NORTHERN GULF INSTITUTE

Cooperative Institute Progress Report

Reporting Period: July 01, 2008 –June 30, 2009

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Submitted to NOAA on July 30, 2009 via:
https://www.GrantsOnline.noaa.gov

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The Northern Gulf Institute (NGI) is a Cooperative Institute funded by:
National Oceanic and Atmospheric Administration Award #A06OAR430264

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1. INTRODUCTION

1.1 Institute and Core Activities

The Northern Gulf Institute (NGI) is a NOAA Cooperative Institute, a partnership of five complementary academic institutions and NOAA. The collaboration is led by Mississippi State University (MSU), partnering with the University of Southern Mississippi (USM), Louisiana State University (LSU), Florida State University (FSU), and the Dauphin Island Sea Lab (DISL) in Alabama, and NOAA scientists at various laboratories and operational centers. 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—especially at the intersection of upland-watershed systems and coastal waters, habitats, resources and hazards, integrating the interaction and impacts of people and communities. The NGI contributes to NOAA's priority interest research themes in Ecosystem Management, Geospatial Data Integration and Visualization, Coastal Hazards, and Climate Effects on Regional Ecosystems.

The initial funding for the NGI was awarded on October 1, 2006. 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, and a Program Office at Stennis Space Center, Mississippi. 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 original base funded activities have continued through NGI years 1 through 3 and this progress report reflects these projects. In addition to the base funding for research, several other NOAA funded activities have begun and are building in earnest during this program reporting period. A listing of those activities is provided at the end of the discussion on Performance of NOAA/NGI Funded Projects.

The NGI Education and Outreach office is developing programs to educate the public on NGI research and to facilitate the transition of NGI research to NOAA operational centers. NGI is working closely with the educational programs at the Gulf of Mexico Alliance, the various Gulf of Mexico Sea Grant programs and the NOAA Gulf of Mexico Regional Collaboration Team to develop an immediate communication and significant long term mesaging campaign to address identified priority issues. More detail on this effort is provided in Appendix A under the summary of the NGI Outreach Project.

The overall goal of the NGI research is transition to NOAA operations and, ultimately, to customer applications. Creation and continuous development and updating of the institution's website are essential components of the collaboration, operation, and outreach of the research. See www.NorthernGulfInstitute.org. This progress report reviews accomplishments applicable to the research and education and outreach goals. The report consists of two (2) sections. The first part begins with this Introduction and includes discussion of the other key performance measures (Performance of Projects, Relationship of Projects to NOAA Goals, NGI Publications, and Personnel

Supported by NGI Funding). The second part is Appendix A, a detailed Summary of Performance of Projects.

1.2 NGI Vision, Mission, Goals, and 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

The NGI Goals, Strategies and Objectives are specified in the NGI Implementation Plan. NGI has made significant gains in reaching its initial goals and evaluates the objectives regularly in order to keep the institute moving toward fulfilling NOAA goals for the northern Gulf region. Some of the objectives have already been met and are being updated. Others are below planned progress levels and provide more challenge. Transitioning research to applications and NOAA operations will be greatly enhanced with recent hiring of the NGI Science Coordinator by NOAA to help identify the best paths for transition efforts. The six (6) NGI Goals are:

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

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

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

GOAL 4: Transition research into new or enhanced products and operations.

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

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

NGI Organization

Figure 1.1 below 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 the High Performance Computing Collaboratory, the NGI MSU 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.

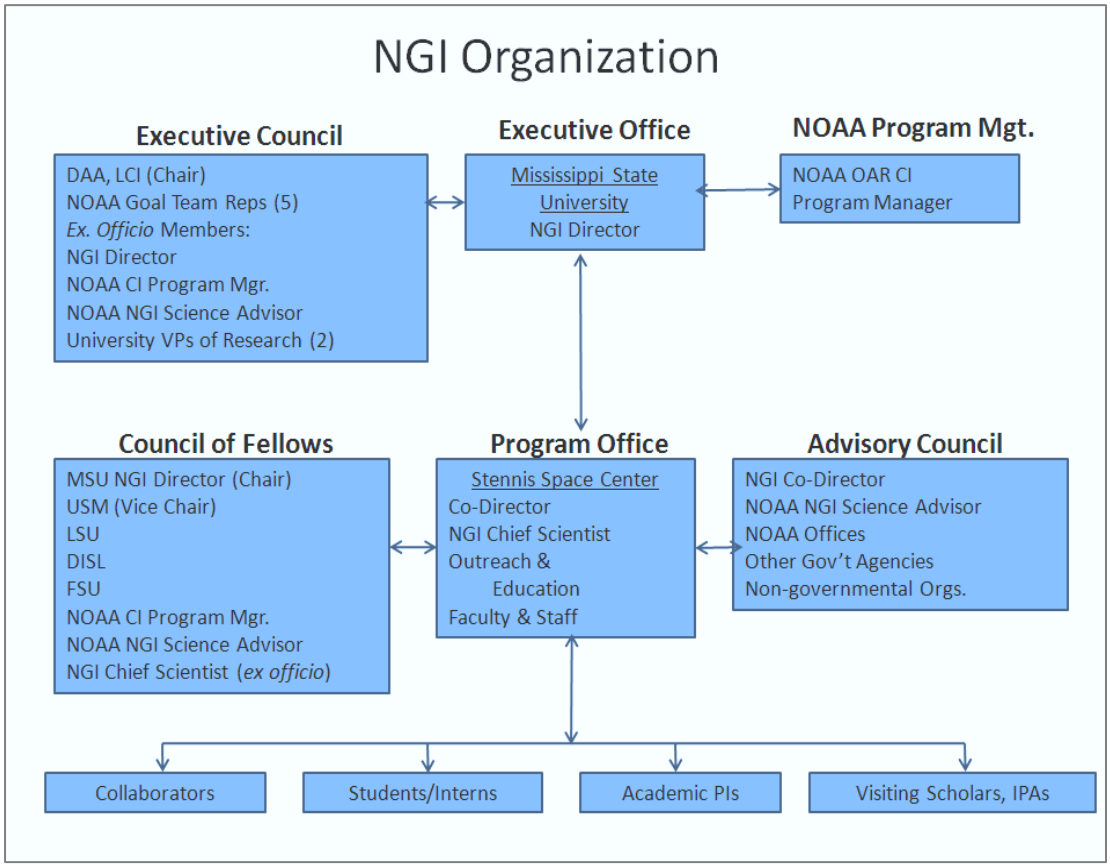


Figure 1.1 NGI Organizational Structure and Collaborative Connections

An NGI Program Office is located at the Stennis Space Center, Mississippi, is led by the NGI Co-Director and supported by the MSU team at Stennis, including research and outreach faculty and a Chief Scientist. The NGI Program Office is responsible for maintaining regular interaction with the Council of Fellows, the lead academic body for the NGI, and the Advisory Council, the NOAA NGI Science Advisor and serves as a member of the NOAA Gulf of Mexico Regional Collaboration Team. The NGI Program Office has prime responsibility for the day-to-day management of the Institute, with particular reference to Stennis-based and regional coordination, meetings of the Council of Fellows, the NGI Annual Conference, the NOAA NGI Minority Summer Internship Program, and NGI students, contractors and visiting scholars on-site at Stennis.

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 Strategic Plan and NGI Implementation Plan provide the road maps for planning and operations of the Institute. The Executive Office and Program Office staff coordinate through the NOAA Office of Oceanic and Atmospheric Administration modifications to the original award to provide research and education of the region for several NOAA line offices including National Marine Fisheries Service, National Environmental Satellite Data and Information Service, and the National Ocean Service. The implementation framework presents policy, program and procedural guidance to the NGI and communications with NOAA's CI Program and participating NOAA offices, and to the various review, advisory and working-level entities affiliated with NGI.

NGI Key Functions

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

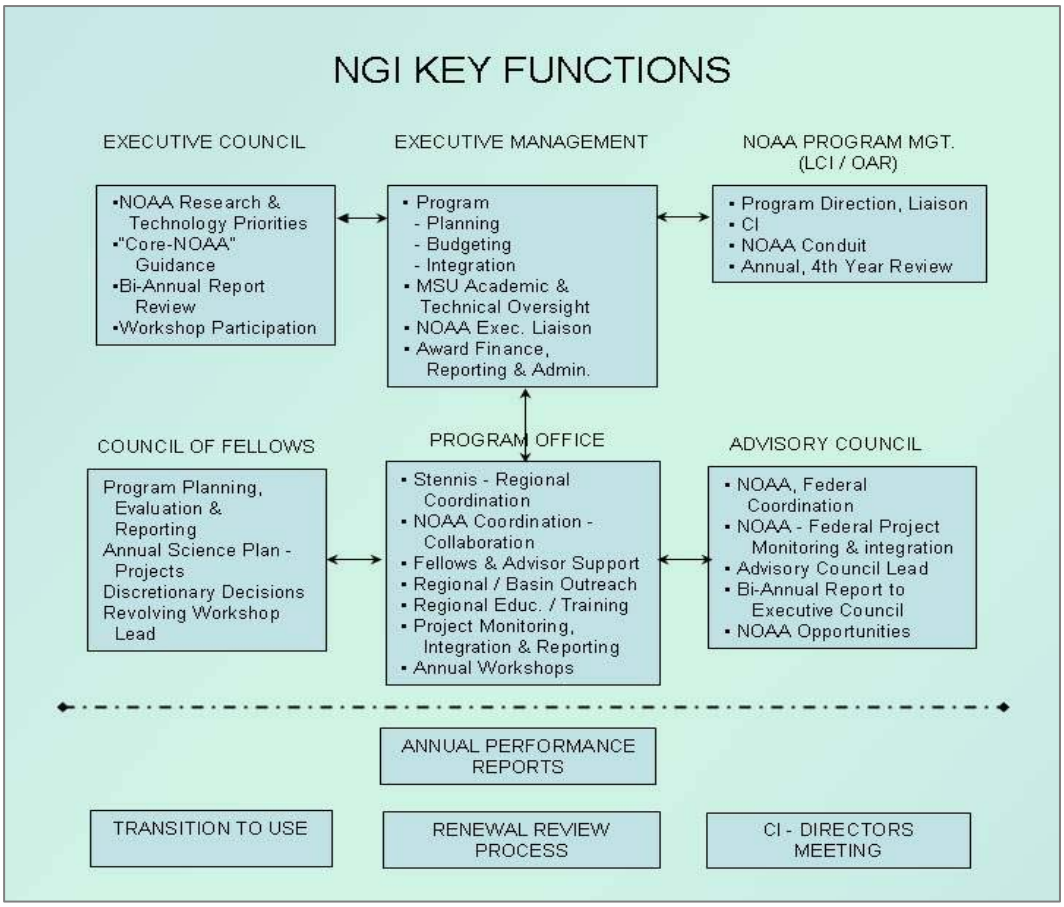


Figure 1.2 Key NGI Functions

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 Science Advisor, the NGI Director, and the NOAA Cooperative Institute Program Manager serves 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 provides 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 first meeting of the Executive Council was held in October 2008 in Miami, FL. Direction provided by the Executive Council was transmitted to the Council of Fellows.

The NGI Executive Council consists of:

Robert Atlas, Ph.D., Director, Atlantic Oceanographic Meteorological Laboratory
Cecil Burge, Ph.D., Vice President, R&D, University of Southern Mississippi
Gary M. Carter, Director, Office of Hydrologic Development
Roy Crabtree, Ph.D., Regional Administrator, SE Region, NOAA Fisheries Service
Margaret Davidson, Director, NOAA Coastal Services Center
Louisa Koch, Director, NOAA Office of Education
Al Powell, Ph.D., Director, Center for Satellite Applications and Research
Glenn Steele, Ph.D., VP for Research & Econ. Dev., Mississippi State University

Role of the Council of Fellows: The Council of Fellows is composed of senior scientific/ technical representatives from each NGI member academic institution, as well as the NOAA 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 biannual review by the Advisory Council. It produces an Annual Progress Report to NOAA and oversees the Annual NGI Work Plan. It receives overarching guidance from the Executive Council, and builds the Annual Work Plan based on needs assessments and recommendations from the Advisory Council, the Gulf of Mexico Alliance Action Plan and the Sea Grant Research Plan. This group is also responsible for ensuring that 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 consists of:

David Shaw, Ph.D., Mississippi State University
Steven Lohrenz, Ph.D., University of Southern Mississippi
Eric Chassignet, Ph.D., Florida State University
Robert Twilley, Ph.D., Louisiana State University
George Crozier, Ph.D., Dauphin Island Sea Lab[1]

[1] George Crozier, Director of DISL retired on July 1, 2008. Dr. Scott Quackenbush became the director of DISL and the DISL NGI Fellow but died after a short illness on October 12, 2008. Dr. Crozier returned as the Director of DISL and resumed his role as an NGI Fellow.

