signals of varying frequency cannot be used to estimate and eliminate tropospheric refraction.

The effect of the hydrostatic component on the GPS signals accounts for about 90% of the total troposphere delay (zenith delay of ~240 cm). It is a function of temperature and atmospheric pressure; however, it can be computed from atmospheric pressure observations at the receiving antenna [Leick, 2004]. This pressure value can be estimated from the height of the antenna above sea level; therefore, site-specific observations are not necessary. However, the wet delay component is more problematic. It comprises about 10% of the total troposphere delay (zenith delay of up to ~40 cm), and is far more variable than the dry component [Leick, 2004]. The irregularity of water vapor content, while small in magnitude, represents the major obstacle to precise position estimation – i.e., cm-level.

GPS Processing Techniques

The processing techniques used in this study were developed to simulate, as closely as possible, a real-time, dynamic marine environment. The software was developed to compute a position solution at every epoch, using broadcast ephemeris. Multiple position computation algorithms were developed to accommodate different processing scenarios, such as:

1. Double differencing, dual frequency, code and carrier, ionosphere-free positioning with sequential-least-squares (SLS)
2. Double differencing, dual frequency, four observation (L1, L2, CA [or P1], and P2), with SLS (ambiguity float solution)
3. Double differencing, dual frequency, four observation (L1, L2, CA [or P1], and P2), with SLS (ambiguity fixed solution)

The sequential-least-squares (SLS) processes were included for ambiguity resolution algorithms. Ambiguity estimates were included as unknowns in the least squares process and, once established, did not change. Ambiguity estimates and confidences (aposteriori variance-covariance) established for one epoch were sent to the next epoch for use in that solution. As the confidence in the ambiguity estimates increased, more weight was put on the values transferred from the previous epoch, to a point where they no longer changed. As part of the SLS process, positions and ZPD values (if applicable), along with their confidences, were also transferred from epoch to epoch.

Collaborators:

- i. OAA/ESRL
 - o Collaboration established prior to the beginning of this NGI project
 - o Collaborator supplies real-time troposphere maps necessary for this study
- ii. NOAA/SEC
 - o Collaboration established prior to the beginning of this NGI project
 - o Collaborator supplies real-time ionosphere maps necessary for this study
- iii. USM/GCGC
 - o February, 2008
 - o Collaborator supplies GPS base station observations for this study
- iv. USM/CenGOOS
 - o Collaboration established prior to the beginning of this NGI project
 - o Collaborator supplies GPS and motion data from an oceanographic buoy in the Northern Gulf of Mexico.

Project Duration:

Project started in the spring of 2007 and will be completed in the summer of 2009

Project Baselines:**NOAA Goals**

The troposphere and ionosphere maps to be used in this study cover the continental US. Future collaboration between the Navy and NOAA could see an expansion of these models to cover the entire world. The processes developed here could then be used to meet the needs of all users of high-accuracy GPS, both on land and at sea. This is inline with NOAA goal number 4: "Support the Nation's Commerce with Information for Safe, Efficient, and Environmentally Sound Transportation.

Personnel from NOAA NGS and SEC have viewed the results obtained from the NGI year-one study and are interested in collaborating with further studies. Discussions have taken place regarding possible model interpolation techniques and alternate integer ambiguity resolution methods.

Regional Priorities:

1. *Eco System Management* by enabling high-accuracy positioning (three dimensional) for habitat mapping using traditional depth soundings or bathymetric LIDAR.
2. *Geospatial Data* by contributing to the precise positioning of marine geospatial information. It will also lead to the ability to store vertical data relative to the ellipse, making comparisons between data sets and land data much easier. This will greatly enhance ocean current modeling and flood inundation estimations.
3. Making precise vertical positioning available to the shipping industry will contribute to their ability to increase capacity by increasing the safe draft limit. This will significantly reduce shipping costs, and lead to a reduction in the cost of goods. Better vertical navigation will also reduce the risk of groundings, which will lead to fewer oil spills.
4. Once the processes have been established, the relevant information will be made to the maritime community via the US Coast Guard Enhanced National DGPS service.

Gaps in Northern Gulf ecosystem knowledge:

Extending the range of high-accuracy GPS will enhance the value for all data collected in support of understanding of ecosystems.

Project Abstract:

This project studies the use of NOAA real-time ionosphere and troposphere products in extending the range of long-baseline, high-accuracy Differential GPS (DGPS) for real-time positioning. In-house GPS processing

software has been developed to ingest the models and compute epoch-to-epoch, float and fixed ambiguity position solutions. Single baseline processing, for multiple baselines (ranging from 20 to 300 km), over multiple days in static and dynamic environments are evaluated.

The tests performed for year-one of this project showed that, overall, the ionosphere-free float solution with the NOAA troposphere model produced the best results. The float solution determined from the four observables (L1, L2, P1 and P2) using the real-time ionosphere model, when combined with the L1-L2 observation, produced results similar to, but slightly worse than, the ionosphere-free solution. For the short (~20 km) baselines, the four-observable, fixed solution produced the best results, but as the range increased the ability of the ambiguity algorithm to resolve the correct integers, reliably, was degraded.

The NOAA real-time troposphere model significantly improved the results for several baselines with stations that experienced different weather conditions. The NOAA real-time ionosphere model (US Total Electron Content or USTEC) performed better than the other models, but required the introduction of high-fidelity effects derived from L1-L2 observations in order to come close to the ionosphere-free solution.

The next set of tests will include the use of NOAA real-time troposphere and ionosphere models with GPS data from USM's oceanographic buoy and associated base stations. This dynamic data will be processed with enhanced algorithms designed to help in the integer ambiguity fixing process. Previous tests have shown that the float solutions are comparable to the ionosphere-free solutions, indicating that they deal with the ionosphere appropriately, leaving only uncertainties with the troposphere. New methods for interpolating wet delay information from the real-time troposphere models will be implemented.

Milestones:

Objective	Status
Enhance Software to include integer ambiguity resolution (AR)	USM in-house software has been enhanced to include the LAMBDA algorithm for integer ambiguity resolution. Results are comparable to commercial-off-the-shelf (COTS) software.
Evaluate NOAA real-time ionosphere and troposphere products for use in AR software	Models were evaluated for a region in south Louisiana. Improvements to position solutions were achieved, however, reliable AR for long baselines (> 100 km) requires further research
Report results at national meetings	Overall study report for year 1 completed (NGI_Yr1_Repot_Dodd_Improved_Accuracy_RTK.doc). Portion of study presented at ION GNSS conference in September 2007, and paper included in the proceedings Study results also included as a portion of a chapter in the PI's PhD. dissertation.

List of Outreach Activities:

Outreach is being coordinated through the administrative project under the direction of Steven Lohrenz. The primary investigator will interact with the administrative project when necessary.

Articles:

Dodd, D. (2007). Utility of Ionosphere and Troposphere Models for Extending the Range of High-Accuracy GPS. PHd. dissertation, Department of Marine Science, The University of Southern Mississippi. Stennis Space Center, Mississippi.

Dodd, D., S. Bisnath, (2007). "Combining L1 L2 Carrier Differences with Ionosphere Model Estimates for an Improved Ionosphere Error Corrector." Proceedings of the ION GNSS 2007 conference. September 26-28, 2007. Fort Worth, TX.

Dodd, D. (2008). "Utility of NOAA Ionosphere and Troposphere Models for Extending the Range of High-Accuracy GPS." Poster, NGI year 2 Conference. May, 2008, Biloxi, MS



Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf

NGI Project File Number 07-USM-03

Stephan Howden, stephan.howden@usm.edu, USM
Charlotte Brunner, charlotte.brunner@usm.edu, USM
Steven Lohrenz, steven.lohrenz@usm.edu, USM
Donald Redalje, Donald.redalje@usm.edu, USM
Alan Shiller, alan.shiller@usm.edu, USM
Kjell Gundersen, kjell.gundersen@usm.edu, USM

List all personnel funded by this project (Person's Name, Category, Percent of Salary Funding from NGI, Individual located at a NOAA Lab?):

Stephan Howden, Associate Professor, 8.3%, No
Charlotte Brunner, Professor, 4.2%, No
Steven Lohrenz, Professor, 0%, No
Donald Redalje, Professor, 8.3%, No
Alan Shiller, Professor, 8.3%, No
Kjell Gundersen, Research Scientist, 0%, No
Kevin Martin, Oceanographic Technician, 20.8%, No
Richard Slaughter, Oceanographic Technician, 16.7%, No

Key Scientific Question(s)/Technical Issues:

The key scientific questions and technical issues addressed in the study include:

- What is the seasonal variability of key water quality parameters in the Lower Pearl River Estuary and Bay St. Louis and what is the effect on the western Mississippi Sound and further offshore into the Mississippi Bight?
- What is the extent of seasonal hypoxia in the Mississippi Bight and what are the mechanisms controlling its development?
- What are the carbon fluxes within the study region?

In order to examine our hypotheses, several objectives have been established:

- 1) Monitor over differing seasonal and discharge conditions and compare nutrient concentrations and nitrogen to phosphorus ratios in different ecosystems including: a) a wetlands-dominated river system (LPRE), b) a small estuarine bay (BSL) experiencing increasing impacts of development, c) the MSS into which with both of these systems open, and d) shelf waters outside the barrier islands;
- 2) In collaboration with NOAA scientists, assess pCO₂ and air-sea flux of carbon dioxide variability in coastal waters, and relate it to environmental conditions, specifically physical properties of water, freshwater discharge, nutrient levels, and algal biomass;
- 3) Characterize bottom water oxygen in shelf waters over seasonal time scales; identify localized hypoxia, and relate it to nutrient and carbon dynamics in overlying surface waters and to water column stratification.
- 4) Determine if hypoxia and anoxia cause species composition of foraminifers to change in the MSB.

We are examining the spatial and temporal variability of micronutrient and selected trace element concentrations in the LPRE, the BSL and the MSS. Temporal variability will help us understand the role of episodic events, whereas spatial distributions will help us understand material sources and sinks. These distributions will be utilized to better constrain the sources of these materials in the local coastal environment. We are planning on

comparing the distributions in the LPRE and the BSL to better understand how these different environments (e.g., marsh-dominated for the Pearl, rapidly developing for BSL) affect nutrient and metal fluxes. For hypoxia in the region of the MSB, crucial questions that remain include the following: what are the frequency of occurrence, duration, and areal extent of hypoxic events; what is the role of anthropogenically enhanced nutrient inputs; what is the extent of effects on benthic species composition; what are the necessary conditions for events; and what are the ramifications of these events? Monitoring of this environment, both with our CenGOOS buoy and with the monitoring cruises described below, will allow us to address these questions. We will work with NOAA scientists examining the local coastal pCO₂ and air-sea flux of carbon dioxide (see attached letters of collaboration), thereby aiding their monitoring efforts and providing them with important ancillary information (e.g., nutrients, temperature, oxygen). Specific objectives include the following:

- 1) Collaborate with NOAA scientists to examine relationships between pCO₂ and environmental conditions (e.g., water physical properties, freshwater discharge, nutrient levels, and algal biomass);
- 2) Utilize moored measurements of pCO₂ to evaluate performance of satellite-based extrapolations of pCO₂ for the coastal region and develop regional extrapolations of surface pCO₂ over differing discharge and seasonal conditions;
- 3) Use wind products to compute air-sea flux of CO₂ for different periods and conditions.

Collaborators(s)/Partners:

Steven Lohrenz, University of Southern Mississippi

Collaboration established on 02/01/07

Partner does not supply monetary support

Partner provides optical profiling package

In support of the USM NGI project *Satellite and In Situ Optical Assessment of Algal Bloom Events in the Northern Gulf of Mexico*, an optics package has been deployed at each NGI station to take optical profiles for comparison with satellite measurements.

Chet Rakocinski, University of Southern Mississippi

Collaboration established on 02/01/07

Partner does not supply monetary support

Partner does not supply in-kind support.

In support of the NGI project *Macrofaunal Indicators of Hypoxia*, the profiles of stratification and dissolved oxygen (bottom values less than 2.2 ml/l were found) from the July 19, 2007 cruise will be used to help document the development of hypoxia in the Mississippi Bight. During select cruises Dr. R takes sediment samples.

Richard Fulford, Mark Peterson, and Harriet Perry, University of Southern Mississippi

Collaboration established on 02/01/07

Partner does not supply monetary support

Partner does not supply in-kind support.

In support of NGI project *Data tools for Ecosystem-based Fisheries Management* the water quality data from this project will be provided.

Russ Beard, NOAA/NCDDC

Collaboration established on 02/01/07

Partner does not supply monetary support

Partner supplies expertise in metadata documentation and archiving.

In support of NGI project *NOAA Ecosystems Data Assembly* the biogeochemical data will be supplied to NCDDC. the water quality data from this project will be provided.

Gustovi Goni (NOAA/AOML) and Peter Ortner (UM/RSMAS)

Collaboration established on 02/01/07

Partner does not supply monetary support

Partner does not supply in-kind support.

In support of NGI project *Enabling and Initiating Observing System Simulation Experiments of a Coastal High Resolution Oceanographic Model in the Northern Gulf of Mexico* the NGI Monitoring data and the Central Gulf of Mexico Ocean Observing System data will be provided. The latter includes data from USM buoy USM3m01 and the three station High Frequency Radar network.

Rik Wanninkhof (NOAA) and Chris Sabine (NOAA)

Collaboration established on 02/01/07

Partner does not supply monetary support

Partner has supplied pCO₂ sensor for CenGOOS buoy USM3m02, which is under final testing at the Geochemical and Environmental Research Group at Texas A&M.

The NGI Monitoring data and the CenGOOS buoy #2 will be used in the NGI project *Estimating Air-Sea Carbon Dioxide Fluxes in the River Dominated Northern Gulf of Mexico*.

Robert Twilley (LSU)

Collaboration established on 02/01/07

Partner does not supply monetary support

Partner does not supply in-kind support.

The ecosystem data from the Mississippi Sound and Bight will be utilized for the NGI project *Delta Ecosystem Forecasting System*

David Dodd (USM)

Collaboration established on 02/01/07

Partner does not supply monetary support

Partner does not supply in-kind support.

The NGI project *Utility of Ionosphere and Troposphere Models for Extending the Range of High-Accuracy GPS* utilizes large raw GPS data that cannot be telemetered from the CenGOOS buoy USM3m01 via the Globalstar link. These data are downloaded from the buoy over a wireless router when the monitoring cruises reach station 8 at the buoy site.

Stephan Howden, Vernon Asper, Steven Lohrenz, Kjell Gundersen (USM)

Collaboration established on 02/01/07

Partner does not supply monetary support

Partner supplies in-kind support for Dr. Kjell Gundersen and for monitoring assets.

The collaboration between the CenGOOS and the NGI monitoring program is multi-faceted. The Monitoring project is utilizing assets of CenGOOS for the sampling cruises. CenGOOS provides near-real time monitoring at buoy USM3m01 and long-range CODAR stations at Gulfport, MS, Orange Beach, AL, and Destin, FL that allow for the monthly monitoring stations to be put into a larger spatial and shorter temporal connect. The monthly NGI physical/biogeochemical sampling line from Bay St Louis out to buoy USM3m01 provide validation data for the buoy.

Crystal Johnson (USM)

Collaboration established on August, 2007

Partner does not supply monetary support

Partner does not supply in-kind support.

A \$1.6M NSF Ecology of Infectious Diseases funded project *Collaborative Research: Identifying Environmental Determinants Favorable for the Presence and Transmission of Pathogenic Vibrios*. The Monitoring and Assessment project will provide water quality data to the NSF project to help improve the Vibrio forecast tool that would be used to help regulate oyster beds.

Project Duration:

Start Date 02/01/07 Estimated End Date 01/31/10

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This project has many facets that contribute to NOAA's Mission to understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs. The NOAA Goals addressed by the project are

- Ecosystems Mission Goal
 - By building a backbone monitoring system for the Mississippi Sound and Bight this project is providing the information that is required to understand effects of fluvial inputs of freshwater, nutrients, and other constituents on the Mississippi Sound and western Mississippi Bight ecosystems. As an example, the physical oceanographic and biogeochemical measurements are being used to understand the seasonality of nutrient concentration, stratification, and dissolved oxygen, which in turn are being used to understand a range of issues such as the development of hypoxia, the sources of nutrients, and the prevalence of Harmful Algal Blooms.
 - Through this projects relationship with NCDDC it is involved with developing the data management system for biogeochemical data, which has not received as much attention as physical data within the IOOS.
- Climate Mission Goal
 - Through this projects relationship with the Central Gulf of Mexico Ocean Observing System, and hence the IOOS, it is involved with the development with the global observation and data management system.
 - Through this projects relationship with NCDDC it is involved with developing the data management system for biogeochemical data, which has not received as much attention as physical data within the IOOS.
- Commerce and Transportation Goal
 - The collaboration with the NGI project *Utility of Ionosphere and Troposphere Models for Extending the Range of High-Accuracy GPS*, will lead to enhanced offshore positioning that will address same transportation directly through better navigation tools.

Contributions to regional problems and priorities:

Gulf of Mexico Alliance

The Governors' Action Plan (GAP) for Healthy and Resilient Coasts outlined five priority issues for states bordering the GoM: Water Quality, Wetland Restoration, Environmental Education, Characterization of Gulf Habitats, and Reduction of Nutrient Inputs. Associated with these priority issues, eleven actions were proposed in the plan to realize the goals of the Gulf of Mexico Alliance in a timely manner.

Several projects and programs are underway in the MSS and MSB that are addressing issues identified by the GAP as priorities. These include the CenGOOS and a collaborative MSS monitoring program

(<http://ms.water.usgs.gov/rt/biloxi/imap.html>) between the Mississippi Department of Marine Resources (MS-DMR) and the U.S. Geological Survey (USGS). The nascent NGI adds to the regional programs that are directly addressing the issues outlined in the GAP, as well as addressing issues important to NOAA's strategic goals. This project within the NGI is contributing additional physical and water-quality monitoring to support other projects within the NGI and to better understanding of the factors and processes that impact water quality. In this region of large riverine input, the data are being used to sort out the relationships between external forcing, stratification, nutrients, and dissolved oxygen.

Four of the five initial priorities of the Gulf of Mexico Alliance (GOMA) are being addressed by this NGI project. A mapping of properties monitored to GOMA priorities is shown in Table 1.

Gulf Alliance Priorities	1. Water Quality	2. Wetland Restoration	3. Education	4. Habitat Characterization	5. Nutrient Loading Reduction
Sampling Requirements					
Temperature	x			x	y
Salinity	x	x		x	y
Dissolved Oxygen	x	x		x	
Nutrients	x	x		x	x
Harmful Algal Blooms	x				x

Table 1. Mapping of properties monitored to GOMA priorities. 'x' denotes that a primary measurement for a given priority and 'y' denotes a secondary measurement (as defined by GOMA).

Gulf of Mexico Ocean Observing System

In order to begin collecting the necessary information on the needs and requirements of stakeholders, the Gulf of Mexico Ocean Observing System (GCOOS) has held a series of stakeholder workshops as funding has permitted. These stakeholder workshops to date are:

HABSOS-GCOOS Workshop, 13-15 April 2004 in St. Petersburg, FL.

GCOOS and the Private Sector: Oil and Gas and Related Industry Workshop, 2-4 November 2005 in Houston, TX.

GCOOS-SECOORA-NOAA CSC Storm Surge & Inundation Workshop, January 24-26, 2007 in New Orleans, LA.

This NGI project is addressing needs and priorities identified by stakeholders participating in these workshops. The Action Plan developed in the first workshop included the need to continue research in biology and ecosystem dynamics to advance knowledge of conditions leading to HAB events. The second of the workshops identified measurements of dissolved oxygen, nutrients, temperature and salinity as a medium priority for the Oil and Gas Industry. In the third workshop report it was stated that it is essential to have baseline conditions from pre-storm monitoring for the post-storm planning and reconstruction.

Mississippi Department of Marine Resources

The Mississippi Department of Marine Resources was very concerned about the potential effects on the Mississippi Sound when the Bonnet Carre (BCS) was opened on April 11, 2008. In 1997, the last time the

spillway was opened, U.S. Army Corps of Engineers (USACE) modeling results indicated a large pulse of freshwater was advected through the Mississippi Sound and fresh waters stayed in Bay St. Louis for several months and oyster reefs in the western Sound were adversely affected. Initially MS Department of Marine Resources expected to receive funding through the USACE to perform extra monitoring for the spillway discharge event and we agreed to enhance our monitoring program in the western Sound until the water quality returned back to “baseline conditions”. That funding was not forthcoming and we have performed sampling as funding permits. Figure 5 shows the initial BC stations sampled on April 15, 4 days after the spillway was opened. This cruise was undertaken to set baseline conditions before the spillway waters had transited Lake Pontchartrain and flowed into the Sound. After Louisiana began additional monitoring in Lake Bourne and Chandeleur Sound, the sampling stations were subsequently modified with stations 4 and 5 dropped, a station 6 added between stations 1 and 2, and NGI station 1 added as BC station 7. Stations 1-3 and 6-7 were sampled on May 15 and June 18.

Gaps:

The region east of the MR is very much understudied compared with the well-know hypoxia region to the west; however, some of the same environmental problems are likely to occur. By making regular, sustained measurements we can fill in this information gap.

Project Abstract

USM is working with NGI partners and state and federal agencies to carry out a multi-faceted approach for building a land-to-sea or monitoring and assessment in selected key coastal regions. Initial efforts focus upon a continuous monitoring station in the Lower Pearl River estuary and on a set of sampling stations from the Bay Saint Louis out into the Mississippi Sound and offshore to the 20 m isobath in the Mississippi Bight. The furthest offshore station is where a buoy of the Central Gulf of Mexico Ocean Observing System (CenGOOS) is located south of Horn Island. At this site, continuous measurements of water quality variables including salinity, temperature, chlorophyll fluorescence, and turbidity are made every half hour .

The Lower Pearl River estuary has been shown to reflect the inputs of nutrients and organic materials into the Sound. The EPA lists the LPR impaired due to high levels of mercury, copper, cadmium, turbidity, nutrients (and associated low dissolved oxygen), and sediment/siltation. Further to the east, the Bay Saint Louis has been listed by the MS Department of Environmental Quality as the most heavily impacted water body in the state due to the inputs of substances into its tributaries and directly into the Bay itself. Studies of this Bay over the last decade have documented these problems.

The overall goal of this project is to document the seasonal variability of critical water quality parameters in these key coastal regions to provide a clearer understanding of the impacts of the two estuaries on the western Sound and further offshore into the MSB. Data collected as part of this NGI effort, as well as historical data from the region, will be assembled in a geospatial information system environment and made accessible to researchers and environmental managers to aid in decision-making.

List major milestones completed and describe any significant research results and transitions:

To date date 9 monitoring cruises have been conducted. Figure 1 show the sampling station locations and Table 1 shows the stations sampled on each cruise. Nutrient data (Figures 2-4) have shown anomalous N:P ratios that may indicate an anthropogenic source of Phosphate into the Mississippi Sound. These nutrient data contrast sharply with earlier data reported in Turner and Rabalais (1999) for the same region. If these relative nutrient levels persist through further NGI sampling then studies are in order to determine effects on the ecosystem.



Figure 5. NGI Monitoring and Assessment Sampling Stations.

The opening of the Bonnet Carre spillway on April 11, 2008 brought a new urgency to our sampling program. In 1997, the last time the spillway was opened, U.S. Army Corps of Engineers modeling results indicated a large pulse of freshwater was advected through the Mississippi Sound and fresh waters stayed in Bay St. Louis for several months. Initially MS Department of Marine Resources expected to receive funding through the USACE to perform extra monitoring for the spillway discharge event. That funding was not forthcoming and we have performed sampling as funding permits. Figure 5 shows the initial BC stations sampled on April 15, 4 days after the spillway was opened. After Louisiana began additional monitoring in Lake Bourne and Chandeleur Sound, the sampling stations were subsequently modified with stations 4 and 5 dropped, a station 6 added between stations 1 and 2, and NGI station 1 added as BC station 7. Stations 1-3 and 6-7 were sampled on May 15 and June 18.

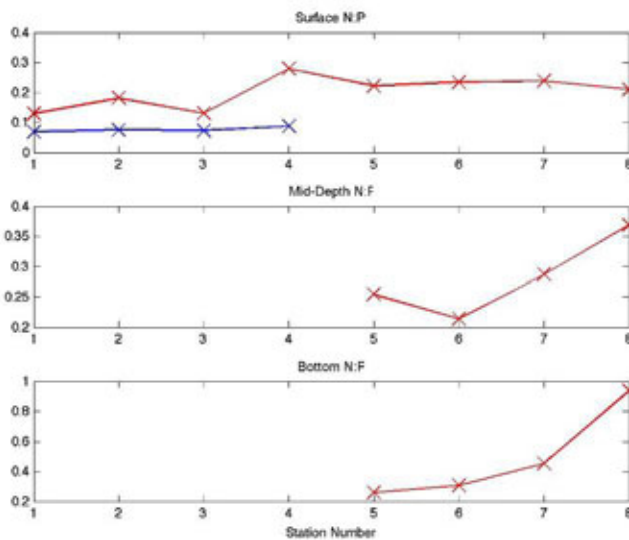


Figure 6. N:P ratios from October (red) and November (blue) cruises.

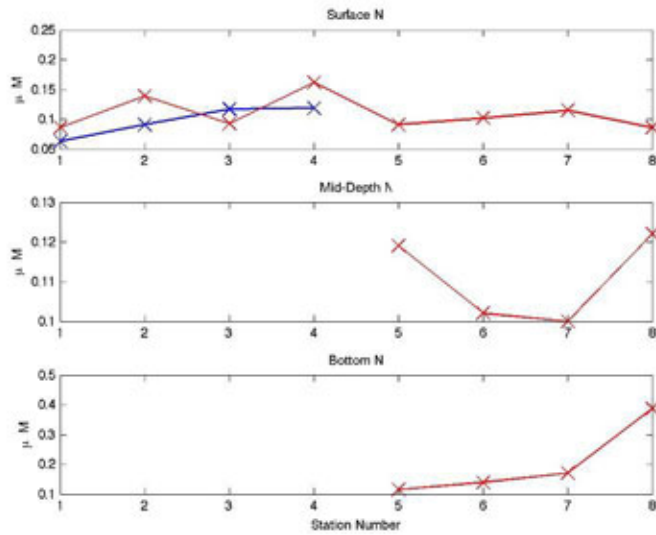


Figure 7. Total N concentration from October (red) and November (blue) cruises.

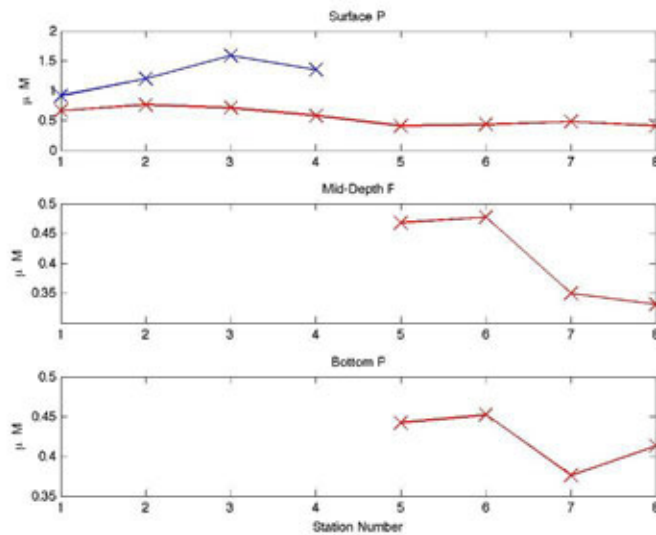


Figure 8. Phosphate concentration from October (red) and November (blue) cruises.

Some rather startling dissolved oxygen profiles were measured on the June 17 NGI cruise (Figure 6). Hypoxic bottom waters were measured from station 4 to station 8. At station 8 the hypoxic layer was over 5 m thick in a 20 m water column. Although hypoxia has been documented in the Mississippi Bight (e.g., Brunner and Howden 2006), the early summer timing of the event and thickness of the hypoxia layer is unprecedented in the region. The cause, or causes, of this event are unknown at this time. There are at least several possibilities: high discharge rates of fresh water into the MS Sound irrespective of the BC discharge; large Mississippi River water discharge being advected north/northeastward into the region; the BC discharge; and some combination of these factors. Figure 7 shows samples being taken for dissolved oxygen on the R/V Le Moyne.

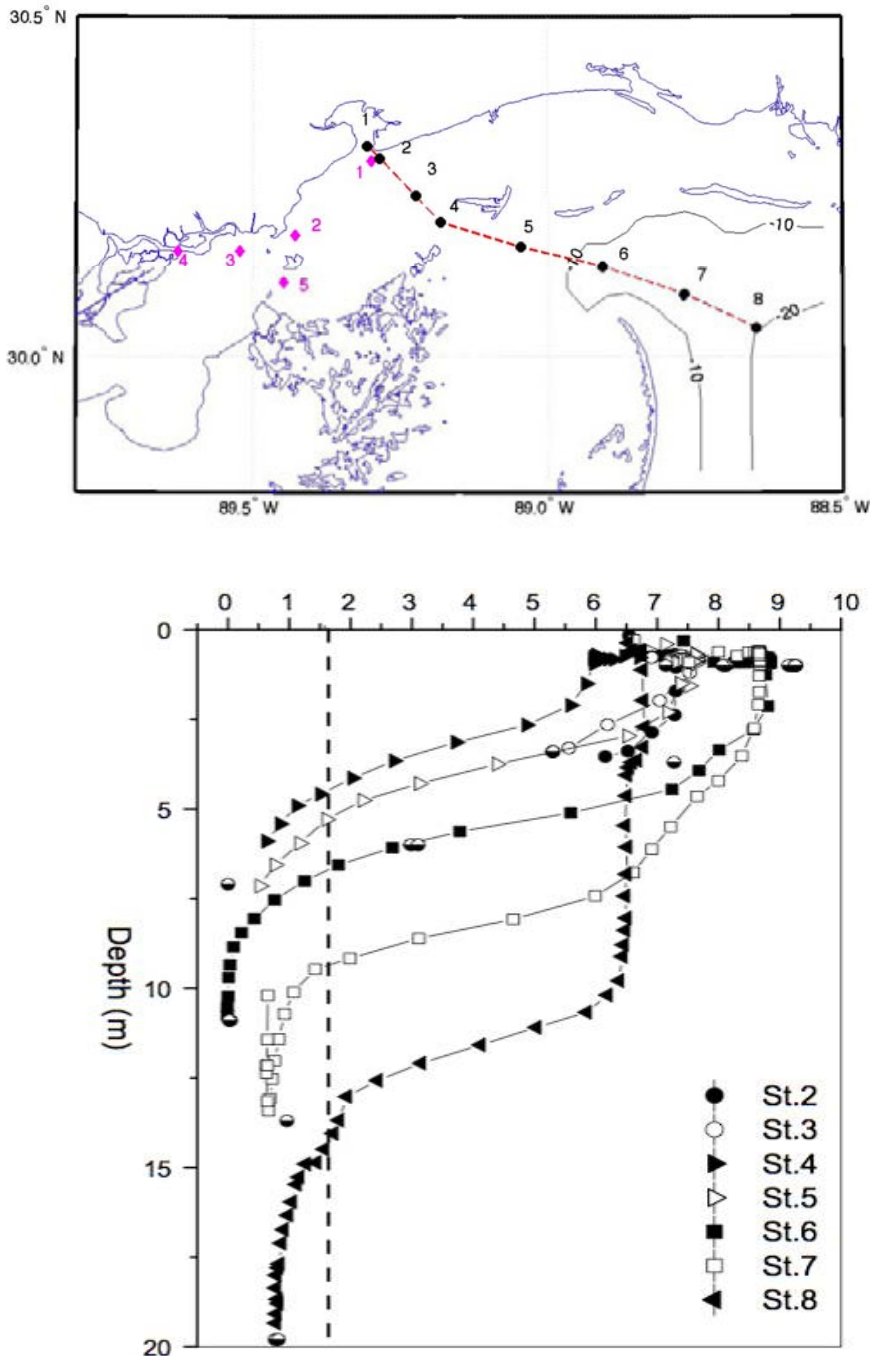


Figure 9. Dissolved oxygen profiles at NGI stations during June 17 cruise.

The Pearl River Monitoring Station has not yet been installed, but progress is being made.

- a. Permission has been granted by the USGS to install a monitoring station on their pier over the East Pearl River located at the Stennis Space Center. At the present time the nutrient sensors are undergoing field testing before the station is installed. The MBARI ISUS was used on the R/V Pelican from 1-8 May, 2008 for Dr. Shiller's NSF funded project Collaborative Research: Tracer Distributions, Chemical Fluxes, and Distribution Comparisons in the Mixing Zone of the Mississippi River. The cruise served as a checkout application for the recently repaired instrument. The Wetlabs Phosphate sensor is a prototype that has required extra lab work to perform calibration validations and integrate with the data logger.

- b. In the Lower Pearl River, monthly discrete water sampling has continued. Samples for nutrients, dissolved and particulate organic matter, and dissolved and colloidal metals are being collected. These data will be compared with a pre-Katrina time series we performed of the river.

Outreach activities

Outreach for all USM projects are coordinated under a separate project (S. Lohrenz, PI). We provide information to that project PI regarding presentations, papers published, key findings and progress and we participate in regular PI planning and data meetings and teleconferences. We also work with Sharon Hodge of Mississippi State University (MSU), NGI Education and Outreach Coordinator and provide information to her as needed for the NGI website and other information venues.

General Description

Below is a list of NGI and/or NGI related outreach and education activities.

June 6-8, 2007 Dr. Sharon Walker and Ms. Tami Wells held a K-12 teacher workshop on Ocean Observing Systems. This was a Centers for Ocean Sciences Education Excellence (COSEE)/Central Gulf of Mexico Ocean Observing System (CenGOOS)/NGI activity.

August-October 2007 a contest for the middle schools in the coastal MS counties was held for naming the ACB research vessel. This was a CenGOOS/NGI activity.

October 1, 2007 Dr. Jessica Kestler replaced Ms. Tami Wells as Education and Outreach (E&O) Coordinator for CenGOOS. She replaced Ms. Tami Wells, who was named E&O coordinator for the Gulf of Mexico Ocean Observing System—Regional Association (GCOOS-RA).

Have you hosted speakers, workshops and/or any training?

No

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

None

List non-refereed articles and reports for this project:

None

List conference presentations and poster presentations for this project.:

Howden, S. D., C. Brunner, S. Lohrenz, D. Redalje, A. Shiller, and K. Gundersen. Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf of Mexico, NGI Annual Meeting, 13-14 May, 2008, Biloxi, MS.

Howden, S. D., V. L. Asper, D. W. Dodd, S. E. Lohrenz, D. Roman, L. Bender, J. Walpert, and C.-A. Blain. Hurricane Katrina Waves and Storm Surge Observations by the Central Gulf of Mexico Ocean Observing System, Session 151, 2008 Ocean Sciences Meeting, March 2-7, 2008, Orlando, FL.

Guinasso, N. L., L. C. Bender, S. D. Howden, J. N. Walpert, Wave Heights from a 3-m Discus Buoy in the Mississippi Sound during Hurricane Katrina, Session 151, 2008 Ocean Sciences Meeting, March 2-7, 2008, Orlando, FL.

Brunner, C., S. Howden, K. Gundersen, Mapping of Hypoxic Zone in the Mississippi Bight in the Summer of 2006, Session 194, 2008 Ocean Sciences Meeting, March 2-7, 2008, Orlando, FL.

Howden, S. D., and C. Brunner. Detection of Hypoxic Conditions in the Mississippi Bight in the Summer of 2006, Mississippi Academy of Sciences, Abstract Issue of the Journal of the Mississippi Academy of Sciences, p 116, 2007.

Williams, Kyle, Tami Wells, Stephan Howden, Conrad Johnson, and Sharon Walker, Central Gulf of Mexico Ocean Observing Systems (CenGOOS) K-12 Program Development, Abstract Issue of the Mississippi Academy of Sciences, p 146, 2007.

Wells, Tami, Sharon Walker, Stephan Howden and Marcus Jarrett, The Role of Ocean Observing Systems in K-12 Education: Explaining the Concepts, Developing the Curricula and Applying the Technology, Abstract Issue of the Mississippi Academy of Sciences, p 148, 2007.



Interaction between Off-shore Circulation and Nearshore Processes during Extreme Weather Events

NGI Project File Number: 07-USM-04

PIs: Vladimir Kamenkovich, e-mail: vladimir.kamenkovich@usm.edu

Dmitri Nechaev, e-mail: Dmitri.Nechaev@usm.edu

Affiliation: Department of Marine Science, University of Southern Mississippi

Phone: 228-688-3091; 228-688-2573; Fax 228-688-1121

List all personnel funded by this project (Person's Name, Category, Percent of Salary Funding from NGI, Individual located at a NOAA Lab?):

Vladimir Kamenkovich, PI, 8.3%, No

Dmitri Nechaev, PI, 1/12 of salary, No

Jay Wallmark, graduate student, 0%, No

David Rosenfield, graduate student, 0%, No

Todd Rayburn, graduate student, 0%, No

Key Scientific Question(s)/Technical Issues:

The major goal of the research is to study the interaction between the near-shore and off-shore processes during extreme weather events by using numerical modeling. The research is based on the Princeton Ocean Model and takes into account the recently suggested approaches to describing wave-currents interaction and the land-sea boundary motion.

Short term objectives: To analyze the effects of moving sea-land boundary and current-wave interaction on storm surges in the near-shore region

Long-term objectives: To advance our understanding of the dynamical links between coastal circulation and near-shore processes during extreme weather conditions to improve modeling and monitoring of the coastal circulation. More precisely, to develop special algorithms that will allow us to predict water level variations and water quality, debris and pollutant transports, to estimate effects of coastal restoration activities on sediment transport and to assess other environmental and economical impact of severe weather events. By these efforts we plan to contribute to the establishment of regional modeling systems off the Mississippi, Alabama and western Florida coasts and the integrated National Backbone for the northern Gulf.