Meetings of the NGI Council of Fellows for this reporting period were held in October 2008 at Louisiana State University and in conjunction with the NGI Annual Conference in May 2009 in Mobile, Alabama. At both of these meetings the Council of Fellows and the Advisory Council held a joint session. Conference calls of the NGI Council of Fellows for this reporting period were held in September and December, 2008 and March and April, 2009.

Role of the Advisory Council: The NGI 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 provides 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. NGI supports the formation and efforts of workgroups around each of the major themes of the NGI and accepts direction from the Advisory Council when the need arises.

The NGI Advisory Council members are:

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

Meetings of the NGI Advisory Council for this reporting period were October 2008 at Louisiana State University and May 2009 in conjunction with the NGI Annual Conference, Mobile, Alabama. At both of these meetings there was also a joint session of the Advisory Council and the Council of Fellows.

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 NGI Implementation Plan and the Science, Education, and Research Management Plan. The implementation and science plans are the primary references for the "Annual Work Plan" delivered to NOAA every year. Each collaborating institution develops 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 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 the use of these funds. Starting in the fourth year of NGI a majority of research projects have co-principal investigators from both university members and NOAA.

Other Collaborators: A number of other federal agencies, (e.g. Environmental Protection Agency, National Air and Space Administration, United States Army Corps of Engineers, Department of Transportation, US Geological Survey, US 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, Sea Grant, 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.

In the institution's first two and a half years, NGI has developed an extensive network of collaborators (see Figure 1.3 below) and sees these collaborators and partners as an essential part of the Institute and will continue to further develop this network as the NGI matures.

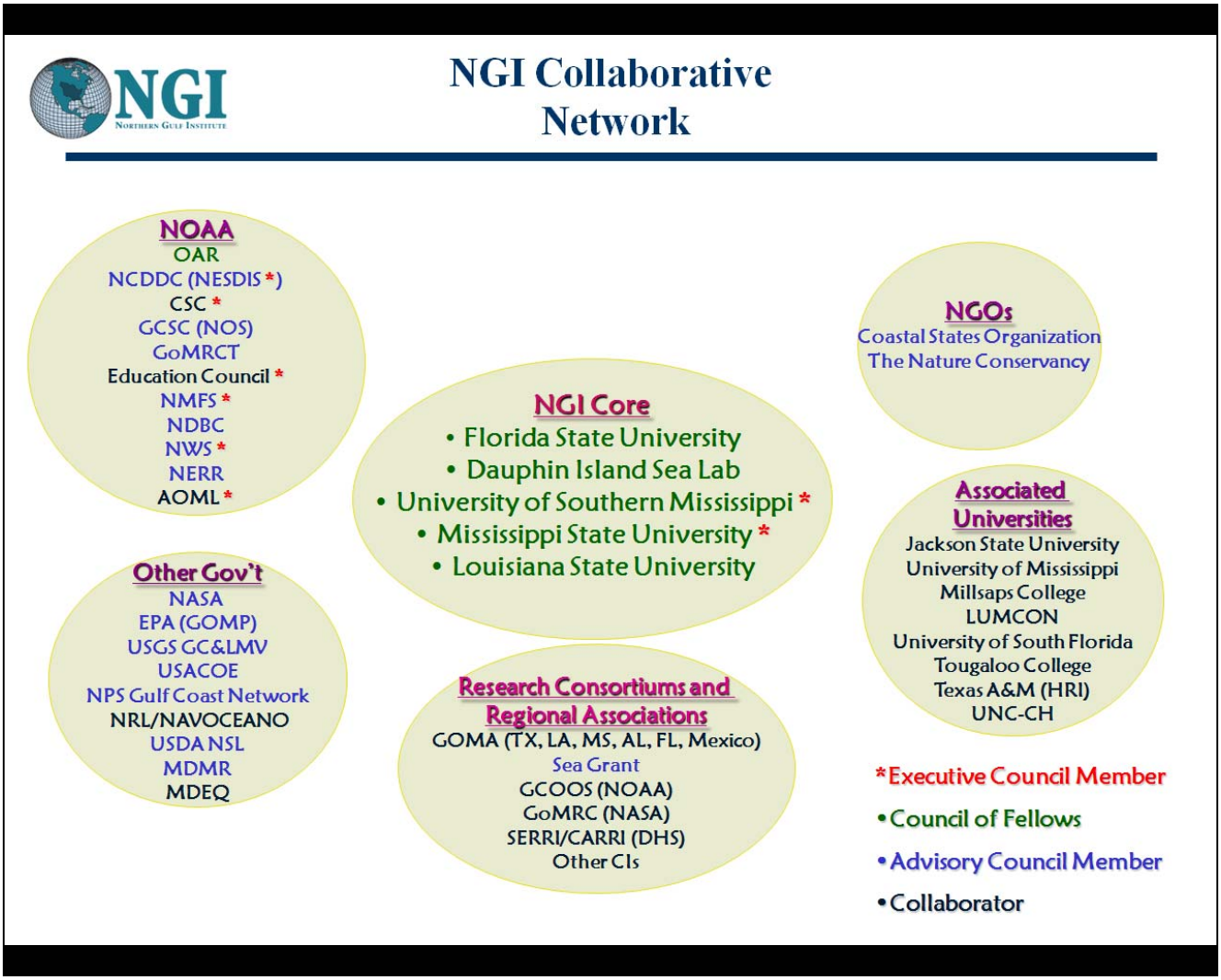


Fig. 1.3 NGI Collaborative Network

1.3 Executive Summary of Important Research Activities

The policies and procedures of the NGI 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 in Starkville, MS. A Program Office is located at Stennis Space Center, MS facilitating a link with NOAA's NGI Science Advisor, the National Coastal Data Development Center (of NESDIS), the Gulf Coast Service Center (of the NOS), the National Data Buoy Center (of NWS) 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 and watershed, coastal zone, and coastal ocean areas from the Sabine River, LA in the west to the Suwannee River, FL in the east (see Figure 1.4 below). The Northern Gulf is a rich and interdependent natural environment of great complexity and is important to the region and the nation. The riverine-dominated Northern Gulf ecosystems are under pressure from increasing population and coastal development, impacts from severe storms and climate variability, inland watershed and coastal wetlands degradation, and many other factors. NGI has chosen an approach to Northern Gulf Region issues, problems and opportunities 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.

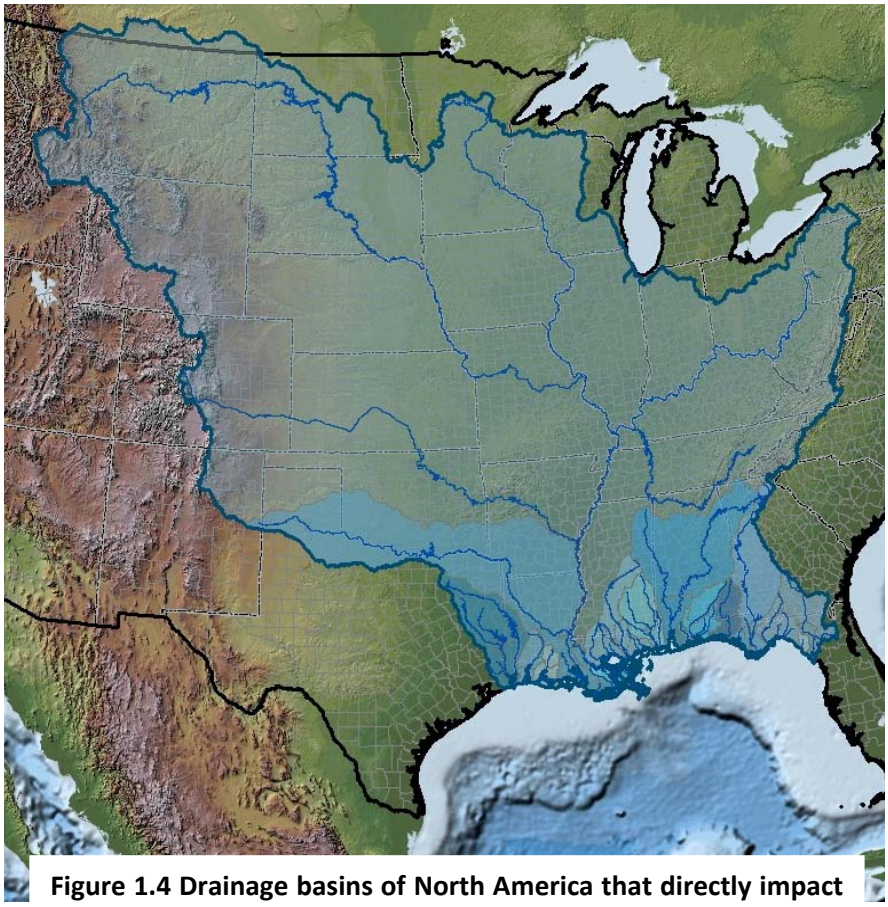


Figure 1.4 Drainage basins of North America that directly impact the Northern Gulf of Mexico

One problem facing this region is the huge loss of wetlands in the Mississippi River delta system and the control of salinity in the nearby bays and bayous requiring periodic releases of fresh water and silt into the wetlands from the Mississippi River. LSU has four NGI projects, all related to the health of the Mississippi River delta and related ecosystem 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. A related project addresses 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. Another investigates 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 MSU research studies the impact of man-made protection structures on hurricane storm surge in areas away from the structures.

The NGI region not only encompasses the Mississippi River system but also other significant watersheds. 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 informed resource management decisions resulting in environmental quality improvements. NGI researchers at MSU working with NOAA, the 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 affecting 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 extend 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. USM and FSU have begun a series of research projects addressing many of the significant issues related to fish population dynamics, harmful algal blooms, microbial source tracking, nutrient and pollutant fluxes and the interaction between near-shore and off-shore processes during extreme weather events. Both USM and FSU 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.

NGI has formed a team, made up of scientists from the NGI universities to begin preliminary Integrated Ecosystem Assessments with a focus on Breton Sound, the Mississippi shelf, and Perdido Bay. NGI is in the process of developing a Memorandum of Agreement with the Harte Research Institute (Texas A&M University, Corpus Christi) to be able to expand this effort to the western Gulf. This team will form the core group of an expanded effort to address integrated ecosystem assessments in the Northern and Western Gulf of Mexico and to address related issues, such as the impact of sea level rise on coastal ecosystems.

The NGI through MSU and the National Coastal Data Development Center operates an experimental Ecosystem Data Assembly Center at Stennis Space Center and is building a data base to allow the study of the impact of extreme events on the economic health of the Gulf Coast region and to develop guidance for coastal managers to develop resilient communities and their associated ecosystems. A series of other research projects related to the NOAA Goals are also underway. Dauphin Island Sea Lab, Alabama's marine science education and research laboratory, has a successful research program to examine the potential benefits of restoration of shallow sub-tidal oyster reefs on adjacent near-shore habitats. The DISL design has been adopted by the Nature Conservancy to help stabilize shorelines in Alabama.

The following is a list of the other NGI activities that were initiated by NOAA during this reporting period. They are for the most part early in the project life and progress will be reported in full as required by each award modification.

Establishing a Data Management System at DISL to Link with Existing NGI Affiliated Programs Enhance Data Retention, Metadata Maintenance, and Faculty Participation

Support to the NOAA NGI Minority Summer Intern Program (& Supplements)

Air Monitoring and Analysis at the Grand Bay National Estuary Research Reserve

Optimizing the Use of Lightning Data in Severe Storm Warning Assessment

WISDOM Balloon and Payload; Part 1: Prototype Acquisition

NGI Sustained Operations Alternatives

Summer Internship for the NGI Ecosystem Data Assembly Center

Development of Prototype Integrated Ecosystem Assessments in the Northern Gulf of Mexico

NOAA Coastal Storms Program - ADCIRC (Storm Surge) Grid Cataloging Project

The Mississippi Digital Earth Model

NOAA Coastal Services Center-Risk Wise Communities Partnership Workshop

Trophic Support of Fishery Production in Salt Marshes Related to Tidal Inundation Patterns

1.4 Distribution of NOAA Funding by Task and NGI Theme[2]

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

Figure 1.5 depicts the ratios of Task I (Administrative/Education), Task II (Research with Significant NOAA involvement) and Task III (Research without significant NOAA involvement) activities. Task IV (research funded by non-NOAA agencies) information is available upon request. During year 4 of the institute we anticipate a further shift from Task III to Task II with almost all of the funded research having university and NOAA collaboration.