Collaborators/Partners:

Naval Research Laboratory, 01/2007, non-monetary support to project. Short description of collaboration: comparison of the POM wave model results with SWAN wave model.

Naval Oceanographic Office, 09/2006, non-monetary support to project. Short description of collaboration: NGI provides educational services related to numerical modeling of coastal circulation and wave dynamics, NAVOCEANO provides some observational data.

Florida State University, COAPS, 2/2008, non-monetary support to project. Short description of collaboration: we discussed possible exchange of modeling results when COAPS provides simulated data for the whole Gulf of Mexico, needed for open boundary conditions for our model, and we assess influence of wave-current interactions and effects of storm surge on shelf processes.

Project Duration:

February 1, 2006 - 12/2009

Project Baselines:**Contributions to specific NOAA Goals/Objectives:**

The project will support NOAA's mission to improve capabilities for monitoring, assessment and prediction of severe weather events in the near-shore region.

Contributions to regional problems and priorities:

The project is aimed at the establishment of regional modeling systems off the Mississippi, Alabama and western Florida coasts and the integrated National Backbone for the northern Gulf.

Gaps:

The analysis of the effects of moving sea-land boundary and current-wave interaction on storm surges in the near-shore region.

Project Abstract

The major goal of the research is to study the interaction between the near-shore and off-shore processes during extreme weather events by using numerical modeling. The model is based on the Princeton Ocean Model and takes into account the recently suggested approaches to describing wavecurrents interaction and the land-sea boundary motion. The advanced numerical model capable of simultaneous reproduction of coastal dynamics and near-shore processes in the Northern Gulf of Mexico is developed.

The short-term objective of the proposed research is to analyze the effects of moving sea-land boundary and current-wave interaction on storm surges in the near-shore region. The long-term objective is to advance the understanding of the dynamical links between coastal circulation and near-shore processes during extreme weather conditions to improve modeling and monitoring of the coastal circulation. More precisely, to develop special algorithms that will allow us to predict water level variations and water quality, debris and pollutant transports, to estimate effects of coastal restoration activities on sediment transport and to assess other environmental and economical impact of severe weather events. By these efforts we plan to contribute to the establishment of regional modeling systems off the Mississippi, Alabama and western Florida coasts and the integrated National Backbone for the northern Gulf.

List major milestones completed and describe any significant research results and transitions.

Milestones completed:

- An algorithm allowing to model effects of the moving sea boundary under strong wind action. Preliminary analysis of interaction of near-shore processes with shelf-break and shelf currents. **Done:** the algorithm was tested. The effect of the moving sea/land boundary was analysed for the model configuration including tides and islands simulating Mississippi Bight.
- An algorithm allowing to model effects of the wave-current interactions under strong wind action. **Done:** the wave model algorithm was tested and compared against the SWAN wave model. Comparison showed quantitative agreement between the models, while the POM wave model is approximately 10 times more efficient for the considered problem.
- Analysis of available observations required for setting up the experiments to study the effects of extreme weather events on off-shore and near-shore circulations. **Done.**
- Project report, presentations at CI workshops and scientific meetings, and submission of manuscripts for peer-reviewed journal articles. **Done.**

Research results:

A comparison of POM wave model with SWAN: this effort involved validating the Mellor-Donelan wave model used in POM against an accepted standard wave model, in this case SWAN. SWAN is a third-generation phase-averaged wave model that computes random, short-crested, wind-generated waves in coastal regions and inland waters. SWAN’s capabilities include modeling of wave propagation in time and space, shoaling, refraction due to current and depth, frequency shifting due to currents and non-stationary depth; wave generation by wind; nonlinear wave-wave interactions (both quadruplets and triads); white-capping, bottom friction, and depth-induced breaking; blocking of waves by current. Results of comparisons are shown in Figure 1.

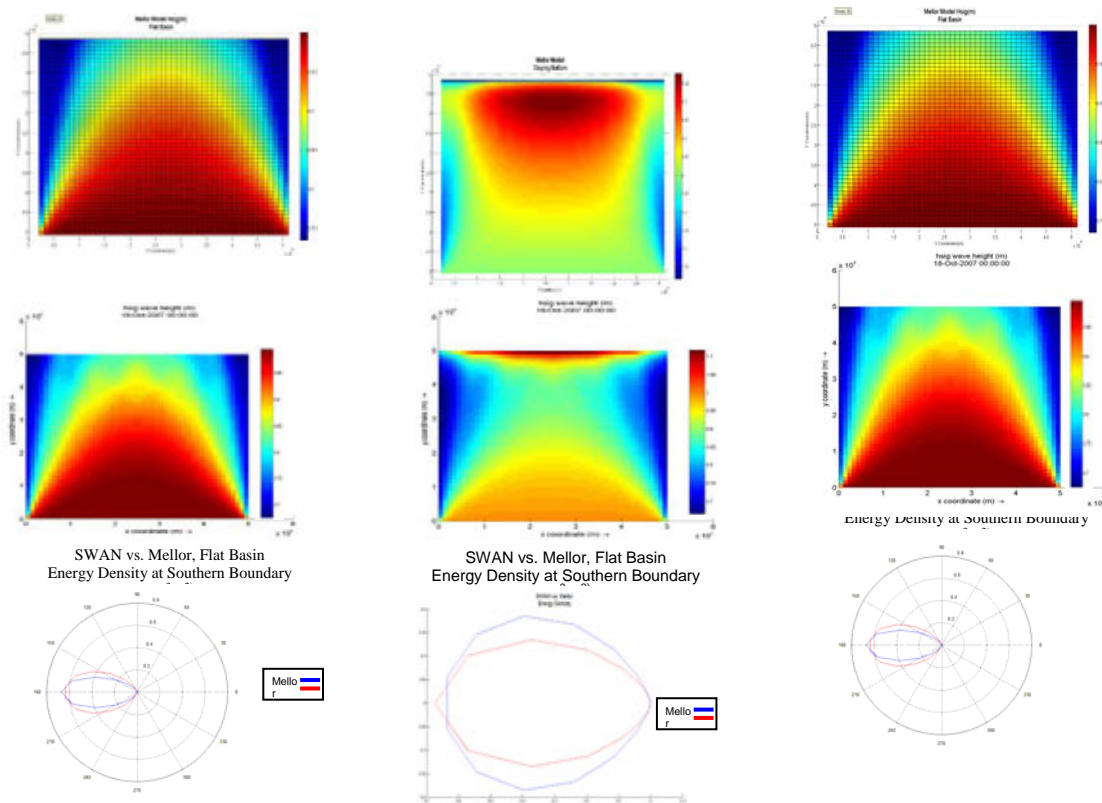


Figure 1. Significant wave height (upper row – POM results, middle row – SWAN results) and directional wave energy spectra (lower row) in SWAN (blue line) and POM (red line) wave models for configurations with flat (left and right) and sloped bottom (middle column).

Figure 1 presents the characteristics of the wave field generated by winds (left and middle columns) and by incoming swell (right column) in the coastal model region with flat and sloped bottom. The wave field characteristics are used to compute wave-current interaction terms, which appear to be quantitatively close for SWAN and POM wave models.

Experiments for validation of the Wetting and Drying Scheme: We analyzed the effects of variable sea-land boundary on the shelf circulation in two cases: (1) tide driven currents, (2) wind and tide driven currents. Comparison is done against the POM model results without wetting and drying scheme. The tides with 1m maximum range were forced at the open boundary. 30 m/s winds are set from 180°.

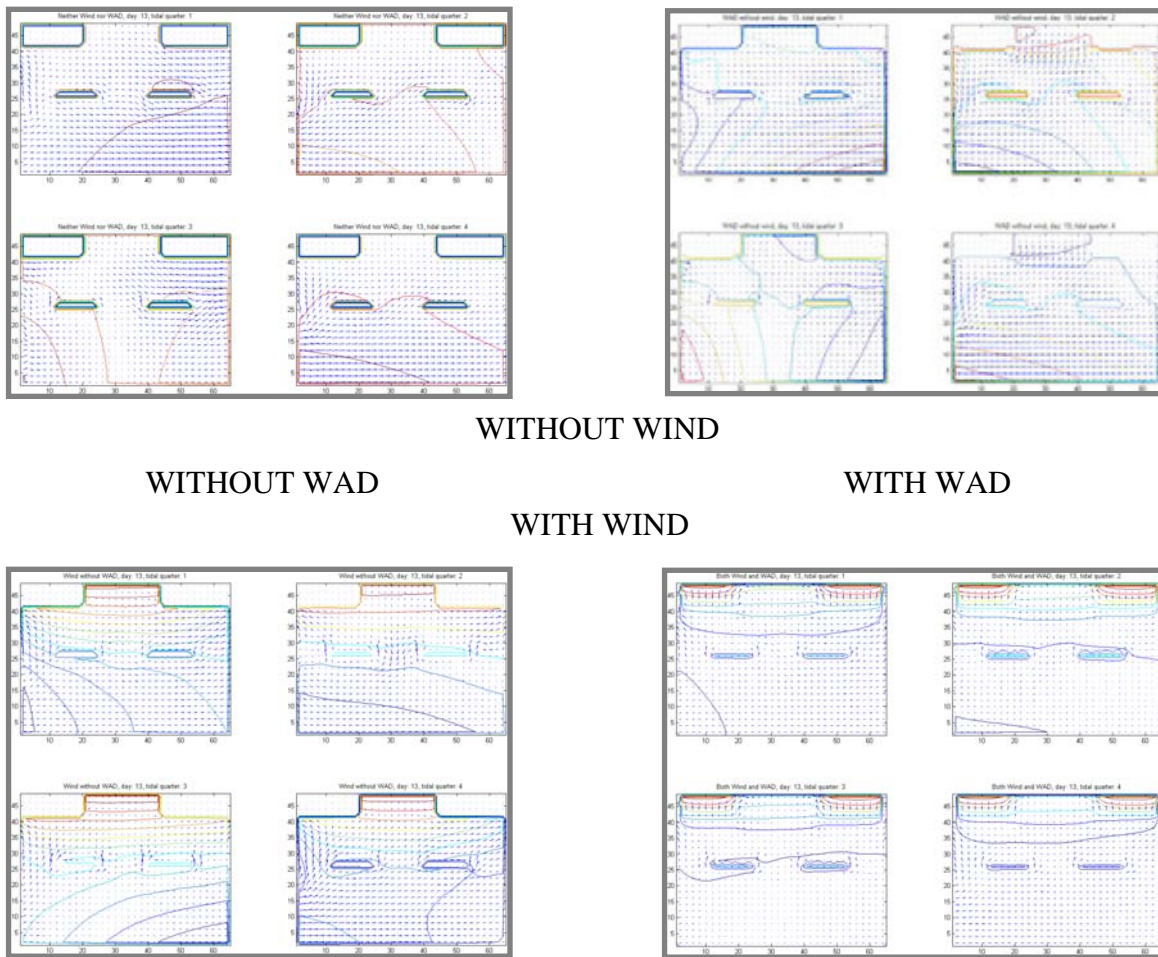


Figure 2. Sea surface elevation and current velocity vectors for four phases of the diurnal tide. Left panels show the circulation patterns with fixed sea/land boundary, right panels - with moving sea/land boundary. Upper panels demonstrate the effect of moving sea/land boundary on the distribution of tides. In lower panels the effect of wind surge on shelf circulation is also considered.

The experiments conducted for validation of the Wetting and Drying Scheme demonstrated importance of this mechanism for both near-shore and off-shore circulations.

Outreach activities

General Description:

Poster presentations were given at the first and second NGI conferences. We trained our two graduate students from NAVOCEANO by providing relevant courses of lectures and advising research along the project lines. We disseminated objectives of the study and the preliminary research results on the Invited Professional Seminar: Kamenkovich, V., D. Nechaev: On the time-splitting scheme used in the Princeton Ocean Model. Seminar of the Mathematical Department of the USM, Hattiesburg, MS, October 26, 2007.

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

Kamenkovich, V. M., D. A. Nechaev: On the time-splitting scheme used in the Princeton Ocean Model. Submitted to J. Computational Physics in 01/2008 (49 pp; 1 fig. + 7x2 figs. + 9x4 figs.).

List non-refereed articles and reports for this project:

J. Wallmark, V. Kamenkovich, D. Nechaev, Simulating onshore saline transport during hurricane Katrina. The Journal of the Mississippi Academy of Sciences (ISSN 0076-9436), Vol 53, No. 1, 89-90, January 2008.

List conference presentations and poster presentations for this project:

V. Kamenkovich, D. Nechaev, J. Wallmark, Interaction between off-shore circulation and near-shore processes during extreme weather events, 2008 Annual Northern Gulf Institute Conference, Biloxi, MS, May 2008. Poster.

J. Wallmark, V. Kamenkovich, D. Nechaev, Simulating onshore saline transport during hurricane Katrina. MAS, Seventy-second Annual Meeting, February 20-22, 2008.



Satellite and In Situ Optical Assessment of Algal Bloom Events in the Northern Gulf of Mexico

NGI Project File Number: 07-USM-05

PIs, Email, and Affiliations:

Steven E. Lohrenz
 Department of Marine Science
 The University of Southern Mississippi
 Stennis Space Center, MS 39529
 228-688-3177
Steven.Lohrenz@usm.edu

Vernon L. Asper
 Department of Marine Science
 The University of Southern Mississippi
 Stennis Space Center, MS 39529
 228-688-3177
Vernon.Aasper@usm.edu

Xiaogang Chen
 Department of Marine Science
 The University of Southern Mississippi
 Stennis Space Center, MS 39529
 228-688-3177
Xiaogang.Chen@usm.edu

Gregory A. Carter
 Gulf Coast Geospatial Center
 The University of Southern Mississippi
 1203 Broad Ave.
 Gulfport, MS 39501
greg.carter@usm.edu

List all personnel funded by this project:

Name	Role	Percent of Salary Funded	Located at NOAA Lab?
Steven E. Lohrenz	Principal investigator	4.2%	No
Gregory Carter	Principal investigator	4.2%	No
Vernon Asper	Principal Investigator	0 (4.2% in kind)	No
Xiaogang Chen	Research Scientist	0%	No
Dan Holiday	Student	0%	No
Joel Borden	Student	25%	No

Key Scientific Question(s)/Technical Issues:

- Develop capability for glider-based optical assessments of algal bloom events in the northern Gulf of Mexico;
- Evaluate the utility of underway hyperspectral above-water radiometry for discrimination and mapping of algal bloom phenomena and other optically distinct features in complex coastal waters;
- Relate satellite observations to in situ discrete analyses of phytoplankton taxa and environmental variables at selected sites;

Collaborators(s)/Partners:

Collaborating Organization	Date Collaboration Established	Does Partner Provide Monetary Support?	Does Partner Provide Non-monetary Support?	Short Description of Collaboration
Dauphin Island Sea Lab	July 2007	No	No	HAB species taxonomic and population density data provided at no cost
Alabama Department of Public Health	July 2007	No	No	HAB species taxonomic and population density data provided at no cost
Naval Research Laboratory - Stennis	July 2007	No	No	Ocean color data and data products

Project Duration:

Start Date: Feb 1, 2007

Estimated End Date: June 2009

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

The objectives of this project are closely aligned with NOAA’s strategic Ecosystems goal, specifically as it relates to the “Forecasting ecosystem events” research area. The project is directly relevant to the performance objective as stated in NOAA’s Five Year Research Plan to “Increase number of regional, coastal, and marine ecosystems delineated with approved indicators of ecological health and socioeconomic benefits that are monitored and understood” and the related NOAA 0-2 Year Milestone to “Define the primary forcing factors and time and space scales that cause HABs and anoxia for selected coastal, ocean, and Great Lakes regions.”

Contributions to regional problems and priorities:

The objectives of this project are closely aligned with the Gulf of Mexico Alliance (GOMA) Water Quality priority, which addresses the need “to improve the detection and forecasting of harmful algal blooms (HABs) in the Gulf of Mexico and to better understand the public health and socioeconomic effects of bloom events.” Specifically, this project relates to various GOMA 2006-2009 Action Blueprint and Commitments as laid out in the GOMA Governors’ Action Plan including participation in “workshops with local, state and federal expert scientists to train personnel in HAB field sampling and microscopic identification methods and to demonstrate

toxin-detection methods...”, advancing “technologies for rapid field screening and enhanced realtime remote sensing, platform sensing and autonomous sensing of HABs”, and researching “the relationship between anthropogenic activities and planktonic cell counts – environmental conditions that lead to bloom conditions and test new HAB detection and tracking technologies for routine use in observation, monitoring and forecasting programs.” We are also working in conjunction with local agencies to develop improved capabilities for monitoring HAB events in the northern Gulf and by providing improved tools for federal, state, and local resource managers and regulators to make informed decisions regarding the distributions of algal blooms.

Gaps: (Describe how the project will narrow gaps in regional knowledge, data, model performance, geographic coverage, etc.)

This project will expand our understanding of the types of HABs that may occur in the northern Gulf of Mexico and their relationship to environmental conditions that lead to bloom events. At present, there is a lack of information regarding the types of HABs and their frequency and extent in the northern Gulf of Mexico. This project will specifically address that knowledge and data gap. In addition, this project explores the use of new technologies to enhance detection and monitoring capabilities for HABs and algal blooms in general.

Project Abstract

There is a need to develop and implement robust protocols for harmful algal bloom (HAB) recognition, monitoring, and impact assessment on a national level. An effective method of bloom classification will contribute to a better account of the incidence, trends, and causative factors of harmful algal bloom events. This project seeks to examine the feasibility of detection of diagnostic optical patterns that allow identification and characterization of harmful algal bloom events. The primary goal of this second year of the project is to refine and evaluate optical and satellite-based approaches to detect and monitor bloom events of harmful algal species in Gulf of Mexico waters. Our objectives can be organized into three major efforts including: 1) development of a capability for glider-based optical assessments of algal bloom events in the northern Gulf of Mexico; 2) evaluate capabilities for rapid, high resolution above water hyperspectral radiometry as a means for mapping of algal bloom phenomena and other optically distinct features in complex coastal waters; and 3) relate satellite observations to in situ discrete analyses of phytoplankton taxa and environmental variables at selected sites. It is anticipated that this three pronged approach will yield a predictive capability for environmental conditions conducive to HAB development in turbid waters.

List major milestones completed and describe any significant research results and transitions:

Milestones are described in the following paragraphs and are organized according to each of the three major project objectives.

Objective 1: Develop capability for glider-based optical assessments of algal bloom events in the northern Gulf of Mexico

USM currently operates a Web Slocum glider (Figure 1) as part of the Central Gulf of Mexico Ocean Observing System (CenGOOS). We are working with colleagues at the Mote Marine Laboratory to integrate the Optical Plankton Discriminator (OPD or “Brevebuster”) into the glider payload and conduct glider missions (Figure 2) in conjunction with in situ sampling to determine the capabilities for discriminating algal signatures from other optical constituents (i.e., CDOM, detritus). Initial efforts consist of personnel training and evaluation of the instrument. Glider deployments will be conducted over a regular sampling line or in response to bloom events detected either through routine water sample analyses or

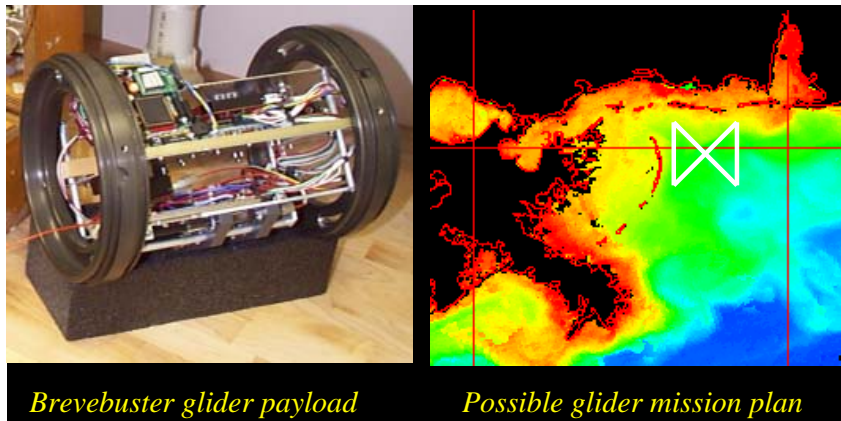
Figure 1



Brevebuster equipped AUV is launched into the Gulf of Mexico. Photo courtesy of Mote Marine Laboratory

based on inspection of satellite imagery (e.g. NOAA HAB-FS Bulletin). Prior results using a prototype version of the Brevebuster off the west Florida shelf showed a good relationship between *K. brevis* similarity index and cell counts (G. Kirkpatrick, unpublished). Due to delays in the acquisition and installation of the Brevebuster on the USM vehicle, AUV glider deployments are not planned until later this summer. This will coincide with the period when blooms are most likely to occur (late summer to fall).

Figure 2



Objective 2: Evaluate the utility of underway hyperspectral above-water radiometry for discrimination and mapping of algal bloom phenomena and other optically distinct features in complex coastal waters

To evaluate the utility of hyperspectral reflectance for monitoring and detection of *K. brevis* blooms, we used data derived from hyperspectral measurements of

remote sensing reflectance, R_{rs} , measured on a cruise during 18-21 September 2006 aboard the R/V Suncoaster. Phytoplankton absorption (a_{ph}) was retrieved from R_{rs} spectra using the Lee et al. (2002) quasi-analytical algorithm (QAA). The retrieved a_{ph} spectra were compared to a reference absorption spectrum obtained from laboratory measurements of a *K. brevis* culture using the similarity index (SI) method (Millie et al., 1997). The SI was significantly correlated with cell concentrations (Figure 4), although shallow water (<10 m) stations 33, 34 and 35 were omitted as they yielded high values of SI even in the absence of *K. brevis* cells (data not shown).

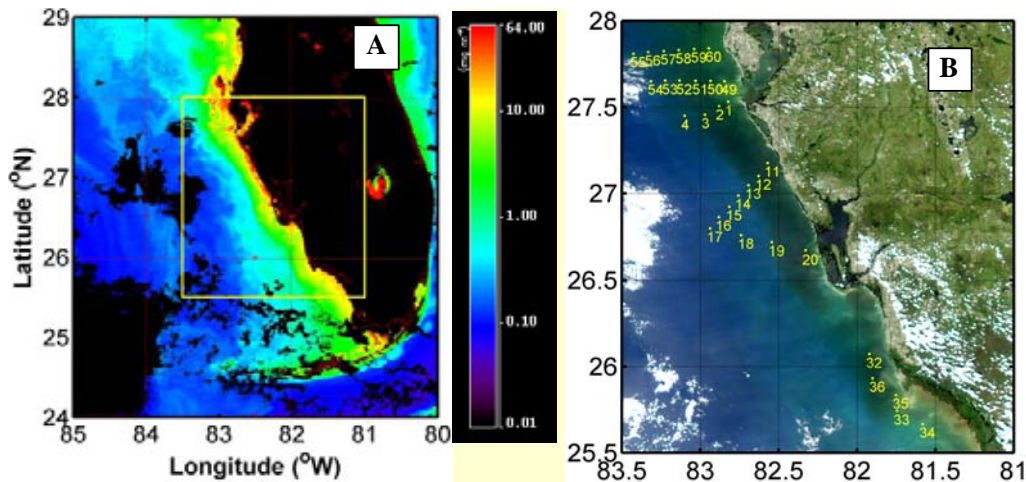


Figure 3. A) Chlorophyll distributions derived from MODIS Aqua for 21 September 2006 showing relatively high concentrations in the nearshore region during a *K. brevis* bloom event off Tampa Bay. The yellow box corresponds to the image areas in B and C; B) MODIS Aqua 250 m resolution RGB image for 21 September 2006 with stations locations;

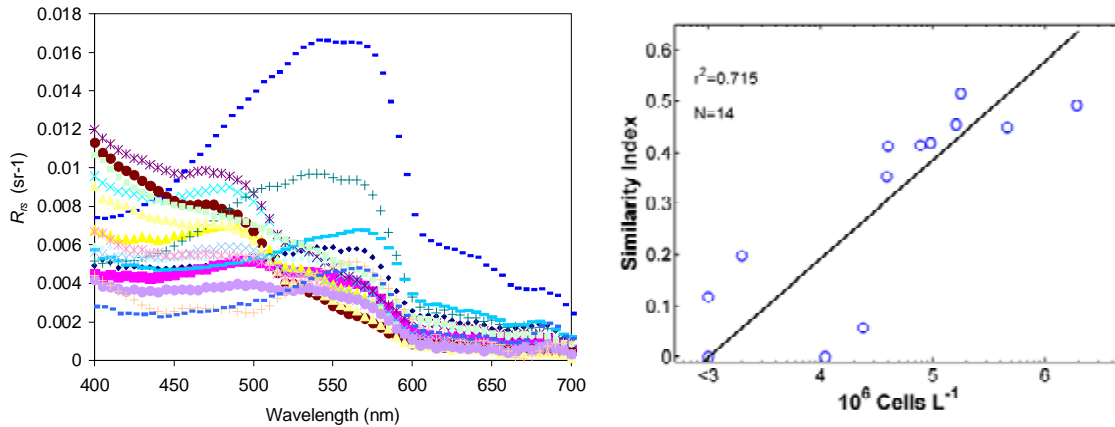


Figure 4. In the left panel, remote sensing reflectance, R_{rs} , is plotted versus wavelength as determined using the ASD radiometer. Right panel shows a plot of the similarity index derived from R_{rs} as described and related to *K. brevis* cell counts.

Objective 3: Relate satellite observations to in situ discrete analyses of phytoplankton taxa and environmental variables at selected sites;

For our third objective, we have collaborated with Dr. Hugh MacIntyre at the Dauphin Island Sea Lab (DISL) and the Alabama Department of Environmental Management (ADEM) and the Alabama Department of Public Health (ADPH) to provide enumerations of HAB species and other environmental variables at various locations in the northern Gulf.

Historical In Situ Data

Water samples were collected at 3-6 week intervals from July, 2005, through June, 2006, at 12 sites in Mobile Bay and 5 sites in the Mississippi Sound (Figure 5).



Figure 5

Water samples were transported to DISL laboratories where pigment type and concentrations, spectral absorption, cell number, particulate organic nitrogen and carbon (PON, POC), and inorganic nutrient concentrations were determined. Subsamples were transported to the ADPH for light microscopy analysis of taxa and population cell counts. All in situ data were provided by the EPA-funded project number X-8319041, entitled “Environmental Monitoring and Primary Production in Mobile Bay: A Research and Education Initiative”, Drs. Hugh MacIntyre and John Dindo, DISL, Principle Investigators.

Stepwise regression analyses determined relationships between phytoplankton population data and in situ nutrient data. Independent variables included SST, PPT, Chla, TSS, total carbon (TC), total nitrogen (TN) and total phosphates (TP). Selected nutrients were chosen for their known importances in phytoplankton population cycles, eutrophication of estuaries and correlation with comparable satellite-derived data products. Phytoplankton species used for MODIS and SeaWiFS statistical analyses were chosen based on number of occurrences in samples and correlation with corresponding in situ measurements. Stepwise regression determined the satellite-derived variables that related most strongly with phytoplankton population data. Species used represented those with highest correlations to in situ values and those with greatest economic importance (e. g. the dinoflagellate *K.*

brevis and the diatoms *Pseudo-nitzschia* spp.). These analyses are providing a baseline for the development of HAB prediction models given satellite-derived water conditions.

Satellite Observations

Concurrent with in situ sampling dates, daily and weekly composite MODIS Aqua and SeaWiFS imagery at 1 km resolution encompassing the Mississippi Bight region in the northern Gulf of Mexico were acquired from the NRL. Satellite-derived data products from the NRL included Particulate Organic Matter concentration (POM), Particulate Inorganic Matter concentration (PIM), Total Suspended Solids concentration (TSS), CDOM absorption (412 nm), detrital absorption (412 nm and 443 nm), phytoplankton absorption (443 nm), sediment absorption (443 nm), backscattering coefficient (555 nm), sea surface temperature (SST), chlorophyll-a (Chla) (MODIS oc3m and SeaWiFS OC4M algorithms), diffuse attenuation coefficient at 490 nm, and remote sensing reflectance at 11 band central wavelengths (MODIS rrs_412, 443, 488, 531, 667; SeaWiFS rrs_412, 443, 490, 510, 555, 670). Regression analyses determined relationships of these data products with in situ and phytoplankton population data. Results were used to determine functionality for use in predictive modeling, i.e., the satellite products best suited for modeling purposes.

Results and Discussion

Phytoplankton population surveys indicated high diversity, with samples often including tens of genera and high cell counts (>1,000,000 cells/L). Collections represented 13 phyla and 95 genera. Multiple regression analyses were performed using in situ values of Chla, TSS, PPT, SST, TC, TN, TP, and nitrates plus nitrites as independent variables (Table 1). These variables were chosen due to their importance in phytoplankton biology, eutrophication of estuaries and relationship with corresponding satellite-derived variables.

Table 1. Results of multiple regression analyses for the most frequently-encountered species (n) in Mobile Bay and Mississippi Sound showing the strongest relationship (r^2 value) with an independent variable.

Species	Variable	r^2 value	n
<i>Gonyaulax digitale</i>	chl	0.9228	18
<i>Katodinium glaucum</i>	sst	0.1963	65
<i>Karenia brevis</i>	chl	0.4756	25
<i>Scripsiella trochoidea</i>	chl	0.6750	67
<i>Chaetoceros</i>	ppt	0.0933	88
<i>Pleurosigma</i>	sst	0.2630	112
<i>Pseudo-nitzschia</i>	ppt	0.0591	93
<i>Nitzschia</i>	chl	0.5694	41

Four species were chosen for analyses with MODIS and SeaWiFS data products, including the dinoflagellates *G. digitale* and *K. brevis* and diatoms *Pseudo-nitzschia* spp. and *Chaetoceros* spp. (Table 1). Analyses focused on these taxa due to their high rate of occurrence in sampling (range= 18 – 93), taxonomic relationship with known HAB species and correlations between species occurrence and nutrient data ($r^2 > .5$). Populations of Chlorophytes, Cryptophytes, and Cyanophytes exhibited seasonal dominance and occur typically in freshwater, responding to seasonal cycles of rainfall and runoff into the GOM. Thus, these taxonomic groups were not included in subsequent analyses.

The NASA Ocean Biology Processing Group (OBPG) at Goddard Space Flight Center provides chlorophyll estimations, attenuation coefficient products, aerosol corrections, and water leaving radiance data for both MODIS and SeaWiFS imagery, although these products are primarily designed for Case I, oligotrophic waters

(O'Reilly, et al., 2002) and tend to perform poorly in optically complex Case II waters. The NRL has developed statistically based bio-optical models to estimate sediment/detrital absorption (a_{sd}), CDOM absorption (a_g), and TSS absorption (TSS_gould). These algorithms were developed for northern GOM waters using regional in situ collections of physical data and multi-year SeaWiFS imagery (Greene, et al., in review) and have been applied to both MODIS Aqua and SeaWiFS data. However, these algorithm products exhibited weak relationships with phytoplankton population data (ranging from $r^2 = .02$ to $r^2 = .17$). Patterns seen in relationships between phytoplankton populations and satellite-derived values are being further explored with the goal of developing predictive models. The knowledge engineer function within Erdas Imagine v7 is being used to formulate decision tree analyses (Figure 6) utilizing the range of satellite-derived values available through the NRL and NASA OBPG. Daily and weekly SeaWiFS or MODIS Aqua images containing Chlorophyll estimates, diffuse attenuation coefficients at 490 nm, TSS, a_g , a_{sd} , and reflectance band data are imported by the software and a decision tree model is applied. Those pixels that contain data meeting all criteria relevant to bloom formation by a particular species or within a given ecological condition will be shown as a data product and the location of that pixel is shown as a data product output.



Figure 6

Summary

Historically, comparison of existing satellite data products and development of new bio-optical algorithms has been a major research focus (Babin, et al., 2003). Particular emphasis has been placed on studies involving near-shore waters (Tomlinson, et al., 2004; Stumpf, et al., 2003) as a result of increasing focus on affects of phytoplankton blooms. MODIS and SeaWiFS data products have been designed to retrieve Chla concentration with the purpose of achieving better performance in Case II waters without compromising their performance in Case I waters. In this study, we have found the use of SeaWiFS algorithm products to be of more utility than those of MODIS Aqua. SeaWiFS data have consistently performed better in statistical analyses with in situ data, including phytoplankton population counts. Also, SeaWiFS imagery products are more consistently available due to satellite design. SeaWiFS is capable of adjustments in its relationship to the earth's surface, using telemetry readings to minimize the influence of sunglint in output imagery (Barnes, et al., 1999). MODIS does not have this capacity, causing many daily image products to be not accessible on days when all other conditions are optimal for data acquisition.

For more information about the progress on this project including research references, please refer to this project at the NGI website: www.NorthernGulfInstitute.org.

Outreach activities:

Outreach activities for this project are coordinated under a related USM project: "Coordination and Educational Support for USM Northern Gulf Institute Activities." In addition, one of the PIs (Lohrenz) has been involved in efforts to develop a HABs Integrated Observing System in the northern Gulf of Mexico and participated in the HABs Integrated Observing System workshop in November 2007.

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

None to date.

List non-refereed articles and reports for this project.

None to date.

List conference presentations and poster presentations for this project:

Holiday, Dan, 2008, Harmful Algal Blooms In The Northern Gulf Of Mexico: Using MODIS Aqua And In Situ Data Toward HAB Prediction In Turbid Coastal Waters, Northern Gulf Institute Annual PI Workshop, Biloxi, MS, 13-14 May 2008.

Lohrenz, S.E., Summary of USM HAB Research Activities in the Northern Gulf of Mexico, 2007, Harmful Algal Blooms Integrated Observing System (HABIOS) Workshop, New Orleans, LA, 14-16 November 2007.

Lohrenz, S.E., Asper, V.L., Chen, X., Carter, G. A., Holiday, D., 2008, Satellite and In situ Optical Assessment of Algal Bloom Events in the Northern Gulf of Mexico, Northern Gulf Institute Annual PI Workshop, Biloxi, MS, 13-14 May 2008.



**Coordination and Educational Support for
USM Northern Gulf Institute Activities**

NGI Project File Number: 07-USM-06

Steven E. Lohrenz
 Department of Marine Science, The University of Southern Mississippi
 Stennis Space Center, MS 39529
 228-688-3177
Steven.Lohrenz@usm.edu

List all personnel funded by this project:

Name	Role	Percent of Salary Funded	Located at NOAA Lab?
Steven E. Lohrenz	Principal investigator	4.2% (additional 4.2% in-kind)	No
Sarah White	Program Coordinator	16.7%	No
Robin Barnett	Program Coordinator	16.7%	No
Adam Boyette	Student	25%	No
Sumit Chakraborty	Student	16.7%	No
Valerie Hartmann	Student	75%	No
Allison Mojzis	Student	25%	No
Luz Molina	Student	75%	No
MooJoon Shim	Student	100%	No
Matthew Stone	Student	100%	No
Zhengzhen Zhou	Student	50%	No

Key Scientific Question(s)/Technical Issues:

- A primary objective is to provide coordination and integration among USM-led activities associated with the Northern Gulf Institute, and among activities of other academic and federal participants;
- An additional objective is to provide graduate student support for student participation in NGI projects;
- The proposed effort will work to publicize USM activities related to the NGI in various venues;

Collaborators/Partners:

Collaborating Organization	Date Collaboration Established	Does Partner Provide Monetary Support?	Does Partner Provide Non-monetary Support?	Short Description of Collaboration
Dauphin Island Sea Lab	July 2007	No	No	Coordination of regional outreach and education activities on behalf of NGI
Gulf of Mexico Coastal Ocean Observing System Regional Association	July 2007	No	No	Coordination of regional outreach and education activities on Northern Gulf of Mexico related issues

Project Duration:

Start Date: April 2007

Estimated End Date: August 2009

Project Baselines:**Contributions to specific NOAA Goals/Objectives:**

The objectives of this project focus on education and outreach and are therefore closely aligned with NOAA's strategic Ecosystems goal, specifically as it relates to the "building capacity to support regional management" research area. The project is directly relevant to the performance objective as stated in NOAA's Five Year Research Plan to "Increase portion of population that is knowledgeable of and acting as stewards for coastal and marine ecosystem issues" and the related NOAA 3-5 Year Milestone to "Expand extension and education approaches to provide scientific information in advance of actions and regulations and to assist NOAA in fostering increased understanding and partnerships among fishers, conservation and environmental groups, coastal use community, and scientists." In addition, this project serves to coordinate and publicize the various USM NGI project activities related to other NOAA goals and objectives.

Contributions to regional problems and priorities: (i.e., How is the project tied to regional issues and priorities? Identify priority stakeholders, e.g., Gulf of Mexico Alliance, specific user groups, etc.)

This project promotes student involvement in NGI project activities providing training and education to meet regional needs for resource management and environmental stewardship. The project is directly aligned with the Gulf of Mexico Alliance (GOMA) Environmental Education priority, which addresses various actions including "coordinating education and outreach activities across the Gulf States to increase access to materials and programs that address Alliance priority issues", "Translate, communicate and disseminate relevant scientific data and information to the public, including students, educators, resource managers, local decision-makers and the business community improve the detection and forecasting of harmful algal blooms (HABs) in the Gulf of Mexico and to better understand the public health and socioeconomic effects of bloom events", and "Promote an environmentally literate citizenry who understands the relevance of the Gulf of Mexico watersheds and coasts to the quality of their everyday lives and to the economic vitality of the region and the nation."