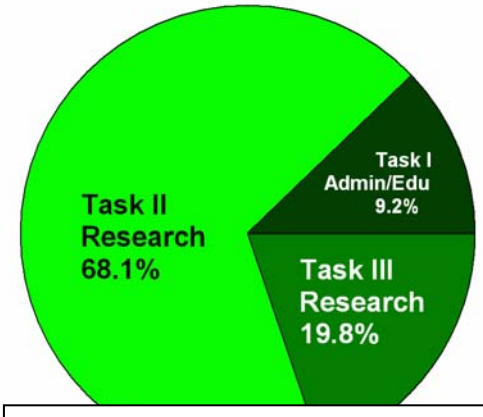


Figure 1.5 Distribution of Tasks I, II, and III Funding (includes NGI NOAA Projects)

[2] This figure includes both base funding and modifications approved from July 1, 2008 to June 30, 2009

NGI's four (4) 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. The fourth theme, climate effects and hazard/ resilience issues will incorporate social and economic elements and research endeavors. We anticipate an increase in the study of the impact of climate change on coastal marine ecosystems starting in year 4 of the Institute.

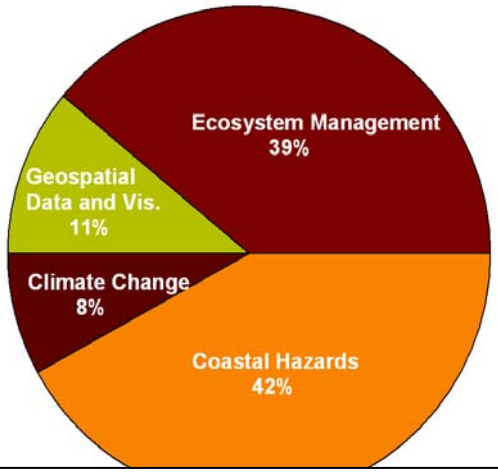


Figure 1.6 NGI Funding by Research Theme

Figure 1.6 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 I Activities with Distribution of Funding

During this reporting period, NGI has continued Task I administrative activities and program development that started in October 2006, conducted program planning, and continued to recruit and staff the central program office at 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 1.7 depicts the

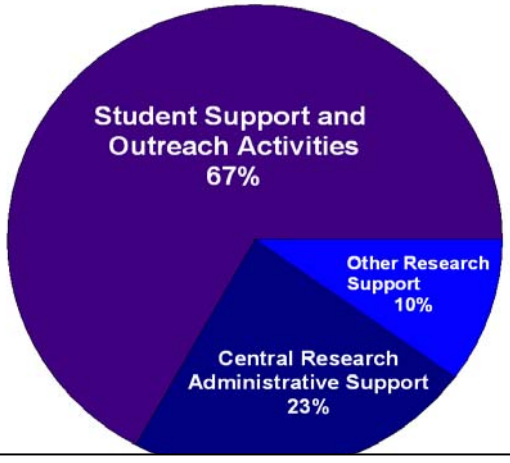


Figure 1.7 Distribution of Task I

relative funding of the administrative components of Task I activities.

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 third annual conference in May 2009 to provide a forum for presentation of current research and activities to foster collaboration. During this meeting, representatives of all of the Priority Issue Teams from the Governor's Gulf of Mexico Alliance presented the new goals of the new Action Plan II.

NGI staff continued the Education and Outreach Program supports NOAA's education goals of ocean literacy and workforce development. In this past year, the team facilitated topical workshops and presented 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. For the second year, NGI staff, in cooperation with the NCDDC, held a minority internship program. A major accomplishment of the NGI education and outreach staff, working with partners throughout the region, was to support the creation of the Gulf of Mexico Environmental Education Network website. (See www.gulfallianceeducation.org.)

NGI staff, working in concert with the Council of Fellows, developed a year four proposal and program review and evaluation process. Proposals from the five NGI universities and from NOAA labs and operational centers were evaluated and selected for funding. All proposals received two or more anonymous reviews by reviewers selected by NOAA. These proposals made up the basis of the NGI Year 4 Proposal and Work Plan which will be funded in late September 2009 with FY-09 funds.

2. PERFORMANCE OF NOAA/NGI FUNDED PROJECTS

Appendix A provides a full description of the 34 base NGI projects (24 academic and 10 NOAA). The project profiles and progress reports include performance, principal investigator(s) contacts and staff supported by the funding. The primary NOAA contacts for the NGI are Dr. Julien Lartigue, NGI Science Advisor and Dr. John Cortinas, Cooperative Institute Program Manager, NOAA Office of Oceanic and Atmospheric Research.

3. RELATIONSHIP OF NGI PROJECTS TO NOAA GOALS

The following table lists the NGI university-led research projects categorized in a matrix with NOAA Goals listed in the NOAA Strategic Plan.

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

NOAA Goals from the NOAA Strategic Plan 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 number are provided in the table below, Summary of Publications for NGI.

Summary of Publications for NGI						
		Year 1	Year 2	Year 3	Year 4	Year 5
Peer Reviewed						
	Institute Lead Author	4	18	33		
	NOAA Lead Author		1	1		
	Other Lead Author	4	0	11		
Total		8	19	45	0	0
		Year 1	Year 2	Year 3	Year 4	Year 5
Non-Peer Reviewed (not to include presentations)						
	Institute Lead Author	2	51	24		
	NOAA Lead Author		11	1		
	Other Lead Author	1	0	11		
Total		3	62	36	0	0

5. PERSONNEL SUPPORTED BY NGI FUNDING

The NGI funding availability and support for NGI institutional staff began on October 1, 2006. NOAA projects were awarded in mid 2006 and have been completed or are nearing completion at the time of the preparation of this report. The university personnel participating in the research projects are for the most part the same researchers participating in the projects from the beginning of NGI, on projects first evaluated in the fall of 2006 and funded in the winter of 2007. The majority of the projects will be nearing the end of the planned three year effort in February 2010. A few were completed at the end of two or two and one half years. The summary table depicting the research and administrative personnel supported by NOAA Award Number NA06OAR4320264 and by direct funding of NOAA from OAR is found below, Summary of NGI Personnel Year 3.

Summary of NGI Personnel Year 3				
Employees that receive > 50% NOAA Funding (not including students)				
Category	Number	B.S.	M.S.	Ph.D.
Research Scientist	7	1	0	6
Visiting Scientist	0	0	0	0
Postdoctoral Fellow	6	0	0	6
Research Support Staff	17	9	8	0
Administrative	7	1	2	4
Total	**37**	**11**	**10**	**16**
Students				
Undergraduate Students	25	25	0	0
Graduate Students	62	34	20	8
Total	**87**	**59**	**20**	**8**
Employees that receive < 50% NOAA Funding (not including students)				
Category	Number	B.S.	M.S.	Ph.D.
Research Scientist	114	1	14	99
Visiting Scientist	0	0	0	0
Postdoctoral Fellow	2	0	0	2
Research Support Staff	26	13	12	1
Administrative	1	0	0	1
Total	**143**	**14**	**26**	**103**
Located at Lab (include name of lab)*	34	11	5	18
Obtained NOAA Employment	0	0	0	0

***NOAA Labs:** 8 - Atlantic Oceanographic and Meteorological Laboratory, Miami, FL, 6 - Center for Coastal Fisheries and Habitat Research, 1 - Estuarine Habitats and Coastal Fisheries Center, Lafayette, LA, 6 - National Marine Fisheries Service/SEFSC/ Mississippi Laboratories/ Pascagoula Facility, 1 - National Marine Fisheries Service/SEFSC/Miami Laboratory, 1 - National Marine Fisheries Service/SEFSC/SEFSC Woods Hole Laboratory, 4 - NOAA Fisheries Service, Galveston Laboratory, 6 - NOAA Fisheries Service, Southeast Fisheries Science Center, Panama City Laboratory, 1 - NOAA Great Lakes Environmental Research Laboratory

Appendix A: Summary of Performance of NOAA NGI Funded Projects

Table of Contents

NOAA 01

A. NGI Project file Number: 08-NOAA-01

B. Project title, PI(s), Email, and Affiliation: NOAA ECOSYSTEM DATA ASSEMBLY CENTER (EDAC) SUPPORTING THE NOAA NORTHERN GULF OF MEXICO COOPERATIVE INSTITUTE (NGI)

PI : Russ Beard
EMAIL : russ.beard@noaa.gov
AFFILIATION : National Environmental Satellite Data and Information Service/National Oceanographic Data Center/National Coastal Data Development Center

PI: Rost Parsons
EMAIL : rost.parsons@noaa.gov
AFFILIATION : National Environmental Satellite Data and Information Service/National Oceanographic Data Center/National Coastal Data Development Center

C. List all non-student personnel funded by this project:

NAMES: Carleton/Martinolich/Strange/Lundy (NCDDC/Radiance Technologies)
CATEGORY: EDAC Operations/Research Support
PERCENT OF SALARY FUNDING FROM THIS PROJECT: Total 1.7 man-years effort
ARE INDIVIDUALS LOCATED AT A NOAA LAB? No

NAME: Robert A. Arnone, Head Ocean Sciences Branch, Naval Research Laboratory
CATEGORY: Research Support
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

Additional Direct Funding Provided by NOAA (NCDDC) to EDAC Project Co-Investigators

1. Dauphin Island Sea Lab – Dr. Just Cebrian -$79.5K
2. Dauphin Island Sea Lab – Dr. Ruth Carmichael - $70.5K
3. Dauphin Island Sea Lab – Dr. Hugh McIntyre - $20K
4. Louisiana State University – Dr. Aixin Hou - $20K
5. Louisiana State University – Dr. Sibel Bargu - $20K

D. List all students funded by this project:

NAME: Stephen Beeson, Mississippi State University
CATEGORY: EDAC Summer Intern 2008 – Research Support
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

NAME: Micah Elkins, Louisiana State University
CATEGORY: EDAC Summer Intern 2009 – Research Support
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

NAME: Armand Hindrichs, Louisiana Tech University

NAME: Aspen Nero, University of South Alabama

CATEGORY: EDAC Summer Intern 2009 – Research Support
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

CATEGORY: EDAC Summer Intern 2009 – Research Support
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes

E. Key Scientific Question(s)/Technical Issues(s): The objectives of the EDAC are to demonstrate the utility of integrating a broad spectrum of 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. The highlights of activities for Year 3 were the addition of new data and web services now available through the EDAC server, the establishment of automated collection tools to track web-traffic statistics, training and outreach to collaborating partners, continued metadata publication, and continued development and delivery of remote sensing and coastal modeling products to support ecosystem identification, classification and assessment via the EDAC.

F. Collaborator(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 (NMFS), Southeast Fisheries Science Center, Pascagoula Lab; Naval Oceanographic Office (NAVOCEANO): Dr. Frank Bub, Co-Investigator, Models and Prediction System; NGI: Dr. David Shaw, Mississippi State University (MSU), Co-Investigator, Glade Woods, MSU, Co-Investigator, Sharon Hodge, J.D., MSU, Co-Investigator.

NAME OF COLLABORATING ORGANIZATION: Mississippi State University
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 (DISL) 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*.

NAME OF COLLABORATING ORGANIZATION: Dauphin Island Sea Lab
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: Dauphin Island Sea Lab (Cebrian) supports the EDAC's effort in collecting comprehensive ecosystem data in representative marine bays and lagoons on the Alabama and Florida coasts. These clearly support management assessments of anthropogenic influences as well as 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).

NAME OF COLLABORATING ORGANIZATION: Louisiana State University (LSU)

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: 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.

NAME OF COLLABORATING ORGANIZATION: Naval Research Laboratory (NRL) at Stennis Space Center (SSC)

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: 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 National Ocean Service (NOS) as well as NMFS. Data streams are being evaluated by both the 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.

NAME OF COLLABORATING ORGANIZATION: NAVOCEANO

DATE COLLABORATING ESTABLISHED: Sept 2006

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP: NAVOCEANO is providing the Navy Coastal Ocean Model (NCOM) distributed through the EDAC which has been greatly anticipated by researcher's nationwide.

G. Project Duration:

a. START DATE: Oct 2006
b. ESTIMATED END DATE: Sept 2009

H. Project Baselines:

a. 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 2008-2012 to include "key investment in an enhanced understanding of ecosystems by establishing necessary knowledge, tools, and management." The EDAC and NGI 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.

b. 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).

c. 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. The data gap analysis within the EDAC will also leverage the corresponding Gulf of Mexico Alliance data efforts which continue through summer 2009.

I. Project Abstract: The establishment of EDAC within NGI will create research activities supporting NOAA's ecosystem approach to management as detailed in the NOAA Strategic Plan (FY2006-FY2010, the OAR Five-Year Research Plan 2005-2009, and the NGI 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 Gulf of Mexico and the regional sub-units; and (3) facilitating the use of Gulf of Mexico 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 Regional Associations (RA), ensuring interoperability of legacy and emerging technologies, systems, and databases in the Gulf of Mexico. The EDAC and NGI 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.

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

- Incorporating comprehensive ecosystem data from Dauphin Island Sea Lab
- Provided support for Federal Geographic Data Committee metadata and the use of NCDDCs Metadata Enterprise Resource ManagementAid (MERMAid) to Dauphin Island Sea Lab
- Published metadata records via MERMAid to the NCDDC Catalog. These records were then harvested by the Geospatial One-Stop for discovery. Dauphin Island Sea Lab has a total of 14 records published to the NCDDC Catalog and Geospatial One-Stop via MERMAid.
- http://dim.disl.org/metadata_main.cfm (Figure 1)
- Ocean National Operational Model Archive and Distribution System (NOMADS) site was added to the EDAC. This site focuses on ocean model data. Portions of this data are being served from the original EDAC site and the Thematic Realtime Environmental Distributed Data Services data server. These datasets are the NCOM global data and the Intra-Americas Seas Now-cast Forecast system data.

- Ocean NOMADS began hosting the National Centers for Environment Prediction Real-Time Ocean Forecast System (RTOFS) data. This data is a model of the Atlantic Ocean, Gulf of Mexico, and Caribbean. Because the original Grib2 format of the data is difficult to use for many applications, a NetCDF version of the data is automatically produced at the EDAC. The NetCDF version is served via Open-source Project for a Network Data Access Protocol (OPeNDAP) and is available for direct download, as is the original Grib2.
- A visualization tool was implemented on the Ocean NOMADS site that allows the user to select an ecosystem of interest, a variable from the file, and for multilevel data, a depth, to get a pseudo color image of that data (Figure 2).

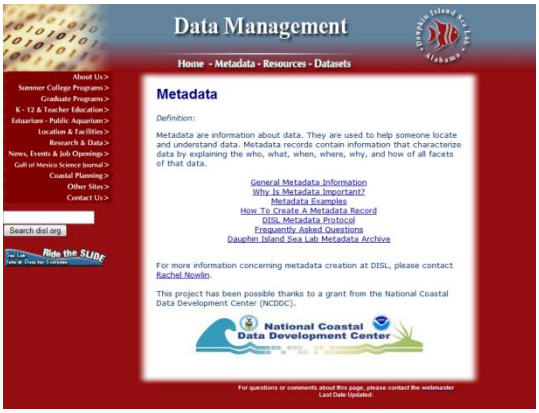


Figure 1. Screen capture of the Dauphin Island Sea Lab's Metadata Home Page found at http://dim.disl.org/metadata_main.cfm.

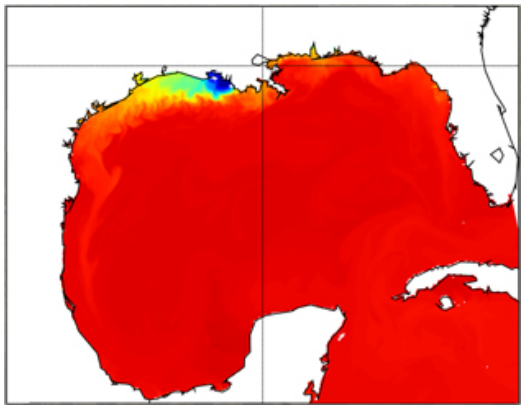


Figure 2. Salinity at the surface of the Gulf of Mexico as rendered by EDAC's Ocean NOMADS RTOFS visualizer. The Ocean NOMADS site is http://edac-dap2.northerngulfinstitute.org/ocean_nomads/

- The EDAC was used to host a web service that provides access to information about water quality monitoring programs and the locations of their monitoring stations. The database contains a list of programs along with contact information, number of stations, and which water quality attributes they are monitoring. The web application can filter the data that it sends back based on what is being measured, organization, program names, and locations. Locations can be defined as being between specific co-ordinates, or being within a specified radius of a geographic co-ordinate. Queries to the database are standard HTTP GET messages, while responses can be in XML, JSON, or KML depending on the client request. Data for the site was collected manually by sending spreadsheets to program managers for them to fill out. While the data service can be accessed via a browser, the current version is intended for use through the NASA COAST Viewer (http://www.coastal.ssc.nasa.gov/coast/coast.aspx).
- Beginning January 2009, statistics on visitors accessing EDAC's main site and OPeNDAP server has been monitored using AWStats. AWStats measures traffic based on browser, operating system, unique users, IP addresses, and other criteria. The successful use of AWStats at EDAC led to its deployment on NCDDC's core web servers.
- Global NCOM data has been made available on the EDAC server and is now available via the NOAA Southwest Fisheries Science Center Environmental Research Division's Data Access

Program (ERDDAP), a web application that can convert data from OPeNDAP servers into various output formats and graphs (Figure 3). ERDDAP was developed at the Pacific Fisheries Environmental Laboratory. The latest file from NCOM regions 1, 6, and 7 are available. ERDDAP is used to create images and KML files for records in NCDDC's Regional Ecosystem Data Management (REDM) website. http://edac-dap2.northerngulfinstitute.org/erddap/

- Sample outputs from NMFS Southeast Fisheries Science Center (Dr. Woody Nero) shrimp larval tracking software have been published on EDAC. One animation shows the final location of many modeled larvae, giving an idea of how many larvae make it to suitable habitats compared to how many get lost at sea. http://edac.northerngulfinstitute.org/fisheries/brown_shrimp_tracking/nero_shrimp_settlement.html. The other animation shows the start and end points of the larvae along with their path. The animations are flash plug-ins, so they can be viewed on the webpage with explanations. http://edac.northerngulfinstitute.org/fisheries/brown_shrimp_tracking/nero_shrimp_tracks.html.
- Maps of Essential Fish Habitats (EFH) published on the EDAC fisheries page has been upgraded from simple PDF files to high quality GIS data sufficient for direct publishing and integration with other GIS data. Shape files of each EFH are now available. KML files generated from this data are available as well. http://edac.northerngulfinstitute.org/fisheries/index.html (Figure 4).

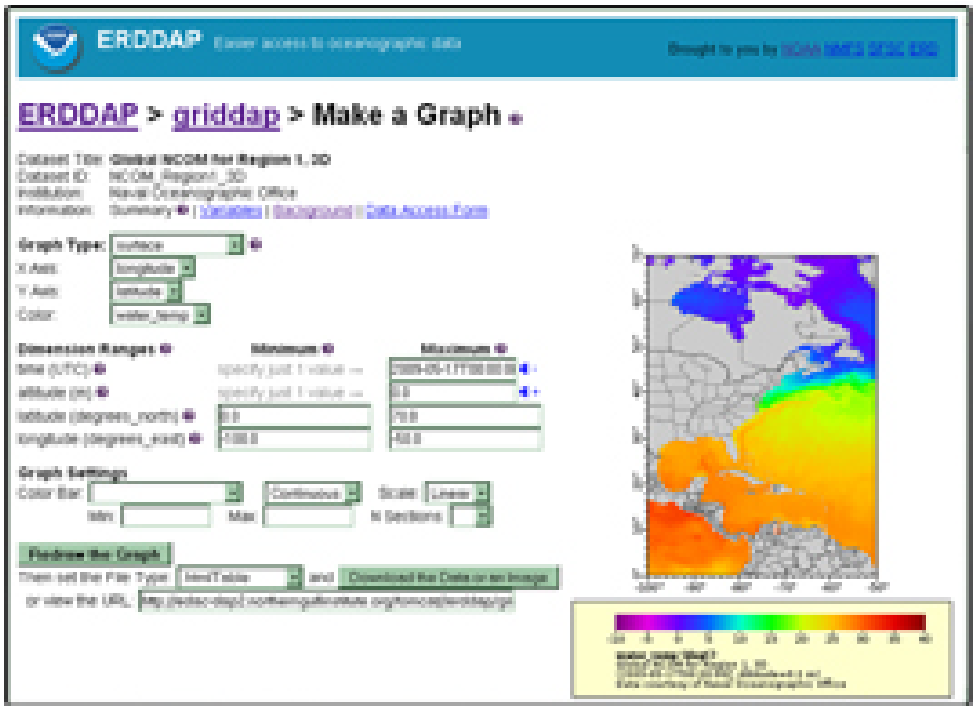


Figure 3. ERDDAP graph control screen for one of the NCOM data sets served via the EDAC. ERDDAP uses OPeNDAP to connect to EDAC's NCOM data. The graph shows surface water temperature for NCOM region one. EDAC's ERDDAP page is found here:http://edac-pap2.northerngulfinstitute.org/erddap/

Figure 4. Essential habitat of the stone crab with markers at the locations of chlorophyll sensors in that area. These two data sets are available as KML from EDAC and displayed together using Google Earth.

K. Outreach Activities

a. GENERAL DESCRIPTION: Outreach for Project Year 3 included one training session.

b. The training session titled "Introduction to Metadata" was hosted by Kathy Martinolich of NCDDC.

i. *Type:* Training

ii. *Name of event*: Introduction to Metadata

iii. *Date*: 12 May 2009

iv. *Location*: Dauphin Island Sea Lab

v. *Description*: NCDDC's Metadata Enterprise Resource Management Aid (MERMAid) was used as a hands-on tool for the training. Presentation material was provided and metadata application exercises administered.

vi. *Number of Participants*: 6

L. Has anyone been hired by NOAA? No

M. Peer Reviewed Articles: None

N. Non-refereed articles and reports: None

O. Conference presentations and poster presentations:

Charles Carleton, NCDDC; Russ Beard, NCDDC; Eric Roby, NCDDC; A. Rost Parsons, NCDDC; Sharon Mesick, NCDDC. Data Services at the Northern Gulf Institute Ecosystem Data Assembly Center. Northern Gulf Institute Annual Conference, 20-21 May 2009, Renaissance Riverview Plaza, Mobile, AL.

NOAA 02

A. NGI Project file Number: 08-NOAA-02

B. Project title, PI(s), Email, and Affiliation: FORECASTING THE ECOLOGICAL IMPACTS OF HURRICANES THROUGH THE INTEGRATION OF RETROSPECTIVE REMOTELY SENSED IMAGERY WITH HYDOGRAPHIC AND BIOLOGICAL DATA FROM THE NORTHERN GULF OF MEXICO

PI : Erik Davenport
EMAIL : eric.davenport@noaa.gov
AFFILIATION : 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

Co-PI: Randy Ferguson
EMAIL : randy.ferguson@noaa.gov
AFFILIATION : 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

Co-PI: Jeff Govoni
EMAIL : jeff.govoni@noaa.gov
AFFILIATION : 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

C. List all non-student personnel funded by this project: None

D. List all students funded by this project: None

E. Key Scientific Question(s)/Technical Issues(s): What is the vulnerability of the northern Gulf of Mexico ecosystem and fisheries production to hurricane events of differing winds, precipitation, and storm surge?

F. Collaborators(s)/Partners: None

G. Project Duration:

a. START DATE: August 2006
b. ESTIMATED END DATE: September 2009

H. 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.

I. 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 the 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. canes on marine habitats and commercial fisheries.

J. 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 the larval fish diversity in the Gulf of Mexico.
- Developed a Nutrient, Phytoplankton, and Zooplankton ("NPZ") dynamic numerical model to simulate changes in biological production after a hurricane event.

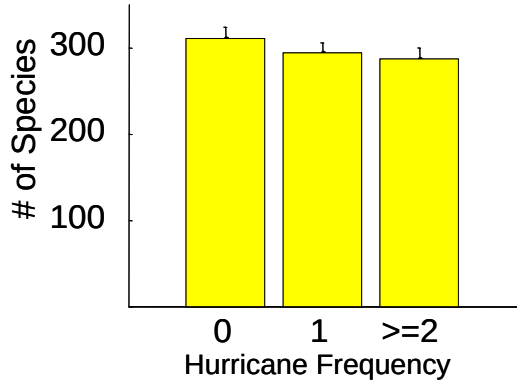


Figure 5. Bar graph displaying a non significantly lower species richness in years when there were 2 or more hurricanes.

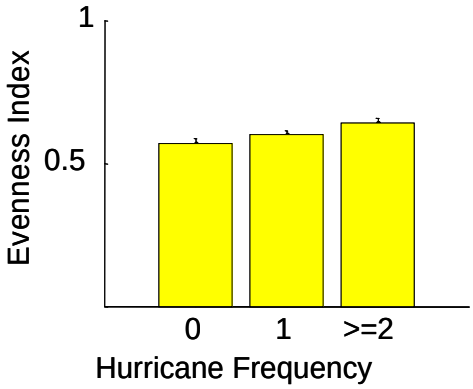


Figure 6. Bar graph displaying a significantly higher evenness index in years when there were 2 or more hurricanes. The higher species evenness suggests that there are similar abundances among the species in years where there are two or more hurricanes.