Gaps: (Describe how the project will narrow gaps in regional knowledge, data, model performance, geographic coverage, etc.)

Coordination and publicity of the multiple research activities is a key element to the success of the NGI and of USM's contributions specifically. This project seeks to provide needed support for critical elements of coordination, outreach and graduate education for the central northern Gulf of Mexico region. In addition to the outreach and education mission of this project, this effort serves to coordinate activities among the different USM projects, which address various aspects of the mission and goals of the NGI. Five of the projects comprise complementary studies focused on northern Gulf ecosystem management and ecosystem hazards (specifically hazards to human health and living marine resources). These studies together will address issues including detecting and tracking of microbial contamination, nutrient loading, seasonal and interannual development of stratification and hypoxia, the effects of hypoxia on the benthic community, and how both restoration and degradation of emergent salt marshes and oyster reefs affect secondary production both locally and on the larger ecosystem. Some of these projects are further linked by common sampling programs (e.g., the two monitoring and assessment projects). The information for the coastal region provided by this work will also establish a baseline for assessing climate change. Two other studies are concentrated on methods for improving storm surge models and strategies for high accuracy GPS positioning in the offshore marine environment, both critically important to the NGI theme of ecosystem hazards. The storm surge modeling project will also enhance capabilities for

improved prediction in response to climate change. The interactions between these projects will be strengthened through quarterly PI conferences.

USM NGI Projects 2008	NGI Theme 1	NGI Theme 2	NGI Theme 3
	Ecosystem Management	Coastal Hazards	Climate Change
Coordination and educational support for USM NGI activities	X	X	
Utility of ionosphere & troposphere models for extending Range of high-accuracy GPS		X	
Interaction between off-shore circulation & near-shore processes during extreme weather events		X	X
Microbial source tracking & and its application to the northern Gulf of Mexico	X	X	
Monitoring & assessment of coastal and marine ecosystems in the northern Gulf	X	X	X
Monitoring & assessment for ecosystem management-macrafaunal indicators	X	X	
Quantifying ecosystem services of different coastal habitat types in support of ecosystem-based fisheries	X	X	
Satellite & in situ optical assessment of algal bloom events in the northern Gulf of Mexico	X	X	

Project Abstract

The purpose of this project is to coordinate USM activities involved with the Northern Gulf Institute and provide outreach and education support for individual projects including graduate student participation in NGI projects. The objective is to provide coordination and integration among USM-led activities associated with the Northern Gulf Institute (NGI), and among activities of other academic and federal participants. An additional objective is to provide graduate student support for student participation in NGI projects. Finally, the proposed effort will work to publicize USM activities related to the NGI in various venues. Success of the NGI depends on meaningful communication among partners and within each participating organization. In addition, a principle goal of the NGI is to advance educational activities in fields associated with NOAA’s strategic goals. This project will support the overall goals of the NGI and specifically provide support for graduate student participation in NGI projects. Key findings and results will be publicized through websites, press releases, and other media outlets. Where feasible and appropriate, efforts will be made to transition research findings to operational elements within NOAA or other agencies.

List major milestones completed and describe any significant research results and transitions:

The PI will serve as a member of the NGI Council of Fellows and represent USM in meetings of the Council. In addition, the PI will arrange for regular meetings and teleconferences among USM principal investigators to encourage collaborative interactions and communication about project activities and findings. The PI will also monitor progress of USM-led projects and promote transition of research findings into operational products where feasible and appropriate.

The following tasks are being or have been performed:

Participation in Council of Fellows Teleconferences/Meeting: As the USM NGI Fellow, the PI regularly participates in NGI Council of Fellows meetings and teleconferences and provides feedback to the NGI director as requested.

Participation in Regional Workshops Relevant to NGI and NOAA Strategic Goals: The PI on this project and other USM PIs participated in the NOAA Gulf of Mexico Hypoxia Summit held at Stennis Space Center on 30-31 January 2007. Results of this meeting will guide the development of a regional hypoxia monitoring plan. The PI also participated in the Mississippi River and Gulf of Mexico Watershed Nutrient Task Force meeting in New Orleans on 12 June 2007 and plans to attend the meeting on 16-17 June 2008. The PI serves on the Steering Committee for the Gulf of Mexico Hypoxia Monitoring Implementation Plan. This activity will provide a linkage between project efforts to examine hypoxia on the Gulf coast and a regional monitoring plan. The PI participated in the Gulf of Mexico HABs Integrated Observing System workshop in November 2007 in New Orleans, LA. This activity will promote linkages between project efforts for optical and satellite detection and monitoring of HABs and regional observing activities. Finally, this project provided support for a USM PI to attend the recent Gulf of Mexico Alliance Monitoring Forum in St. Petersburg, FL held on 3-5 June 2008.

Coordination of outreach strategy with NGI and other Gulf outreach and education contacts: We are actively working with the NGI program office (Sharon Hodge, Joby Prince), other NGI partners (e.g., Tina Miller-Way), as well as other Gulf educators to develop and coordinate among the NGI institutions various educational and outreach activities. Outreach activities for this project include the following: participation by PIs and students in conferences and workshops, preparation of materials highlighting NGI projects such as the research spotlights series; preparation and submission of materials for the newsletters, NGI website, and other media outlets; and working with local businesses (e.g., casinos) to help promote environmental education. Annual summaries of the USM NGI projects have been and will continue to be submitted to the NGI program office for the Institute annual report.

NGI USM PI (and student) Teleconference/Meetings: Regular teleconferences with USM NGI PIs have been held to enhance coordination and planning among the projects and communicate information about the NGI. More frequent meetings and telecons are routinely held with the USM NGI Executive Committee members and this has helped in promoting more interaction and collaboration among USM PIs.

PI and student presentations at meetings, workshops, seminars: Various presentations on NGI-related activities have been made by the PI and students at the recent NGI Annual PI Workshop. USM is planning a special one day meeting of its own PIs sometime in January 2009 to provide an opportunity for meetings, workshops and seminars.

Media releases on NGI project activities: We continue to work with USM Marketing and Public Relations to develop news releases on NGI-related activities.

Development of graduate curricular materials from NGI projects: We continue to explore ways to incorporate information derived from NGI project activities into graduate research and course curricula.

Preparation of draft manuscripts for publication: Manuscripts from NGI project efforts are in preparation.

Outreach activities:

Outreach activities for this project are coordinated with other NGI outreach activities and include participation by PIs and students in conferences and workshops, preparation of materials highlighting NGI projects such as the research spotlights series, preparation and submission of materials for the newsletters and other media outlets, and working with local businesses (e.g., casinos) to help promote environmental education. Immediate plans include participation by USM PIs and students in upcoming events such as Bay and Bayous and Oceans 2009. The USM NGI Program Coordinator (Robin Barnett) has been working with local casino operators to promote the key card project and will assist with content for the NGI newsletter, The Portal. Other activities related to outreach have already been described in other sections in this report.

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

None to date.

List non-refereed articles and reports for this project.

None to date.

List conference presentations and poster presentations for this project.

Oral Presentations:

Lohrenz, S.E., Summary of USM HAB Research Activities in the Northern Gulf of Mexico, 2007, Harmful Algal Blooms Integrated Observing System (HABIOS) Workshop, New Orleans, LA, 14-16 November 2007.

Lohrenz, S. E., Overview of USM Capabilities for the Northern Gulf Institute, Annual NGI PI Workshop, Biloxi, MS, 13-14 May 2008.

Poster Presentations:

Brunner, C., V. Hartmann (student), and S. Howden, The Impact of Hypoxia on Foraminifera in the Northern Mississippi Bight, Annual NGI PI Workshop, Biloxi, MS, 13-14 May 2008.

Dodd, D. and S. Bisnath, Utility of NOAA Ionosphere and Troposphere Models for Extending the Range of High-Accuracy GPS, Northern Gulf Institute Annual PI Workshop, Biloxi, MS, 13-14 May 2008.

Holiday, D. (student), Harmful Algal Blooms In The Northern Gulf Of Mexico: Using MODIS Aqua And In Situ Data Toward HAB Prediction In Turbid Coastal Waters, Northern Gulf Institute Annual PI Workshop, Biloxi, MS, 13-14 May 2008.

Kamenkovich, V., D. Nechaev, D. Rosenfield (student), J. Wallmark (student), J. Veeramony, Interaction between off- shore circulation and near-shore processes during extreme weather events, Biloxi, MS, 13-14 May 2008.

Lohrenz, S.E., V. L. Asper, X. Chen, G. A. Carter, D. Holiday (student), Satellite and In situ Optical Assessment of Algal Bloom Events in the Northern Gulf of Mexico, Northern Gulf Institute Annual PI Workshop, Biloxi, MS, 13-14 May 2008.

Mojzic, A., D. Redalje, L. Guo, and Y. Cai, Bacterioplankton Abundances in the Bay of St. Louis, MS Relative to Environmental Water Quality, Northern Gulf Institute Annual PI Workshop, Biloxi, MS, 13-14 May 2008.

Fulford, R. S., M. S. Peterson, H. Perry, P. Grammer, and R. Haehn (student), Assessing the Ecosystem Value of Various Habitat Types to Fishery Production in the Northern Gulf of Mexico, Northern Gulf Institute Annual PI Workshop, Biloxi, MS, 13-14 May 2008.

Shim, MooJoon (student) and A. Shiller, The Effect of Hurricane Katrina and Floodplain Processes on the Trace Element Transport through the Pearl River, Mississippi, Annual NGI PI Workshop, Biloxi, MS, 13-14 May 2008.

Stone, Matthew (student), D. Redalje, A. Mojzic (student), S. Lohrenz and S. Howden, Physical Measurements in the Bay of St. Louis, Mississippi March 2007 – September 2007, Annual NGI PI Workshop, Biloxi, MS, 13-14 May 2008.



Quantifying Ecosystem Services of Different Coastal Habitat Types in Support of Ecosystem-based Fisheries Management

NGI Project File Number: 07-USM-07

Richard S. Fulford, University of Southern Mississippi, Department of Coastal Sciences, Gulf Coast Research Lab, 703 East Beach Dr. Ocean Springs, MS 39566, Richard.Fulford@usm.edu, 228-872-4282

Harriet M. Perry, Center for Fisheries Research and Development, Gulf Cost Research Laboratory, 703 East Beach Dr., Ocean Springs, MS 39566, harriet.perry@us.edu, 228-872-4218

Mark S. Peterson, University of Southern Mississippi, Department of Coastal Sciences, Gulf Coast Research Lab, 703 east Beach Dr. Ocean Springs, MS 39566, mark.peterson@usm.edu, 228-872-4203

List all personnel funded by this project (Person's name, Category, Percent of support by NGI, at NOAA Lab):

Rebecca Haehn, MS student, 100% salary support, No
Paul Grammer, Research technician, 100%, No
Cindy Gavins, Research Technician, 40%, no

Key Scientific Question(s)/Technical Issues:

Emphasis area 1: Habitat-production modeling of juvenile fish EFH

- 1) Delineate estuarine habitat quality for juvenile estuarine-dependent fishes in the lower Pascagoula river delta based on spatial and temporal GIS dataset of both structural and dynamic habitat characteristics.
- 2) Refine and validate an existing fish habitat-production model based on a landscape modeling approach for use as a planning tool for coastal habitat management.
- 3) Collect data on the distribution and biomass of juvenile fishes and relate it to spatial variation in structural and dynamic habitat characteristics.

Emphasis area 2: Oyster reef 2⁰ production and trophic connections to pelagic ecosystem

- 4) Collect data on oyster reef recovery from impacts of hurricane Katrina with a focus on community recolonization and changes in net secondary production through time.
- 5) Quantify the production export from oyster reefs in western Mississippi Sound to the coastal food web with a focus on recreationally important fin fishes.
- 6) Develop a food web model optimized for quantifying the energetic role of oyster reef secondary production within the coastal ecosystem as a tool for coastal planning and management.

NGI data handling and database support

- 7) Develop metrics of ecosystem services based on trophic interactions and physical habitat structure in support of ecosystem-based management in NGOM including analytical models and GIS maps.
- 8) Organize all project data in compliance with federal metadata standards in order to facilitate the creation of a database for the Northern Gulf of Mexico coastal ecosystem.

Collaborators(s)/Partners:

Rebecca Allee, NOAA Gulf Coast Services Center, no monetary support. Dr. Allee is assisting us with georeferencing and archiving project data and the development of habitat quality maps which are the principle input for the habitat quality simulation model.

Dr. Ken Heck, DISL, no monetary support, We are collaborating with Dr. Heck in the evaluation and comparison of similar oyster reef restoration projects in Mississippi and Alabama.

Mississippi Department of Marine Resources, Shellfish Division. No monetary support, data collection support provided for assessment of oyster biomass and water quality data for oyster reef study area in western Mississippi Sound. We are collaborating with MDMR in monitoring and assessment of the restoration natural oyster reef after Hurricane Katrina. Our habitat modeling work will provide valuable baseline data on how the reefs are responding to restoration efforts conducted by MDMR.

Project Duration:

Start Date *2/1/2007* Estimated End Date *1/31/2010*

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This research addresses NOAA research priorities as described in the NOAA Strategic Plan to ‘Protect, Restore, and Manage the Use of Coastal and Ocean Resources through an Ecosystem Approach to Management’ through data collection and model development in support of Ecosystem models applicable to management.

Contributions to regional problems and priorities:

The project is also directly relevant to the Gulf of Mexico Alliance theme of Ecosystem-based management. The development of modeling tools intended for management is a key milestone in the development and practical application of EBM concepts. The development of these tools will also benefit our collaborating state agency, MDMR.

Gaps:

One of the key limitations in habitat conservation and restoration plans is how to prioritize limited resources. A great deal of habitat research is focused on this question through the identification of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC). Lacking specific information EFH designations can be extremely broad resulting in little or any guidance on how to prioritize management actions. A key question in the NGOM ecosystem is whether all coastal marsh is equivalent in terms of fish nursery habitat quality or whether interactions with fish behavior, hydrodynamics, and water quality result in marsh subsets that may be more important to fish production. A second and equally important question is how important sub-tidal oyster reefs are to fish production in the NGOM ecosystem as a source of primary production. This project will provide critical data to address these two questions and also provide a model framework to guide decision making.

Project Abstract:

USM will contribute to research in support of ecosystem-based fisheries management efforts through the development of quantitative tools for measuring ecosystem services of different aquatic habitat types in the coastal Gulf of Mexico ecosystem. Ecosystem services related to habitat quality have been broadly defined (Peterson et al. 2003; Worm et al. 2006) and include nutrient recycling, amelioration of anthropogenic stressors, and the promotion of biological production. The focus of this proposal is quantifying changes in secondary production and the transfer of secondary production from two important types of coastal habitat (emergent saltmarsh and oyster reefs) to the larger coastal ecosystem in response to both habitat restoration and degradation. Deliverables from this project will be data on the habitat quality-production relationship for these two key habitat types, modeling tools for measuring and predicting fishery response to habitat change, and an assessment of habitat quality based on collected data and model analysis projected onto GIS map layers. This project will have two emphasis areas. From a fishery perspective, habitat quality can be measured in terms of how much fishery production a habitat type exports to the entire coastal ecosystem. Emphasis area 1 will address links between habitat quality in emergent marsh estuaries and production of estuarine-dependent juvenile fishes. This emphasis area will involve modeling habitat change over a broad range of scales that can be integrated with fish growth,

mortality, and movement to understand how annual and multi-annual production may be influenced by habitat change. Our approach will involve the application of a general landscape model in a coastal estuary that predicts fish production based on fish movement behavior and both spatial variation in stationary habitat and temporal variation in ephemeral habitat characteristics. We will augment and validate an existing Habitat-production model (Fulford and Peterson 2006; Schumaker 1998) and use the model to make predictions about how potential changes in marsh habitat may affect fish productivity.

Emphasis area 2 will address how secondary production on sub-tidal oyster reefs is recovering from damage caused by Hurricane Katrina and quantify the trophic connections of oyster reefs with the larger pelagic ecosystem. Key aspects of this assessment effort will include measuring secondary production at index reefs in western Mississippi Sound and correlating these data with physical conditions, oyster density, and reef location. We will also develop ecosystem models of trophic structure and how efficiently secondary production on oyster reefs is exported to the larger coastal ecosystem as fish production. Objectives include the development of a food web model for oyster reefs and comparative analyses between sites and years. Taken together, data and modeling products from both emphasis areas will be combined to develop a model tool set for both an assessment of habitat quality from a fishery prospective and a predictive tool for understanding how both human-induced change and future severe storm events may affect fishery production in terms of changes in available habitat in the coastal region.

List major milestones completed and describe any significant research results and transitions

TASK	Start Planned/Actual	Scheduled completion Planned/Actual
1. Collect data on juvenile fish distribution	Jan 07/Jan 08	Dec 09/50%
2. Collect data on oyster reef macrofauna	Jun 07/Aug 07	Dec 09/50%
3. Collect data on adult sportfish diet	Oct 06/Aug 07	Nov 09/33%
4. Data analysis and synthesis for modeling	Jun 07/Jan 08	Dec 09/25%
5. Initial validation of habitat production model	Sep 07/Sep 08	Dec 07/Dec 08
6. Initial validation of ECOPATH model for oyster reefs	Jan 07/Jan 08	Dec 08/Jan 09
7. Habitat production export analysis	Mar 07/Mar 08	Dec 09/Dec 09
8. ECOPATH/ECOSIM simulation analysis	Jan 07/Jan 08	Dec 09/Dec 09
9. Synthesis for EBFM	Jan 09/Jan 09	Feb 10/Feb 10

Outreach activities

General Description:

Outreach for this project has been coordinated among all NGI-funded projects at USM as a single project (PI: Steve Lohrenz). We will provide information to Dr. Lohrenz regarding presentations, papers published, key findings and progress, and we will participate in regular PI planning and data meetings and teleconferences. In addition we will work with Sharon Hodge of MSU and provide information to her as needed for the NGI website and other information venues.

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

No

List non-refereed articles and reports for this project.

No

List conference presentations and poster presentations for this project.

Fulford, R.S., M.S. Peterson, H. Perry, P. Grammer and R. Haehn. 2008. Assessing the ecosystem value of various habitat types to fishery production in the northern Gulf of Mexico. 2nd Annual Northern Gulf Institute Conference, 13-14 May, Biloxi, MS [Poster].



Monitoring and Assessment for Ecosystem Management – Macrofaunal Indicators

NGI Project File Number: 07-USM-08

Chet F. Rakocinski
The University of Southern Mississippi
Department of Coastal Sciences
Gulf Coast Research Laboratory
703 East Beach Drive
Ocean Springs, MS 39564
(228) 872-4284
chet.rakocinski@usm.edu

List all personnel funded by this project (Person's name, Category, Percent of support by NGI, at NOAA Lab):

Kathy VanderKooy, Research Support Staff , 46%, No

Key Scientific Question(s)/Technical Issues:

Hypoxia changes ecosystem function partly by causing shifts in abundance, body-size composition and attendant vital rates, and taxonomic composition of the macrobenthos. However, functional macrobenthic metrics have not been widely used as ecological indicators of eutrophication and hypoxia.

Collaborators(s)/Partners:

Name of collaborating organization: USM Department of Marine Science

Date collaborating established: June 2007

Does partner provide monetary support to project? Amount of support?: NO

Does partner provide non-monetary (in-kind) support? : YES

Short description of collaboration/partnership relationship.

This project is a collaborative effort with the NGI funded USM project: "Monitoring and Assessment for Ecosystem Management" (Stephan Howden, lead PI). Collaboration entails coordinated sampling and assistance with sampling logistics and transportation to sites from the USM Department of Marine Science.

Project Duration:

Start Date: Feb 1, 2007

Estimated End Date: 30-Sep-2009

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

Part of NOAA's mission is "to improve the capability of coastal zone managers to effectively prevent or reduce the ecological and economic impacts of hypoxia", and to "advance understanding, predicting, and managing the causes and ecological and economic impacts of hypoxia in representative coastal ecosystems". This project will support this effort within the central Gulf of Mexico, where hypoxia is a major concern.

This project falls within the Ecosystem Management Research Theme of the NOAA NGI Program, the stated goal of which is to, "Characterize Northern Gulf of Mexico Coastal Wetland and Fisheries Habitats, including Restoration Strategies".

Contributions to regional problems and priorities:

Hypoxia, due to high nutrient loading and resulting eutrophication, has been identified as a major water quality concern in estuaries of the East Coast and Gulf of Mexico regions of the U.S. (USEPA 1999). Moreover, population growth and global warming is exacerbating hypoxia worldwide (Wu 2002). Coastal and marine ecosystem goods and services support many societal needs, including the areas of seafood, human health, and commerce. Fulfillment of these needs depends directly and indirectly on proper ecosystem function. This project addresses the issue of assessment of proper aquatic ecosystem function within the rapidly developing Mississippi coastal zone, which was recently decimated by catastrophic Hurricane Katrina.

The goal of a former EPA funded CEER-GOM STaR grant which ensued prior to this macrobenthic monitoring project was to devise and validate practical indicators of macrobenthic function that are responsive to eutrophication and hypoxia. The NOAA CI macrobenthic project provides a test case for the use of the macrofaunal indicators as a demonstration to national and regional resource managers, such as US EPA, NOAA and MS DMR and DEQ.

Gaps:

This study will extend the use of macrofaunal functional indicators to a wider range of benthic habitats including stations at depths up to 20 m. An existing dataset only includes stations at depths up to 6 m. Moreover, there are no samples of macrofaunal functional indicators from the within the Mississippi coastal zone portion of the GoM. Such an extended dataset will facilitate the development of simulation models by other projects. A proposal to do just that was recently submitted to the NOAA Coastal Hypoxia Research Program. This proposal was selected, but not funded in 2007, due to an allocation deficit.

Project Abstract

Macrobenthic communities provide reliable indicators of biotic integrity because they (1) reside in association with bottom sediments where stress is often greatest (Schubel and Carter 1984), (2) are relatively sedentary, and thus cannot readily avoid stress (Gray et al. 1992), (3) occur on a proper spatial scale for assessing anthropogenic impacts, (4) occur on a proper temporal scale for detecting stress, as set by community-turnover intervals (Reice and Wohlenberg 1993), (5) integrate multiple environmental stresses (Rakocinski et al. 1997). Macrobenthic processes metrics should reflect changes in aquatic ecosystem function, because the macrofauna mediates trophic function by affecting rates, directions, and pathways of exchange and transformation between the water column and the sediment (Hansen and Kristensen 1997). Hypoxia changes ecosystem function partly by causing shifts in abundance, body-size composition and attendant vital rates, and taxonomic composition of the macrobenthos. However, functional macrobenthic metrics have not been widely used as ecological indicators of eutrophication and hypoxia.

This project is a collaborative effort with another USM project, "Monitoring and Assessment for Ecosystem Management" (Stephan Howden, lead PI). Macrobenthic subsystem function will be characterized through the measurement of macrofaunal indicators that may respond to hypoxia and other stressors, including production potential, biomass-size spectra, community turnover time, and trophic dynamics. In addition, the USEPA Benthic Index for the northern Gulf of Mexico will be calculated as a "benchmark". In a recent EPA sponsored study, a suite of macrobenthic functional metrics derived from the abovementioned indicators comprised two major orthogonal Benthic Indicator Functions (BF's) representing a community-maturity indicator and a production-based indicator (Rakocinski 2007). The benthic functions related better with functional environmental variables than the traditional Benthic Index (BI); and moreover, the latter indicator related most strongly to a DO-driven environmental factor.

In Year 2, ten to twelve macrobenthic sampling events will be completed in conjunction with hydrographic sampling conducted as part of the monitoring and assessment project of the USM Department of Marine Science. Subsets of likely hypoxic and reference stations will be sampled at two or three seasonal time points. Stations are

located along an onshore-offshore transect running between Saint Louis Bay and the western-most CenGOOS buoy. These macrofaunal indicators still need to be assessed in deeper near-shelf habitats, where late-summer hypoxia is caused by turbid bottom waters trapped beneath the local pycnocline.

List major milestones completed and describe any significant research results and transitions:

Plans for coordinated sampling of the NOAA-NGI USM transect have been made and implemented. Preparations for sampling have been made and necessary gear, including a precision winch, has been acquired. Funding for the project began in May 2007, so funding was delayed. Because this project is tied to the larger USM monitoring effort, the same obstacles apply to the benthic study. Specifically, there were delays in obtaining necessary vessel modifications. In September 2007 a sampling trip was made, but only three stations were completed due to excessive seas: stations 2, 4, and 8. Only one grab was obtained from Station 8 located at the CenGOOS Buoy, but this sample was obtained from the deepest site ever sampled by USM GCRL for macrofaunal indicators of hypoxia. Nevertheless, most taxa at this site were familiar ones often occurring at shallower inshore sites. Benthic samples from the September trip are processed, but the still data needs to be analyzed when more samples are acquired.

Further plans for coordinated sampling of the NOAA-CI USM transect with other USM NGI colleagues have been made and initiated. On 20 May 2008, the macrobenthic PI joined the USM Department of Marine Science team on a sampling trip along the designated transect. Unfortunately, again weather conditions were prohibitive; however, benthic samples were obtained from offshore station 6 at about 10 m depth, as well as from two inshore stations near Saint Louis Bay. Benthic samples were accompanied by samples of optical water-column properties, in situ water quality, trace metals, water column nutrients, phytoplankton abundance, HPLC, and CDOM. An especially productive macrofaunal community was noted at station 6. The May samples will serve as a benchmark of normoxic conditions. Additional sampling will ensue later in the summer, when oxygen supply conditions should become more limiting. Some plans have been made to accompany Dr. Charlotte Brunner of the USM Department of Marine Science in summer 2008 to take benthic samples using a multi-corer device, which will enable concurrent sampling of benthic foraminiferans and macrobenthos; two communities that should respond to environmental perturbation on completely different time scales. In addition, benthic sampling will be coordinated with USM NGI transect sampling in late summer and early autumn of 2008.

Outreach activities

General Description:

We have been in touch with Dr. Tina Miller-Way, who is working for the Northern Gulf Institute in the area of outreach/education. We provided slides containing narrative and images for a poster on the NGI containing images about the benthic monitoring project in the context of hypoxia for display in the DISL Estuarium. Dr. Miller-Way is actively pursuing other avenues of outreach for this and other NGI projects.

Have you hosted speakers, workshops and/or any training?

No

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

Continuing analysis of the data generated during a preceding related EPA funded project will engender at least 4 manuscripts related to the current project:

Rakocinski, C.F. Linking macrobenthic functional metrics to hypoxia using the Peters mass balance model. Submitted to Journal of Marine Biology and Ecology – Special NOAA CSCOR CHRP Symposium Hypoxia Issue, November 2007.

Ferguson, H.J. and C.F. Rakocinski. Macroinfaunal Functional Metrics for Tracking Marsh Restoration: Implementing a Practical Approach. In Press for Wetlands Ecology and Management 13 pp. doi:10.1007/s11273-008-9088-4

Rakocinski, C.F. Diagnostic comparisons of composite macrofaunal functional metrics as assessment tools within several estuarine systems. In Prep. for Ecological Applications.

Rakocinski, C.F. Variability in functional macrofaunal metrics reflects spatial and inter-annual differences in estuarine condition in East Bay, Fl. In Prep. for Ecological Indicators.

List non-refereed articles and reports for this project:

None.

List conference presentations and poster presentations for this project:

Northern Gulf Institute 2008 Annual Conference. (May 2008), Biloxi, MS. Macrofaunal Indicators of Hypoxia. (Poster).

19th International Estuarine Research Federation Conference. (November 2007), Providence, RI. Linking the Peters Mass Balance Model to Macrofaunal Indicators of Hypoxia. Invited Participant in Organized Oral Session.



DELTA Ecosystem Forecasting System

NGI Project File Number: 07-LSU-01

Dubravko Justic, Kenny Rose, Masamichi Inoue, Chunyan Li and Robert Twilley

djusti1@lsu.edu

Louisiana State University

List all personnel funded by this project (Person's name, Category, Percent of support by NGI, at NOAA Lab):

Dubravko Justic, Research Scientist, 8.3%, No
Kenny Rose, Research Scientist, 8.3%, No
Masamichi Inoue, Research Scientist, 0%, No
Chunyan Li, Research Scientist, 8.3%, No
Robert Twilley, Research Scientist, 0%, No
Shaye Sable, Postdoctoral Researcher, 100%, No
Anindita Das, Graduate Student, 16.7%, No
Eddie Weeks, Research Support Staff, 50%, No
Mo Chen, Graduate student, 20%, No

Key Scientific Question(s)/Technical Issues:

The central objective of the DELTA research plan is to understand the different types of pulsing scenarios on coastal ecosystem dynamics. There are two fundamental types of pulses that this project will investigate: 1) pulsing of controlled river diversion structures that simulate specific frequency and duration events on ecosystem state change (Breton Sound), and, 2) proposed pulsing of river water in a basin with much longer freshwater residence time (Barataria Basin). From this central objective we have developed five Research Projects that will focus on selective transects relative to the questions that are proposed: 1) DELTA observation and management system developed with funding from a Shell grant to LSU, 2) DELTA Ecosystem Modeling System (this proposal), 3) N-P-Z-F Processes, 4) Wetland-Hydro-Biogeochem Processes, and, 5) DELTA Stressors and Public Health. Each Research Project will guide specific methodological approaches described in respective sections. Our coordinated modeling and field observation system allows systematic evaluation of working hypotheses concerning how system pulses (freshwater input, storm surge, sea level) drive the geophysical and geomorphic processes that control ecosystem response in biogeochemistry (e.g. nutrient sinks) and energy flow (e.g. higher trophic levels) patterns.

The LSU NGI will utilize Breton Sound compared to Barataria Basin to: a) investigate ecosystem resiliency and responses to large-scale perturbations, b) document patterns of ecosystem state change, and, c) advance testing of models that forecast ecosystem resiliency. The effects of cyclone disturbance, climate forcings, land-surface dynamics on coastal landscapes, and their vital linkages to human land use and engineering applications will be investigated relative to the recovery of ecosystems to large scale perturbations. As one part of our knowledge-building efforts to guide restoration and recovery of estuarine and wetland systems in the Gulf of Mexico, we will evaluate the stability of former, current (i.e., post Katrina), and potentially altered stable states. The interrelationships of biological, biogeochemical, and physical processes at temporal (seconds to years), spatial (1m^2 to 100's km^2), and process level (microbial to complex population dynamics) will be evaluated within the context of human influences on river-dominated coastal ecosystems.

We proposed a coordinated observation and modeling (this project) program to track and compare different types of pulses that can change geophysical, biogeochemical and ecological characteristics of estuarine ecosystems. Our research setting is unique in that we can manipulate the duration and magnitude of water pulses at the landscape scale in two of the coastal basins (Breton Sound and Barataria Basin), and examine biogeochemical cycles over broad biological, temporal and spatial scales. This interdisciplinary approach consists of three integrated research components, each with a model and associated data collection: a) wetland-hydro-biogeochemistry processes associated with wet-dry responses from different pulsing regimes, b) nutrient – production – zooplankton – fish (higher trophic levels) coupling associated with pulsing, and c) stressors and public health issues associated with freshwater input to shallow coastal waters.

We are developing a series of linked simulation models that will allow tracking the effects of pulsed freshwater inputs through hydrodynamics, biogeochemical cycling, primary production, zooplankton dynamics, fish growth, and landscape dynamics. Each of these models necessarily operate on temporal and spatial scales appropriate for their dynamics; common development of these models will enable them to share information and be linked via the predictions of one model being used as input values for another model. Hydrodynamic models will integrate ecosystem responses (biological, biogeochemical) at the regional scale. Model predictions will be aggregated as appropriate so that all of the models generate weekly maps on a common spatial grid. In addition to the mean values of the state variables on the weekly spatial maps, we will also generate weekly maps that show the variability of each state variable that arise from the temporal and spatial aggregation. The coordinated field sampling and modeling will enable development of a consistent set of data to ensure that the different models can be calibrated to the same conditions. The proposed field effort will generate nearly three years of data on the many, short pulses, and fewer, longer pulses, and these data will be used to support the development, calibration, and validation of each of the models.

Collaborators(s)/Partners:

This Project is coordinated with the DELTA observation system developed with funding from a Shell grant to LSU. That observation system includes physical, chemical and biological information as fixed platforms and surveys (monthly) along the axis of Breton and Barataria estuaries, as well as paired wetland sites. The information from this observation system complements the existing regional monitoring programs (e.g., National Coastal Assessment, Gulf Coast Ocean Observing System; Sura Coastal Ocean Observing Program; Ocean.US), statewide monitoring programs (e.g., USGS, USACE, LDEQ, LDWF, WAVCIS) and program-specific monitoring programs (e.g., CWPPRA, NRDA).

Project Duration:

Start Date: 2/1/2007 Estimated End Date: 1/31/2010

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This project specifically addresses the NOAA's ecological forecasting initiative. The proposed approach could enhance ecological forecasting, planning restoration strategies, placement of future sensors, control of water diversion for salinity control, or predict/control harmful algal blooms.

Contributions to regional problems and priorities:

Rehabilitating the Mississippi River delta ecosystem is a formidable challenge whose failure and ineffectiveness would have huge consequences to the Gulf coast region and the nation's ecological and economic resources. The national assets within this region include 25% of U.S. coastal wetlands and 40% of all salt marshes in the contiguous 48 states. Approximately 17% of U.S. oil and 25% of its natural gas come from Gulf coastal waters. The ports of New Orleans, South Louisiana, Baton Rouge, and Lake Charles together handle more tonnage than

any other port in the world, and Louisiana operates the only super-port (the Louisiana Offshore Oil Port) in the contiguous 48 states. Louisiana ranks first among all states in the commercial harvest of menhaden, oysters, and crabs and is a major producer of shrimp. Overall, Louisiana's commercial fisheries account for about 30% of the U.S. total fish catch. The Mississippi River delta also protects one of the most culturally rich regions of the U.S., including New Orleans, by providing an important buffer against the damage from tropical storms and hurricanes. The DELTA Program will lead the huge challenge of building a coastal system science, ecology and engineering program that will provide the following benefits: (1) improve decisions to sustain ecosystem productivity and lessen the impacts from extreme natural events and human activities, (2) bring scientists and resource managers together with engineers to solve resource management problems with new public works projects, (3) focus scientific research and monitoring priorities to reduce uncertainties in ecological forecasts and improve risk management, and, (4) forecast recovery rates of natural resources to increase cost-effectiveness of ecosystem restoration projects.

Our connections to the interagency advisory committees in Louisiana and the state review team for science and engineering will facilitate a rapid transfer to the decision makers. Participants in our project participate in stakeholder meetings such as the Caernarvon Interagency Advisory Committee (CIAC), whose members represent all major stakeholders of the region. CIAC members include fishery representatives (oyster, shrimp, and recreational fishers), representatives of local governments, local landowners who care about the environment, and natural resource agencies (LA Depts. of Wildlife and Fisheries, Natural Resources (DNR), Environmental Quality, and Health and Human Resources; and US Fish and Wildlife Service, National Marine Fisheries Service, EPA, and Army Corps of Engineers.

Gaps:

Previous efforts have shown the need to understand consequences of variable hydrologic pulses, export related to higher trophic levels, and extrapolation of site-specific measurements to the whole ecosystem using integrated hierarchical models and remote sensing. The implementation of the DELTA forecasting system has broad implications to fundamental and applied research, ecosystem-based management and sustainability in the Gulf's coastal region. The DELTA forecasting system will substantially enhance existing regional monitoring and modeling programs (e.g., National Coastal Assessment, Gulf Coast Ocean Observing System; Sura Coastal Ocean Observing Program; Ocean.US; NOAA N-GOMEX continental shelf hypoxia).

Project Abstract:

The Mississippi River delta is one of the most impacted coastal ecosystems in the world including four of the most significant national issues relative to the NOAA mission: 1) climate change and sea level impacts on coastal resources, 2) hazards including hurricane disturbance to cultural, economic and natural resources of coastal regions, 3) habitat loss and ecosystem management including the loss of nearly one-third of the deltaic wetland landscape (4,500 km²) in the last one hundred years, and, 4) water quality including the periodic occurrence of one of the largest hypoxic zones among coastal ocean regions. The immense challenges to promoting the resilience of this coastal region, including the urban, industrial, and natural landscape components, represents a laboratory to develop new technologies that reduce risks to both social and natural resources.

The central tenet of the proposed research is that wetlands and adjacent waters associated with deltas are pulse-regulated ecosystems. Different spatial and temporal scales and the pattern of pulsed freshwater inputs are critical parameters controlling nutrient cycling, productivity, residence time and export, and trophic structure. The central objective of this DELTA research plan is to understand the different types of pulsing scenarios on coastal ecosystem dynamics. There are two fundamental types of pulses that this project will investigate: 1) pulsing of controlled river diversion structures that simulate specific frequency and duration events on ecosystem state

change (Breton Sound), and, 2) proposed pulsing of river water in a basin with much longer freshwater residence time (Barataria Basin). We are developing and applying a series of linked simulation models that will allow tracking the effects of pulsed freshwater inputs through hydrodynamics, biogeochemical cycling, primary production, zooplankton dynamics, fish growth, and water quality changes. Each of these models necessarily operate on temporal and spatial scales appropriate for their dynamics. Common development of these models will enable them to share information and be linked via the predictions of one model being used as input values for another model. All of the models are being implemented to the Breton Sound estuary and Barataria Basin, and will be used to generate spatio-temporal maps of key state variables. The coordinated field sampling and modeling will enable development of a consistent set of data to ensure that the different models can be calibrated to the same conditions. Both field data and models will be used to evaluate the hypotheses that contrast how energy and nutrients are propagated up the food chain and exported under the many, small and the fewer, large pulsing scenarios. Models will also be used to guide us in future data acquisition. As one part of our knowledge-building efforts to guide restoration and recovery of estuarine and wetland systems in the Gulf of Mexico, we will evaluate the stability of former, current (i.e., post Katrina), and potentially altered stable ecosystem states.