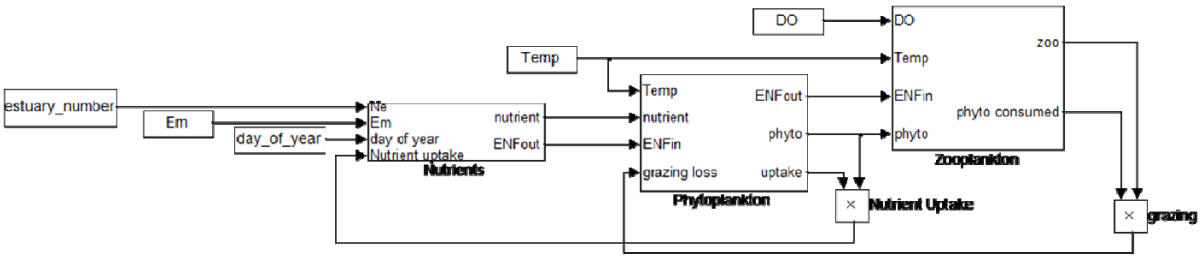


Figure 7. Simulink schematic of NPZ model developed to simulate changes in biological production after a hurricane event.

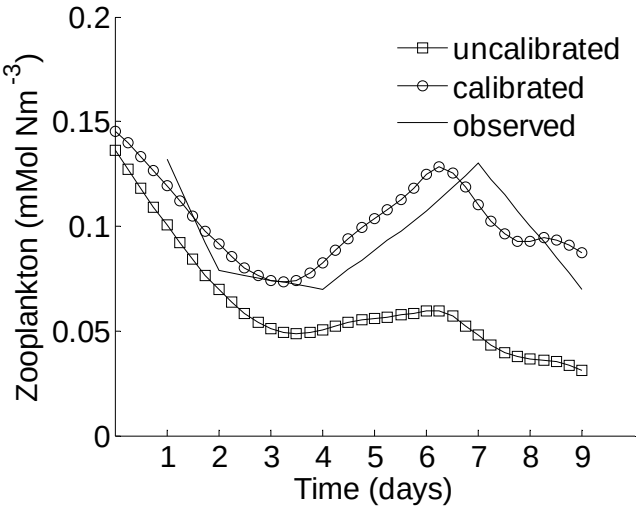


Figure 8. Line plots of calibrated, uncalibrated, and observed results for zooplankton stocks. The uncalibrated model tends to underestimate the in situ zooplankton biomass. The calibrated model tends to overestimate the in situ zooplankton, but provides a better approximation to the observed data.

K. Outreach activities: None

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Modeling Hurricane effects on zooplankton production using a Simple NPZ Numerical Model, 16th Annual Morgan State University Research Symposium, 4/16/2009, Baltimore, MD.

NOAA 03

A. NGI Project file Number: 08-NOAA-03

B. Project title, PI(s), Email, and Affiliation: HABITAT-LINKAGES, SPATIAL DEMOGRAPHICS AND FOOD WEB COMPONENTS OF THE NORTHEASTERN GULF FISHERIES ECOSYSTEM

PI : Doug DeVries
EMAIL : doug.devries@noaa.gov
AFFILIATION : NOAA Fisheries, Panama City Laboratory

Co-PIs: Gary Fitzhugh, Chris Gardner, Robert Allman, Linda Lombardi-Carlson
AFFILIATION : NOAA Fisheries, Panama City Laboratory

Co-PI: Mark Monaco
EMAIL : mark.monaco@noaa.gov
AFFILIATION : National Ocean Service, Biogeography Program

Co-PI: Tim Battista
AFFILIATION : National Ocean Service, Biogeography Program

Co-PI: Jeff Chanton
EMAIL : chanton@ocean.fsu.edu
AFFILIATION : Florida State University

Co-PI(s): Felicia Coleman, James Nelson
AFFILIATION : Florida State University

C. List all non-student personnel funded by this project:

PERSON'S NAME: Chris Gardner
CATEGORY: Research Scientist
DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes, NOAA Fisheries Service, Southeast Fisheries Science Center, Panama City Laboratory.

D. List all students funded by this project: None

E. Key Scientific Questions:

a. 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.

b. 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.

F. Collaborators/Partners:

NAME OF COLLABORATING ORGANIZATION: Florida State University – Jeff Chanton, Chris Koenig, Felicia Coleman, and James Nelson.

DATE COLLABORATING ESTABLISHED: July 2006.

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Partners have provided considerable in-kind support.

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. FSU's role has included providing guidance on conducting stable isotope analysis, assisting in preparation of tissue samples for those analyses, 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.

G. Project Duration: 3 years

a. START DATE: September 2006
b. ESTIMATED END DATE: September 2009

H. Project Baselines:

a. 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. NOAA Fisheries strategic and 5-year plans highlight the agency's planned move towards merging sustainable fishing and ecosystem preservation goals, making habitat (delineation, protection and restoration) a key theme. Developing survey and monitoring approaches that can be stratified by, or linked to, habitat is essential for an ecosystem approach. 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.

b. 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 Alliance (GOMA), is identification and characterization of Gulf habitats to

inform management decisions. GOMA 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 off NW Florida (and the third we plan to map in Sep 09) with high resolution multibeam sonar 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 and artificial reefs. 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 or community effects can be detected against climate cycles. As we move from drought 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 (Lombardi et al. 2008[1]). 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 them from those of fishing.

c. GAPS: Our research will 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, essential to reef fish populations, in the NE Gulf. High resolution habitat delineation maps will greatly expand regional knowledge on an ecosystem level scale and be invaluable in dealing with MPA and artificial reef siting issues. Information on trophic pathways in the fish communities inhabiting these hard bottom habitats is scarce to non-existent, and sorely needed if ecosystem-based management is to succeed. The geo-referenced, cross-shelf demographic data will be of great value for spatially-explicit fisheries' modeling. 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,[2] Walters and Martell 2004[3]) and combines spatial population dynamics parameters,

[1] Lombardi-Carlson, L., G. Fitzhugh, C. Palmer, C. Gardner, R. Farsky, and M. Ortiz. 2008. Regional size, age and growth differences of red grouper (Epinephelus morio) along the west coast of Florida. Fisheries Research, 91(2-3): 239-251.

[2] 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.

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.

I. Project Abstract: This study, begun in fall 2006, has two broad goals: 1) to delineate and quantify hard bottom reef habitats from nearshore to the shelf break off the Florida panhandle, and 2) to examine the fish community structure, trophic dynamics, demographics, and habitat associations on those habitats. Two cross-shelf multibeam sonar transects, ranging from 20 to 75 m depths, and 2 to 2.5 km x 30 km (~ 420 km2 total), have been mapped (Figure 9). Geo-referenced ground truth video and still images were and continue to be collected for use in habitat classification of the multibeam data. Based on local knowledge and initial mapping, 9 fixed sites in one of the transects - 3 in each of 3 depth strata [23 m = inshore (In), 37 m = midshelf (Mid), and 49 m = offshore (Off)] - were chosen and sampled during three seasons: summer, fall, and winter. Video data on species composition, abundance, and size structure were collected at each site each season from 2-4 transects, 25-40m in length, using an ROV with parallel scaling lasers. Additional data on size structure and cryptic and rarer species were gathered using the ROV during a 20-30 min random search following the transect work. Specimens for age, food habits, and stable isotope analyses were collected at reefs near each fixed site using two types of standardized hook-and-line gear (5/0 circle hooks and No. 4 sabiki bait rigs). Fish commonly observed with the ROV but seldom captured on hook and line (e.g., gray snapper, blue angelfish, scamp) were collected on inshore sites using spear guns. Tissue samples were analyzed for stable isotopes of C and N (13C and 15N) by FSU collaborators. Surface to bottom profiles of temperature, salinity, depth, and light transmissivity were taken each time a site was sampled. The mapping and biological sampling have revealed considerable areas of diverse, mostly low relief hard bottom (carbonate) reef habitat in both transects, especially in the inshore half of each, which are inhabited by large numbers of virtually all of the most commonly exploited reef fishes in the northern Gulf of Mexico, especially pre-recruit sizes, with red snapper and scamp the most abundant snapper and grouper.

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

a. Biological and environmental data were collected in Mar 07, Jun 07, Oct 07, Feb-Mar 08, Oct-Nov 08, Mar 09 and Jun 09 at the 9 fixed sites (53 sea days and 62 ROV dives). All video tapes collected through Mar 09 have been read and the data digitized, with 1324 fish (46 species) measured with the ROV's lasers. A total of 976 fish have been collected from the hook and line sampling and spear fishing (15 scuba dives); and otoliths, gonads, stomachs, and tissue samples for stable isotope analysis have been taken from all of those.

b. To date, stomach contents of 612 fish have been examined. Of these, 79% contained food items and 57% contained prey identifiable to some degree. Overall, tissue samples from 167 fish and

[3] Walters, C., and S. Martell. 2004. Fisheries Ecology and Management. Princeton Univ. Press, Princeton, N.J.

8 species have been analyzed and the results contained 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. An additional 60 tissue samples have been sent to FSU for stable isotope analysis and more are currently being selected for processing to resolve gaps in the food web models.

c. A total of 148 geo-referenced habitat images have been compiled and forwarded to the NOAA Biogeography team for ground-truthing and habitat classification of multibeam backscatter data. Recently a new ground-truthing video system with a geo-referenced video camera has been employed to rapidly acquire habitat images over large areas. These are essential in accurately classifying the multibeam sonar data and deciphering between exposed rock and rock covered by a thin veneer of sand.

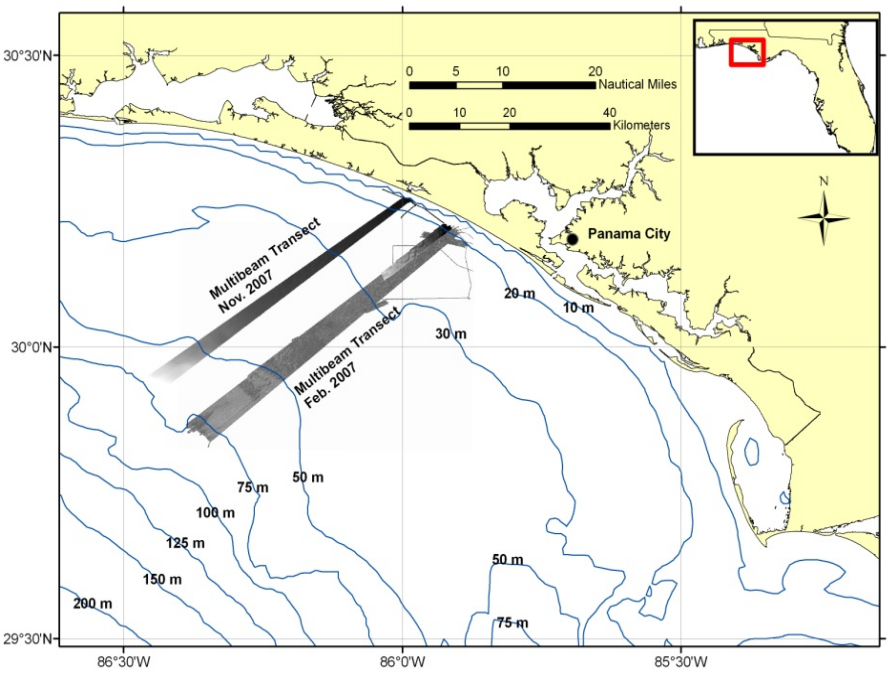
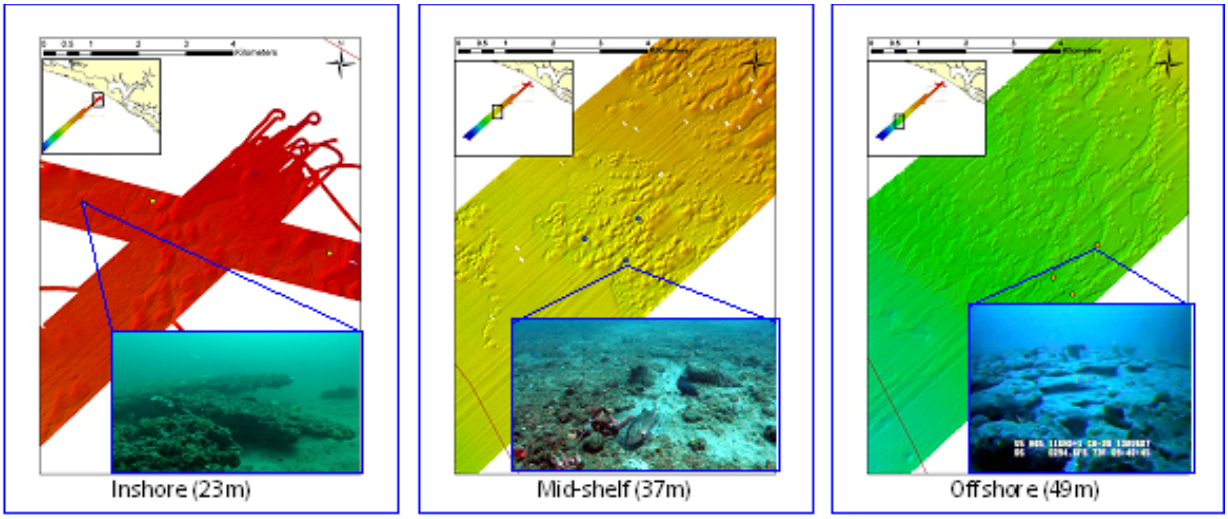


Figure 9. Inshore to offshore transects surveyed with a multibeam echosounder in Feb and Nov 2007 off northwest Florida.

d. Some preliminary research results:

- The shallowest depths (20-25m), where our inshore sampling sites were located, contain a mixture of sandy areas and numerous rocky reefs with the highest (up to 1.5 m) relief found in the survey (Figure 10). These reefs typically have a less diverse and lower population of macro epifauna than the deeper ones. The area between 25 and 35m, which included our midshelf sites, is characterized by large patches of lower relief (~0.5m) reef and some areas of rock covered by a thin veneer of sand. The reefs here are patchier and provide a more

complex habitat than those nearshore, with numerous sponges, gorgonians, soft corals, ascidians, and other epifauna attached to exposed or slightly buried rock. The area encompassing our offshore sites, in 35-50m, is very sandy with only a few isolated strips of hard bottom habitat. These very patchy reefs, dominated by cracks and small holes, generally have <0.5 m relief. The offshore-most area, in 50-75m, has virtually no relief, but extremely large areas of alternating hard backscatter returns (rock) and sand which may be flat pavement type exposed rock or dense areas covered by sand. They, however, have yet to be ground-truthed.



Lions Paw Reef, one of the highest profile (~1.5m) sites. The other 2 sites in this stratum have ledges as high as 1m.

Red grouper and speckled hind at mid-shelf site showing typical low-profile rocky habitat and sponge fauna.

Offshore rocky habitat characterized by smooth, pavement-like rock and sponge fauna.

Figure 10. Multibeam bathymetry, sampling site locations, and habitat images in each stratum from transect mapped in Year 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 including gray triggerfish, gray snapper, scamp, vermilion snapper, and red porgy. Except for gray snapper inshore, red snapper was the most abundant exploited reef fish, averaging 96/ha (In), 114/ha (Mid), and 95/ha (Off) (Figure 11). Scamp was the most abundant exploited serranid ($\bar{x}$: 20-76/ha). The relative abundance of gray snapper was 35 fold higher inshore than at midshelf (426 vs 12 /ha), with none observed offshore. Bank sea bass and vermilion snapper were very common in the midshelf and offshore strata. Diversity indices at midshelf and offshore were similar and much higher than inshore, primarily because of greater numbers of more tropical, unexploited species,

although total number of species varied little among all three strata: 56 (In), 61 (Mid), and 53 (Off) (Figure 12).

- Red snapper increased in size with depth, with modes of ~275 (In), 300 (Mid), and 350 mm FL (Off); not surprisingly, a comparison of laser-measured red snapper with those from hook and line samples suggests a slight bias by the latter gear towards larger individuals (Figure 13). Age structure of red snapper, unlike size, differed very little across the shelf. Two and three year olds dominated in each stratum, composing 88, 65, and 79 % of inshore, midshelf, and offshore collections. In those same strata, 100, 94, and 99 % were between ages 1 and 4. Red grouper were much smaller inshore ($\bar{x}$ ± 95% CL: 283±30 mm FL) than at midshelf (538±39 mm FL) and offshore (602±49 mm FL); and all those collected inshore were ages 1-2 and from the very strong 2006 year class (Figure 14). In contrast, 3 of the 4 red grouper collected at midshelf and offshore were much older (ages 8-9) and also from a very large (1999) cohort. Scamp differed little in size across depths, with all but one between 138 to 360 mm FL ($\bar{x}$ =237 mm). Scamp this small are all pre-recruits to the fishery and estimated to be 1-2 yr old.

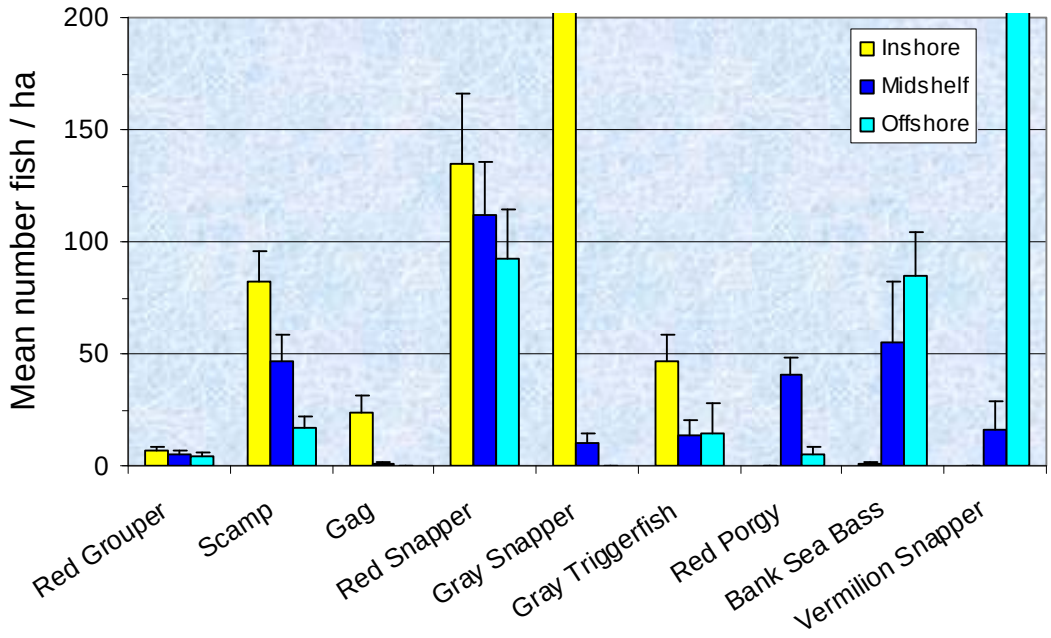


Figure 11. Average number of fish/ha (exploited species only) and standard error, by depth stratum, from ROV transect counts made during Mar 07- Mar 09. Inshore gray snapper = 452 fish/ha. Offshore vermillion snapper = 241 fish/ha.

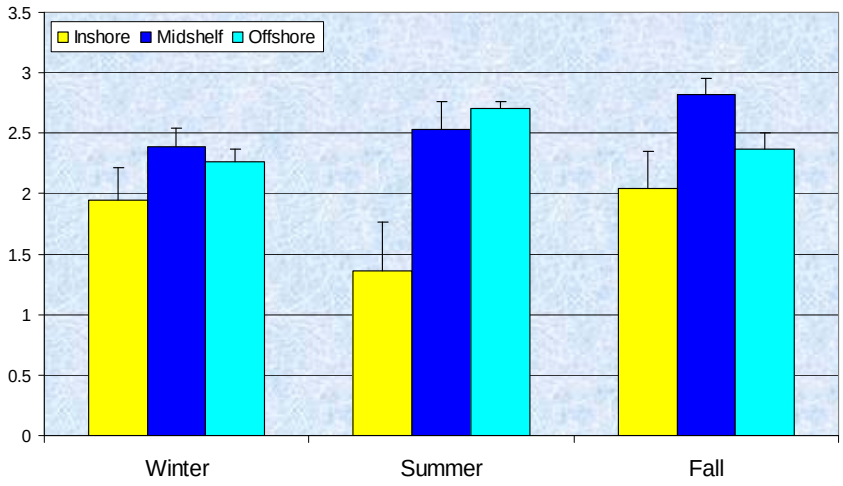


Figure 12. Shannon Weaver diversity indices and standard errors by stratum and season. Observations were transformed by square root to decrease the influence of extremely abundant taxa.

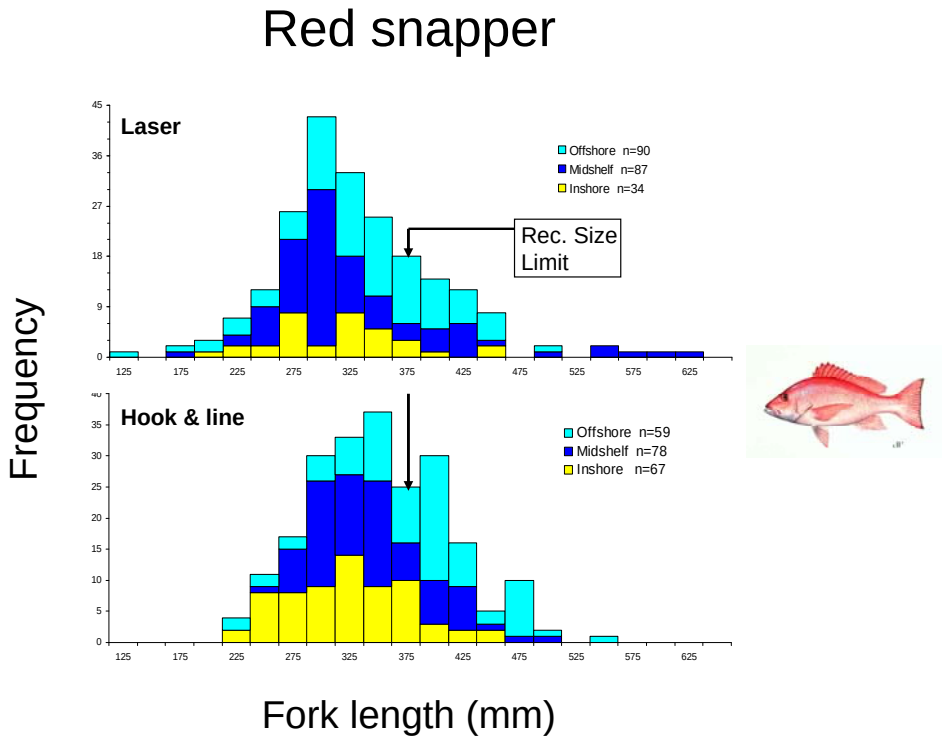


Figure 13. Size distributions of red snapper from Mar 07 – Mar 09 sampling by depth strata from the ROV laser-scaled video data and for all strata combined from the hook and line collections.

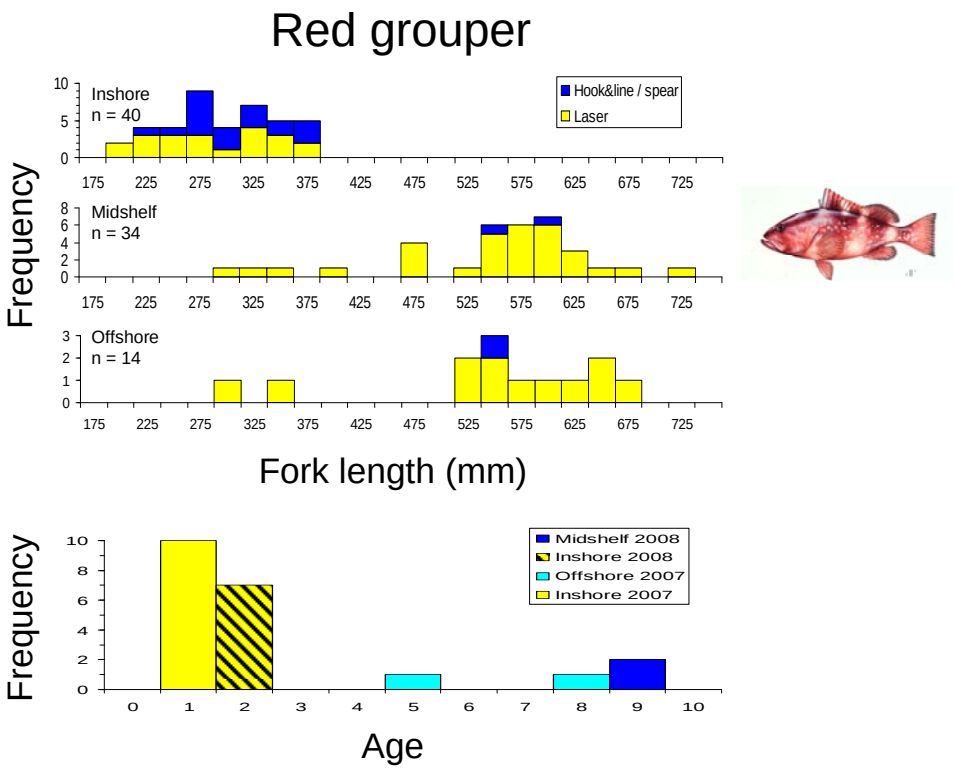


Figure 14. Size and age distributions of red grouper from Mar 07 – Mar 09 sampling by strata from the ROV laser-scaled video data and hook and line collections.