List major milestones completed and describe any significant research results and transitions:

Justic and Das completed the code for a 6-box mass-balance hydrodynamic model of the Barataria estuary and successfully calibrated the model against observed salinity and water level variations observed across the Barataria Bay (Das et al., in review). The 2002 data were used as the reference data set for model calibration. The Davis Pond diversion started operating in July 2002 and so we were able to examine system responses with and without diversion. During 2002, coastal Louisiana experienced frequent frontal passages that increased the amplitude of sea level variations significantly above the mean tropical diurnal tide range of 0.35 m. Also, tropical storm Isidore and hurricane Lili affected the area during September 2002. These storms had similar water level responses but significantly different rainfall amounts that provided a unique opportunity to test model responses to simultaneous variations in the two key forcing functions. Finally, between November 1 and December 7, 2002, the ADCP current measurements were carried out in all four tidal passes (Moffatt and Nichol, 2005). This data set was used as a benchmark against which the calibrated model was verified. The model results show that the Barataria estuary receives nitrogen through the tidal passes and releases carbon to the coastal ocean. The mean calculated tidal water discharge of $6,930 \text{ m}^3 \text{ s}^{-1}$ is equivalent to about 43 % of the lower Mississippi River discharge. The annual TOC export is 109 million kg, or $57 \text{ gC m}^2 \text{ yr}^{-1}$ when prorated to the total water area of the estuary. This carbon export is equivalent to a loss of 0.5 m of wetland soil horizon over an area of 8.4 km^2 , and accounts for about 34 % of the observed annual wetland loss in the estuary between 1978 and 2000. Compared to the lower Mississippi River, the Barataria estuary appears to be a very small source of TOC for the northern Gulf of Mexico (2.7 % of riverine TOC), and is unlikely to have a significant influence on the development of the Gulf's hypoxia.

Li has developed a 3D hydrodynamic model covering the entire Gulf of Mexico using the Finite Volume Coastal Ocean Model (FVCOM). The model has gone through constant improvements refining the mesh and resolution to include the coastal bays, lakes, barrier islands, tidal inlets, and wetlands. It now has over 260K triangles with a highest resolution of about 30 m. Simulations of tidal, river induced, and wind driven flows have been made with this model and results are being analyzed for evaluation of the performance of the model.

Sable and Rose developed a marsh community model based on a spatially-explicit, individual-based model. The model uses a 100 X 100 grid comprised of 4-m^2 cells. The population dynamics of six species are simulated: grass shrimp, inland silverside, sheepshead minnow, gulf killifish, bay anchovy, and blue crab. A one-hour time step was used for simulation of growth, mortality, reproduction, and movement for one year simulations. One of the inputs is water levels, which controls access to the marsh. This model can be used to simulate how pulses in river flow affect community dynamics and production. Currently, they are using this model as one means for integrating the results of the different project components, as an aid for designing field data collection, and for predicting the responses of the marsh community to river pulsing under current marsh conditions, degraded conditions, and projected future conditions after land building.

Outreach activities:**General Description**

The project specifically targets outreach at the state level through interactions with stakeholder groups, including the interagency advisory committees for the Breton Sound and Barataria Basins. The proposed research involves a significant amount of modeling research, with opportunities for student training in both graduate and undergraduate settings. Several Ph.D. students collaborate on this project and receive training and partial support. Finally, this project advances the educational missions of Louisiana State University by enhancing its land-grant and sea-grant institution status. The Louisiana Sea Grant Program annually sponsors “Ocean Commotion”, which brings more than 3,400 area students and teachers to LSU to learn about our coast and sea¹. Project results from LSU NGI will contribute to this program by demonstrating the complexity of ecosystem management. Undergraduate research at Louisiana State University is offered informally through research laboratories and faculty and also formally via the Undergraduate Research Opportunities Program (UROP), funded by the Louisiana Sea Grant Program. This allows talented undergraduates to conduct marine-oriented research under the supervision of faculty mentors. Finally, participants in our project will contribute to community outreach by participating in stakeholder meetings such as the Caernarvon Interagency Advisory Committee (CIAC), whose members represent all major stakeholders of the region. CIAC members include fishery representatives (oyster, shrimp, and recreational fishers), representatives of local governments, local landowners who care about the environment, and natural resource agencies (LA Depts. of Wildlife and Fisheries, Natural Resources (DNR), Environmental Quality, and Health and Human Resources; and US Fish and Wildlife Service, National Marine Fisheries Service, EPA, and Army Corps of Engineers).

Have you hosted speakers, workshops and/or any training?

No

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

Justic, D., V. Bierman, D. Scavia, and R. Hetland. 2007. Forecasting Gulf’s Hypoxia: The Next 50 Years. *Estuaries and Coasts* 30:791-801.

Das, A., Justic, D., Swenson, E. Modeling estuarine-shelf exchanges in a deltaic estuary: Implications for carbon budgets and hypoxia. *Ecological Modelling* (In review).

List non-refereed articles and reports for this project.

None

List conference presentations and poster presentations for this project:

Justic, D., Rose, K., Inoue, M., C. Li, and S. Sable. 2008. DELTA Ecosystem Forecasting System. 2008 Northern Gulf Institute Conference, May 13-14, 2008, Biloxi, Mississippi (Poster Presentation).

Rego, J. and C. Li. 2008. Interaction of tide and storm surge on a broad and shallow shelf, Ocean Science Meeting, Orlando, FL, March 2-7, 2008 (Oral presentation).

¹ http://www.lsu.edu/university_relations/oceancommotion/

- Li, C., Roberts, H., Weeks, E., Stone, G. and Z. Feng. 2008. Observation of Saltwater Intrusion into the Atchafalaya Bay, Ecosystem Functions and the Dynamic Atchafalaya River from the Old River Control Structure to the Continental Shelf, Baton Rouge, LA, Jan 10, 2008 (Oral presentation).
- Robert, H., C. Li, N. Walker and E. D'Sa. 2008. Wax Lake Delta: Depositional Architecture Delta Evolution, and Impacts Beyond Atchafalaya Bay, Ecosystem Functions and the Dynamic Atchafalaya River from the Old River Control Structure to the Continental Shelf, Baton Rouge, LA, Jan 10, 2008 (Oral presentation).
- Rego, J. and C. Li. 2007. Storm Surge Development Over a Broad and Shallow Shelf, 10th International Conference on Estuarine and Coastal Modeling, Newport, Rhode Island, Nov. 3-7, 2007 (Oral presentation).
- Li, C., M. Inoue, R. Crout, L. Rouse, S. Welsh and E. Weeks. 2007. Comparison of Non-hurricane and Hurricane Induced Inertial Oscillations in Deep Water of Gulf of Mexico, Oceans '07 MTS/IEEE Vancouver, Canada, Oct. 1-4, 2007 (Oral presentation).
- Li, C., Walker, N., Hou, A., Laws, E. and L. Huichan. 2007. Tidal Jets and Wind Straining on Mixing in Lake Pontchartrain: Numerical Modeling Using FVCOM, ERF 2007 Nov 4-8, 2007, Rhode Island (Poster presentation).
- Justic D., B. Fry, Z.J. Quiñones-Rivera, and B. Wissel. 2007. Multi-budget hypoxia models: approach, advantages and limitations. 19th Biennial Conference of the Estuarine Research Federation, November 4-8, 2007, Providence, Rhode Island (Oral presentation).
- Das, A., Justic, D., Swenson, E. M. 2007. Estuarine Shelf Exchanges in a Deltaic Louisiana Estuary: Implications for Coastal Carbon Budgets. 19th Biennial Conference of the Estuarine Research Federation, November 4-8, 2007, Providence, Rhode Island (Oral presentation).
- Justic, D., Rose, K., Inoue, M. and C. Li. 2007. DELTA Ecosystem Forecasting System. 2007 Northern Gulf Institute Conference, May 16-17, 2007, Biloxi, Mississippi (Poster presentation).
- Justic, D., Mashriqui, H. and A. Das. 2007. Modeling the impacts of Pulsed Riverine Diversions on Water Quality in the Breton Sound Estuary, LA. Advances in Coastal Restoration Research, May 17, 2007, Baton Rouge, Louisiana (Poster presentation).
- Justic, D. 2007. Estuarine-Shelf Exchanges in the Northern Gulf of Mexico: Implications for Coastal Carbon Budgets and Hypoxia. U.S. EPA Gulf Ecology Division Seminar Series, February 23, 2007, Gulf Breeze, Florida (Oral presentation).
- Das, A., Justic, D. and E. Swenson. 2007. Modeling the impacts of Mississippi River Diversions on Water Quality in the Barataria Bay Estuary. ASLO Aquatic Sciences Meeting, February 4-9, 2007, Santa Fe, New Mexico (Poster presentation).
- Das, A., Justic, D. and E. Swenson. 2007. Modeling the impacts of Mississippi River Diversions on Water Quality in the Barataria Bay Estuary. 2007 Graduate Student Symposium, March 2-4, 2007, Ocean Springs, MS (Oral presentation).



Public Health and Stressors

NGI Project File Number: 07-LSU-02

Sibel Bargu Ates ¹	sbargu@lsu.edu	225-578-0029
Eugene Turner ¹	eeturne@lsu.edu	225-578-6454
Aixin Hou ²	ahou@lsu.edu	225-578-4294
Brian Fry ¹	bfry@lsu.edu	225-578-9403

¹ Department of Oceanography and Coastal Sciences, 1001 Energy, Coast & Environment Building, Louisiana State University, Baton Rouge, Louisiana 70803

² Department of Environmental Studies, 001 Energy, Coast & Environment Building, Louisiana State University, Baton Rouge, Louisiana 70803

List all personnel funded by this project (Person's name, Category, Percent of support by NGI, at NOAA Lab):

Charlie Milan, Research Associate, 12%, No

Jessica Czubakowski, Graduate Student, 100%, No

Brian Matherne, Graduate Student, 65%, No

Key Scientific Question(s)/Technical Issues:

1. Community Biomass and Turnover. We will quantify temporal and spatial dynamics of community biomass in the two estuaries, using POM samples collected from open waters during routine monthly transects and algal growth bioassays. Because N is often a limiting element for planktonic biomass and turnover, we will also focus on quantifying N sources to the estuaries using isotope measurements of nitrate and N fixation.

2. Community Metrics. We will determine plankton community metrics, using fingerprint of microbial metabolites, nutrient bioassays (algae) and sediment records.

3. HABs. We will routinely sample estuarine waters to quantify occurrence and abundance of harmful algal species, and also begin to quantify HAB toxicity using ELISA and HPLC in water and possibly animal tissue samples. We will specifically determine the effects of nutrient loaded freshwater pulses on species community composition and phytoplankton group succession on a seasonal timescale and under varying flow regimes within Breton Sound Estuary, specifically focusing on harmful algal bloom species and will measure the potential phycotoxin production and correlate it to environmental characteristics within Breton Sound Estuary

4. *Vibrio*. We will develop qPCR protocols to detect and quantify potentially pathogenic *Vibrio* species of interest in coastal waters and study the temporal and spatial dynamics of *Vibrio vulnificus* and *Vibrio parahaemolyticus* using both culturing and molecular methods. We will also determine the impacts of physiochemical parameters (temperature, salinity, and nutrients in particular) on the development of the populations.

Collaborator(s)/Partners:

This Project will be coordinated with the DELTA observation system proposed with funding from a Shell grant to LSU.

Project Duration:

Start date 7/1/2007

Estimated end date 1/31/2010

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

The Mississippi River delta is one of the most impacted coastal ecosystems in the world including four of the most significant national issues relative to the NOAA mission: 1) climate change and sea level impacts on coastal

resources; 2) hazards including hurricane disturbance to cultural, economic and natural resources of coastal regions; 3) habitat loss and ecosystem management including the loss of nearly one-third of the deltaic wetland landscape (4,500 km²) in the last one hundred years; and 4) water quality including the periodic occurrence of one of the largest hypoxic zones among coastal ocean regions.

Contributions to regional problems and priorities:

Coastal wetland sustainability, eutrophication, sea level rise, freshwater inputs to coastal areas, and fishery productivity can all be addressed by evaluating their status and functioning in a major river system, such as at the Mississippi River Delta. Information regarding the role of hydrologic pulsing (as imitating natural flood regimes) will be of significant value to occupants of other major river systems in the world. This project will impact the educational missions of Louisiana State University in several ways by enhancing the mission of its land-grant and sea-grant institution status.

Regional Awareness:

Our connections to advisory committees in Louisiana will facilitate a rapid transfer to the decision makers. Some funds were re-allocated to investigate the consequences of the opening of the Bonnet Carre on Lake Pontchartrain in April-May 2008. This extraordinary event introduced enough nutrient-rich Mississippi River water into the lake equivalent to 126% of the volume of the lake. The present (June 2008) Chl a concentration in the lake is five times higher after the diversion, compared to the baseline value. Two formal meetings, in the spring and fall, are dedicated to the consequences to the Lake's ecology which we will attend and present our findings. The attendees include all the state and federal natural resource agencies involved in Louisiana's water quality, e.g. LaDNR, LaDEQ, USCOE, USEPA, USFWS, and the USGS.

Regional Interest:

The long-term consequences of eutrophication may include reduced biodiversity, increased dominance of opportunistic species, and changes in material and energy flows. It has become increasingly apparent that these symptoms of eutrophication are not minor and localized, but have large-scale implications and are spreading. The estuaries and coastal waters of the northern Gulf of Mexico (GOM) are classic examples of these phenomena. Concerns for the Barataria and Breton Sound Estuaries targeted for "restoration" by increased inputs of Mississippi river water thus include possible eutrophication and hypoxia, probably in localized areas. Eutrophication can also stimulate HABs and HAB toxin production. Phytoplankton toxins have been the subject of regional interest for many decades in the Gulf of Mexico. Clearly, large rivers like the Mississippi can have a significant impact on biological processes in the coastal zone and shifts in nutrients within estuaries may promote growth of potentially toxic algal species. Besides HABs, pathogenic *Vibrio* bacteria can also pose health risks in coastal systems. Infection by *Vibrio vulnificus* is one of the leading causes of seafood-related illnesses in the United States.

Regional Understanding:

We will develop, in cooperation with Dr. S. Hodge (NGI Outreach Coordinator), a formal Outreach Plan, facilitated through Louisiana Sea Grant.

Regional Acceptance:

Concerns for the Barataria and Breton Sound Estuaries targeted for "restoration" by increased inputs of Mississippi river water include possible eutrophication and hypoxia in localized areas, as well as possible increased occurrence of HABs and toxigenic *Vibrio* spp. Therefore, the results of this research have the potential to greatly enhance our understanding of the ecological function of coastal wetlands, particularly as they translate to environmental health issues, and given the importance of these issues to Louisiana, we anticipate our work will be well accepted. Our connections to advisory committees in Louisiana will facilitate a rapid transfer to the decision makers.

Gaps:

This project will contribute significantly to a number of scientific and management issues at local, regional, and global scales. Eutrophication, sea level rise, freshwater inputs to coastal areas, and public health and stressors can all be addressed by evaluating their status and functioning in a major river system, such as at the Mississippi River Delta. The burden placed on coastal water bodies by humans (e.g. as point and non-point source inputs) has

been implicated in the alarming rates of coastal eutrophication. Studies of Louisiana coastal waters document the occurrence of potentially toxic algal populations and potentially pathogenic bacteria for many years; often in bloom quantities. However, the species level response and toxin production to changing environmental conditions, and many aspects of species-specific dynamics of this microbial and algal community that contributes to bloom formation are, however, still poorly understood.

Project Abstract

Inputs of Mississippi River water change both hydrologic regime and nutrient loading to the Breton Sound and Barataria Bay estuaries. It is hypothesized that this bottom-up forcing changes in community structure and function of phytoplankton and microbial communities, creating fast turnover dynamics under nutrient-rich, fast flow-through systems. River inputs also flush marshes during flood events and likely result in a more complex mixed system in the open waters sampled during transect work. It is also hypothesized that the algal groups that will respond to eutrophication will differ between marine and fresh water systems.

The objectives of this project are to quantify temporal and spatial dynamics of community biomass in the two estuaries, using POM samples collected from open waters during routine monthly transects; determine plankton community metrics, using fingerprint of microbial metabolites, nutrient bioassays (algae), respiratory demand (whole plankton community) and sediment records; routinely sample estuarine waters to quantify occurrence and abundance of harmful algal species, and also begin to quantify HAB toxicity using ELISA and HPLC; and develop qPCR protocols to detect and quantify potentially pathogenic *Vibrio* species of interest in coastal waters and study the temporal and spatial dynamics of *Vibrio vulnificus* and *Vibrio parahaemolyticus* using both culturing and molecular methods. This project also determine the impacts of physiochemical parameters (temperature, salinity, and nutrients in particular) on the development of the populations.

List major milestones completed and describe any significant research results and transitions:

We have completed nine monthly transects (September 2007-May 2008) in Barataria and Breton Sound estuaries and have been processing water samples from these transects.

1. Community Biomass and Turnover.

R. Eugene Turner, unpublished

Twelve years of monthly transect data, including data from this collaborative project with Shell are being summarized and the trends identified. A significant drop in Chla in the Barataria Basin has been quantified.

Brian Fry. Unpublished

POM dynamics for Barataria Bay over 8 year was summarized, and relatively constant biomass patterns between seasons and years was found. The effects of diverting Mississippi River water through the Bonnet Carre Spillway into Lake Pontchartrain was also studied, especially using oxygen-18 measurements to track the turnover of river water as it is slowly flushed to the sea.

2. Community Metrics.

Eugene Turner, unpublished

A sediment core is being collected this summer. The microbial indicators are under development. A change in the sampling strategy was made when the Bonnet Carre Spillway was opened in April 2008. The algal bloom in Lake Pontchartrain is being followed and some microbial indicators being tested to see the response variables. Samples are being collected from the Barataria transect, as planned. Bioassay results are underway and a summary of analyses being done for comparisons.

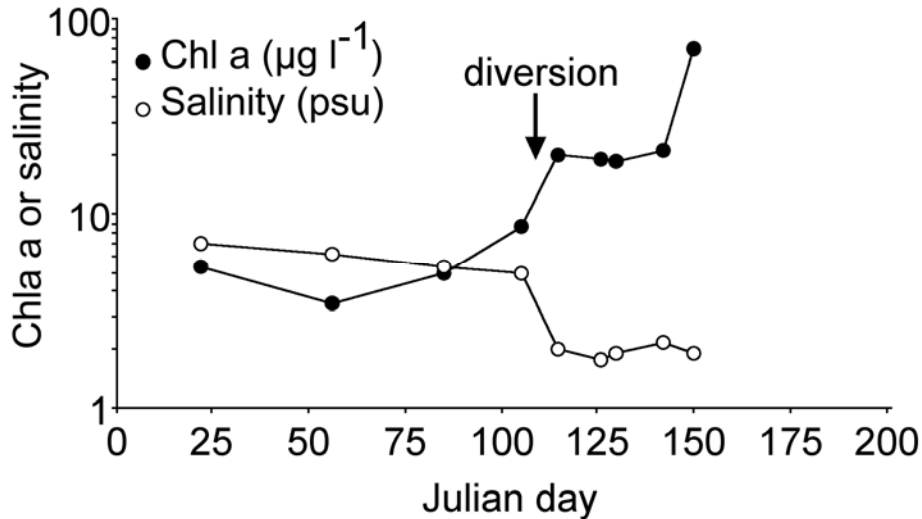


Figure 1. The average salinity and chlorophyll a (PSU and Chl a) at the 7 stations on the Causeway across Lake Pontchartrain. The salinity dropped from 7 to 1.2 psu, and the Chl a concentration rose from a baseline value of 5-8 $\mu\text{g l}^{-1}$ to greater than 70 $\mu\text{g l}^{-1}$, and continues to rise.

3. HABs.

Jessica Chuzobokowski and Sibel Bargu. 2008. *The role of nutrient loaded freshwater pulses on phytoplankton succession and phycotoxin production in Breton Sound Estuary, Louisiana. Poster presented at 2008 NGI conference, Biloxi, MS.*

Breton Sound Estuary is directly influenced by Mississippi River water from the Caernarvon Diversion, operating southeast of New Orleans on the Mississippi River since 1991. The nutrient rich freshwater is pulsed into the estuary affecting the nutrient ratios and salinity at irregular intervals creating a highly dynamic habitat. The effects of the changing salinity and nutrient ratios on phytoplankton groups, especially harmful algal species, throughout the year within Breton Sound Estuary have yet to be investigated. To examine the changes in the phytoplankton community under decreased freshwater flow, samples were taken 3 and 10 days after the discharge of freshwater was decreased to approximately 1000 cfs at Caernarvon Diversion and again 3 and 10 days after the discharge of freshwater was increased at the diversion to approximately 75000 cfs.

In general, chlorophyll concentrations were higher during low flow conditions and decreased when flow was increased into the estuary. Higher chlorophyll *a* was measured in the more saline stations, where nutrients concentrations were low. With the increase in flow, chlorophyll concentrations decreased from an average of 129 $\mu\text{g L}^{-1}$ during low flow to 55 $\mu\text{g L}^{-1}$ during the subsequent high flow. The dominant phytoplankton species for each station remained consistent over both flow regimes. However, the dominant species shifted from a chlorophyte in the upper freshwater stations to either a diatom or dinoflagellate in the lower, more saline stations. During this short study period, no harmful algal bloom species was observed. The highest chlorophyll *a* value (366.9 $\mu\text{g/L}$) measured during the pulse sampling period was observed on 24 Mar 2008 at the second low flow sampling. When the flow was increased, the chlorophyll *a* measured at the same station decreased dramatically. *Klebsormidium* sp., a green filamentous chlorophyte, was the dominant phytoplankter at this time. The corresponding nutrient concentrations of nitrate, phosphorus and silica were 1.49, 0 and 4.43 $\mu\text{M L}^{-1}$, respectively. Generally, chlorophyll increased as nitrate and silica concentrations decreased from the upper estuary to the lower estuary; where as, phosphorus concentration changes were small over the same gradient. As expected of an estuary, salinity increased from the inland stations to the outer estuary, although the salinity in the outer estuary was lower during high flow compared to low flow conditions.

Over the period of this study, we saw that decreasing the flow in Breton Sound Estuary resulted in an increase in chlorophyll concentrations, likely as a result of an increase in phytoplankton biomass. The increase in phytoplankton may have been due to the decrease in turbulence allowing calmer, more stable water. At the highest chlorophyll concentrations, the low concentrations of nutrients indicate that they were potentially incorporated into the phytoplankton biomass at that location. Subsequently, higher concentrations of nutrients measured at low chlorophyll *a* samples may indicate other factors besides nutrients, such as turbulence or grazing, controlling phytoplankton growth at these locations.

This preliminary study also shows the shift in the phytoplankton community from inland to more coastal stations, following the salinity and nutrient gradients, from a chlorophyte species to pennate diatom dominance. This shift may be a result of a change in the salinity and nutrients relative to each other from the more inland stations to the outer stations within the estuary. Because the salinity and nutrients are controlled by river discharge, the community composition of Breton Sound Estuary may be controlled by river discharge. If not controlled properly, the river discharge may promote the growth of large algal blooms that may be potentially toxic to the entire food web.

Ana C Gracia, Sibel Bargu, Padmanava Dash, Nan Walker. 2008. Evaluating a Potential Risk to Louisiana's Blue Crab Fishery: Exposure of the estuarine blue crab (Callinectes sapidus) to cyanotoxins present in Lac des Allemands, LA. Poster presented at 2008 NGI conference, Biloxi, MS.

Life history characteristics, particularly prey preference, make the blue crab (*Callinectes sapidus*) especially vulnerable to toxin contamination. Lac des Allemands, located within the Barataria Estuary System of Louisiana, contains many hepatotoxin- and neurotoxin- producing cyanobacteria, and accelerated eutrophication may be leading to more frequent occurrence of toxic blooms. Our interests for this study focus on the toxin-producing phytoplankton community found within Lac des Allemands, and the potential exposure of blue crab to these phycotoxins. Light microscopy was used for the enumeration of the toxin producing cyanobacterial cells of *Cylindrospermopsis*, *Microcystis*, and *Anabaena* spp. Enzyme-Linked Immunosorbent Assay (ELISA) was used to quantify cyanotoxins present within blue crab tissue and water samples taken from Lac des Allemands.

While *Microcystis* spp. were present at highest concentrations (6.8×10^4 cells mL⁻¹; Figure 2) during a June 2007 bloom event, they remained the dominant phytoplankton spp. during the entire 8 months of sampling.

Cylindrospermopsis spp. were present at their highest concentrations (4.43×10^2 cells mL⁻¹; Figure 2) during a December 2006 bloom event. *Anabaena* spp. were present at their highest concentrations (2.8×10^3 cells mL⁻¹; Figure 2) during an April 2007 bloom event. The highest Chl *a* concentrations ($208 \mu\text{g L}^{-1}$) occurred on April 20, 2007 corresponding to the *Anabaena* spp. bloom (Figure 2).

All water samples tested for particulate microcystin-LR were below the detection limit for ELISA ($0.10 \mu\text{g/L}$). Highest toxin concentration ($17.5 \mu\text{g kg}^{-1}$) was found on July 18, 2007, from blue crab hepatopancreas tissue (not shown below), collected from halfway between station 7 and 9. The same crab also contained the highest microcystin-LR concentration found in viscera tissue samples ($5.5 \mu\text{g kg}^{-1}$; not shown below). The highest concentration of microcystin-LR from edible meat ($9.5 \mu\text{g kg}^{-1}$; figure 3) was found from a blue crab collected from site 4 on June 29, 2007. Highest tissue contamination from site 7 (Figure 3), correlated with highest cell abundances of *Microcystis* spp. at the same site (Figure 2).

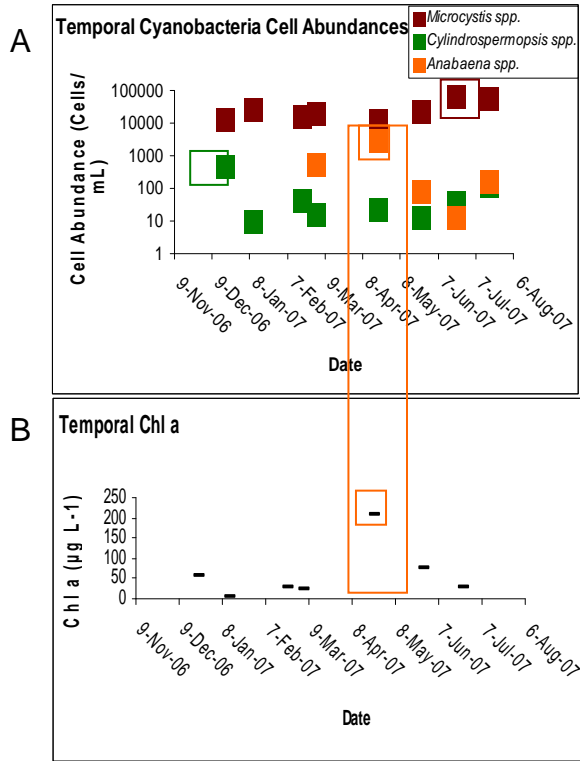


Figure 2: (A) Cell abundance of *Anabaena*, *Cylindrospermopsis*, and *Microcystis* spp. and (B) relative Chl a values in site 7

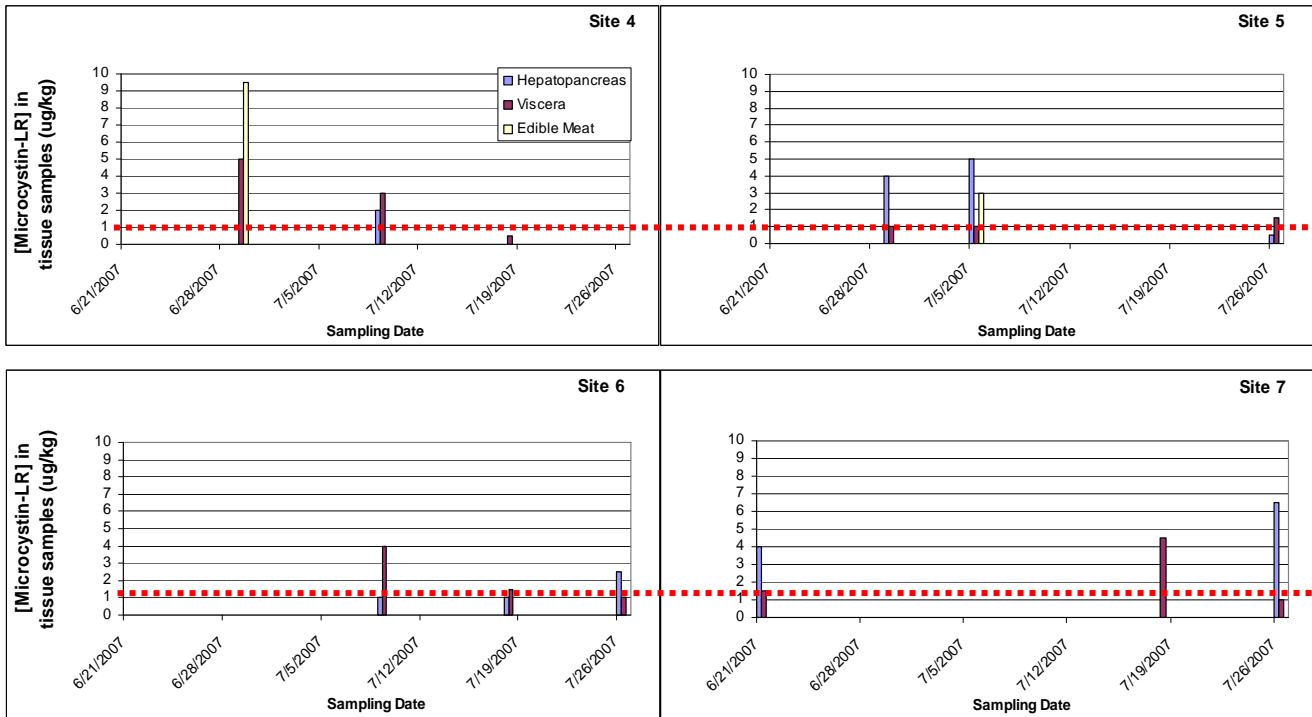


Figure 3: Concentrations of Microcystins found in blue crab hepatopancreas, viscera, and edible meat during 2 months of sampling period. Dashed red line represents recommended upper limit for microcystin-LR within drinking waters ($1 \mu\text{g L}^{-1}$ or $1 \mu\text{g kg}^{-1}$) as set by the World Health Organization.

4. *Vibrio*.

Brian Matherne, Hee-Sung Bae, Josh Mire, and Aixin Hou. 2008. Populations of *Vibrio vulnificus* and *Vibrio parahaemolyticus* in Breton Sound and Barataria Bay. Poster presented at 2008 NGI conference, Biloxi, MS. Water samples were collected along two salinity gradient transects in these two water bodies, at a monthly frequency, from September 2007 through May 2008, and from March 2008 through May 2008 sediment and live oyster samples were collected exclusively from the Breton Sound. Populations of total culturable *V. vulnificus* and *parahaemolyticus* in water, sediment, and shellfish were measured using the three-tube most probable number (MPN) and plating methods according to the *Bacteriological Analytical Manual* procedures. For the MPN method, a series of 10-fold dilutions of each sample with phosphate-buffered saline (PBS) were individually inoculated into test tubes containing 10 ml alkaline peptone water (APW). The test tubes were then incubated at 37°C for 24 hours. The plating method used two types of growth medium, thiosulfate-citrate-bile-sucrose (TCBS) agar and cellobiose-colistin (CC) agar, which were prepared for two replicates for each of the six sampling sites. Biomass from each sample was collected through a membrane filtration (0.45 µm). The membrane filters were then placed on each plate and incubated at 37°C for 24 hours. MPN tubes with positive growth and resulting cultivated strains on plates will be further confirmed for the two vibrio species using PCR by targeting the *vvhA* gene for *V. vulnificus* and *tlh* for *V. parahaemolyticus*. Genes to be targeted for pathogenic strains are *viuB* for *V. vulnificus* and *tdh*, and *trh* for *V. parahaemolyticus*. We are still in the progress of our study and have only obtained preliminary results. Information is being gathered for ranges of population size of each species in Breton Sound and Barataria Bay, highest and lowest numbers, seasonal variations, and a comparison between both water bodies. Also, we will determine the impacts of physiochemical parameters such as temperature, salinity, and nutrients on the development of these populations in Louisiana coastal water. Preliminary results (not yet PCR confirmed) have shown similar growth patterns of *Vibrio vulnificus* or *Vibrio parahaemolyticus* between the waters of the Breton Sound and the Barataria Bay. We have observed a typical population growth model thus far, with higher vibrio numbers appearing during warmer months, and reduced vibrio numbers during colder months. We are currently in the progress of confirming the positive tubes and the resulting strains using PCR techniques. Our work has also shown vibrios present in the oyster tissues sampled, but it has not been determined if these levels are unsafe for human consumption. The majority of our sediment samples from the Breton Sound have produced few, if any, vibrio colonies. However, one sampling location has shown a consistently and significantly high number of vibrios. This sampling location is the only sampling site located on the coast and not within the estuary.

Outreach activities

General Description

No activity yet.

Have you hosted speakers, workshops and/or any training?

No

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

None at this point

List non-refereed articles and reports for this project:

None at this point

List conference presentations and poster presentations for this project:

Sibel Bargu, Brian Fry, Aixin Hou, Gene Turner. 2008. Public Health, Stressors and Water Quality in Coastal Louisiana. Poster presented at 2008 NGI conference, Biloxi, MS.

Ana C Gracia, Sibel Bargu, Padmanamava Dash, Nan Walker. 2008. Evaluating a Potential Risk to Louisiana's Blue Crab Fishery: Exposure of the estuarine blue crab (*Callinectes sapidus*) to cyanotoxins present in Lac des Allemands, LA. Poster presented at 2008 NGI conference, Biloxi, MS, and at Graduate Student Symposium, LUMCON, Chauvin, LA (2008),

Jessica Czubakowski and Sibel Bargu. 2008. The role of nutrient loaded freshwater pulses on phytoplankton succession and phycotoxin production in Breton Sound Estuary, Louisiana. Poster presented at 2008 NGI conference, Biloxi, MS and at Graduate Student Symposium, LUMCON, Chauvin, LA (2008)

Brian Matherne, Hee-Sung Bae, Josh Mire, and Aixin Hou. 2008. Populations of *Vibrio vulnificus* and *Vibrio parahaemolyticus* in Breton Sound and Barataria Bay. Poster presented at 2008 NGI conference, Biloxi, MS.



Trophic Linkages and Biomass Production in Estuarine Ecosystems

NGI Project File Number: 07-LSU-03

Malinda M. Sutor
Department of Oceanography and Coastal Sciences
School of the Coast and Environment
Louisiana State University
Baton Rouge, LA 70803-7503
225-578-8055
msutor1@lsu.edu

Sibel Bargu Ates
Department of Oceanography and Coastal Sciences
School of the Coast and Environment
Louisiana State University
Baton Rouge, LA 70803-7503
225-578-0029
sbargu@lsu.edu

James H. Cowan
Department of Oceanography and Coastal Sciences
School of the Coast and Environment
Louisiana State University
Baton Rouge, LA 70803-7503
225-578-9400
jhcowan@lsu.edu

Richard F. Shaw
Department of Oceanography and Coastal Sciences
School of the Coast and Environment
Louisiana State University
Baton Rouge, LA 70803-7503
225-578-6734
rshaw@lsu.edu

List all personnel funded by this project:

Malinda Sutor, Research Scientist, 8.3%, No
Sibel Bargu Ates, Research Scientist, 8.3%, No
Benjamin Von Korff, Research Associate (Research Support Staff), 100%, No
Marianne Alford, Research Associate (Research Support Staff), 58.3%, No

Key Scientific Question(s)/Technical Issues:

- 1). To determine how pulsed water regime will affect pelagic productivity and plankton community composition and biomass.
- 2). To determine if estuarine-dependent and/or estuarine-resident fishes assimilate a significant portion of the available carbon and nitrogen delivered to Breton Sound and Barataria Bay via high consumption rates of

zooplankton and benthos, which then are exported as fish biomass at the end of the growing season (late fall-early winter).

This project is also linked to Dr. Bargu Ates' work in 06-LSU-03 "Public Health and Stressors" and the related scientific question is:

To determine the effects of nutrient loaded freshwater pulses on species community composition and phytoplankton group succession on a seasonal timescale and under varying flow regimes within Breton Sound Estuary, specifically focusing on harmful algal bloom species

Collaborator(s)/Partners

Louisiana Department of Wildlife and Fisheries

7/1/2007

Partner does not supply monetary support

Partner does provide non-monetary support

LDWF provides data on fish population assessments in the Barataria and Breton Estuaries

Project Duration:

Start Date 7/1/2007 Estimated End Date 12/31/2010

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

Our project addresses the ecological function of coastal wetlands under different freshwater pulsing regimes. A greater understanding of seasonal trophic processes will help to address several issues specific to NOAA mission, namely 1) enhance our understanding and management of hazards including hurricane disturbance to cultural, economic and natural resources of coastal regions; and 2) provide information that will increase our understanding of the implications of habitat loss and better guide ecosystem management and coastal restoration in this important river delta system.

Contributions to regional problems and priorities:

Regional Awareness: This project is closely tied to work at LDWF and will enhance regional awareness of the seasonal functions of estuarine and coastal habitats for important fish stocks.