- Of 172 red snapper stomachs examined, 78% contained food. Of these, 32% of the stomachs contained only unidentifiable remains, 31% held only fish, 11% only crustaceans, and 26% had multiple prey items. Among red grouper with food in their stomach (n=9, 75%), 56% contained only unidentifiable remains, 33% held only fish, and 11% had a mixture of fish and crustaceans. Red snapper and red grouper had very similar C to N isotope ratios and occupied very similar trophic levels (Figure 15).

K. Outreach Activities: Gardner and D. DeVries: short, oral presentations on our NGI project to various student and other groups touring the Panama City NOAA Fisheries lab, Panama City, FL. Number of participants varied.

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None

N. List non-refereed articles and reports for this project: None

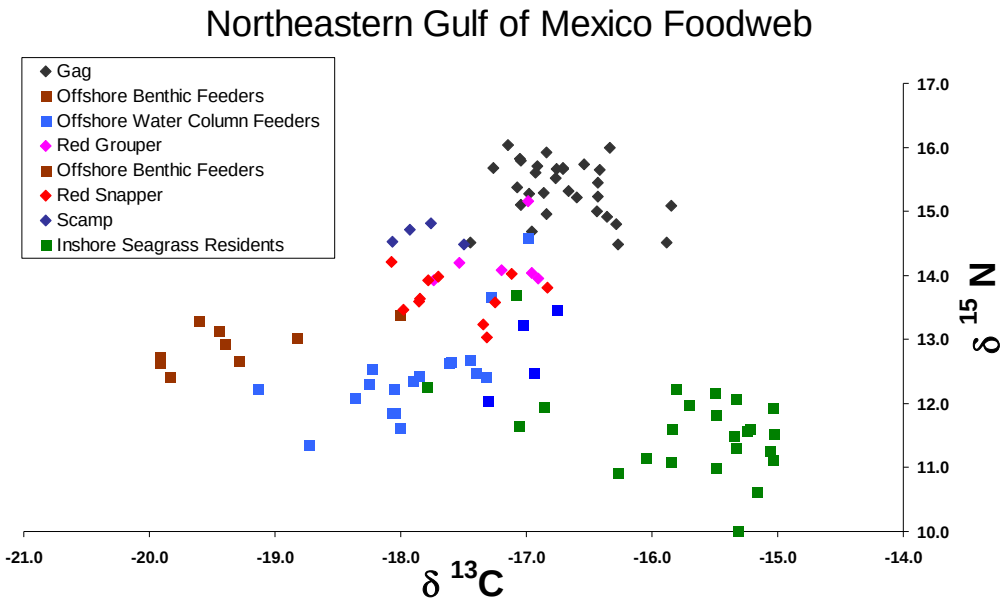


Figure 15. Preliminary stable isotope analysis of the foodweb in the northeastern Gulf of Mexico from samples collected as part of the NOAA/FSU collaboration under NGI. Major fishery species (gag, red grouper, and red snapper) are shown as well as major prey groups identified by stable C & N isotope values. Benthic feeders = red porgy 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).

O. 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.

Gardner, C., D. DeVries, D. Naar, G. Fitzhugh, and T. Battista. Mapping the low relief reef fisheries habitat off northwest Florida. 2009. Poster, 2009 Annual Northern Gulf Institute Conference, Mobile, AL.

DeVries, D., C. Gardner, G. Fitzhugh, and R. Allman. 2009. Cross-shelf reef fish community structure and demographics on natural reefs off northwest Florida. Oral presentation, 2009 Annual Northern Gulf Institute Conference, Mobile, AL.

NOAA 04

A. NGI Project File Number: 07-NOAA-04

B. Project title, PI(s), Email, and Affiliation: MERCURY BIOACCUMULATION IN MOBILE BAY: A MODEL FOR OTHER GULF OF MEXICO ESTUARIES

PI: David Evans
EMAIL: david.w.evans@noaa.gov
AFFILIATION: Center for Coastal Fisheries and Habitat Research, Beaufort NC

C. List all non-student personnel funded by this project:

PERSON'S NAME: David Cerino
CATEGORY: Research Scientist
DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 21%
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes, Center for Coastal Fisheries and Habitat Research

PERSON'S NAME: Colleen Rochelle
CATEGORY: Research Scientist
DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100%
Is individual located at a NOAA Lab? Yes, Center for Coastal Fisheries and Habitat Research

D. List all students funded by this project: None

E. Key Scientific Question(s)/Technical Issues(s): 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.

F. Collaborators(s)/Partners:

NAME OF COLLABORATING ORGANIZATION: Mississippi State University
DATE COLLABORATING ESTABLISHED: May 30, 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: 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? AMOUNT OF SUPPORT? No
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 (University of South Alabama) - PhD dissertation: Benthic-Pelagic Coupling: Microalgal Transfer of Mercury from Contaminated Sediments
- Ruth Carmichael (Dauphin Island Sea Lab) : Relationship sewage inputs to success of oyster restoration in Mobile Bay
- Anne Boettcher (University of South Alabama) and Charlyn Partridge (Texas A&M University): The Effect of Non-Point Source Pollution on Gulf Pipefish Populations in and around Weeks Bay Reserve
- John Dindo (Dauphin Island Sea Lab)and Lauren Showalter (University of Alabama): Mercury in colonial marine birds in relation to food supply in Mobile Bay

G. Project Duration:

a. START DATE: June 2, 2006
b. ESTIMATED END DATE: September 30, 2009

H. Project Baselines:

a. 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.

b. 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.

c. GAPS: 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.

I. 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.

Figure 16. Sediment sampling

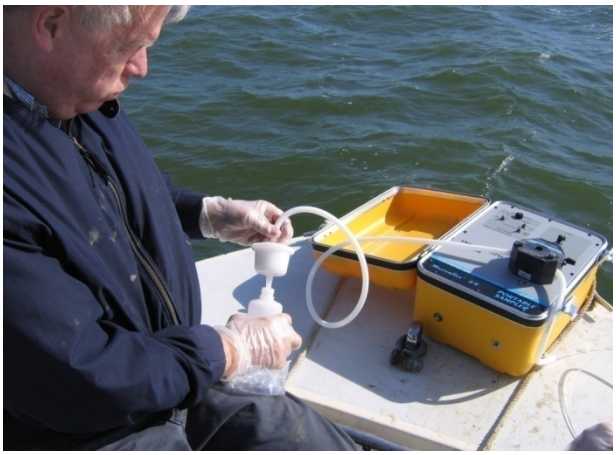


Figure 17. Water sampling

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

We have obtained the following results to date:

- Established first watershed inputs of methylmercury to Mobile Bay.
- Measured low total mercury and methylmercury in both water and sediments of Mobile Bay.
- Found highest mercury concentrations in upstream or marginal areas with adjacent wetlands such as Weeks Bay and the Delta.
- Discovered that these latter areas seem to be sites of net mercury methylation.
- Suggested that similar areas in the Gulf of Mexico are likely to be higher in mercury.
- Sampled an algal bloom event, in February 2008, and found very high total and methylmercury concentrations, suggesting either the bloom's physiology or the bloom's source area (e.g. Weeks Bay) are causes.
- Built active collaborations with NGI partners at Mississippi State University and Dauphin Island Sea Lab.

K. Outreach activities

a. GENERAL DESCRIPTION: Outreach activities have focused building partnerships with NGI academic investigators and local (Mobile Bay) resource managers.
   - Presentations – see sec. O

b. HAVE YOU HOSTED SPEAKERS, WORKSHOPS AND/OR ANY TRAINING? No

Figure 18. Sites sampled for water and sediments.

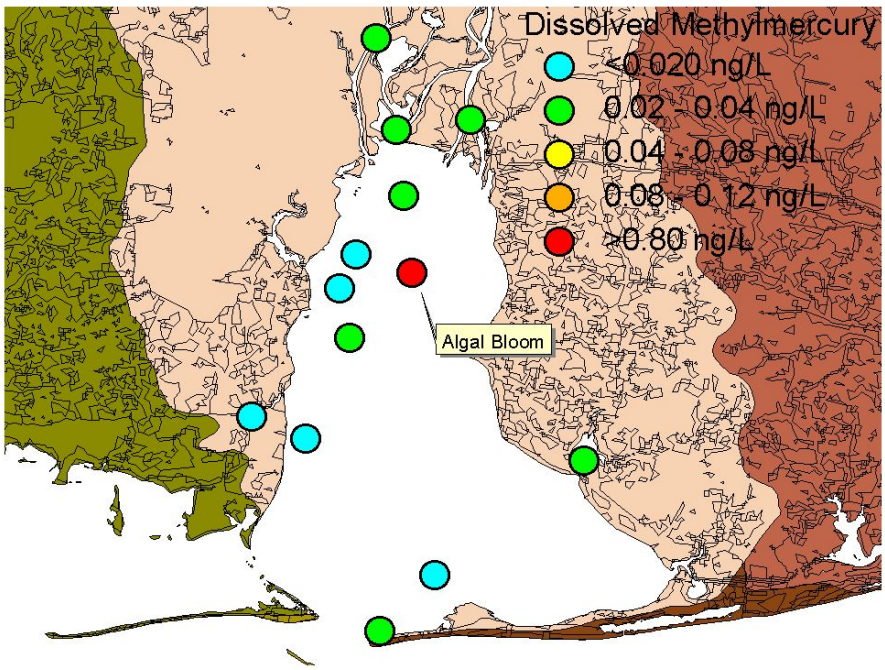


Figure 19. Concentrations in MeHg in dissolved, or filtered, water samples were low, ranging from 0.01 ng/L (detection limit) to 2.34 ng/L. During an algal bloom event in February 2008, water sampled yielded the highest MeHg concentration. Suggests that mercury methylation is occurring in the water column where microalgal biomasses are high or that it originated in Weeks Bay and moved with the bloom.

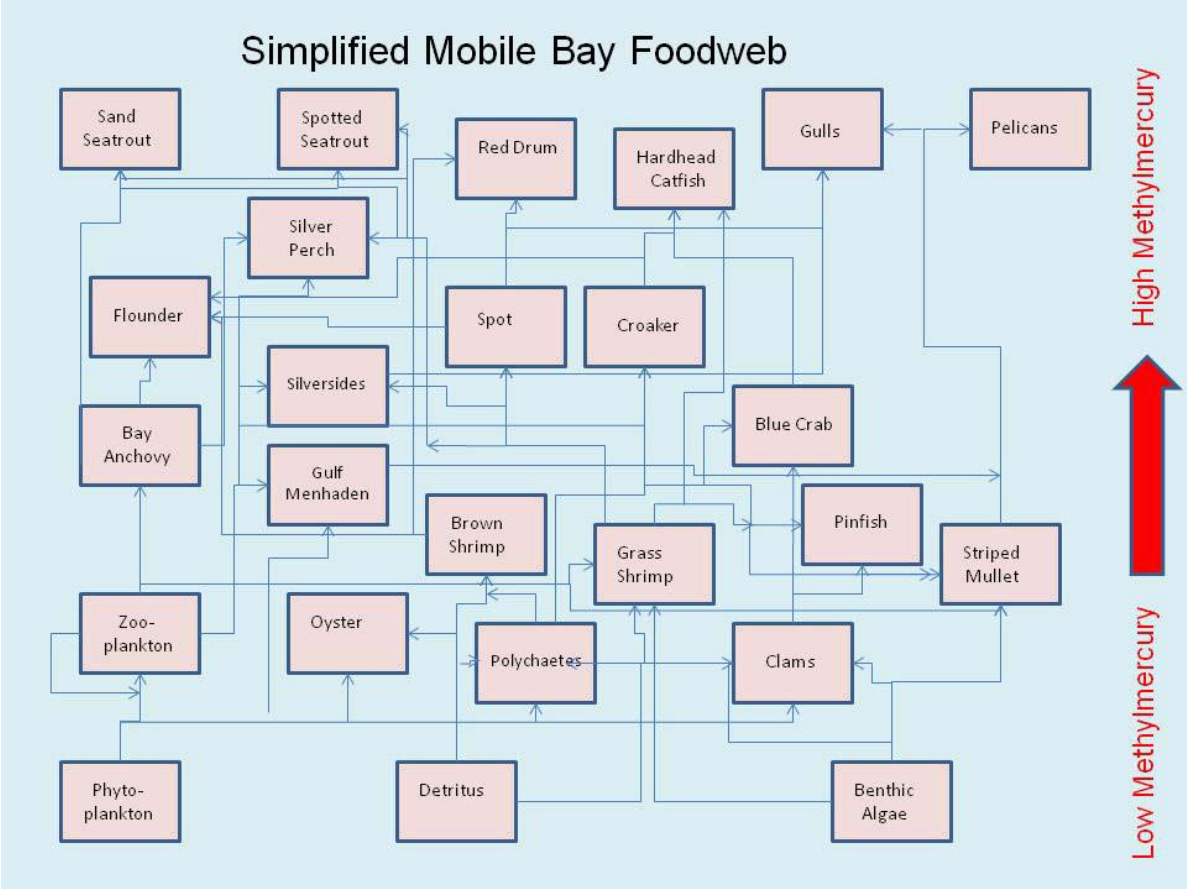


Figure 20. A full model will be parameterized in Ecopath which will be used with the Ecotracer module to predict methylmercury concentrations in the biota. From this we expect to gain insights into critical habitats and processes contributing to high mercury concentrations in seafood and to special risks to wildlife.