Regional Interest: The ecological functioning of estuarine and coastal environments in southern Louisiana is critical to assess to determine the relative impacts of coastal loss and degradation and to guide restoration efforts. As many commercial fish species important to the economy of southern Louisiana utilize these areas as critical habitat, we feel there will be great interest in our findings.

Regional Understanding: We will develop, in cooperation with Dr. S. Hodge (NGI Outreach Coordinator), a formal Outreach Plan, facilitated through Louisiana Sea Grant.

Regional Acceptance: The results of this research have the potential to greatly enhance our understanding of the ecological function of coastal wetlands, particularly as they translate to fisheries issues, and given the importance of these issues to Louisiana, we anticipate our work will be well accepted.

Gaps:

There is a great need for enhanced knowledge of biogeochemical and energy cycling in coastal ecosystems to improve model prediction of biomass changes over various temporal and spatial scales. The data collected on plankton biomass and taxonomic distributions in these areas will be of great value as there is a relative paucity of these data collected in coastal Louisiana.

Project Abstract:

Higher trophic level production in estuaries is governed by the laws of trophic supply and demand (Kemp et al. 1991) and changes in nutrient supply for primary producers can filter up through the food web to fishes, thereby increasing organismal production, if overall production is increased at lower trophic levels. Moreover, estuaries serve as nursery areas for fishes that spawn offshore, enter the estuary as larvae and, after a period of juvenile residency, move back offshore to complete their life cycles. Evidence suggests that the migration of juvenile fishes offshore represents a significant export of energy from estuaries. Although this link has rarely been quantified, biogeochemical cycling may be affected in northern Gulf of Mexico estuaries through energy translocation via biomass (and its constituent composition of C and N) export by estuarine dependent fishes, and this pathway may be important in the top-down control of energy subsidies to coastal ecosystems. **The central tenet of our proposal is that wetlands and adjacent waters associated with deltas are pulse-regulated ecosystems. Different spatial and temporal scales and the pattern of pulsed freshwater inputs are critical parameters controlling nutrient cycling, productivity, residence time and export, and trophic structure.**

List major milestones completed and describe any significant research results and transitions

We have completed nine monthly transects (September 2007-May 2008) in Barataria and Breton and have been processing plankton samples from these transects. Preliminary results show that the plankton community composition is different between estuaries, between low and high freshwater input events within each estuary and on a salinity gradient within each estuary (see poster included below under N).

Outreach activities**General Description:**

No activities yet.

Have you hosted speakers, workshops and/or any training?

No

Has anyone on this project been hired by NOAA?

No

Peer Reviewed Articles:

None at this point

List non-refereed articles and reports for this project.

None

List conference presentations and poster presentations for this project:

Sutor, M.M., M. Alford, S. Bargu Ates, R.F. Shaw, J.H. Cowan. 2008. Trophic Linkages and Biomass Production in Estuarine Ecosystems. Poster presented at 2008 NGI conference, Biloxi, MS.



Investigating Material Exchange between the Marsh and Channel along an Estuarine Gradient

NGI Project File Number: 07-LSU-04

Jaye E. Cable
jcable@lsu.edu

Personnel Funded by the Project (Person's name, Category, Percent of support by NGI, at NOAA Lab):

Jaye E. Cable, Associate Professor, 8.3%, No
John R. White, Assistant Professor, 8.3%, No
Irving Mendelsohn, Full Professor, 0%, No
Robert Twilley, Professor and Assistant Vice Chancellor of Research, 0%, No
Joseph Baustian, Research Associate, 50%, No
Chester Keating (M.S. Student), 100%, No
Brett Marks (M.S. Student), 100%, No

Key Scientific Questions / Technical Issues:

The scientific goal of this project is to assess impacts of rising sea level and/or fluvial inputs on C and N budgets in an hydrologically-modified deltaic estuary. We intend to establish (1) a quantitative baseline for water, C, and N cycling between the marsh and channel and (2) how this cycling contributes to marsh productivity and accretion. This working group will address the following related questions:

How do rising sea levels and/or riverine pulses

- (a) enhance carbon and nitrogen export from the wetland and*
- (b) modify processes responsible for marsh sustainability (e.g. productivity, accretion)?*

The major scientific tasks of this project are :

1. quantify material exchange of water and C, N, and P fluxes between the marsh and channel
2. assess changes in plant productivity and role in carbon sequestration and marsh sustainability
3. identify the major biogeochemical transformation processes responsible for C, N, and P cycling, and ultimately, long-term marsh sustainability.

Collaborators/Partners:

- Shell Oil funded DELTA observation system
- Collaboration established 2007
- One-time monetary support was awarded ~ \$45,000
- No in-kind support is given
- The DELTA observation system includes physical, chemical, and biological information as fixed platforms and surveys (monthly) along the axis of Breton and Barataria estuaries. Our wetland material exchange study will directly support the DELTA regional modeling effort by providing much needed data for baseline calibration.

Project Duration:

Start Date: 7/1/2007 Estimated End Date: 12/31/2010

Project Baselines:

Contribution to specific NOAA Goals/Objectives

Our study directly benefits the major NGI research theme of Ecosystem Management due the strong implications for coastal restoration in the northern Gulf of Mexico. Additionally, predictions for accelerated sea level rise due

to global climate change imply that intertidal exchange and marshes may have a significant, though as yet undocumented, impact on coastal ocean carbon budgets. As such, this proposed study also fits well within the major NGI research theme of Climate Variability.

Contributions to regional problems and priorities.

This project is tied to a number of regional issues including wetland loss and coastal hypoxia. The net balance of carbon from these coastal wetlands determines whether marsh is lost or is maintained through accretion. The biogeochemical cycling, in particular, nitrate removal from diversions is linked to coastal hypoxia as is the flux of dissolved carbon and other nutrients exported from the marsh under a range of hydrologic conditions.

Project Abstract

The wetland boundary between terrestrial and coastal ocean environments is a dynamic and highly productive zone, but its role in biogeochemical cycling and ocean productivity is not well understood. However, studies such as Dittmar et al. (2006) estimate that >10% of the terrestrial DOC fluxes to the world oceans are derived from mangrove wetlands alone. More specifically, material exchange with marshes and groundwater are two key sources for carbon to the coastal ocean (e.g. Cai and Wang, 1998; Cai et al., 2003). Along the northern Gulf of Mexico coast, prolific point and non-point sources of carbon and nitrogen exist in the form of major rivers and expansive wetland ecosystems that extend from Florida to Texas. Most notably, the Mississippi River and its associated deltaic estuaries have been linked to carbon and nitrogen storage and offshore transfer of energy (e.g., Dagg et al., 2005). The Mississippi River has the highest discharge ($18,400 \text{ m}^3 \text{ sec}^{-1}$; Milliman and Meade 1983) and the largest watershed (3.3 million km^2) in North America. Using mean discharge as the metric, it is the sixth largest river in the world, yet this mighty river has been altered hydrologically to prevent the historically substantial sediment and water supplies from reaching coastal wetlands and contributing to the depositional environment. Additionally, relative sea level rise due to subsidence and eustatic changes in sea level has enhanced coastal wetland destruction. Diversions have been built along the Mississippi River corridor south of New Orleans which deliver freshwater, sediments, and nutrients to Barataria and Breton Sound estuaries. The effectiveness of these diversions as marsh sustenance tools are not clear, but biogeochemical processing occurring within estuaries as a result of fluvial discharge through these diversions may impact how deltaic marshes contribute to the coastal ocean nutrient (C, N, P) budgets. Inundation frequency and duration of marsh water levels will have a strong impact on the net retention or release of C, N and P in accreted occurring within estuaries as a result of fluvial discharge through these diversions may impact how deltaic marshes contribute to the coastal ocean nutrient (C, N, P) budgets. Inundation frequency and duration of marsh water levels will have a strong impact on the net retention or release of C, N and P in accreted organic matter. Recent studies have shown that extended low water or dry periods in a marsh can lead to a net export of nutrients (White et al., 2004; 2006; Bostic and White, 2007) as well as loss of carbon (DeBusk et al., 2003). Rapid wetland loss due to rising sea levels combined with landscape-scale hydrologic alterations indicate these buried carbon repositories may be vulnerable to remineralization processes and ultimately contribute to ocean-atmosphere carbon pools. The proposed study contributes to two NGI major research themes and several ongoing NOAA funded research efforts aimed at ecosystem management and climate change variability.

Major Milestones

Activity	Year 2				Status
	JFM	AMJ	JAS	OND	
Hire Personnel	■				the last student began in Jan 2008
Order supplies	■	■	■	■	supplies are ordered as research is on-going
construct/modify platforms, plots	■	■	■	■	construction of 7 platforms is complete
Ongoing deployments		■	■	■	data loggers and data are being collected
Seasonal sampling		■	■	■	Soil characterization data has been collected and analysed.
Data Organization			■	■	TBA
Data Synthesis			■	■	TBA
Dissemination of Research Findings			■	■	One presentation is scheduled for an International meeting in Oct. Much more planned for year 3 once a full years data is collected

Outreach Activities

General Description

The PIs contribute to community outreach in number of ways already and will continue to do so within the scope of this project. Development of a Master Plan for coastal protection is currently underway along the Gulf coast, which includes both infrastructure protection and coastal habitat protection and restoration. Our proposed research, by providing a better understanding of those processes controlling marsh sustainability, will aid in the formulation of projects and activities that promote, rather than hinder, these processes. One of the Co-PIs, Mendelssohn, is a member of the Science and Engineering Review Team currently advising the State of Louisiana for the Master Plan. Another PI, Cable, has participated regularly in the annual stakeholder meetings of the Caernarvon Interagency Advisory Committee (CIAC), whose members represent all major stakeholders of the Breton Sound basin. CIAC members include fishery representatives (oyster, shrimp, and recreational fishers), representatives of local governments, local landowners who care about the environment, and natural resource agencies (LA Depts. of Wildlife and Fisheries, Natural Resources (DNR), Environmental Quality, and Health and Human Resources; and US Fish and Wildlife Service, National Marine Fisheries Service, EPA, and Army Corps of Engineers). The CIAC has been very receptive to our research findings in the past, and we will continue this relationship with an annual presentation at their meetings for the duration of this project. We will also coordinate our activities with the LA DNR through routine communication with Coastal Restoration personnel.

Hosted Speakers/workshop/training

This project will impact the educational missions of Louisiana State University in several ways by enhancing the mission of its land-grant and sea-grant institution status. The proposed research involves a significant amount of both field and laboratory-based research, with opportunities for student training (both graduate and undergraduate) in both settings. We will actively recruit excellent students, including minorities and females, in the areas of hydrology, sediment transport and deposition, nutrient biogeochemistry, and ecosystem modeling. We have a demonstrated commitment to education and outreach and will continue to promote awareness of coastal and ocean sciences. For example, the NOAA/Louisiana Sea Grant Program annually sponsors "Ocean Commotion", which brings more than 3,400 elementary and middle school students and teachers to LSU to learn about coastal processes and the sea (http://www.lsu.edu/university_relations/oceancommotion/). Project results from LSU NGI will contribute to this NOAA-sponsored Ocean Commotion program by exposing these young students to coastal restoration and sustainability concerns for the Northern Gulf of Mexico. Cable also currently hosts a NOAA-sponsored minority undergraduate researcher in her laboratory.

Hires by NOAA:

None

Peer Reviewer Articles:

None to date

Non-Refereed Articles:

None to date

Conference Presentations and Poster Presentations:

Cable, J.E., White, J.R., Mendelssohn, I.A., and Twilley, R. 2008. Investigating material exchange between the marsh and channel along an estuarine gradient, NOAA/Northern Gulf Institute meeting, Biloxi, MS, 12-14 May 2008

Marks, B. and J.R. White. 2008. Effects of Marsh position and Salinity on the denitrification enzyme activity of wetland soil. Poster Presentation at the Annual Meeting of the Soil Science Society of America held jointly with the Geological Society of America. Houston, TX Oct 2008.



NOAA Ecosystems Data Assembly Center (EDAC) supporting the NOAA Northern Gulf of Mexico Cooperative Institute

NGI Project File Number: 07-NOAA-01

PI(s): Russ Beard (russ.beard@noaa.gov) and A. Rost Parsons, PhD. (rost.parsons@noaa.gov), National Environmental Satellite, Data, and Information Service (NESDIS)/National Oceanographic Data Center (NODC)/National Coastal Data Development Center (NCDDC)

List all personnel funded by this project:

(None located at a NOAA Lab)

Person's Name: Dr. Hugh MacIntyre, Dauphin Island Sea Lab

Category: Research Scientist

Percent of Salary Funding from NGI: 0% (NOAA Funded)

Person's Name: Dr. Just Cebrian, Dauphin Island Sea Lab

Category: Research Scientist

Percent of Salary Funding from NGI: 0% (NOAA Funded)

Person's Name: Dr. Ruth Carmichael, Dauphin Island Sea Lab

Category: Research Scientist

Percent of Salary Funding from NGI: 0% (NOAA Funded)

Person's Name: Dr. Sibel Bargu, Louisiana State University

Category: Research Scientist

Percent of Salary Funding from NGI: 0% (NOAA Funded)

Person's Name: Dr. Aixin Hou, Louisiana State University

Category: Research Scientist

Percent of Salary Funding from NGI: 0% (NOAA Funding)

Person's Name: Robert Arnone, Head, Oceans Sciences Branch, Naval Research Laboratory

Category: Research Scientist

Percent of Salary Funding from NGI? 0% (NOAA Funded)

Person's Name: Charles Carleton, NCDDC/Radiance Technologies

Category: Research Support -- Engineer/Technical Development Staff

Percent of Salary Funding from NGI? 0% (NOAA Funded)

Person's Name: Tom Strange, NCDDC/Radiance Technologies

Category: Research Scientist

Percent of Salary Funding from NGI? 0% (NOAA Funded)

Key Scientific Question(s)/Technical Issues:

The objectives of the EDAC are to demonstrate the utility of integrating a broad spectrum ecosystem data, models, and observations for the purpose of determining the health of the ecosystem, identifying the challenges

ahead, and developing creative solutions based on sound natural-science criteria. The EDAC concept has been embraced as a core function supporting NOAA's Integrated Ecosystem Assessments under the Ecosystem Goal Team. Year 2 Tasking under this statement of work included the planned expansion of the EDAC activities into Louisiana and Alabama and increased partnerships with the NGI. The highlights of activities for Year 2 were increased focus on data discovery and access from the NOAA National Marine Fisheries Service, expansion of the Phytoplankton Monitoring Network into the Northern Gulf, a small-scale integrated ecosystem assessment (IEA) effort in coastal Alabama, mercury and ancillary monitoring data from the Louisiana coast, and continued development and delivery of remote sensing and coastal modeling products to support ecosystem identification, classification and assessment via the EDAC.

Collaborators(s)/Partners:

NOAA: Dr. Scott Cross, NCDDC Southeast Liaison Officer, Co-Investigator; Dr Geoff Scott, Director, Coastal Center Environmental Health and Biomolecular Research (CCEHBR) Co-Investigator for Phytoplankton Monitoring Network (PMN), Dr. Steve Morton Co-Investigator for PMN, and Nelson May, Co-Investigator, National Marine Fisheries Service, Southeast Fisheries Science Center, Pascagoula Lab; Naval Oceanographic Office (NAVOCEANO): Dr. Frank Bub, Co-Investigator, Models and Prediction System; NGI: Dr. David Shaw, MSU, Co-Investigator, Glade Woods, MSU, Co-Investigator, Sharon Hodge, J.D., MSU, Co-Investigator

Date collaborating established: Sept 2006

Does partner provide monetary support to project? No

Does partner provide non-monetary (in-kind) support? No

Short description of collaboration/partnership relationship.

MSU and NCDDC expanded NOAA's Center for Coastal Environmental Health and Biomolecular Research's (CCEHBR) Phytoplankton Monitoring Network into operational status in the Northern Gulf (Alabama, Mississippi, Louisiana, and Texas) Weekly/Monthly phytoplankton observations in the Northern Gulf are incorporated into the PMN database maintained at NCDDC, made discoverable and available through the NGI EDAC. In addition, Dauphin Island Sea Lab and Louisiana State University faculty support the PMN activities and phytoplankton monitoring activities in their coastal waters with emphasis on *Karenia brevis* and recently *Pseudo-nitzschia*.

Dauphin Island Sea Lab (Cebrian) supports the EDAC's effort in collecting comprehensive ecosystem data sets in representative marine bays and lagoons on the Alabama and Florida coasts. These clearly support and demonstrate management assessments of anthropogenic influences as well as derive the current and projected health of these systems – i.e. a small-scale IEA. *The linkage of Cebrian's ecosystem data and research findings into an ecosystem assessment directly supports the core function of the EDAC and the NOAA IEA effort.* Physical and chemical variables include: Water-column salinity, temperature, oxygen, light penetration, water-column dissolved inorganic nitrogen, dissolved organic nitrogen, particulate organic nitrogen, phosphate, and sediment porewater inorganic nutrients. Biological variables include: microalgal chlorophyll concentrations in the water column and sediment, seagrass structure, biomass and productivity, seagrass nutrient content, epiphyte biomass, diversity and abundance of invertebrate fauna in seagrass patches and bare sediment, and system metabolism (gross primary productivity, respiration, and net community productivity for water column, seagrass patches and bare sediment).

LSU contributed results from continued monitoring studies of mercury concentration in fish tissue samples along the Louisiana coast both distant and in proximity to offshore oil production. Ancillary data will be combined with the mercury data within the EDAC for potential assessment of anthropogenic and natural sources of mercury. NRL-SSC provides near real-time MODIS Terra and Aqua satellite products on an OpenDAP server accessible to the EDAC that include total suspended sediments (TSS), optical water mass classification, estimated salinity, overall turbidity as well as anomalies of chlorophyll concentration and TSS. At the EDAC, these ocean color

products are transformed into CoastWatch HDF format. Independently this EDAC developed software has been provided to NOS as well as NMFS. Data streams are being evaluated by both the CoastWatch Gulf of Mexico CoastWatch Node as well as the West Coast CoastWatch node. Additionally, NRL-SSC provides near-real-time, high resolution, coastal numerical modeling output that include 48-hour forecasts of temperature, salinity and currents. NRL-SSC also provides state of the art composite satellite products of SST and TSS that serve to minimize the effects of clouds on daily images.

NAVOCEANO is providing the Navy Coastal Ocean Model (NCOM) distributed through the EDAC which has been greatly anticipated by researcher's nation wide

Project Duration:

Start Date Oct 2006 Estimated End Date Sept 2009

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

The EDAC supports Mission Goal One of the *NOAA Strategic Plan FY 2006- FY 2010 (SP)* - "Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management." This ecosystem approach includes integrating ecosystem system data, data management, data management services, data stewardship, and interoperability. The EDAC will help NOAA meet Ecosystem Mission Goal Outcomes, e.g., "A well-informed public that acts as a steward of coastal and marine resources," and Performance Objectives, e.g., "Increase number of regional coastal and marine ecosystems delineated with approved indicators of ecological health and socioeconomic benefits that are monitored and understood" detailed in the SP through the five Ecosystem Strategies, e.g., "Engage and collaborate with our partners to achieve objectives by delineating regional ecosystems, promoting partnerships at the ecosystem level, and implementing cooperative strategies to improve regional ecosystem health." The EDAC and CI will address research goals found in the OAR publication *Research in NOAA: Toward Understanding and Predicting the Earth's Environment A Five-Year Plan: Fiscal Years 2008-20012* to include "key investment in an enhanced understanding of ecosystems by establishing necessary knowledge, tools, and management." The EDAC and CI will collaborate with stakeholders to develop "an end-to-end research to operational observing system" for the northern Gulf of Mexico and include capacity building and the transfer of knowledge, e.g., "alternative management options, geographic information services, and data visualization.

Contributions to regional problems and priorities:

The data sets assembled address protected habitats, essential fish habitat, HABS, ocean observations, coastal and ocean modeling used in integrated ecosystem assessments (IEAs).

Gaps:

An inherent component within the broad effort of data assembly under the IEA framework is a data gap analysis. Through the EDAC, gaps in both temporal and spatial coverage will be identified. In Year 1, a data analysis report was generated organized by variable and dataset. At the end of Year 3, a updated report will be generated which will highlight gaps discovered during the project. The data gap analysis within the EDAC will also leverage the corresponding Gulf of Mexico Alliance data efforts which continue through Summer 2009.

The establishment of a NOAA Ecosystem Data Assembly Center (EDAC) within the NOAA Northern Gulf of Mexico Cooperative Institute (GOM CI) will create research activities supporting NOAA's ecosystem approach to management as detailed in the NOAA Strategic Plan (FY2006-FY2011), the OAR Five-Year Research Plan

2005-2009, and the CI research themes detailed in the RFP by: (1) providing a presence at Stennis Space Center dedicated to developing information technology infrastructure supporting the discovery and management of ecosystem and observational data from diverse and distributed sources; (2) identifying, cataloging, and providing access to the physical, biological, and chemical data sets that characterize the GOM and the regional sub-units; and (3) facilitating the use of GOM environmental indicators to assist the coastal resource manager in making informed decisions. These research and development activities will identify and incorporate regional priorities by forming a working group of stakeholders. All data-management architectures and practices will ensure interoperability with the Integrated Ocean Observing System (IOOS) national backbone by incorporating the IOOS Data Management and Communications Plan within the RAs, ensuring interoperability of legacy and emerging technologies, systems, and databases in the Gulf of Mexico. The EDAC and CI will demonstrate the utility of integrating ecosystem data and observations for the purpose of determining the health of the ecosystem, identifying the challenges ahead, and developing creative solutions based on sound natural-science criteria. These improved capabilities will address NOAA product lines as well as priority concerns detailed in the NOAA Strategic Plan, OAR 5-Year Research Plan, and the 2005 Gulf Governor's Action Plan, e.g., harmful algal blooms, hypoxia, water quality, coastal resource management, sustained fish stocks, stabilizing protected species, increasing habitat, and providing education and outreach to increase public knowledge concerning ecosystem management. The center will serve as an agent for assembling ecosystem data and DMAC certification criteria. Data protocols, standards, formats, applications, practices, and architectures developed by the EDAC and proven effective in meeting operational standards will be transitioned to the national NESDIS data centers, NOAA "centers of data," and NOAA Ecosystem Mission Goal activities, e.g., the Ecosystem Research Program and Ecosystem Observation Program.

List major milestones completed and describe any significant research results and transitions:

Major Milestones (Project Year 2):

1st Quarter:

- Begin Alabama PMN data collection- completed
- Complete set-up of OpenDAP (Hyrex) server- completed
- Temporary access archive of large data sets established at MSU HPCC -- in discussion
- High resolution NRL model output available through EDAC to support Nero et al. NGI project completed

2nd Quarter:

- Small-scale Alabama IEA data available through EDAC- on-going
- Louisiana coastal mercury and ancillary data online at EDAC (mercury data on-line; ancillary archived at NODC- completed

3rd Quarter:

- GIS Mapping layers through EDAC online (including clip and ship capability) – completed
- Google Map browse and ontological search capability within EDAC – completed
- THREDDS server online – on-going
- Updated EDAC web access – on-going

4th Quarter:

- Begin Louisiana PMN and Phytoplankton data collection - on-going
- EDAC Data inventory published - on-going
- EDAC Gulf of Mexico model inventory NCOM, RTOFS, and Inter-American Seas transitioned to operational OceanNOMADS website – NCOM completed; remainder on-going
- Material: NCDDC "one-pager". See the EDAC website at: <http://edac.northerngulfinstitute.org>

Outreach activities

General Description:

None

Have you hosted speakers, workshops and/or any training?

Type: Workshop (informal)

Name of event: The use of an Ontology and the Semantic Web

Date: August 2, 2007

Location: Bay St Louis, MS

Description: Dr. Roger King and Dr. Surya S. Durbha, MSU, held discussions with NOAA National Data Buoy Center, Gulf Services Center and NCDCC on techniques for data discovery and potential uses within the EDAC.

Approximate Number of Participants: 10

Has anyone on this project been hired by NOAA?

N/A

Peer Reviewed Articles:

N/A

List non-refereed articles and reports for this project.

N/A

List conference presentations and poster presentations for this project:

Beard, Russell, L., (2008) The NOAA Ecosystem Data Assembly Center, 2008 Northern Gulf Institute Annual Conference, May 13 through May 14, 2008, Biloxi, Mississippi

Cross, Scott, L, S. L. Morton, A. R. Parsons, (2007) Data management supporting regional volunteer phytoplankton monitoring efforts, Fourth Symposium on Harmful Algae in the U.S., October 29 through November 1, 2007, Woods Hole, Massachusetts



Forecasting the Ecological Impacts of Hurricanes through the Integration of Retrospective Remotely Sensed Imagery with Hydrographic and Biological Data from the Northern Gulf of Mexico

NGI Project File Number: 07-NOAA-02

PI: Eric Davenport, eric.davenport@noaa.gov,

Co-PIs: Randy Ferguson, Ph.D., randy.ferguson@noaa.gov and Jeff Govoni, Ph.D., jeff.govoni@noaa.gov,

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Centers for Coastal Ocean Science, Center for Coastal Fisheries and Habitat Research, 101 Pivers Island Road Beaufort, North Carolina 28516-9722.

List all personnel funded by this project:

There are currently no persons funded by this project.

Key Scientific Question(s)/Technical Issues:

What is the vulnerability of the northern Gulf of Mexico ecosystem and fisheries production to hurricane events of differing winds, precipitation, and storm surge?

Collaborators(s)/Partners:

There are currently no collaborating organizations or partners associated with this project.

Project Duration:

Start Date: August 2006

Estimated End Date: December 2008

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This project contributes to NOAA's research goal to forecast ecosystem events. Baseline analysis of changes in abiotic and biotic data associated with the passage of a hurricane will be integrated to provide managers with an index of ecosystem vulnerability to varying types of hurricane events. The index of ecosystem vulnerability to hurricanes fulfills the performance objective of this research goal to "increase the number of coastal communities incorporating ecosystem and sustainable development principles into planning and management." In addition, this study provides baseline analysis that assist NOAA in accomplishing its 3-5 year milestone to "forecast the ecological effects of varying weather patterns and extreme physical events."

Contributions to regional problems and priorities:

The development of an index of hurricane vulnerability will enable the identification and characterization of Gulf habitats that are most sensitive to hurricane wind, precipitation, and/or storm surge. The ability to identify and characterize Gulf habitats to inform management is a priority issue of the Gulf of Mexico Alliance that is addressed by this research. Resource and conservation managers in the Gulf of Mexico are the priority stakeholders, and they could utilize the hurricane vulnerability index to develop strategies that minimize ecosystem recovery time after a hurricane.

Gaps:

This study will narrow the gap in our understanding of the vulnerability of specific biota and overall impacts to the Gulf of Mexico ecosystem from hurricanes by providing a tool for characterizing and comparing the overall ecological impact of a hurricane.

Project Abstract:

Ecological forecasts to predict ecosystem response to hurricanes of the last 10 years will be derived from retrospective geo-spatially improved SST (Sea Surface Temperature) imagery and contemporary NOAA oceanographic and fisheries-dependent and fisheries-independent data collections from the Northern Gulf of Mexico. Geospatial data integration and visualization is one of the themes defined for the Northern Gulf of Mexico Cooperative Institute. Our improvement of SST imagery and its association with field data fits into this theme and will assist ecosystem managers with their regional forecast, resource management, and policy decisions in the Northern Gulf of Mexico. Characterization of environmental conditions using SST imagery, and in situ oceanographic and biological data are fundamental for forecasting fisheries harvests. The enhanced scientific understanding of the interconnections between remotely collected geospatial data, oceanographic and biological data supporting these forecasts will enable an ecosystem based approach to the management of this region, which is one of NOAA's primary goals.

Synoptic SST images derived from AVHRR (Podesta et al. 1993, Scavia et al. 1995, Ladner and Arnone 1998) collected daily by NOAA provide a spatially coherent record of water temperatures in the Northern Gulf of Mexico that can be used to characterize the impacts of past hurricane events and forecast the effects of future events in this area. Water temperature is an important ecological variable that is linked to oceanographic and biological processes: destratification (upwelling), Gulf Loop and Gulf Stream meanders and eddy propagation, biological production, spawning, recruitment, and species distributions. SST imagery will be associated with additional oceanographic measurements and biological data will provide information on ecosystem status and production for ecosystem managers. As an ecosystem based approach for the development of marine management strategies and policy decisions concerning extreme events, such as hurricanes, forecast developed from retrospective data analysis provide a powerful tool that can be used to predict the impacts from hurricanes on marine habitats and commercial fisheries.

List major milestones completed and describe any significant research results and transitions:

Compiled, registered and cross-calibrated SST images for the Gulf of Mexico from 1995 through 2003.
Examined the impact of hurricane frequency on ichthyoplankton structure in the Gulf of Mexico.

Outreach activities:

No outreach activities were completed.

Peer Reviewed Articles:

None

List non-refereed articles and reports for this project:

None

List conference presentations and poster presentations for this project:

Larval Fish Diversity after the passage of Hurricanes in the Gulf of Mexico, NOAA Hurricane Conference, 5/6/2008, Beaufort, NC



Habitat-linkages, Spatial Demographics and Food Web Components of the Northeastern Gulf Fisheries Ecosystem

NGI Project File Number: 07-NOAA-03

All NOAA and NGI scientists associated with this project:

NOAA Fisheries, Panama City Laboratory - Doug DeVries (Doug.DeVries@noaa.gov), Gary Fitzhugh, Chris Gardner, Robert Allman, and Linda-Lombardi-Carlson

NOAA National Ocean Service, Biogeography Program - Mark Monaco (Mark.Monaco@noaa.gov), Tim Battista Florida State University - Jeff Chanton (Chanton@ocean.fsu.edu), Chris Koenig, Felicia Coleman, and James Nelson

Personnel funded by this project:

Chris Gardner, Research Scientist, 100%. Yes, NOAA Fisheries, Panama City Laboratory

Key Scientific Questions:

Overall objective –

Provide spatially-explicit demographic and biological information linked to habitat parameters for economically and ecologically important reef fishes to enhance fishery ecosystem model development and management.

Specific objectives –

- 1) Examine temporal and spatial patterns in community structure. Estimate key metrics of abundance and demographics of reef-associated fishes.
- 2.) Delineate and quantify hard bottom / reef habitats in two transects across the northeastern Gulf of Mexico shelf using multibeam imagery to enable process-related investigations of essential fish habitat (EFH) and evaluate relationships between fish production and habitat type.
- 3.) Provide habitat ground-truth video data for multibeam backscatter data.
- 4.) Characterize diets, predator-prey interactions, resource overlap and habitat associated differences in diet of the reef fish communities within and across depth strata.

Collaborators/Partners:

Florida State University – Jeff Chanton, Chris Koenig, Felicia Coleman, and James Nelson

Date collaborating established: July 2006

No monetary support

Partners have provided considerable in-kind support.

FSU's role has included providing guidance on conducting stable isotope analysis, assisting in preparation of tissue samples for stable carbon and nitrogen ratios, and running all of the analyses (n=167 specimens to date and more are currently being processed). NOAA Fisheries' primary role has been to provide tissue samples from our NGI project from a variety of reef fish species for FSU's tropic pathways project and which they have been unable to collect.

Project Duration:

Start Date: September 2006 Estimated End Date: September 2009

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

Our work primarily addresses the ecosystem mission goal of the NOAA 5-year plan; specifically, to advance understanding of ecosystems, to improve resource management, and to forecast ecosystem events. Our integrated mapping and habitat classification also meets the "Explore Oceans" objective. Specific milestones in NOAA's 5-year research plan addressed by this study include 1) map habitat types and identify key habitat functions 2) create

models coupling physical variability and biological effects on productivity, fish recruitment and distribution and 3) develop the next generation of multi-species fisheries and food-web production models. This project also contributes to at least two of the general goals of NOAA's strategic plan, including 1) increase the number of fish stocks managed at sustainable levels and 2) increase the number of regional and coastal ecosystems delineated with indicators of ecological health and socioeconomic indicators that are monitored and understood.

Contributions to regional problems and priorities:

One of the five priority issues of regional significance identified in the [Governors' Action Plan for Healthy and Resilient Coasts](#), drafted by the Gulf of Mexico (GOM) Alliance, is identification and characterization of Gulf habitats to inform management decisions. The GOM Alliance noted that habitat maps are 1) essential for other priorities such as establishing and maintaining long-term monitoring programs to determine the status and trends of marine habitats, 2) are necessary if states hope to improve ecosystem-based management, and 3) would considerably enhance efforts to designate essential fish habitat. The two cross-shelf transects we have mapped with high resolution multibeam sonar off NW Florida as part of this project cross areas with significant amounts of hard bottom habitat, and are the only such maps from the inner and mid shelf of the NE Gulf publicly available.

Another high regional priority addressed by this project is the conservation and management of the many economically and ecologically valuable reef fish species which are so closely tied to these hard bottom habitats. Data from this study will be of immediate value to fishery managers, and especially as they move from single species to ecosystem-based management. The seasonal and cross shelf patterns in community structure could be very valuable for design and siting of MPA's. Other stakeholders who will benefit secondarily are the producers and consumers of the reef fishes utilizing these habitats, as well as the many industries associated with those producers and consumers.

With this study, we are also attempting to take enough of a macro-scale view (e.g., ROV-based fish community survey stratified by habitat across continental shelf depths) to gauge whether population/community effects can be detected against climate cycles which are now being better measured and reported to us in such formats as: http://www.floridadisaster.org/bpr/EMTOOLS/florida_drought_center.htm.

As we potentially move from drought conditions to positive (stronger) ENSO conditions and higher rainfall, we may expect more intense or frequent red tide episodes. An expansive outbreak in the NE Gulf in 2005 particularly affected reef species such as red grouper (see Lombardi et al., in press). With better habitat maps and knowledge of the fish communities, their distribution, and trophic pathways, managers will be better able to predict the effects of such events and separate those effects from those of fishing. We have learned that ongoing synoptic and broad spatial scale monitoring is required to meet the observation and forecasting goals asked of NOAA's long-term research plans.

Lombardi-Carlson, L., G. Fitzhugh, C. Palmer, C. Gardner, R. Farsky, and M. Ortiz. In press. Regional size, age and growth differences of red grouper (*Epinephelus morio*) along the west coast of Florida. Fisheries Research.

Gaps:

Our research intends to bridge gaps in knowledge between inshore and offshore fisheries, explicitly habitat and biological interactions. Little is known about the quantity and quality of hard bottom habitats which are essential to reef fish populations. High resolution habitat delineation maps will greatly expand regional knowledge on an ecosystem level scale. Information on the trophic pathways in the fish communities inhabiting these hard bottom habitats is scarce to non-existent, and is sorely needed if ecosystem-based management is to succeed. The geo-referenced, cross shelf demographic data from this study will be of great value for use in spatially-explicit fisheries' models. One such model, FISHMOD, has been developed to explore dynamics in the shallow-water grouper complex in the eastern Gulf of Mexico (MARFIN #04MF008 to Mahmoudi et al., Martell et al. 2000, Walters and Martell 2004) and combines spatial population dynamics parameters, including seasonal and ontogenetic movement patterns, with the simulation of spatial allocation of fishing effort to model multiple

stocks. FISHMOD permits the user to not only manipulate maps to identify nursery and spawning areas, preferred fishing areas (suitable habitat) by gear type, and closed areas (marine protected areas), but also to input age based movement patterns, harvest policies by gear type, and stock dynamic parameters.

Martell, S., C. Walters, and S. Wallace. 2000. The use of marine protected areas for conservation of lingcod (*Ophiodon elongates*). Bull. Mar. Sci. 66: 729-743.

Walters, C., and S. Martell. 2004. Fisheries Ecology and Management. Princeton Univ. Press, Princeton, N.J.

Project Abstract:

The major objectives of this study, begun in fall 2006, are to examine the fish community structure, trophic dynamics, demographics, and habitat associations on hard bottom reef habitats from nearshore to the shelf break in the northeastern Gulf of Mexico. Other objectives are to delineate and quantify these habitats in two 3 x 30 nm transects using multibeam sonar. Three fixed sites, located within one of these transects, in each of 3 depth strata: 23, 37, & 49 m, are sampled during February, June, and October. Video data on species composition, abundance, and size structure are collected using an ROV equipped with scaling lasers. Specimens for age, food habits, and stable isotope analyses are collected using standardized hook-and-line gear at reefs near each fixed site. Fish commonly observed with the ROV but seldom captured on hook and line (e.g., gray snapper, blue angelfish, scamp) are collected in the nearshore stratum using spear guns. Data collected to date have shown the fish community was much more diverse on midshelf than nearshore reefs - 58 vs 43 species (Table 1). The three most economically valuable reef fishes in the eastern Gulf – red snapper, red grouper, and gag – were commonly to frequently observed in all depth strata and seasons, as were other exploited reef fishes such as gray triggerfish, gray snapper, scamp, vermilion snapper, and red porgy. Red snapper was the most abundant exploited reef fish overall, with the exception of gray snapper in the shallowest stratum, and scamp was the most abundant exploited serranid in all three strata. Gray snapper showed the greatest cross shelf differences in abundance; 491/ha at the nearshore versus 16/ha at the midshelf sites (>30 fold difference), with none observed at the outer shelf sites. Red grouper were much smaller inshore (mean±95% CL: 249±31 mm FL) than in the two deeper strata (midshelf: 556±37 mm FL and outer shelf: 549±113 mm FL). In contrast, scamp and gray triggerfish showed no obvious bathymetric differences in size structure. The multibeam sonar data showed evidence of considerable areas of hard bottom habitat in both transects, especially in the inshore half of each.

List major milestones completed and describe any significant research results and transitions:

Biological and environmental data were collected in Mar 07, Jun 07, Oct 07, and Feb-Mar 08 at the 9 fixed sites on reef/hard bottom habitat (24 sea days). Video data on species composition, abundance, and size composition were collected on 41 ROV dives. All video tapes collected through Mar 08 have been read and the data entered in the lab database. Length measurements were obtained from 922 fish using the ROV's scaling lasers. Size distributions of red snapper showed larger fish in deeper water and suggested that hook and line gear was slightly biased towards larger individuals (Figure 1). Red grouper were also larger at midshelf and offshore sites than nearshore (Figure 2).

Among exploited species, gray snapper dominated the inshore reefs, while red snapper and scamp were very common to abundant in all three depth strata (Figure 3). Bank sea bass and vermilion snapper were very common in the midshelf and offshore strata (Figure 3). Diversity was also much higher in the midshelf and offshore strata, primarily because of greater numbers of more tropical, unexploited species (Figure 4).

Nine scuba dives were made at sites in the shallowest depth stratum to supplement hook and line collections. A total of 672 fish were collected from all gears combined, with otoliths, gonads, stomachs, and tissue samples for stable isotope analysis taken from all of those.

To date, stomach contents of 569 fish have been examined. Of these, 79% contained food items and 57 % contained prey identifiable to some degree. Tissue samples from 167 fish (8 species) have been analyzed for

stable carbon and nitrogen isotopes. Results of the preliminary stable isotope analyses were consistent with the rule of thumb that on average, N delta values increase about 2-3 parts per mil with each increase in trophic level (Figure 5).

A second inshore to offshore transect off NW Florida (approx. 136 km²) was surveyed by Dr. David Naar in Nov 07 with a multibeam echo sounder using the R/V Suncoaster (Figure 6). He also completed surveying an area (23 km²) in the transect mapped in Feb 07 which he was unable to finish at that time because of U.S. Navy operations in the area. Figure 7 shows the locations of each of the three fixed sites in each stratum overlaid on the multibeam bathymetry data and images from the ROV videos showing typical examples of the habitat in each of the strata.

Investigators met in June 07 in Panama City with Mark Monaco (NOS), Tim Battista (NOS), and David Naar (USF geological oceanographer contracted to conduct multibeam work) to discuss preliminary multibeam findings, post-processing issues, future directions, and ground-truthing of data. Post processing of the backscatter data from the first (Feb 07) transect was completed in Nov 07 and from the second (Nov 07) transect in Feb 08. A total of 148 geo-referenced habitat images were compiled and forwarded to the NOAA Biogeography team for ground-truthing and habitat classification of multibeam backscatter data.

Table 1. Overall list of exploited and non-exploited species observed with ROV and the strata in which each were observed. N = nearshore (23 m), M = mid-shelf (37 m), and O = offshore (49 m).

Exploited				Non-Exploited							
Species	N	M	O	Species	N	M	O	Species	N	M	O
Banded rudderfish	●	+	*	Bank butterflyfish		+	*	Jackknife fish			+
Bank sea bass	●	+	*	Barracuda	●			Leopard toadfish			+
Calamus spp.	●	+	*	Barred blenny	●			Painted wrasse			*
Gag	●	+	*	Beaugregory	●			Pipefish			*
Gray snapper	●	+		Belted sandfish	●	+		Purple reeffish	●	+	*
Gray triggerfish	●	+	*	Bicolor damselfish	●	+		Rainbow runner			*
Greater amberjack	●			Blenny	●	+		Reef Butterflyfish		+	*
Gulf flounder	●		*	Blue angelfish	●	+	*	Rock beauty			+
Hogfish	●			Blue Chromis	●	+		Roughtongue bass			+
Lane snapper			+	Blue Goby	●	+	*	Sand perch	●	+	*
Littlehead porgy			+	Blue runner	●			Segastes spp.	●		
Red drum	●			Cherubfish		+		Sharpnose puffer		+	*
Red grouper	●	+	*	Cocoa damselfish	●	+	*	Short bigeye		+	*
Red porgy	●	+	*	Cowfish		+		Spadefish	●		
Red snapper	●	+	*	Creole fish		+		Spotfin butterflyfish	●	+	*
Scamp	●	+	*	Cubbyu	●	+	*	Spotfin hogfish		+	*
Seriola spp.	●	+	*	Dragonet	●			Squirrelfish			*
Sheepshead	●			Dusky damselfish	●			Striped burrfish			+
Spanish mackerel	●			Goby	●	+	*	Tattler		+	*
Speckled hind		+	*	Greenband wrasse	●	+	*	Twospot cardinalfish		+	*
Tomtate		+	*	Gulf surgeonfish		+	*	Whitespotted soapfish	●	+	*
Vermilion snapper		+	*	Gulf toadfish	●			Wrasse bass		+	*
White grunt	●			Halichoeres spp.	●	+	*	Yellow cheek wrasse			+
				High hat		+	*	Yellowtail reeffish		+	*

● Nearshore + Mid-shelf * Offshore

Red Snapper

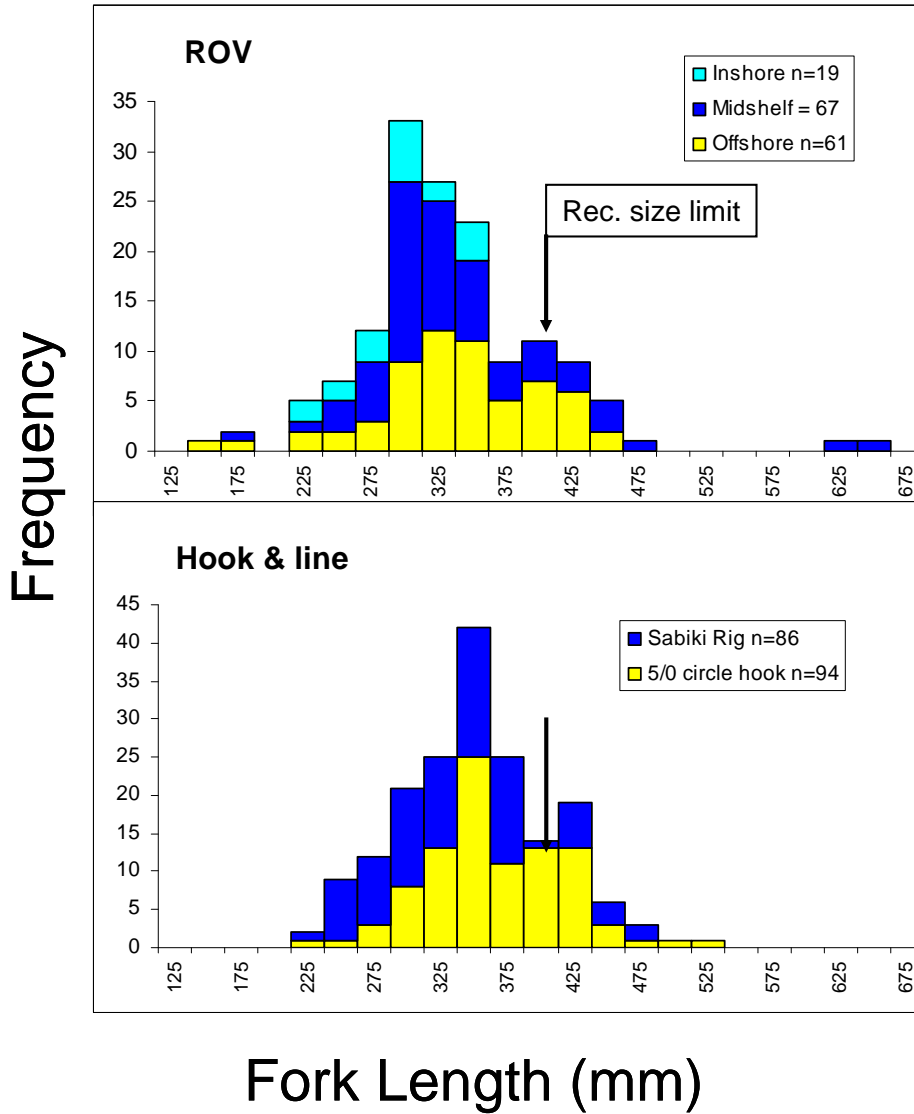


Figure 1. Size distributions of red snapper from Mar 07 – Mar 08 sampling by depth strata from the ROV laser-scaled video data and for all strata combined from the hook and line collections.

Red Grouper

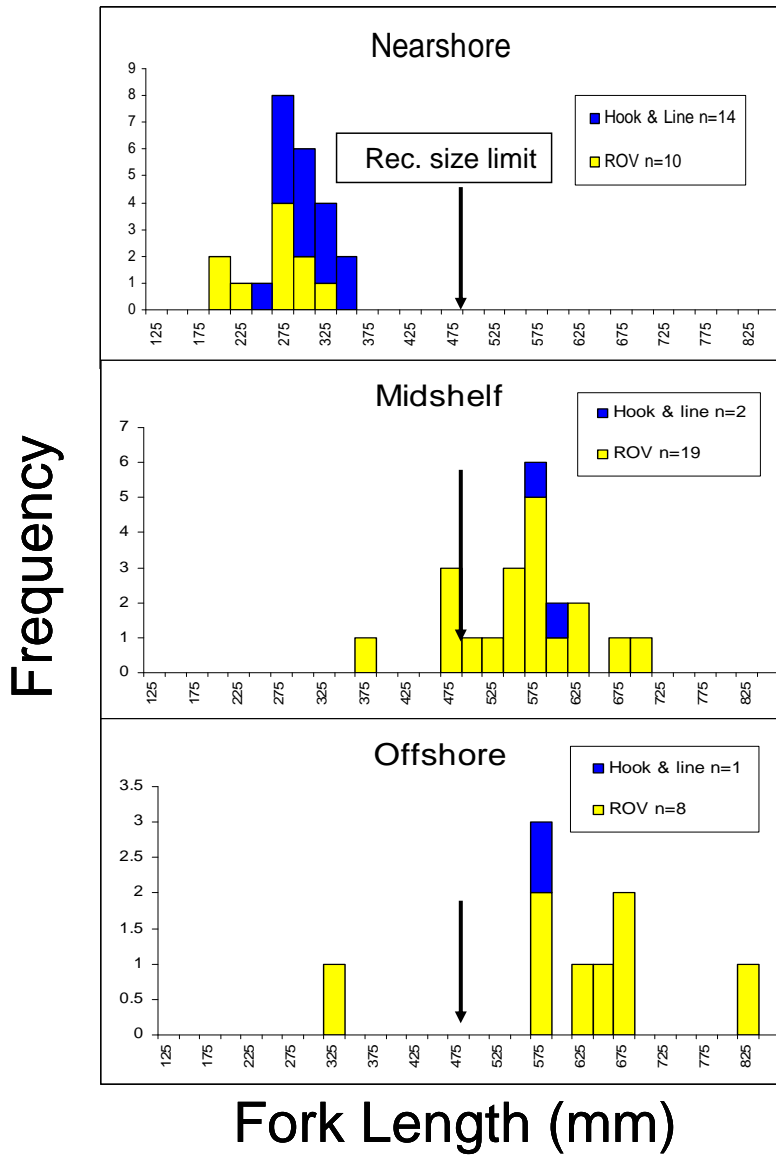


Figure 2. Size distributions of red grouper from Mar 07 – Mar 08 sampling by strata from the ROV laser-scaled video data and hook and line collections.

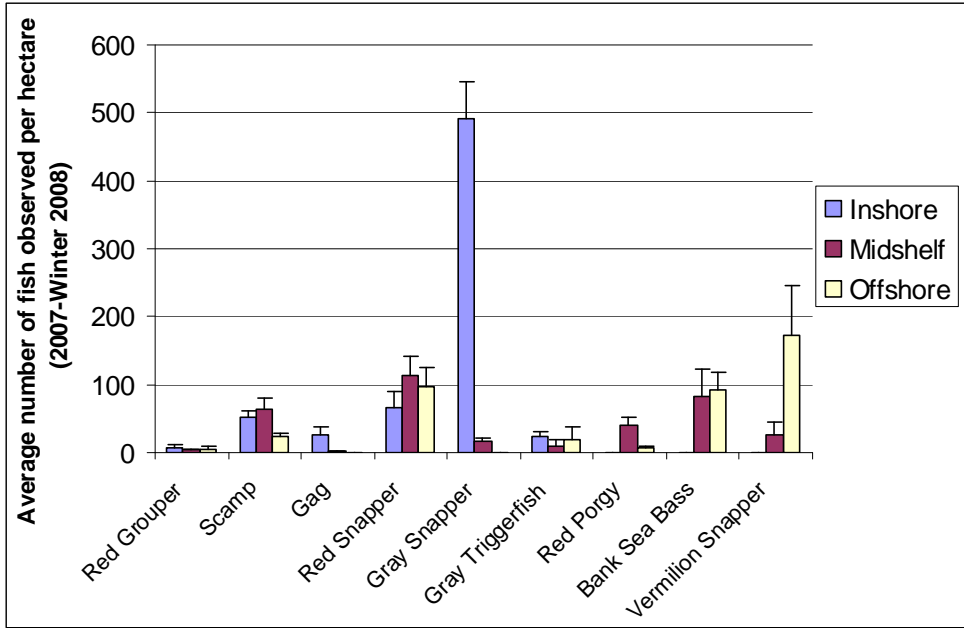


Figure 3. Average number of fish/ha (exploited species only) and standard error, by depth stratum, from ROV transect counts made during Mar, Jun, Oct 07, and Mar 08.

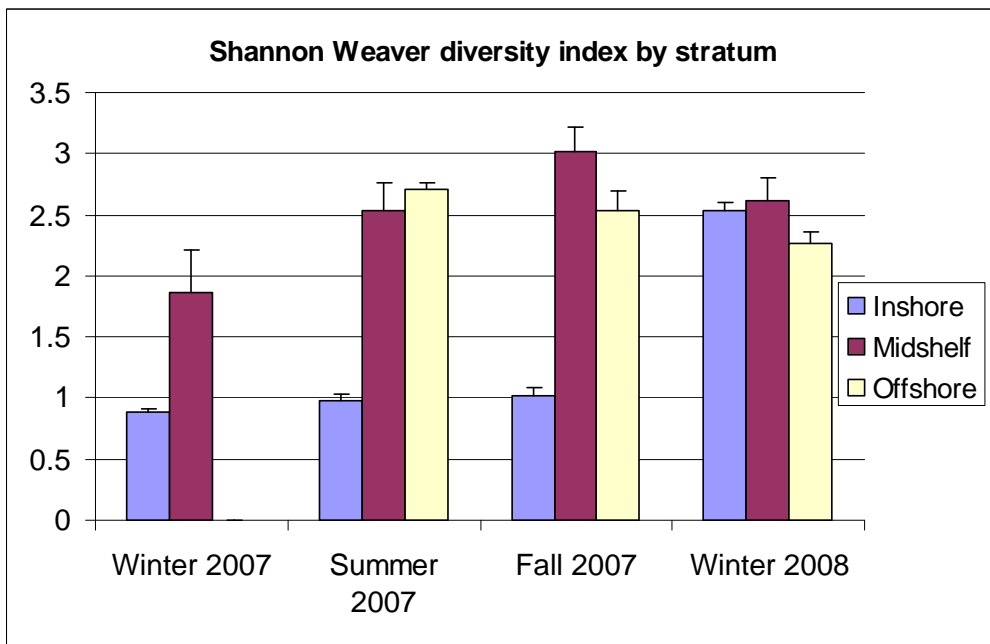


Figure 4. Shannon Weaver diversity indices and standard errors by stratum and season. Observations were transformed by square root to decrease the influence of extremely abundant taxa.

Northeastern Gulf of Mexico Foodweb

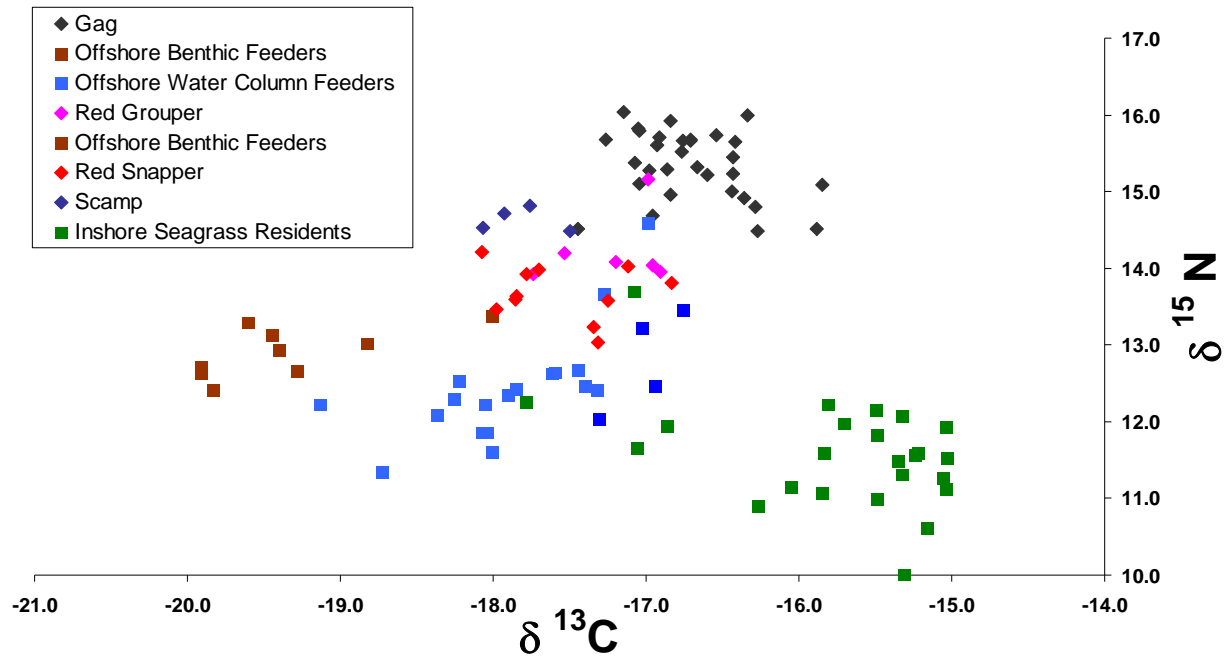


Figure 5. Preliminary stable isotope analysis of the foodweb in the northeastern Gulf of Mexico from samples collected thus far as part of the NOAA/FSU collaboration under NGI. Major fishery species (gag, red grouper, and red snapper) are shown as well as major prey groups identified by stable C & N isotope values. Benthic feeders = red pogy and blue angelfish. Water column feeders = vermilion snapper, tomtate, sand perch, bank seabass, and inshore lizardfish. Inshore seagrass residents = pinfish, pigfish, and spot. Figure provided by J. Nelson (FSU).

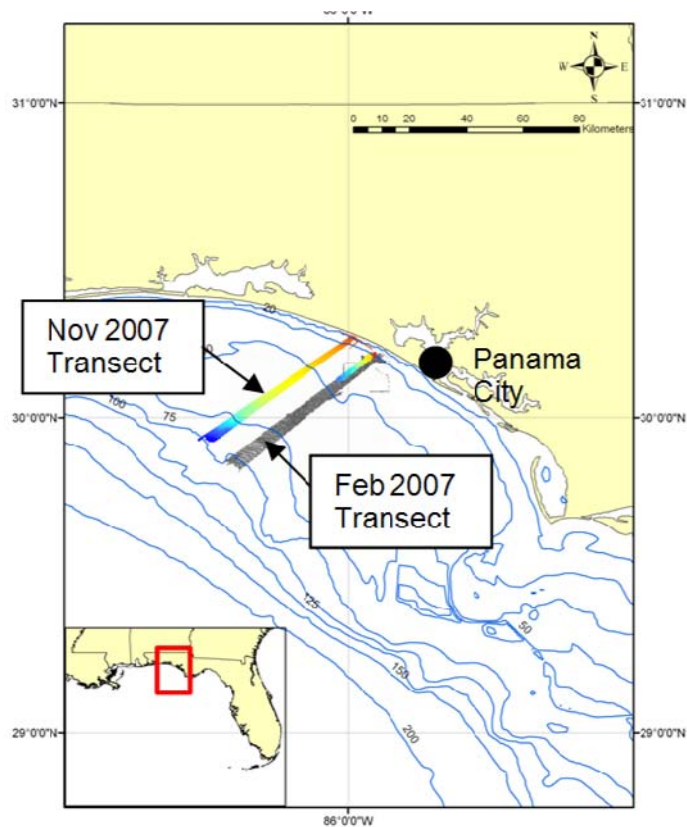


Figure 6. Inshore to offshore transects surveyed with multibeam echosounders in Feb and Nov 2007 off northwest Florida.

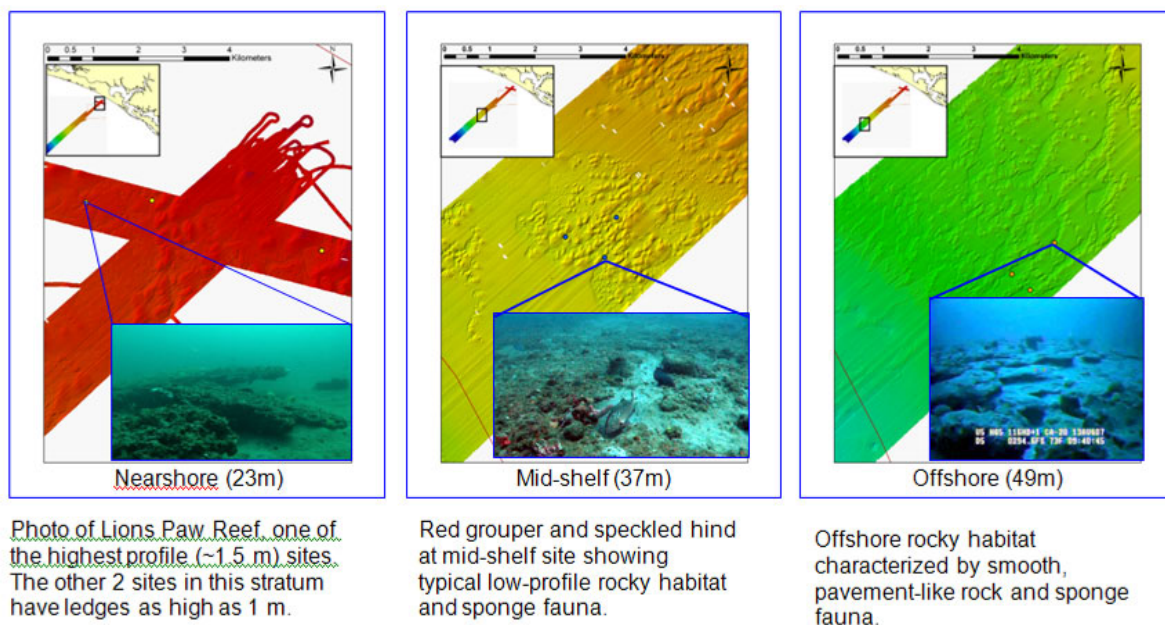


Figure 7. Multibeam bathymetry and ROV sampling sites in each stratum in transect mapped Feb 2007, along with photos of representative habitat.

Outreach Activities

C. Gardner, speaker at Panama City spearfishing club on 6 Nov 2006, Panama City, FL. Talk on Gulf of Mexico research and reef fish identification. Approximately 20 participants.

C. Gardner, speaker at Boy Scout scout masters convention on 9 Aug 2007, Panama City, FL. Talk on Gulf of Mexico research and local fishing techniques and fishing opportunities for kids. Approximately 30 participants.

C. Gardner, speaker at Blounstown Elementary School science night on 6 Nov 2007, Blounstown, FL. Talk on NOAA research and marine biology. Approximately 150 participants.

Has anyone on this project been hired by NOAA?

N/A

Peer Reviewed Articles:

None

List non-refereed articles and reports for this project:

None

List conference presentations and poster presentations for this project:

Gardner, C., and D. DeVries. 2008. Cross-shelf patterns in fish community structure and demographics on hard bottom habitat off northwest Florida. Oral presentation, 28th Annual Meeting of Florida Chapter, American Fisheries Society, Ocala, FL.

Nelson, J.A., J.P. Chanton, F.C. Coleman, and C.C. Koenig. 2008. FLUX by FIN: Fish mediated carbon and nutrient flux between northeastern Gulf of Mexico seagrass beds and offshore reef fish communities. Oral presentation, 28th Annual Meeting of Florida Chapter, American Fisheries Society, Ocala, FL.

DeVries, D., C. Gardner, G. Fitzhugh, M. Monaco, T. Battista, R. Allman, and L. Lombardi-Carlson. Habitat-linkages, spatial demographics and food web components of the northeastern Gulf fisheries ecosystem - Year 2 Progress. Poster for 2008 Annual Northern Gulf Institute Conference, Biloxi, MS.



Mercury Bioaccumulation in Mobile Bay: a Model for Other of Gulf of Mexico Estuaries

NGI Project File Number: 07-NOAA-04

David Evans, david.w.evans@noaa.gov. NOAA, Center for Fisheries and Habitat Research, Beaufort NC

List all personnel funded by this project (Person's name, Category, Percent of support by NGI, at NOAA Lab):

David Cerino, Research Support Staff, 79%, Yes, Center for Coastal Fisheries and Habitat Research
Colleen Rochelle, Research Support Staff, 100%, YES, Center for Coastal Fisheries and Habitat Research)

Key Scientific Question(s)/Technical Issues: Collect water, sediment, and biota from Mobile and analyze these samples for total mercury and methylmercury. Using these data, develop a mass balance of mercury and methylmercury in Mobile Bay in order to define sources of mercury and environmental processes that contribute to high bioaccumulation of methylmercury in biota consumed by humans and wildlife. This information will be useful in developing predictive models applicable Mobile Bay and other Gulf of Mexico estuaries that can be used in evaluating responses to changing mercury inputs resulting from new policies and regulations as well as predicting sites where high mercury bioaccumulation can occur and suggesting modes of mitigation.

Collaborators(s)/Partners:

Name of collaborating organization: Mississippi State University

Date collaborating established: May 30, 2007

Does partner provide monetary support to project? No. Amount of support? none

Does partner provide non-monetary (in-kind) support? Yes.

Short description of collaboration/partnership relationship: We provide historical and current information on mercury concentrations in sediments and water useful in parameterizing and evaluating MSU's models on mercury distribution in Mobile Bay and its watershed. We also review MSU proposals and reports in the context of our expertise on the environmental behavior of mercury in coastal zones and estuaries.

Name of collaborating organization: Dauphin Island Sea Lab

Date collaborating established: May 18, 2007

Does partner provide monetary support to project? No. Amount of support? none

Does partner provide non-monetary (in-kind) support? Yes

Short description of collaboration/partnership relationship: Arranged for, received, or began mercury analyses of biota samples for NGI collaborators at Dauphin Island Sea Lab. These analyses support four projects at DISL:

Lucy Novoveska - PhD dissertation: Benthic-Pelagic Coupling: Microalgal Transfer of Mercury from Contaminated Sediments

Ruth Carmichael: Relationship sewage inputs to success of oyster restoration in Mobile Bay

Anne Boettcher: The Effect of Non-Point Source Pollution on Gulf Pipefish Populations In and Around Weeks Bay Reserve

John Dindo: Mercury in colonial marine birds in relation to food supply in Mobile Bay

Project Duration:

Start Date: June 2, 2006

Estimated End Date: September 30, 2009

Project Baselines:**Contributions to specific NOAA Goals/Objectives:**

This proposed work falls clearly within NOAA's Ecosystem Mission Goal, as outlined in the NOAA 5-Year Strategic Plan. Specifically our work will "Increase number of regional coastal and marine ecosystems with approved indicators of ecological health and socioeconomic benefits that are monitored and understood." From the NOAA Five-year Research Plan, we will specifically support ecosystem planning and management to "Investigate sources, fates, and effects of anthropogenic influences, including contaminants..." We further serve NOAA's mission by providing an integrated assessment of mercury in one of the Gulf of Mexico's critical estuaries and thereby further NOAA plans to conduct a regional ecosystem-wide assessment of mercury in the Gulf of Mexico.

This project supports three of NOAA's research areas: 1. Advancing understanding of ecosystems to improve resource management. Within this area, we will contribute to the performance objective to increase number of coastal and marine ecosystems delineated with approved indicators of ecological health and socioeconomic benefits that are monitored and understood. 2. Forecasting ecosystem events under the performance objective Define the primary forcing factors and time and space scales that affect water quality [mercury] and quantity for selected ocean, coastal, and Great Lakes regions 3. Develop integrated ecosystem assessments and scenarios, and building capacity to support regional management under the performance objective Produce at least two integrated ecosystem assessments that evaluate the ecological response to various anthropogenic stressors [e.g. Pollution - mercury as a contaminant].

This project addresses NOAA's research priority to support an ecosystem approach to management employing a pilot study on Mobile Bay as a starting point for an assessment of mercury pollution for all NOAA defined Gulf of Mexico estuaries.

Three of the five themes of NOAA's ecosystem mission goal: 1) support collaborative approaches to science and management at the regional level, 4) protect marine and coastal resource integrity and security, and 5) develop more robust ecosystem modeling and integrated assessment capability to serve current and future management information needs. Support for the first theme is explicit in the NOAA: academic partnership of the Northern Gulf Institute mission. Support for the fourth theme resides in provision of information to identify environments with high mercury bioaccumulation and the underlying causal influences. Through both mass balance and Ecopath/Ecosim/Ecotracer modeling, we will provide tools supporting the fifth theme.

This project contributes to priority areas in the following NOAA research programs:

Ecosystem Research Program – Develop a suite of tools for ecosystem forecasting that improves ecosystem understanding and decision making, and reduces risks to ecosystem and human health.

Ecosystem Observation Program – Generate and manage data and information necessary for conducting IEAs and risk analyses.

Coastal and Marine Resources Program – Characterize the biological, chemical, physical and ecological conditions of coastal and marine ecosystems to quantify change due to natural and anthropogenic stressors.

Habitat Program – Develop technologies to detect, prevent, and remediate coastal pollution and habitat degradation.

Contributions to regional problems and priorities:

The National Science And Technology Council, Committee on the Environment and Natural Resources, Interagency Working Group On Methylmercury has recommended the following research activities in its 2004 report, Methylmercury in the Gulf of Mexico: State of Knowledge and Research Needs:

“More research is needed on the atmospheric pathway and emission sources of mercury depositing in the Gulf of Mexico Region. This research would use expanded monitoring data recommended above, would include both natural and anthropogenic sources, and would account for evasion (evaporation) of mercury after initial deposition.” Our work employs existing atmospheric deposition data, atmospheric mercury measurements, and modeled source tracking information as inputs into our mercury mass balance modeling efforts

“More research is needed on methylation mechanisms in estuarine and marine environments and in coastal wetlands.” We are using patterns of methylmercury distribution in sediments to infer causal mechanisms.

“ Fate and transport models of mercury cycling in estuarine and coastal wetlands are needed, building upon the modeling techniques developed in the Everglades and other wetlands” We are integrating our monitoring data with MSU collaborators who are developing fate and transport models of mercury in Mobile Bay and its Watershed.

“Determination of the chemical form of mercury is needed in various environmental media, and for different locations and environments within the Gulf of Mexico region.” We are measuring both total mercury and methylmercury in water, sediments, and biota of Mobile Bay

“Research is needed to determine how methylmercury is incorporated into the food web in the Gulf of Mexico and in adjacent estuaries and coastal wetlands.” We are developing food web models to determine where in the base of the food web methylmercury is incorporated. Stable isotopes of C, N, and S are employed to determine the dominant primary producers are at the base of the food web where methylmercury is incorporated..

Gaps: (Describe how the project will narrow gaps in regional knowledge, data, model performance, geographic coverage, etc.):

Data on mercury and methylmercury concentrations in waters of Mobile Bay and the adjacent ocean are rare or non-existent. This project is providing the first measurements of methylmercury in this region. We are integrating atmospheric mercury deposition data with water and sediment mercury concentrations through a mass balance model. We are developing the first known food web model for Mobile Bay and employing it to model mercury bioaccumulation. We are identifying locales of mercury methylation in Mobile Bay. We are developing methods to extend our modeling approaches to other Northern Gulf of Mexico estuaries.

Project Abstract:

Methylmercury has been identified as a major concern in the Gulf of Mexico because of the potential risks to human health through the consumption of marine fish (NSTC, 2004). NOAA hopes to build a comprehensive program to investigate methylmercury in the Gulf beginning in FY2009. We are conducting a pilot study in support of this anticipated effort, focusing on Mobile Bay. Our work provides initial information on mercury inputs, cycling, and bioaccumulation in fish useful both for specific concerns in Mobile Bay and as a model approach used in the larger gulf-wide program. Existing historical information and ongoing monitoring data are being integrated with newly collected sampling data from Mobile Bay to provide an initial estimate of the mass balance of mercury for the bay. We are identifying habitats and sites of mercury transformation to methylmercury, the bioaccumulated form of mercury. Finally, we are developing a predictive model of mercury transfer and biomagnifications through the Mobile Bay food web and will test these predictions with measurements of mercury in higher trophic level fish and their supporting food web.

List major milestones completed and describe any significant research results and transitions

We have obtained the following results to date:

Measured low mercury and methylmercury in both water and sediments of Mobile Bay.

Identified mercury methylation rates, ocean and watershed inputs, and an adequately defined food web as key data gaps in development of a mass balance model of mercury in Mobile Bay

Confirmed the general uniformity of mercury and methylmercury concentrations in sediments through much of the bay. Sampling in warmer seasons and in peripheral marsh areas may provide better estimates of seasonal and spatial variations in methylmercury concentrations and production.

Established first watershed inputs of methylmercury to Mobile Bay.

Discovered exceptionally high total mercury and methylmercury in a dinoflagellate bloom in Mobile Bay, suggesting an important role of phytoplankton in both the sequestration of mercury and its methylation.

Built active collaborations with NGI partners at Mississippi State University and Dauphin Island Sea Lab

Outreach activities

General Description:

Outreach activities have focused building partnerships with NGI academic investigators and local (Mobile Bay) resource managers.

Presentations :

Visit to Grand Bay National Estuarine Research Reserve to discuss cooperative research needs and opportunities, April 23, 2008

Visit to Alabama Marine Resources Division to discuss data sharing, May 21, 2008

Have you hosted speakers, workshops and/or any training?

No

Has anyone on this project been hired by NOAA?

N/A

Peer Reviewed Articles:

none

List non-refereed articles and reports for this project.

none

List conference presentations and poster presentations for this project.

Evans, David. "What Do We Know About Mercury in Mobile Bay?"

Dauphin Island Sea Lab, May 19, 2007.

Evans, David. "Mercury Bioaccumulation in Mobile Bay: A Model for Other Gulf of Mexico Estuaries" Mobile Bay National Estuary Program -Technical Interagency Committee. June 21, 2007.

Evans, David and David Cerino "Mercury in Mobile Bay Water and Sediments?" NOAA Northern Gulf Institute annual meeting May 13-14, 2008, Biloxi MS.



Northern Gulf Cooperative Institute: Development of Molecular Assays to Monitor Waters for Threats to Human Health

NGI Project File Number: 07-NOAA-05

List all personnel funded by this project (Person's name, Category, Percent of support by NGI, at NOAA Lab):

Goodwin, Research Scientist, 17%, Yes, AOML
Sinigalliano, Research Scientist, 67%, Yes, AOML
Wanless, Research Support Staff, 67%, Yes, AOML

Key Scientific Question(s)/Technical Issues:

Contribute to a collaborative laboratory and field validation study of source tracking methods being conducted by NGI scientists in order to improve the ability to diagnose and remediate water quality problems in coastal beach and shellfishing areas.

Collaborators(s)/Partners:

R. D. Ellender, Ph.D.
University of South Mississippi
Department of Biological Sciences
Johnson Science Tower 609
(601) 266-4720 – phone
(601) 266-5797 - fax
rudolph.ellender@usm.edu

Valerie J.(Jody) Harwood, Ph.D.
University of South Florida
4202 E. Fowler Ave.
Tampa, FL 33620
(813) 974-1524 - phone
(813) 974-3263 - fax

Date collaborating established: 2006
Does partner provide monetary support to project? No
Does partner provide non-monetary (in-kind) support? No
Short description of collaboration/partnership relationship.

This project includes collaboration with the NGI scientists listed above, with lead contact being Dr. J. Harwood. Interactions include the following:

Protocol Exchange
Sample Exchange (standards, controls, sewage samples, field samples)
Round-Robin Testing
Data Sharing

Project Duration:

Start Date 6/2006 Estimated End Date 6/2009

Project Baselines:**Contributions to specific NOAA Goals/Objectives:**

This research supports NOAA's Ecosystems Mission Goal to protect, restore, and manage use of coastal and ocean resources through Ecosystem Approaches to Management (EAM). Specifically, this research supports the Ecosystems Goal by developing tools and technologies to support integrated ecosystem assessments and to advance understanding of ecosystems to improve resource management. The research will help NOAA achieve the Outcome of healthy and productive coastal and marine ecosystems that benefit society. Furthermore, this work maps to the Performance Objectives to increase the number of regional, coastal, and marine ecosystems delineated with approved indicators of ecological health and socioeconomic benefits that are monitored and understood.

This research falls under the following Ecosystem Goal Research Areas:

- support collaborative approaches to science and management at the regional level
- enhance resilience to hazards (by developing tools and technologies that can be incorporated into, for example, Health Early Warning Systems)
- protect marine and coastal resource integrity and security (from biological threats and emerging disease).

In addition, this project aligns with the NOAA goal of serving society's needs for water information and with the Weather and Water Performance Objective of increasing the development and transition of advanced science and technology to operations and services. In addition, this work meets Cross-Cutting Priorities for developing a world-class workforce by producing individuals with a combination of abilities in molecular biology, microbiology, microbial ecology, and oceanography.

Furthermore, this project aligns with research priorities outlined in NOAA's Annual Guidance Memorandum for FY 2010-2014. The molecular assays developed and field tested as part of this project can be integrated into biosensing platforms. Therefore, this research responds to the Ocean Research Priorities Plan (ORPP) and Implementation Strategy focus of Sensors for Marine Ecosystems.

Contributions to regional problems and priorities:

Microbial source tracking methods will help Gulf Coast states better address beach and shellfish contamination problems by helping environmental managers to identify the sources of contamination so that remediation efforts can be scientifically and economically sound

(see http://dep.state.fl.us/gulf/files/files/WaterQuality_Florida.pdf)

Gaps:

Work will help develop reproducible, quantitative, and inexpensive source tracking tests

Project Abstract:

There is a need to develop rapid biodetection methods to aid infrastructure management (e.g., septic tank & sewer function, harmful algal distributions, wetland restoration, levee construction, ballast water treatment and release, seafood safety), integrated ecosystem assessments, resource management (e.g., beach closure), and to increase resiliency of coastal hazards.

List major milestones completed and describe any significant research results and transitions

During the first year of this project, much progress was made on adapting and developing molecular assays for the following fecal indicators, source tracking markers, and pathogens:

pathogens: *E. coli* O157:H7, *Campylobacter jejuni*, *Salmonella* spp., *Staphylococcus aureus*, adenovirus, and *Cryptococcus neoformans*.

fecal indicating bacteria: *Enterobacteriaceae*, *Enterococcus* spp., *E. coli* & *Shigella* spp.

alternative fecal indicators: *Bacteroides* spp.

source tracking markers: human HF8 gene cluster of *Bacteroides* spp., human-specific *esp* gene of *Enterococcus faecium*; dog-specific *Bacteroides*
toxic dinoflagellate: *Karenia brevis*.

The first year of this project predated the award of the NGI. Once the NGI was established, the original work plan of the this project was modified to align with interests of NGI scientists working on a proposal entitled “Microbial Source Tracking and its Application to the Northern Gulf of Mexico” (Ellender, Wang, Lepo, and Harwood) and a Gulf of Mexico Alliance Regional Partnership Project (EPA) entitled “Validation and Field Testing of Microbial Source Tracking Methodologies in the Gulf of Mexico” (Harwood, Ellender, Wang, and Lepo). Our primary point of contact and interaction has been Dr. J. Harwood from the University of South Florida. Through discussions with NGI scientists, we developed the following objectives for this project (Year 2 and 3):

- Optimize and test a source tracking marker for dogs
- Adapt a marker for dog fecal pollution to a qPCR assay
- Share protocols with Northern Gulf cooperative Institute researchers working on microbial source tracking
- Participate in round-robin testing
- Adapt human source tracking markers to a qPCR assay

Source Tracking Marker for Dogs: Initially, the molecular assay to detect fecal contamination from dog feces was based on a standard PCR test for dog-specific *Bacteroides* published by Dick et al. (2005). Specificity for the primer set (DF475F and Bac708R) was shown in this paper to be dog-specific in tests against fecal DNA extracts from dog, cat, human, gull, chick, pig, and cow. In year 1, specificity testing in our laboratory with standard PCR confirmed that the test was specific for dogs when tested against DNA extracted from human and bird feces.

We demonstrated successful results with this primer set using PCR and detection via gel electrophoresis (Fig. 1). The source tracking assays for dogs as well as the assays for the other targets mentioned above were transferred into a research field program. The molecular assays are being utilized by the Florida Area Coastal Environment Program (FACE). The objective of this program is to assess the loads of nutrients and microbial contaminants delivered to the coastal environment from a variety of sources, including treated wastewater, inlets, and groundwater.

An objective of for this reporting period was to adapt the standard PCR assay to a quantitative PCR (qPCR) format. Our initial attempts utilized Dick et al. (2005) primers and a SybrGreen qPCR format (Fig. 2). Despite good specificity testing via analysis by gel electrophoresis, melting curve analysis (Fig 3) indicated that there were multiple amplified bands, including primer dimer using the SybrGreen approach. The melting curve analysis should yield a single peak of fluorescence, showing only one generated product (215 bp). Instead, Fig. 3 shows that when the primers were used with SybrGreen and the fluorescence visualized via the sensitive qPCR instrument, multiple fragments were generated from dilutions of dog feces. *In conclusion, the original primers were not specific enough to use for a real-time assay.*

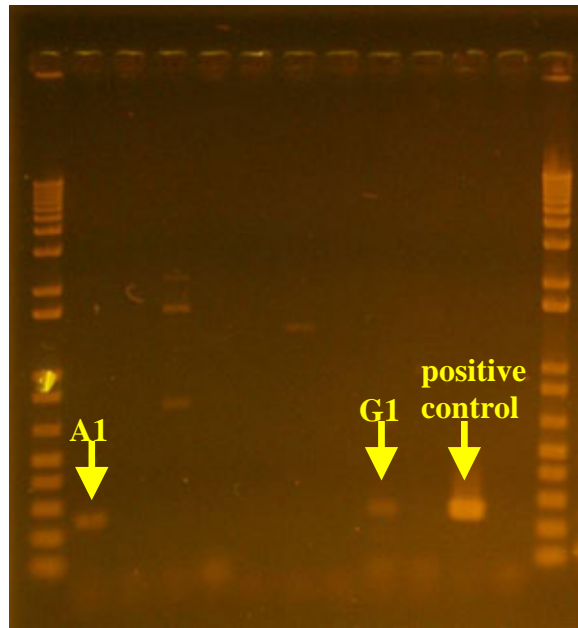


Fig. 1. Example positive detection of fecal contamination derived from dogs for two samples (site A1 & G1) collected from the FACE research field program.

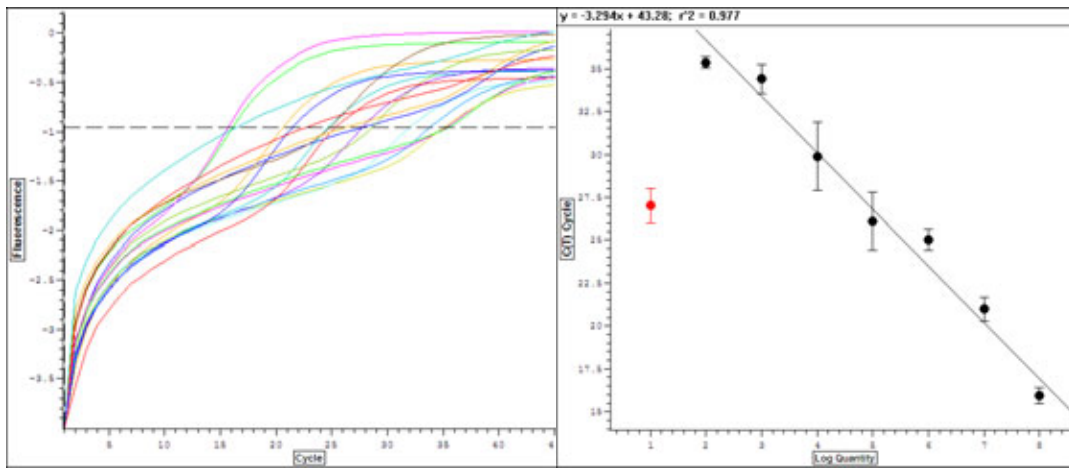


Fig. 2. SybrGreen qPCR amplification plot and standard curve for Dick et al. (2005) primer set.

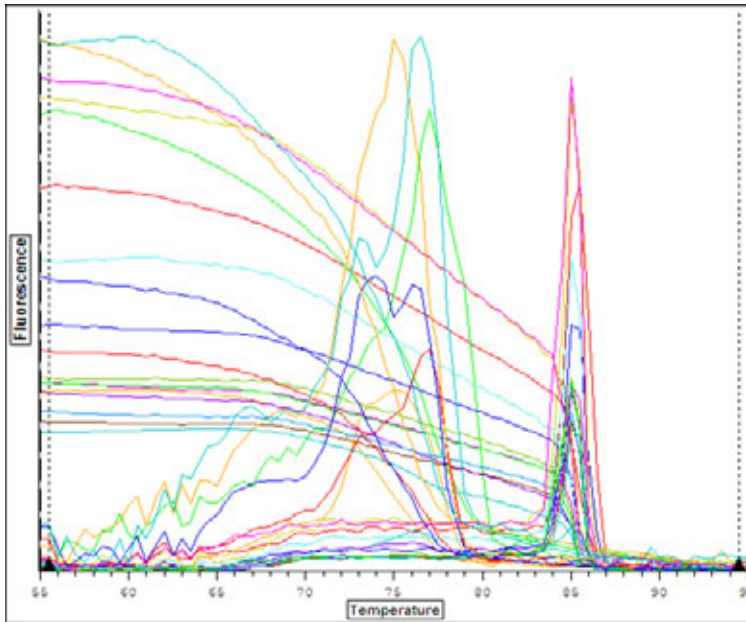


Fig. 3. Melting curve analysis of SybrGreen-based qPCR of dog feces DNA extracts using the Dick et al. (2005) primer set, showing multiple-size amplification products interfering with quantitation of the proper target band.

Our next approach was to adapt the dog-specific *Bacteroides* assay to a qPCR assay in TaqMan format. The approach was to use the primer set of Dick et al. (2005) and to design a TaqMan probe in order to eliminate fluorescence interference from non-target products and thus ensure specificity of the assay under real-time conditions. A qPCR assay for quantitative detection of fecal pollution derived from dogs was successfully developed. The new assay, termed “DogBac,” consists of the following:

Primers:

Forward primer (DF475F): 5’ - CGCTTGTATGTACCGGTACG -3’

Reverse primer (Bac708R): 5’ - CAATCGGAGTTCTTCGTG -3’

Dog-specific TaqMan probe (DogBac probe):

5’-6FAM –ATTCTGGTGTAGCGGTGAAATGCTTAG – BHQ1-3’

Thermocycling conditions:

Step 1: 95°C for 15 min

Step 2: 95°C for 15 sec

Step 3: 60°C for 30 sec

Step 4: Plate read

Step 5: Go to step 2, 44 more times

Reaction conditions - 1X reaction mix, 25 µl final reaction volume:

0.5 µl of target sample (i.e. reaction template)

0.125 µl of DF475F (from 100µM stock)

0.125 µl of Bac708R (from 100µM stock)

0.100 µl of DogBac probe (from 100µM stock)

12.5 µl of 2X MasterMix (Qiagen Quantitect Probe MasterMix kit, Cat# 204343)

11.65 µl of water

This new assay proved to be a significant improvement of the previous SybrGreen assay (Fig. 4). Fluorescence is now only generated by amplification of the targeted 215 bp product. primers.

The qPCR assay underwent additional development in order to obtain genomic controls that will allow absolute quantification. The current controls allow relative quantification to our dog fecal “standard.” To develop a reliable, consistent, and uniform standard amplicon from the DogBac assay was cloned in order to produce a plasmid control of known copy #. The DogBac amplicon was isolated on a preparative gel shown in Fig. 5A, excised as shown in Fig. 5B, and cloned into a plasmid vector with the TOPO cloning kit at known copy number. DogBac quantitation control standards were prepared by digesting the DogBac target inserts from the plasmid vector (as shown in Fig 5C), purifying target fragments from the gel, quantifying the target concentration by fluorometry, then adding known amounts of target copy number to the reactions as quantitation standards.

The qPCR assay for source tracking dogs has been transferred into an epidemiology study being conducted by the University of Miami Center of Excellence in Oceans and Human Health (UM COOH) (Fig. 6). Furthermore, the assay has been utilized on samples provided by NGCI scientists (Table 1).

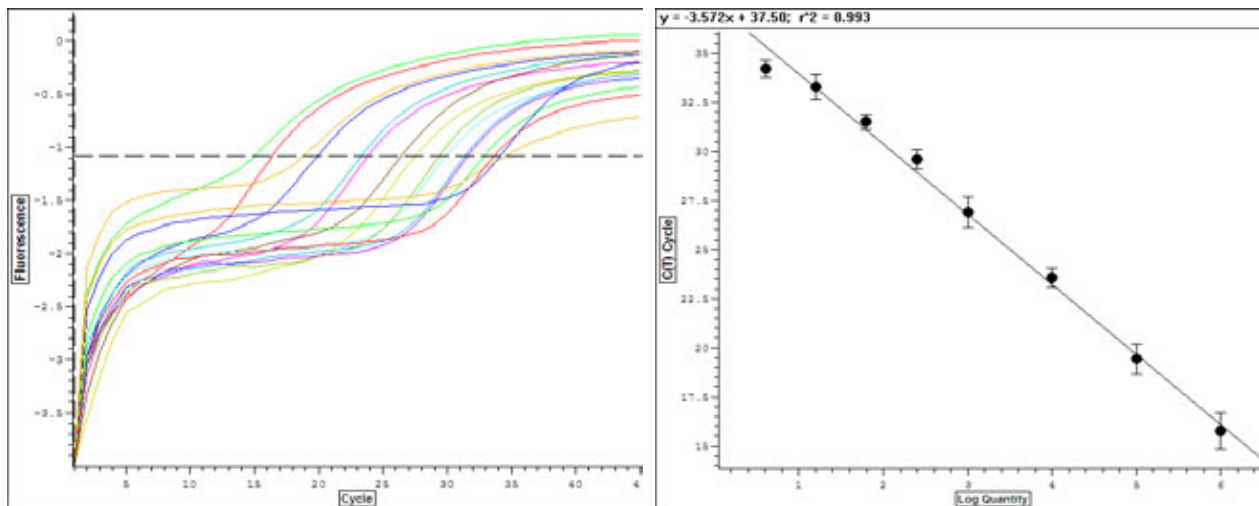


Fig 4. qPCR amplification plot for the dog-specific Bacteroides TaqMan assay, showing amplification signal from various dilutions of dog feces, and the standard curve of dilutions of dog feces extract.

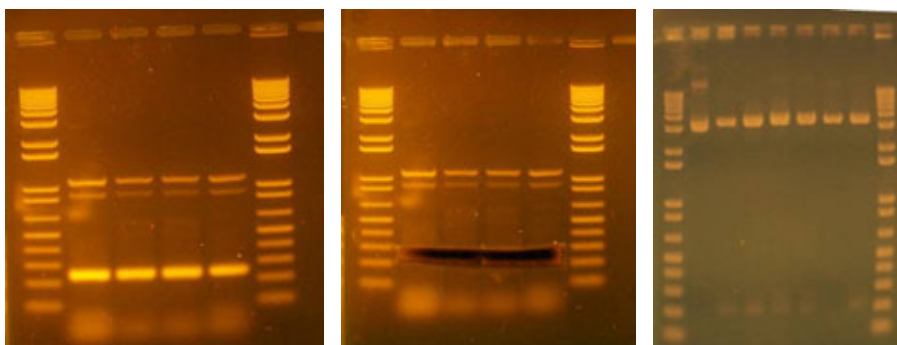


Fig 5. Cloning of DogBac Plasmid control to generate a control. A) (left): prep gel of DogBac amplicon; B) (middle): excising amplicon for purification and cloning; C) (right): linearized plasmid vector and digested DogBac amplicon insert.

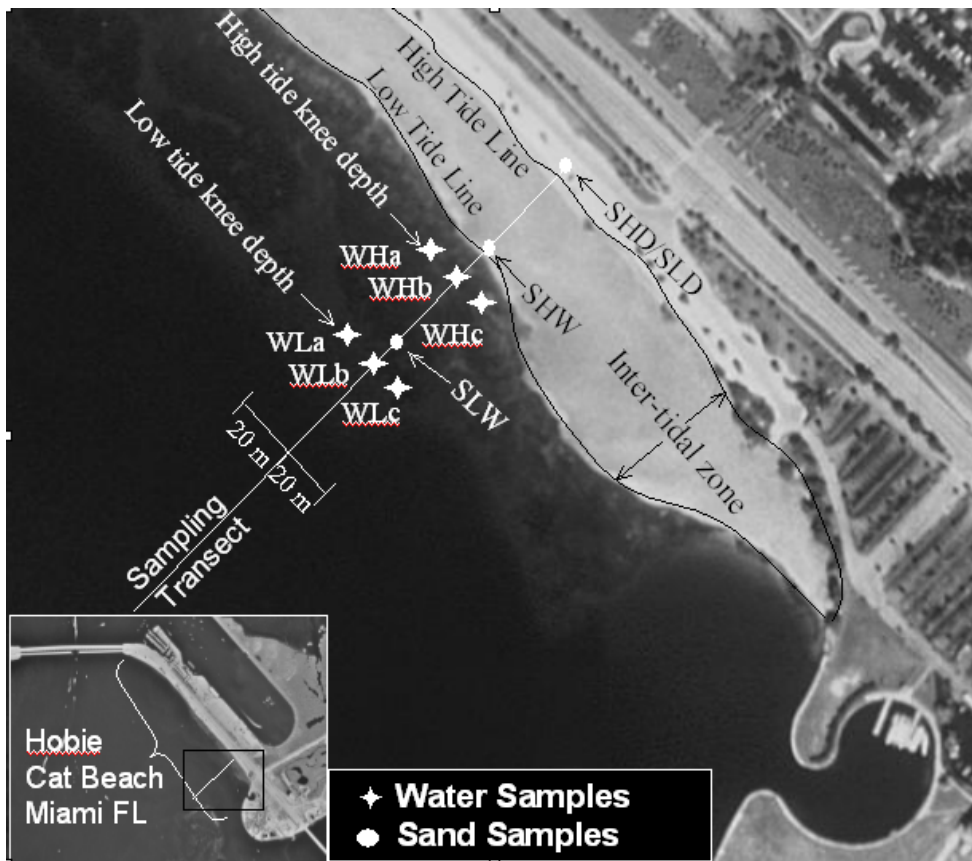


Fig 6. Water and Sand Sampling Locations at High and Low Tide along the Sampling Transect at Hobie Cat Beach, Miami, FL USA, the site of the UM COOH epidemiology study.

The DogBac qPCR assay was used to process a variety of dog fecal samples provided by NGCI scientist, Dr. Jody Harwood. The samples were collected in early 2008 from freshly deposited dog feces from healthy dogs (no antibiotics or known illness) at a humane society in Tampa, FL. Each sample represents one individual dog. Table 3 shows that out of 33 independent dog fecal samples, 90% tested positive with our DogBac assay (Table 1), with 69% yielding greater than 1×10^4 gene copies per μl of fecal DNA extract (Table 1, bold).

Table 1: qPCR assay results for dog fecal pollution for 33 DNA extracts from dog feces provided by NGCI scientist, Dr. Jody Harwood.

SAMPLE	qPCR copies of gene in 1 µl of sample	Comment
Dog sample 1	0.46	negative
Dog sample 2	1.7E+08	
Dog sample 3	4.8E+06	
Dog sample 4	112	
Dog sample 5	3.4E+04	
Dog sample 6	339	
Dog sample 7	0.37	negative
Dog sample 10	3.0E+04	
Dog sample 12	2.3E+06	
Dog sample 13	1.8E+05	
Dog sample 14	8.4E+04	
Dog sample 15	3.0E+04	
Dog sample 16	7729	
Dog sample 17	6.3E+06	
Dog sample 18	2.3E+06	
Dog sample 19	6.5E+06	
Dog sample 20	15	
Dog sample 21	9.4E+06	
Dog sample 22	1.1E+07	
Dog sample 23	1.4E+06	
Dog sample 24	0.84	negative
Dog sample 25	1.6E+05	
Dog sample 26	9.1	
Dog sample 27	1.3E+05	
Dog sample 28	7.4E+06	
Dog sample 29	6061	
Dog sample 30	9.7E+05	
Dog sample 31	2.0E+04	
Dog sample 33	1.2E+07	
NTC	0.58	negative control
NTC	1.1	negative control

Outreach activities

General Description

None to Report

Have you hosted speakers, workshops and/or any training?

None

Has anyone on this project been hired by NOAA?

N/A

Peer Reviewed Articles:

None to report

List non-refereed articles and reports for this project.

None to report

List conference presentations and poster presentations for this project:

D. Wanless, K.D. Goodwin, C. Sinigalliano. Development of Genetic Sensors to Monitor Waters for Threats to Human Health. Northern Gulf Cooperative Institute PI meeting, Biloxi, MS, May 12 -14, 2008.



Building a Comprehensive Database on the Early Life Stages of Fishes in the Northern Gulf of Mexico

NGI Project File Number: 07-NOAA-06

Dr. Joanne Lyczkowski-Shultz (Joanne.Lyczkowski-Shultz@noaa.gov), Mark McDuff and David S. Hanisko, National Marine Fisheries Service/SEFSC/ Mississippi Laboratories/Pascagoula Facility; and Dr. William J. Richards National Marine Fisheries Service/SEFSC/Miami Laboratory

List all personnel funded by this project (Name, Category, Percent of support by NGI, at NOAA Lab):

Katrin Marancik, Research Scientist, 100%, NOAA NMFS NEFSC/SEFSC Woods Hole Laboratory

Glenda Sutphen, IT Contractor, 50%, NOAA NMFS SEFSC Mississippi Laboratories

Michael Holley, IT Contractor, 100%, NOAA NMFS SEFSC Mississippi Laboratories

Key Scientific Question(s)/Technical Issues:

Improve the precision, accuracy and consistency of larval fish identifications in SEAMAP collections over the 25+ year time series. Technical issues encountered in establishing a single, coherent, fully documented and taxonomically updatable SEAMAP plankton database containing all associated collection, station and environmental data and observations included:

- merging divergent data sets implementing ITIS (Integrated Taxonomy Information System)
- providing secure access to SEAMAP information with appropriate rights and privileges

Collaborators(s)/Partners:

The five Gulf States, Gulf States Marine Fisheries Commission and NMFS comprise the Southeast Area Monitoring and Assessment Program or SEAMAP and have in partnership conducted resource surveys in the Gulf of Mexico since 1982. This collaboration involves the collection of plankton samples and environmental data, long-term archival of ichthyoplankton specimens and the review and update of data being assembled into the master SEAMAP database.

During year 2 planning and sample collection for future joint NOAA-NGI research were begun with Drs. Frank Hernandez and Monty Graham at the DISL; Harriet Perry USM/GCRL; and Dr. Woody Nero NOAA/LSU. We have discussed the opportunities for research with these NGI invertebrate zooplankton colleagues and they have agreed to conduct analyses of various invertebrate zooplankton components of SEAMAP plankton samples as future NGI funds become available. Participation of researchers from both NGI institutions is essential as it will result in a more comprehensive zooplankton database because the taxonomic expertise available at the two institutions is uniquely different, yet complementary.

These NGI researchers view their closer relationship with SEAMAP resource surveys and the SEAMAP plankton database as a unique opportunity to link their more localized datasets to the Gulfwide database; to enhance their own sample and data collections; and to expand educational, especially seagoing, opportunities for their students. NOAA Fisheries/NMFS/SEFSC/SEAMAP will benefit from this collaboration because it will result in a more comprehensive (holistic) plankton database with the inclusion of data on the composition and abundance of invertebrate zooplankton including not only the early life stages of fishery resource taxa (meroplankton) but the permanent resident zooplankton (holoplankton) as well.

Project Duration:

August 2006 to August 2009

Project Baselines:**NOAA Mission Goal Research Areas addressed:**

Ecosystem Mission Goal

Advancing understanding of ecosystems to improve resource management

Developing integrated ecosystem assessments and scenarios, and building capacity to support regional management

Climate Mission Goal

Understand impacts of climate variability and change on marine ecosystems to improve management of marine ecosystems

Commerce and Transportation Mission Goal

- Develop the information and tools to make reliable decisions in preparedness, response, damage assessment, and restoration

Technology and the Mission Support Goal

- Data management, associated visualization technology & models, and related high performance computing and communication

Our project is tied to regional issues involving fisheries resources within the Gulf of Mexico. It does so directly as SEAMAP estimates of larval fish abundance are used to index stock size in species specific stock assessments and to assess the impact of anthropogenic effects (e.g. entrainment mortality) on fish stocks. In a more indirect but no less profound way this project provides insights into the nature of variability in a little studied yet basal component of the Gulf ecosystem; the zooplankton. It is hard to think of any group or entity that monitors, regulates or uses the Gulf's marine resources that are not a stakeholder in this project. Unlike many studies which are spatially limited the data from this project is Gulfwide in nature and thus encompasses the entire range of individual fish stocks and the wide diversity of the northern Gulf biome.

Project Abstract:

The work we are undertaking involves examination and, as required, re-identification of larvae of selected fishery resource and non-resource taxa held at the SEAMAP Archive in St. Petersburg, FL. As larval fish identifications are changed so must the ichthyoplankton sample data files be regularly updated. This is not easily accomplished under the current SEAMAP data structure and management system resulting in numerous, independent versions of the data. To remedy this situation we propose to establish a single, coherent, and taxonomically updatable database containing all the associated sample, station and environmental data and observations. The data files in this system will be regularly updated from a single point and will represent the best available scientific data reflecting all corrections and additions made during specimen examination and collection data summaries. This will benefit NOAA's mission goals by advancing our ability to disseminate the best and most current scientific data available for use in stock assessments and forecast models; and to facilitate the integration of these data into decision support tools to improve regional ecosystem management and policy decisions.

Project milestones and accomplishments during Year 2:

Biological (Ichthyoplankton) Component - Analysis of grouper (Epinephelinae) larvae collected during SEAMAP plankton surveys (1982-2005) was completed and a draft manuscript (now in internal review) was written detailing comparisons of SEAMAP specimens to genetically identified grouper larvae, morphological development emphasizing species identification; and decadal variations in relative abundance, distribution patterns and spawning locations. Examinations of other sea bass (Serranidae- reef and reef associated species) and amberjack (*Seriola* spp. coastal pelagics) larvae captured during these same SEAMAP surveys were begun during year 2.

A detailed description of the oceanic habitat of Atlantic bluefin tuna larvae from SEAMAP plankton surveys in the Gulf of Mexico has resulted in a feasibility study planned for April and May of this year during the spring plankton survey. The study will be undertaken to determine if an adaptive sampling design will improve the precision of larval tuna abundance estimates from SEAMAP plankton surveys.

Analysis of larval red snapper captures during SEAMAP plankton surveys with an ocean circulation model resulted in a manuscript describing transport and advection patterns in the northern Gulf (collaboration with USM/GCRL researchers).

The first Gulfwide SEAMAP Winter Plankton survey of shelf waters was completed. This is noteworthy because the samples and environmental data collected at locations off the central coast of Louisiana will be used by NGI NOAA-LSU researchers studying the ingress of early life stages of shrimp and finfish species from offshore to estuarine waters in winter months.

Database/IT Component – Consolidation of SEAMAP and NMFS ichthyoplankton data from three primary data sources into a single database with a common format was completed. The consolidated database serves as the most up-to-date and best available SEAMAP ichthyoplankton data and is the primary source for the final Oracle Database System. Currently, the database contains information from 331 surveys (1982 -2006), comprising 31,041 samples at 11,678 stations. Quantitative data is available for the early life stages of over 800 taxa from 18,626 samples. An export of the database and its documentation has been made available by download for those wanting to conduct quantitative analyses.

Documentation of SEAMAP Spring Plankton Surveys is complete. All cruises have been reviewed and information compiled including cruise reports, station plots and notes of interest. Documentation of the Fall and Winter Plankton Surveys are underway.

Design and documentation of database structures has been completed using the Oracle Designer product. A development version of the tables has been created and scripts to ingest data from the newly compiled historical database and data entry system are being designed and tested. Business rules to provide data integrity are being developed to facilitate the data loads.

Protocols, programming logic and scripts have been developed to centralize the addition of new data, updates and corrections to existing data and taxonomic updates resulting from the re-examination of specimens through a single portal. The protocols also address the documentation of changes made to the database. Along similar lines, programming logic and scripts have been developed to examine outliers and extreme values in the data. Currently, these scripts focus on data variables critical to the quantification of larval fish and egg abundance.

Modifications to shipboard data entry systems to reflect system design are complete. Data is being collected and stored using the same logical design as the new Oracle database structures.

SEAMAP plankton surveys also collect information on fish eggs contained in bongo net samples. This information was not included in previous versions of the ichthyoplankton database. The current database has been modified to include quantitative information on the total number of fish eggs in over 12,000 bongo net samples.

Larval fish identifications are currently entered into Excel spreadsheets at the Plankton Sorting and Identification Center in Szczecin and Gdynia, Poland. A Microsoft Access database entry form was developed to replace Excel spreadsheet entry. This development has facilitated the porting and uploads of larval fish and invertebrate zooplankton identifications to the Oracle base system.

Outreach activities:

None this year

Peer Reviewed Articles:

Marancik K.E., D.E. Richardson, J. Lyczkowski-Shultz, R.K. Cowen. Evaluation of morphological characters to identify grouper (Serranidae: Epinephelinae) larvae in Gulf of Mexico SEAMAP plankton collections using genetically identified specimens with a summary of decadal variations in relative abundance, distribution patterns and spawning locations. (Manuscript in internal review)

Muhling B., J.T. Lamkin, W. J. Richards. Physical oceanographic indices for bluefin tuna larvae in the Gulf of Mexico, analysis of twenty nine years of ichthyoplankton collections. (Manuscript in preparation)

Johnson, D.R., H.M. Perry, J. Lyczkowski-Shultz, D.S. Hanisko. Red snapper (*Lutjanus campechanus*) larval transport in the northern Gulf of Mexico. *Transactions American Fisheries Society*. (Manuscript accepted and in revision).

List non-refereed articles and reports for this project.

None

List conference presentations and poster presentations for this project:

Marancik K.E., D.E. Richardson, J. Lyczkowski-Shultz, R.K. Cowen. Evaluation of morphological characters to identify grouper (Serranidae: Epinephelinae) larvae in Gulf of Mexico SEAMAP plankton collections using genetically identified specimens Oral presentation given at the AFS-ELHS Larval Fish Conference St. Johns, Newfoundland, Canada, July 9-12, 2007.

Bizikov, V.A., I. V. Nikitina, C. Schobernd, J. Lyczkowski-Shultz and T. B. Linkowski. Spatial variation in cephalopod paralarvae assemblages in the northern Gulf of Mexico in relation to water characteristics. (Oral Presentation to be given at the AFS-ELHS Larval Fish Conference in Kiel, Germany, August 2008).



Determining the Relative Contributions of Ekman Transport and Other Meteorologically-Driven Flows and Astronomical Tides in Estuarine Recruitment

NGI Project File Number: 07-NOAA-07

Dr. Redwood W. Nero (NOAA employee)

woody.nero@noaa.gov

NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center

Dr. Richard F. Shaw (2 months support)

rshaw@lsu.edu

Louisiana State University, Department of Oceanography and Coastal Sciences

Dr. Nan D. Walker (0 months support)

nwalker@lsu.edu

Dept. of Oceanography and Coastal Sciences, Louisiana State University

Dr. Chunyan Li (3/4 months support)

cli@lsu.edu

Department of Oceanography and Coastal Sciences, Louisiana State University

List all personnel funded by this project (Person's name, Category, Percent of support by NGI, at NOAA Lab):

1. Ms. Talat Farooqi, M.S., LSU Research Associate 3, 48% (plankton identification)
2. Ms. Jennifer Bodin, B.S., LSU Research Associate 1, 100% (plankton picking and identification field work work).
3. Mr. Matthew Kupchic, LSU Graduate Student, 100% (1/2 time appointment for plankton picking and identification and field work).
4. Ms. Jessica Crochet, LSU Research Support Staff, 15% (remote sensing, image processing).
5. Mr. Eddie Weeks, LSU Research Associate, 30% (physical oceanography).
6. Mr. Zhixuan Feng, LSU Graduate student, 100% (physical oceanography).
7. LSU Undergraduate Students (10) – Part time hourly workers for picking and sorting plankton samples and general lab work: Xi Chen, Christian Gauthier, Xiangli Gu, Kelly Gwin, Zhitie Li, Kate Lingoni, Yanjing Mao, Whitney Polman, Jason Walker, and Weenan Wang.

Key Scientific Question(s)/Technical Issues:

Investigation of the "drift corridor", i.e., the offshore-spawning-ground to estuarine-nursery area recruitment corridor of fall-winter (September-April) spawned, estuarine-dependent, fisheries species, and comparison of meteorological versus tidal transport.

Collaborators(s)/Partners:

NOAA, SEFSC, Pascagoula, Dr. Joanne Lyczkowski-Shultz, date, 2007, In kind support as an NGI collaboration. Dr. J Shultz is providing SEAMAP plankton maps as advisory products to help guide the offshore larval modeling efforts in this study.

Naval Research Laboratory (NRL), April, 2007, \$0, In kind support through a NASA grant to NRL. Dr. D. Ko has been providing technical advice and additional oceanographic modeling support in providing updates to their

Northern Gulf of Mexico Nowcast Forecast System (NGOMNFS) data-base products which are being used as input to the open ocean to estuary modeling effort for this project.

Project Duration:

Start Date August 01, 2006 Estimated End Date July 31, 2009

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This research is aligned with several key components of the NOAA Five Year Plan (2008-2012, Toward Understanding and Predicting Earth's Environment). Investigation of the "drift corridor" is basic research and is aimed at providing first, a better understanding of the role the environment plays in biologically important processes and second, a predictive ability. The species involved in the recruitment corridor are a key group of species which can be strongly influenced by weather events. Understanding their linkage to climate is critical in understanding the linkage of broader climate events to key marine resources of the fragile northern Gulf of Mexico marsh ecosystems. Therefore, this project directly addresses one of NOAA's Mission Goals: "To understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet our nation's economic, social, and environmental needs." This research will give a better understanding of the relationship between tidal flows and wind driven events such that future predicted changes in overall weather patterns could be translated into predictions of potential changes in fishery recruitment and productivity. Finally, work within NOAA on this project (Dr. Nero as PM) is also providing a rapid transition of research to direct application (NOAA goal) with the development of an Eckman Transport Index suitable for various NOAA fisheries management questions in the Gulf of Mexico.

Contributions to regional problems and priorities:

Although runoff, nutrients, and physical geography explain roughly half of the variability in estuarine fisheries recruitment, a knowledge gap still exists in explaining the remaining unexplained variability. Within this project knowledge is being gained on how physical oceanography and tidal forcing in combination with climate forcing interact as part of the causative factors in fisheries recruitment variability. This project also ties in with NOAA Integrated Ecosystem Assessment activities within the Gulf of Mexico by providing knowledge on estuarine ecosystem function.

Project Abstract

An investigation of the "migrating life-history circuit," the "drift corridor", i.e., the offshore-spawning-ground to estuarine-nursery area recruitment corridor of fall-winter (September-April) spawned, estuarine-dependent, fisheries species, e.g., larval gulf menhaden (*Brevoortia patronus*) and postlarval brown shrimp (*Farfantepenaeus aztecus*). By synoptically sampling a combination of biological, physical and satellite oceanographic parameters, we will determine the relative contributions of remote wind effects (i.e., Ekman transport and other meteorologically-driven flows including atmospheric cold front passages) and astronomical tides to the successful estuarine recruitment of ichthyoplankton and postlarval brown shrimp in a tidal pass, Pass Fourchon, on the central coast of Louisiana over a two year, field study period. The third and final year of the project will involve data analyses and report/journal article writing that will advance our understanding and predictive capabilities of the relative contributions of the operative physical forcing functions with respect to successful recruitment to, and retention within, estuarine nursery grounds

List major milestones completed and describe any significant research results and transitions

During Year 2 the LSU Zoo/Ichthy-plankton team continued the Port Fourchon core sampling design (14 sample trips, 558 samples) from September 2007 to April 2008, with samples presently being picked, sorted and identified. This plankton sampling provides the critical species specific information that is the core of testing the wind versus tidally driven estuarine recruitment hypothesis. The environmental data is provided by remote sensing and oceanography.

The Earth Scan Lab (ESL) continues to provide image coverage of the Louisiana shelf from Southwest Pass of the Mississippi River Delta to Terrebonne Bay on a dedicated web page with potential daily repeat coverage (<http://katrina.esl.lsu.edu/katrina/fourchon>). Products include true color images from both sensors, chlorophyll *a* estimates from OCM, and larger Gulf views with scatterometer data when available. The satellite products (with a spatial resolution of ~250m) are helpful in assessing coastal circulation, Mississippi River plume kinematics, and estuarine to shelf fluxes of bay water which is most pronounced post- cold front passage events as is shown in the OCM true color imagery. Satellite coverage was initiated in early October 2006 and will continue for the duration of the field work. Quicktime movies for 4 month periods are being produced of individual sensor products to facilitate viewing the satellite image data. Although fluxes through Belle Pass (connecting to Fourchon Pass) are relatively small relative to Barataria and Caminada Passes, the “big picture” provided by satellite may assist in the interpretation of physical and biological measurements.

During year two the LSU Oceanographic group has continued several types of physical measurements (oceanographic and meteorological) to quantify tidal and wind-forced processes and their atmospheric forcing mechanisms that are hypothesized to drive the flux of plankton in the estuary. A weather station at the Fourchon site and continuous oceanographic measurements at both the plankton sampling site and 1 mile offshore, are providing continuous data on water mass fluxes in the channels. Three detailed ADCP surveys conducted during the field sampling trips in combination with the mid-channel ADCP are providing a calibration of the total transport calculated from the oceanographic measurements.

To provide the connection between the offshore oceanic habitat of spawned larvae and the nearshore coastal zone a Lagrangian particle tracking of ‘intelligent’ particles - model was developed by Dr. Nero. This model is now fully operational, reading hourly sets of oceanographic input from NRL (Naval Research Laboratory), NGOMNFS’ (Northern Gulf of Mexico Nowcast Forecast System) archive of currents, temperature, and salinity for June 2006 to June 2007, and running as many hours as the larvae require for their at sea phase.

Outreach activities:

A briefing and guided tour of the LSU facilities, Laboratories of Shaw, Walker and Li, was conducted in August 2007 for the NGI staff and NOAA scientists.

Has anyone on this project been hired by NOAA?

None

Peer Reviewed Articles:

None

List non-refereed articles and reports for this project

Reports:

R. F. Shaw, N. D. Walker and C. Li, Determining the Relative Contributions of Ekman Transport and Other Meteorologically-Driven Flows and Astronomical Tides in Estuarine Recruitment, LSU Accomplishments, Proposal with Annual Report, Year 1 and 2, May 2008 (softcopy attached).

R. W. Nero, R. F. Shaw, N. D. Walker and C. Li, Determining the Relative Contributions of Ekman Transport and Other Meteorologically-Driven Flows and Astronomical Tides in Estuarine Recruitment, Summary and Project Report, May 2008 (softcopy attached).

List conference presentations and poster presentations for this project.

Posters:

Nan Walker, Chunyan Li, Rick Shaw, Eddie Weeks, Mapping of 3D Flow Field in an Intersection of Tidal Channels and Calculation of Transport, ERF 2007 (Estuarine Research Federation), November, 2007, Providence, RI, Poster

Shaw, R., C. Li, R. Nero, N. Walker, and M. Kupchik, Relative contributions of Ekman transport, atmospheric cold front passages and astronomical tides to estuarine recruitment. Northern Gulf Institute, Annual Conference, May 13-14, 2008, Poster.

Presentations:

Chunyan Li, Eddie Weeks, Masamichi Inoue, Using an unmanned boat (U-Boat) for environmental measurements, 3rd International Conference on Environmental Science and Technology 2007, August 5-9, 2007, Houston, USA.

Chunyan Li and Eddie Weeks, Development of an automated unmanned boat for measurements in tidal passes, Ocean Science 2008, Mar 3-7, Orlando, FL.



Enabling and Initiating Observing System Simulation Experiments of a Coastal High Resolution Oceanographic Model in the Northern Gulf of Mexico

NGI Project File Number: 07-NOAA-08

List all personnel funded by this project (Person's name, Category, Percent of support by NGI, at NOAA Lab):

Dr. Gustavo Goni, Physical Oceanographer, 0%, Yes, Atlantic Oceanographic and Meteorological Laboratory, Miami, FL

Dr. Robert Atlas, Director, 0%, Yes, Atlantic Oceanographic and Meteorological Laboratory, Miami, FL

Key Scientific Question(s)/Technical Issues:

The overall objective of this project is to develop a comprehensive, three-dimensional, high resolution numerical model for the Northern Gulf of Mexico, that employs realistic topography and proper representation of land-sea interaction (Mississippi and other rivers), air-sea interaction (high frequency atmospheric forcing) and coastal to offshore interaction (Gulf of Mexico circulation, especially Loop Current and associated eddies) in that such a model is needed to conduct the Observing System Simulation Experiment (OSSE) essential to developing rigorous coastal prediction capability in the Northern Gulf of Mexico. Specific objectives include model simulations that: (i) examine complex interactions among the above circulation forcing mechanisms, with a focus on coastal dynamics; (ii) allow model validation with available observations; (iii) prepare the components of an Observing System Simulation Experiment (OSSE) that will enhance coastal prediction capabilities in the Northern Gulf of Mexico; (iv) provide model output in support of interdisciplinary modeling and observational activities of NGI partners. In addition, this study has included the development and now dissemination in near real-time of specific satellite products useful to all NGI partners.

Collaborators(s)/Partners:

Name of collaborating organization :

Cooperative Institute of Marine and Atmospheric Science, Miami, FL

Date collaborating established: 2006

Project Duration:

Start Date June 2006 Estimated End Date June 2009

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

Ecosystems Mission Goal: Protect, Restore, and Manage the Use of Coastal and Ocean Resources through Ecosystem Approaches to Management

- Advancing understanding of ecosystems to improve resource management
- Forecasting ecosystems events
- Developing integrated ecosystem assessments and scenarios, and building capacity to support regional management

Climate Mission Goal: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

- Improve skill of climate predictions and projections and increase range of applicability for management and policy decisions
- Understand impacts of climate variability and change on marine ecosystems to improve management of marine ecosystems
- Enhance NOAA's operational decision support tools to provide climate services for national socio-economic benefits

Weather and Water Mission Goal: Serve Society's Needs for Weather and Water Information

- Improve NOAA's understanding and forecast capability in coasts, estuaries, and oceans

Commerce and Transportation Mission Goal: Support the Nation's Commerce with Information for Safe, Efficient, and Environmentally Sound Transportation

- Develop the information and tools to make reliable decisions in preparedness, response, damage assessment, and restoration

Contributions to regional problems and priorities:

Gaps:

Project Abstract:

Although the coastal ocean is strongly influenced by surface atmospheric forcing and coastal freshwater runoff, offshore ocean variability can exert a significant influence in many regions due to a wide range of processes such as basin-scale climate variability, boundary current meanders, and mesoscale/submesoscale eddies. To accurately downscale this offshore variability to a coastal ocean model, models must be nested within fields that accurately represent the state of the ocean and its variability at the nested model boundaries. We propose to use a high resolution HYCOM assimilative model covering the Gulf of Mexico through the Florida Straits (GoM-HYCOM), itself nested within the larger-scale, publicly-available HYCOM GODAE product, to obtain initial and boundary conditions for a higher resolution coastal model (Northern Gulf of Mexico NGoM-HYCOM). The proposed three year project builds upon the existing NOPP-funded HYCOM project which includes both local scientists and scientists at a number of academic institutions in the northern GoM and the Naval Research Laboratory, located at Stennis. The GoM-HYCOM model has already successfully incorporated a state-of-the-art assimilation scheme (NCODA) so coastal hindcasts and predictions in the NGoM-HYCOM nested within it will enable us to demonstrate the impact of high resolution initial and boundary conditions on coastal forecasts, to conduct Observing System Simulation Experiments (OSSEs) with available CODE drifter, SVP drifter and satellite data and, therefore, to help guide the design for the Gulf Coastal Oceanographic Observing System (GCOOS).

The regional focus for the coastal model (already under development) will encompass the Northern Gulf Coastal Region (NGCR), which is a very particular coastal region as it is subject not only to air-sea interaction processes, but also intense land-sea interaction due to the Mississippi River runoff. In addition, coastal to offshore interactions are also important, due to the proximity with the Loop Current and the poorly understood interaction between the Mississippi River plume and the Loop Current rings and eddies.

The influence of downscaled information on the capability of nested coastal models to reproduce mean conditions and seasonal variability, and to both hindcast and forecast synoptic and mesoscale/submesoscale variability, will be separately assessed. Results obtained will be directly applicable to other coastal domains and will markedly improve our application therein of coastal HYCOM models (in for example the southeastern GoM). The capability NOAA gains thereby will be directly applicable to predicting the oceanographic consequences of regional climate change and variability (in particular changes in regional precipitation) and coastal hazards (in particular hurricane landfalls and floods) and is, therefore, essential to obtaining the quantitative physical understanding of this system that is required for ecosystem management and regional ecosystem forecasting. Note that, as part of its contribution to the NOAA Ecosystem Goal, AOML expects to establish an Ecosystem Forecast

Center for the Gulf of Mexico in FY09. The proposed effort in conjunction with AOML coastal HYCOM modeling already funded by NOS/NCCOS and the South Florida Water Management District as well as IOOS funding for AOML initiation of oceanographic OSSE's will be essential to enabling rigorous regional ecosystem forecasting. All work proposed will be conducted in close collaboration with northern Gulf of Mexico academic scientists and the Naval Research Lab at Stennis Space Center.

List major milestones completed and describe any significant research results and transitions

- A comprehensive high resolution, three dimensional model that connects coastal to land and offshore hydrodynamics has been developed for the entire Northern Gulf of Mexico (NGoM) coastal region, based on the data assimilative HYCOM (Hybrid Coordinate Ocean Model). Development of the high resolution (~1.8 km horizontal grid) NGoM-HYCOM coastal model has been completed. The NGoM-HYCOM is nested within the regional Gulf of Mexico HYCOM model (GoM-HYCOM), itself nested within the larger-scale, publicly-available HYCOM GODAE (Global Ocean Data Assimilation Experiment) product.
- The Navy Coupled Ocean Data Assimilation (NCODA) scheme was applied to the GoM-HYCOM (collaboration with NRL-SSC) and comparison of Free vs. Data Assimilative simulations were made, evaluating the representation of the Loop Current and its associated eddies, which have a substantial impact on the nested NGoM-HYCOM coastal model.
- Process studies on the Mississippi River plume were conducted to highlight the development and evolution of the river plume and the effects of topography and atmospheric forcing on the advection of low salinity plume waters.
- Satellite derived products were developed to investigate the variability in the upper layers in the Gulf of Mexico (GOM). These products are now produced in semi-operational mode and include time series and maps of Sea Surface Temperature (SST), Sea Surface Temperature Residuals (SSTR), Sea Height Anomaly (SHA) and Sea Height Residuals (SHR) and spectrum and wavelet analyses of the SSTR and SHR time series.
- A methodology of using satellite products for model validation has been developed.
- A preliminary methodology for an Observing System Simulation Experiment (OSSE) in the Gulf of Mexico using the HYCOM model has been developed.

Outreach activities:

General Description:

None

Have you hosted speakers, workshops and/or any training?

No

Has anyone on this project been hired by NOAA?

N/A

Peer Reviewed Articles:

Schiller, R.V. and V.H. Kourafalou, 2008. Modeling River Plume Dynamics with the HYbrid Coordinate Ocean Model (HYCOM). (Submitted to *Ocean Modeling*)

List non-refereed articles and reports for this project:

None

List conference presentations and poster presentations for this project.

Kourafalou, V.H., G. Halliwell, P. Hogan, H. Kang, R. Schiller and C. Paris, 2008. Modeling circulation patterns that influence connectivity of remote ecosystems in the Wider Caribbean Region and the Gulf of Mexico Eos Trans. AGU, 89(23), Jt. Assem. Suppl., Abstract OS34A-05 (oral presentation)

Schiller, R.V., V.H. Kourafalou and P. Hogan, 2008. River plume experiments with the Hybrid Coordinate Ocean Model: application to the Mississippi River discharge. ASLO-AGU Ocean Sciences meeting, Orlando, FL. Available On Line, www.aslo.org/orlando2008, p.404 (poster).



Temperature and Salinity Effects on the Growth and Survival of Juvenile Penaeid Shrimps: Implications for the Influence of River Diversions on Production

NGI Project File Number: 07-NOAA-09

Dr. Lawrence P. Rozas, NOAA Fisheries Service, Estuarine Habitats and Coastal Fisheries Center, 646 Cajundome Blvd., Room 175, Lafayette, LA 70506, Telephone: (337) 291-2110, FAX: (337) 291-2106, lawrence.rozas@noaa.gov

Dr. Thomas J. Minello, NOAA Fisheries Service, Galveston Laboratory, 4700 Ave. U, Galveston, TX 77551, tom.minello@noaa.gov; Dr. Doran M. Mason, NOAA Great Lakes Environmental Research Laboratory and Atlantic Oceanographic and Meteorological Laboratory, 2205 Commonwealth Blvd., Ann Arbor, MI 48105, doran.mason@noaa.gov

List all personnel funded by this project (Person's name, Category, Percent of support by NGI, at NOAA Lab):

Lawrence P. Rozas, Research Scientist, 12%, Yes, Estuarine Habitats and Coastal Fisheries Center, Lafayette, LA
Thomas J. Minello, Research Scientist, 6%, Galveston Laboratory, TX
Shawn Hillen, Research Support Staff, 24%, Galveston Laboratory, TX
Juan Salas, Research Support Staff, 24%, Galveston Laboratory, TX
Elizabeth Wilson, Research Support Staff, 32%, Galveston Laboratory, TX
Aaron Adamack, Post Doc, 8%, Great Lakes Environmental Research Laboratory, MI

Key Scientific Question(s)/Technical Issues:

The goals of our study are to: (1) document shrimp growth rates across a range of temperature and salinity values and examine the relationship between shrimp growth and availability of potential prey using field experiments, (2) examine how shrimp distribution is affected by salinity under controlled conditions using lab gradient tank experiments, and (3) develop simulation models to predict shrimp growth rates from water temperature and salinity. The simulation models were initially developed from existing information in the literature and unpublished experimental data. The data from our field and laboratory experiments are being used to improve the original models.

Collaborators(s)/Partners:

Name of collaborating organization: Our current level of collaboration with the NGI is limited because a companion proposal by our NGI partner (Dr. Mark S. Peterson, Department of Coastal Sciences, University of Southern Mississippi) was never funded. We have established collaborations, however, with other scientists from Louisiana State University.

Date collaborating established: 2006

Does partner provide monetary support to project? No Amount of support? N/A

Does partner provide non-monetary (in-kind) support? Yes

Short description of collaboration/partnership relationship: The results from our growth experiments and models will be used by our collaborators working on related projects in the NGI. We have been working cooperatively with Drs. Kenny Rose and Brian Roth of LSU on an individual-based model of brown shrimp production, and our

results will be useful in refining that model. We are currently in the process of funding Dr. Rose to continue work on this production model through the NGL. Dr. Fry also has conducted some preliminary stable isotope analyses to help us characterize the food consumed by the shrimp in our field experiments. The results of the field growth experiments suggest that differences in the quality or quantity of food resources among locations may have led to the differences in growth rates we observed among locations. Stable isotope analysis of the experimental animals would show us whether food resources differed among the four locations and between treatments with and without daily food additions. We are seeking additional funding to continue this collaboration with Dr. Fry.

Project Duration:

Start Date: July 1, 2006

Estimated End Date: June 30, 2009

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

The project addresses research areas under the Ecosystems Mission Goal. The research areas in support of NOAA's Ecosystems Goal that are addressed by our research project include: (1) Advancing understanding of ecosystems to improve resource management, (2) forecasting ecosystem events, and (3) developing integrated ecosystem assessments and scenarios, and building capacity to support regional management.

Contributions to regional problems and priorities:

Water-control structures are currently being used, and more are being planned, in Louisiana to divert freshwater from the Mississippi River into nearby estuaries for wetland restoration. The effect of these large-scale diversions on coastal fisheries is uncertain. The concern is that estuarine temperatures and salinity will be reduced by river diversions, and that this will negatively impact recruitment, growth, and productivity of brown shrimp, white shrimp, and other fishery species. Data from the scientific literature that would inform management decisions for operating diversion structures to minimize impacts to the shrimp fisheries are inadequate. Only a few studies have examined the effect of salinity and water temperature on growth and survival of brown shrimp or white shrimp, and little research has addressed this topic for larger juvenile shrimp. Our project directly addresses this lack of information about the effect of freshwater inflows on coastal fisheries. The results of our study would be used to inform decisions about managing living resources and coastal restoration projects. Priority stakeholders include the Gulf of Mexico Alliance as well as state and federal resource managers in the region.

Gaps:

The results from our project will provide information to establish the relationships between the distribution, growth, and survival of juvenile brown shrimp and white shrimp and two key environmental variables (water temperature and salinity) affected by freshwater inflows. These results will be incorporated into simulation models to predict effects of temperature and salinity on shrimp growth and survival. These models can be linked to a hydrology-hydrodynamic model and used in conjunction with different river diversion scenarios to assist managers in minimizing the impacts of freshwater releases to shrimp production when restoring coastal systems. Our study would advance a modeling approach that may provide a useful tool for evaluating river diversions used for wetland habitat restoration.

Project Abstract:

We are using available information and controlled experiments to establish the relationships between the distribution, growth, and survival of juvenile white shrimp *Litopenaeus setiferus* and brown shrimp *Farfantepenaeus aztecus* and two key environmental variables (water temperature and salinity) affected by

freshwater inflows. We are testing the validity of these relationships using continuously recorded environmental data and growth and survival data from shrimp caged along a salinity gradient in an estuary. The results from these experiments will be incorporated into simulation models to predict the effects of temperature and salinity on shrimp growth and survival. These models can be linked to a hydrology-hydrodynamic model and used in conjunction with different river diversion scenarios to assist managers in minimizing the impacts of freshwater releases to shrimp production when restoring coastal systems.

List major milestones completed and describe any significant research results and transitions:

The project activities, milestones reached, and research results accomplished in Year 2 are described for three research areas (field growth experiments, laboratory gradient experiments, bioenergetics models).

Field growth experiments were conducted May 5-15, 2007 by enclosing brown shrimp for 7 d in 1-m² mesocosms at four locations (12 replicate cages per location) in Barataria Bay along the estuarine salinity gradient (Intermediate, Brackish, SalineA, and SalineB locations). At each location, eight mesocosms were placed in shallow water along the marsh shoreline; half of these cages received daily additions of food and the other half did not. Four mesocosms at each location were located in deeper water (and lower water temperature) away from the marsh. Five shrimp were individually marked with visible implant elastomer, measured, and then assigned randomly to each mesocosm. To avoid handling effects on experimental animals, their initial weights were estimated using a length-weight relationship determined by collecting, weighing, and measuring additional animals at the beginning of the experiment. Environmental variables (salinity, temperature, dissolved oxygen, water depth) were measured in the field during these experiments. We also measured food availability from replicate benthic core samples (=3 pooled 2.5 cm-deep X 5-cm diameter cores) collected at each mesocosm prior to initiating the experiment. An analysis of the results show that brown shrimp grew more slowly at the low salinity than higher salinity locations (mean daily rates: Intermediate=0.58 ±0.108 mm d⁻¹, Brackish=1.03 ±0.058 mm d⁻¹, SalineA= 1.21 ±0.111 mm d⁻¹, SalineB=1.23±0.108 mm d⁻¹). Survival, based on the number of shrimp recovered at the end of the experiment, also was lower at the Intermediate location (mean: 2.3 vs. 4.2-4.6 shrimp mesocosm⁻¹). Interestingly, we also observed a statistically significant effect of food addition in the experiment (Figure 1). Our results suggest that salinity may affect shrimp growth rates indirectly by its effect on food resources (prey populations).

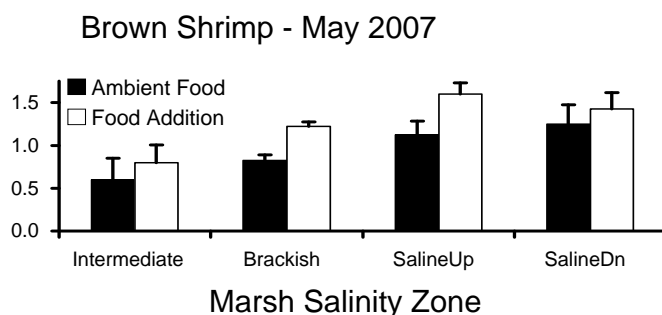


Figure 1. Comparison of daily growth rates for brown shrimp in mesocosms with (food addition) and without (ambient food) daily additions of food.

Laboratory gradient experiments were conducted using white shrimp to examine how salinity may affect the distribution of shrimp under controlled conditions. These experiments were conducted in circular raceway tanks at the Galveston Laboratory. A constant salinity of 20 psu was maintained in the control raceway. The salinity in the experimental raceway also was initially held at 20 psu. For each experiment, 50 shrimp were taken from holding tanks (20 psu) and placed in each of the gradient and control raceways. After the shrimp were dispersed throughout the experimental raceway, a salinity gradient of slowly flowing water was established by introducing freshwater and saline (40 psu) water on opposite sides of the raceway between two drains that maintain the water level. After an initial acclimation period, the distribution of shrimp was recorded hourly over a 5-h period. The results from these experiments show no relationship between salinity and the distribution of white shrimp under controlled laboratory conditions (Figure 2).

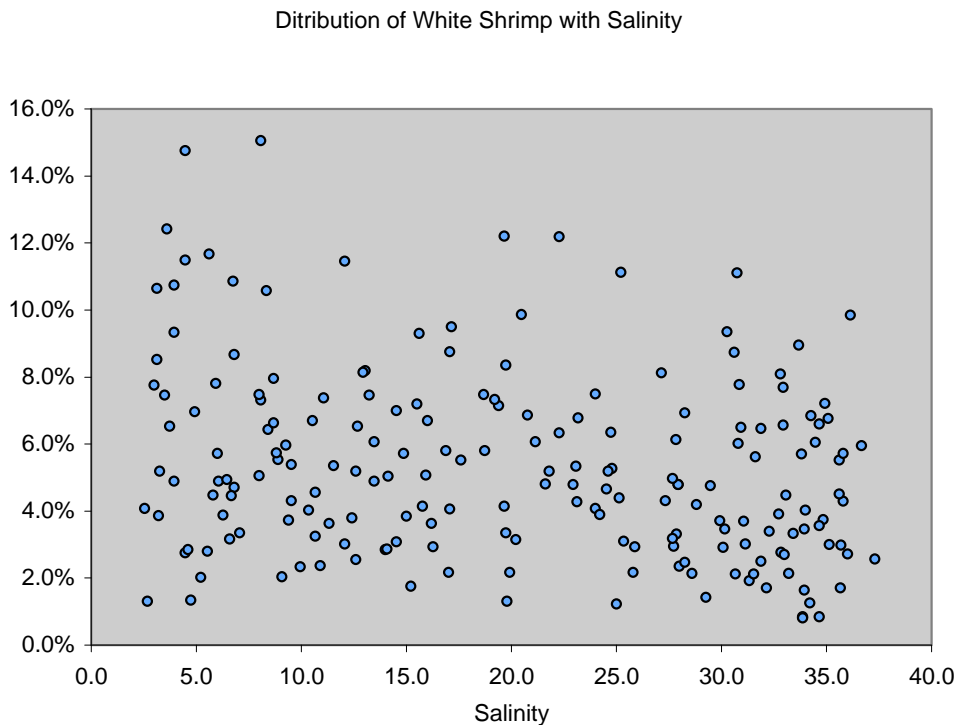


Figure 2. Results from laboratory gradient experiments showing the relative frequency of white shrimp occurrence along a salinity gradient established within the gradient tank. The information shown here are summary data from seven experiments.

Bioenergetics growth, survival, and spatial distribution models were developed and parameterized from existing information in the published literature during Year 2. The relationships between growth rate and water temperature derived from literature values and incorporated into the models are shown below. Based on information gleaned from the literature, growth rates are highest when the water temperature is greater than 20 °C, and little growth occurs when the water temperature falls below 5 °C (Figure 3). The bioenergetics models will be compared with the results from our field and laboratory experiments and will be adjusted accordingly in Year 3.

Growth in length over time for fixed water temperatures

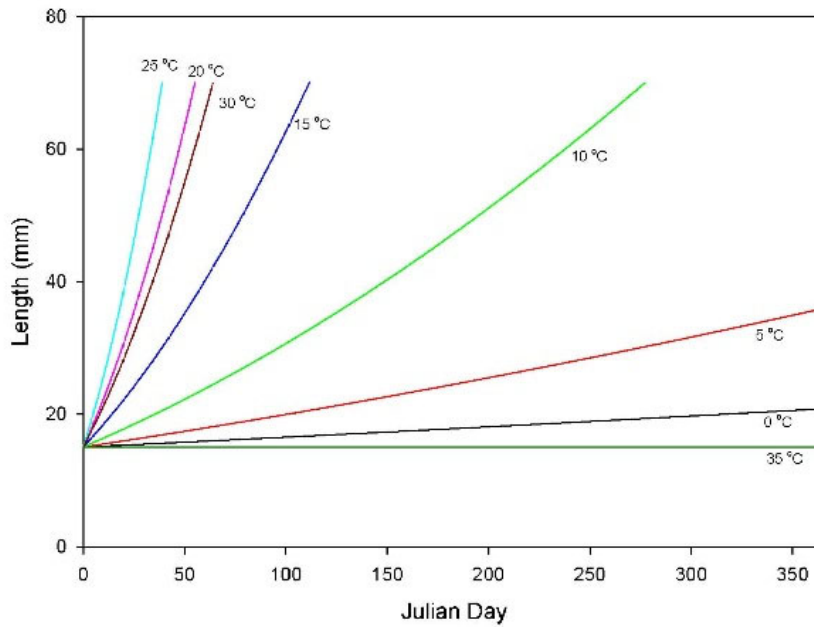


Figure 3. Relationships between growth rate and water temperature developed from the published literature and used in the bioenergetics models.

Outreach activities

General Description:

N/A

Have you hosted speakers, workshops and/or any training?

No

Has anyone on this project been hired by NOAA?

N/A

Peer Reviewed Articles:

None

List non-refereed articles and reports for this project.

None

List conference presentations and poster presentations for this project.

Rozas, L. P. and T. J. Minello. (November 2007). Nekton habitat use associated with landscape features and salinity regimes of the Barataria Estuary, Louisiana. Presentation given at the Nineteenth Biennial Meeting of the Coastal and Estuarine Research Federation, Providence, RI.



Estimating Air-Sea Carbon Dioxide Fluxes in the River Dominated Northern Gulf of Mexico

NGI Project File Number: 07-NOAA-10

PI: Dr. Rik Wanninkhof

E-mail: rik.wanninkhof@noaa.gov

Phone: (305) 361-4379

Affiliation: NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML)

List all personnel funded by this project (Person's name, Category, Percent of support by NGI, at NOAA Lab):

Esa Peltola - Government FTE AOML Research Support Staff (2 mo/yr, 17 %)

Betty Huss- Government FTE AOML Research Support Staff (1 mo/yr, 8 %)

Kevin Sullivan- Cooperative Institute, U. Miami, Research Support Staff (1 mo/yr, 8 %)

Dr. Denis Pierrot- Cooperative Institute, U. Miami, Research Scientist (2 mo/yr, 17 %)

Joaquin Trinanes- Contract Scientist (1mo/yr, 8 %)

Key Scientific Question(s)/Technical Issues:

Quantify air-sea CO₂ fluxes and ocean acidification processes in the riverine dominated Northern Gulf of Mexico through an innovative method of combining *in situ* observations from NOAA ship *Gordon Gunter* and remotely sensed products from the NOAA Coastwatch Caribbean/Gulf of Mexico node.

Collaborators(s)/Partners:

1. Prof. Steven Lohrenz, the University of Southern Mississippi. The collaboration started at the inception of NGI. Prof. Lohrenz contributes his expertise in the biogeochemistry of the Northern Gulf of Mexico and remote sensing to develop methods to interpolate CO₂ fields. These fields are created from remotely sensed wind, color, and sea surface temperature yielding seasonal maps of air-sea CO₂ fluxes and surface ocean acidity.
2. Dr. Redwood Nero, Oceanographer NMFS/SEFSC/MSLAB, Stennis Space Center, Dr. Redwood Nero is the liaison between the NOAA fisheries service and our project. His research interest lies in the possible effect of ocean acidification on the life cycle of fishes and he will be collaborating with us on the ocean acidification component of the effort. Collaboration started in May 2007.
3. LTJG Hector Casanova is a Commissioned Officer in the NOAA Corps and the field operations officer on the *Gordon Gunter*. He is the principal contact for the biogeochemical measurements on the vessel. Collaboration started in September 2007. In-kind (personnel) support.
4. Denice Drass is a Research Fish Biologist at the NMFS/SEFSC/MSLAB Pascagoula, MS Ms. Drass is the cruise leader of the SEAMAP Ichthyoplankton cruises that perform systematic observation in the Northern Gulf. She coordinates sampling and oversees CTD operations during the cruises and provides discrete bottle samples for our project. Collaboration started in May 2008. In-kind (personnel) support.

Project Duration:

August 2006 to June 2009

Project Baselines:

Contributions to specific NOAA Goals/Objectives:

The work is in direct support of establishing a global carbon observing system as outlined in the objectives of the Global Observing Systems of Systems (GOESS). It is linked to the NOAA 5-year plans under the primary goal in the climate mission of "Developing an integrated global observation and data management system for routine delivery of information, including attribution of the state of the climate". It is a cross-linked objective between

climate and ecosystems of "Understandings impacts of climate variability and change on marine ecosystems to improve management of marine ecosystems".

Contributions to regional problems and priorities:

We aim to lay the groundwork for a Northern Gulf of Mexico ocean carbon observing system. The region is unique from a climate and ecosystem perspective as it receives the outflow of drainage of 1/3 of the USA such that it is a critical land-ocean interface as highlighted in the North American Carbon Plan (NACP).

Gaps:

Very few systematic inorganic carbon observations have been made to date in this region making it "Mare Incognitum" for estimating air-sea CO₂ fluxes.

Project Abstract:

A major effort to date has been the procurement, testing, and installation of a pCO₂ system on the NOAA fisheries ship *Gordon Gunter*. We currently oversee operations of state-of-the-art automated instruments to measure surface water and air carbon dioxide levels. The data is telemetered to shore on a daily basis, and combined with remotely sensed SST and wind data to create carbon flux maps. The spatial observations obtained in this work will be combined with the temporal data obtained from our NGOM CI partners from a buoy located just offshore of Stennis Space Center. From this buoy the high frequency variability will be quantified that will not be necessarily captured by the ship and satellite data. The installation of the pCO₂ system on the *Gordon Gunter* is shown in figure 1.

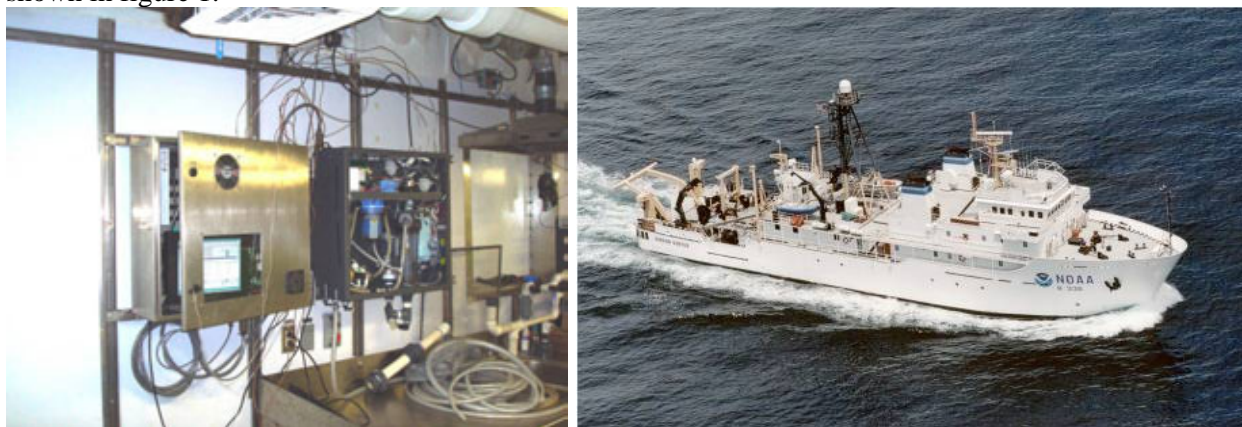
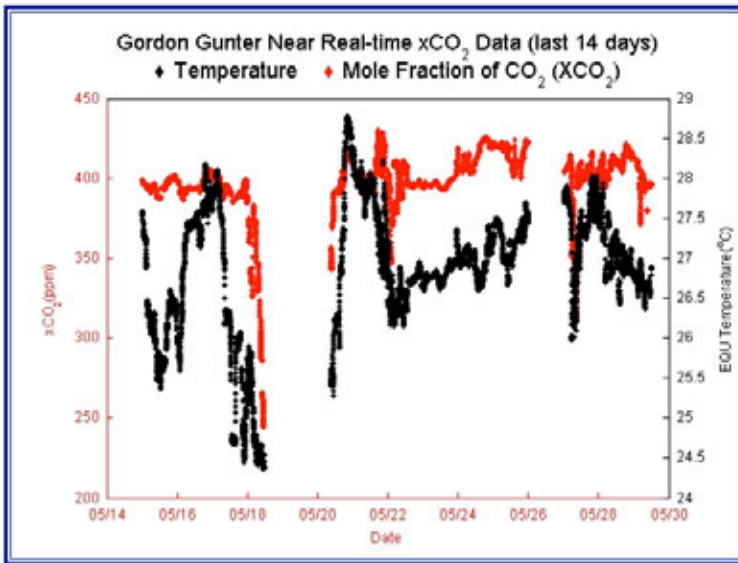


Figure 1. Installation of the autonomous pCO₂ system (left) on the NOAA ship *Gordon Gunter* (right) occurred in March 2008.

The system is fully automated to analyze surface water CO₂ levels utilizing the scientific seawater supply line. Data is telemetered back to shore on a daily bases using Iridium satellite transmission. The data is updated on a web based server and displayed. A sample display from the website showing the latter half of the SEAMAP cruise in May 2008 is shown in figure 2. The color coded line depicts the surface CO₂ levels along the ship track (figure 2b). The scatter plot (figure 2a) gives both the SST and surface CO₂ levels which shows the strong correlation of surface water CO₂ levels and temperature. Based on these findings and work performed by our group on an field campaign the Gulf of Mexico and East Coast Carbon Cruise (GOMECC) co-funded by the NOAA Global Carbon program in July 2007, the CO₂ levels in the Gulf of Mexico are largely controlled by sea surface temperature except near the outflow of the major rivers where significantly lower levels are encountered.



R/V Gordon Gunter cruise track showing color coded $x\text{CO}_2$ data. This display is updated every morning.

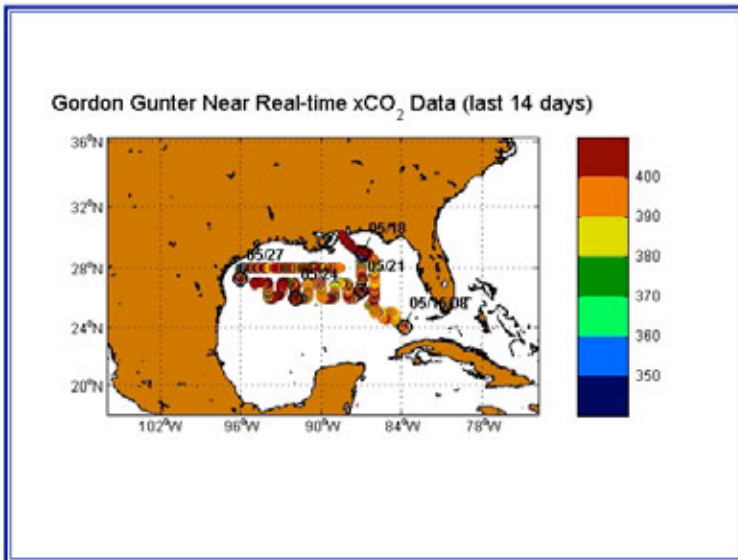


Figure 2. Screenshot of the realtime data display of the CO_2 system on the Gunter (see http://www.aoml.noaa.gov/ocd/gcc/gordongunter_realtime.php)

Figure 3 shows a contour map of the air-water disequilibrium based on the GOMECC cruise that shows the strong effect of continental runoff on the near-shore environment. Algorithms that utilize salinity and color to predict the regional CO_2 fields near the coast are currently being investigated.

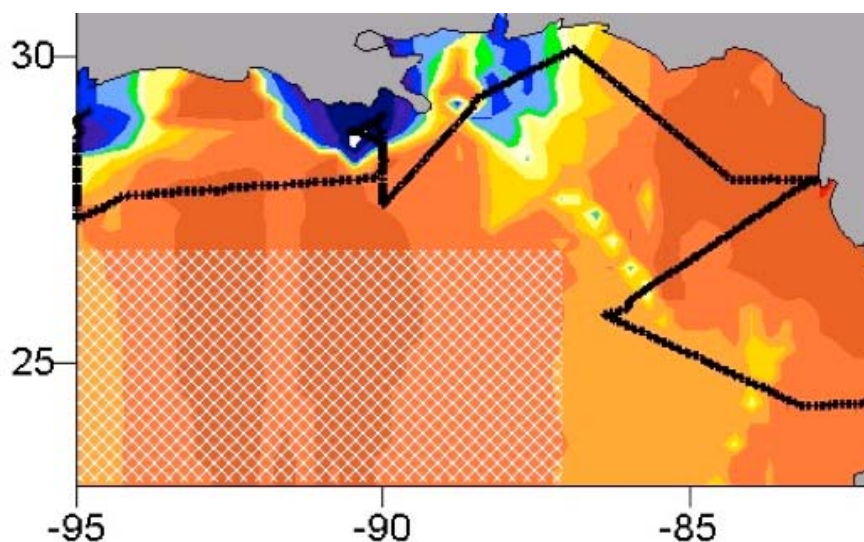


Figure 3. Surface contour plot showing the air-water disequilibrium of CO₂, ΔpCO₂ from the underway pCO₂ system on the BROWN during GOMECC. Yellow and red shading indicate outgassing, with deeper colors indicating stronger sources, while green to blue indicate progressive greater CO₂ uptake by the ocean. The black line is the cruise track with the ticks showing sampling sites. The white-hatched area is outside the region of reasonable extrapolation.

Publications (partially supported by NGI efforts)

Gledhill, D. K., **R. Wanninkhof**, F. J. Millero, and M. Eakin, 2008: Ocean acidification of the greater Caribbean region 1996-2006, *J. Geophys. Res.* **accepted**.

Presentations

Wanninkhof, R. Carbon fluxes in the Gulf of Mexico in "Ocean Carbon and Biogeochemistry Scoping Workshop on Terrestrial and Coastal Carbon Fluxes in the Gulf of Mexico" May 6-8, 2008 in St. Petersburg, Florida.

Peng, T.-H. and Wanninkhof, R. Gulf of Mexico and East Coast Carbon Cruise (GOMECC). Global Carbon Cycle Program Principal investigators meeting, Silver Spring, September, 2007.



NORTHERN GULF INSTITUTE



This Progress Report was prepared under award NA06OAR4320264 06111039 to the Northern Gulf Institute by NOAA's Office of Ocean and Atmospheric Research, U.S. Department of Commerce.

The Northern Gulf Institute and its member universities do not discriminate on the basis of race, color, religion, national origin, sex, sexual orientation or group affiliation, age, handicap/disability, or veteran status.