Figure 21. Mobile Bay

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Evans, David, Colleen Rochelle, and David Cerino. "Methylmercury and Total Mercury in Water and Sediments of Mobile Bay." Oral presentation during Sediments Paper Session for 2009 Annual Northern Gulf Institute Conference, May 20, 2009, Mobile, AL.

David W. Evans, and Colleen Rochelle, Ann Boettcher and Charlyn Partridge, John Dindo and Ruth Carmichael, Lauren Showalter. "Mercury in the Food Web of Mobile Bay." Poster for 2009 Annual Northern Gulf Institute Conference, May 20, 2009, Mobile, AL.

NOAA 05

A. NGI Project file Number: 08-NOAA-05

B. Project title, PI(s), Email, and Affiliation: NORTHERN GULF COOPERATIVE INSTITUTE: DEVELOPMENT OF MOLECULAR ASSAYS TO MONITOR WATERS FOR THREATS TO HUMAN HEALTH

PI : Kelly Goodwin
EMAIL : kelly.goodwin@noaa.gov
AFFILIATION : NOAA

Co-PI: Christopher Sinigalliano
EMAIL : christopher.sinigalliano@noaa.gov
AFFILIATION : CIMAS

C. List all non-student personnel funded by this project:

PERSON'S NAME: Chris Sinigalliano
CATEGORY: Assistant Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 67%
Is individual located at a NOAA Lab? Yes, AOML

PERSON'S NAME: Kelly Goodwin
CATEGORY: Microbiologist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 16%
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes, AOML

D. List all students funded by this project:

PERSON'S NAME: David Wanless
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 67%
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes, AOML

E. Key Scientific Question(s)/Technical Issues(s): Source identification methods are being developed and validated in the in order to improve the ability to diagnose and remediate water quality problems in coastal beach and shellfishing areas.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: Shiao Wang, Ph.D., University of Southern Mississippi, Department of Biological Sciences, 118 College Dr # 5018, Hattiesburg, MS 39406, (601) 266-6795 – phone, (601) 266-5797 – fax, shiao.wang@usm.edu

DATE COLLABORATING ESTABLISHED: 2006
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. This project includes collaboration with the NGCI scientists listed above. Interactions include exchange of protocols, ideas, samples, and data.

NAME OF COLLABORATING ORGANIZATION: 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

DATE COLLABORATING ESTABLISHED: 2006

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. This project includes collaboration with the NGCI scientists listed above. Interactions include exchange of protocols, ideas, samples, and data.

NAME OF COLLABORATING ORGANIZATION: 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? AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? No

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. This project includes collaboration with the NGCI scientists listed above. Interactions include exchange of protocols, ideas, samples, and data.

G. Project Duration:

a. START DATE: 6/2006
b. ESTIMATED END DATE: 12/2009

H. Project Baselines:

a. 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 Objective 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 effort falls under the Ecosystems Research Program Capability to explore and characterize ecosystem health and corresponds to the Performance Measure of annual number of coastal, marine, and Great Lakes ecosystem sites adequately characterized for management (GPRA). These characterizations are used to evaluate ecosystem health and public health impacts, provide new information about relationships between indicators, pathogens, and health effects in non-point-source recreational waters, and support regional assessment of land-based sources of microbial contaminants to coastal environments. The work corresponds to the NOAA Five-Year Research Plan Performance Objective to increase the number of coastal communities

incorporating ecosystem and sustainable development principles into planning and management.

b. CONTRIBUTIONS TO REGIONAL PROBLEMS AND PRIORITIES: There is a need to develop rapid biodetection methods to aid resource management (e.g., beach and shellfish closure), integrated ecosystem assessments, infrastructure management (e.g., septic tank & sewer function, levee construction, ballast water treatment and release), and to increase resiliency of coastal hazards. 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.

   Dog feces near rivers and beaches can contribute to poor water quality because it contains a significant amount of fecal-indicating bacteria (FIB). Loading estimates for canine fecal matter are 8.4x105 CFU of enterococci/dry g and 2.3 x105 CFU of fecal coliform/dry g. In addition, dog feces are a potential source of waterborne pathogens, including methicillin resistant Staphylococcus aureus. However, an estimated 40% of American dog owners do not pick up after their dogs. Source tracking can be used by Gulf Coast states to address beach and shellfish contamination problems by helping environmental managers identify the sources of contamination. Once sources are identified, scientifically and economically sound remediation efforts can be devised.

   These efforts are consistent with priorities identified by Gulf of Mexico Alliance (GOMA) Priority Task Teams. The microbiological safety of coastal waters in the Northern Gulf of Mexico is one of the major concerns in the most recent version of the Gulf of Mexico Alliance (GOMA) II Action Items. The Actions call for improved methods to identify areas that are impaired by pathogens and to track sources of the pathogens, specifically to "develop new and improved methods to identify the coastal waters and beaches that are impaired by pathogens and to track the sources of these disease-causing organisms."

c. Gaps: Work will help develop rapid and quantitative assays for microbial water quality monitoring.

I. Project Abstract: This work seeks to adapt & develop molecular biological assays to improve water quality monitoring. Molecular assays offer a rapid approach for detection of microbial contaminants. Rapid monitoring and assessment methods are needed to promote ecosystem management, public health, and the economic value of coastal resources. Fecal material, including animal waste, contributes to microbial pollution at a number of coastal sites. This project explores standard PCR and quantitative PCR (qPCR) to detect a variety of fecal indicating bacteria, microbial pathogens, and source identification markers. Accurate source identification is important to devise sound remediation strategies and for Total Maximum Daily Load (TMDL) calculations. Several human source identification assays are being evaluated for this project. Human contamination is important to identify because of possible health risks to humans. Another assay being developed under this project identifies fecal matter from dogs. Canine fecal pollution represents a "low

hanging fruit" with regard to management action -- where this source of pollution is identified, modest investments can provide effective remedial action. Actionable items include infrastructure investments (providing bags, disposal cans, and trash pickup), education, and limits on dog access (e.g., seasonal limits). In addition, this project includes evaluation of nucleic acid extraction methods in order to optimize these assays and to prepare them for transfer to state and regional partners.

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

- The developed qPCR assay to identify canine fecal contamination (DogBac) was used to test DNA extracted from a variety of dog fecal samples provided by NGI collaborator, Dr. Jody Harwood. Out of these samples 90% of the dog samples were positive and 69% of the dog samples were "highly positive" (>1x104 copies). For the "highly positive" samples, the average target abundance was 1.2x107 plasmid equivalents (PE) per µl. The samples with lower concentrations contained an average of 2.4x103 PE/µl.
- The DogBac assay was used with environmental samples including samples collected from a beach off Florida's southeast coast (Figure 22) and from a variety of samples collected from Florida's panhandle in the Northern Gulf of Mexico (Figure 23). The assay demonstrated good efficiency and good linear response with these environmental samples.
- The DogBac assay also was used in the Florida Keys in combination with a general assay for Bacteroides bacteria (AllBac) and with a human source tracking marker that also was being tested as part of this project (HuBac) (Figure 24).
- The HuBac marker did not appear to be human-specific (Table 1) but instead appeared to behave like a general marker for Bacteroides spp. (Figure 24, Table 2). This marker was subsequently dropped from the project in favor of the human source identification marker HF8, which is also used by our NGI collaborators. In addition, the human specific marker BacHum-UCD was added to replace the HuBac marker as it demonstrated greater specificity for human fecal samples.
- qPCR results (Table 1) for the quantitative canine fecal identification assay (DogBac) and for two human specific assays (HF8 and HuBac) studied as part of this project. Seawater and sand samples were collected from Hobie Beach, FL. The HuBac assay did not appear to be human-specific at this non-point source beach or in other sites in the Northern Gulf of Mexico (Table 2).

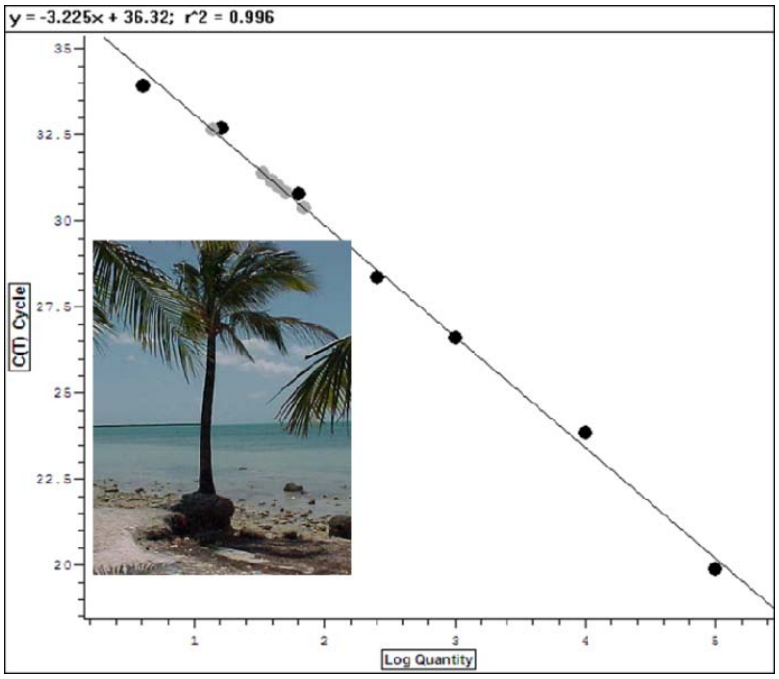


Figure 22. DogBac assay used with samples collected from Hobie Beach Florida (grey circles are environmental samples, black circles are plasmid controls).

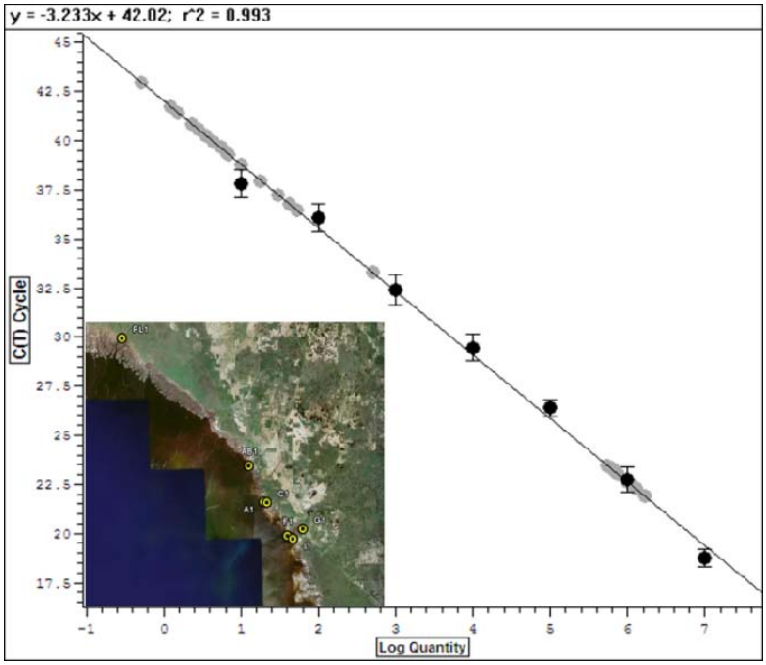


Figure 23. DogBac assay used with samples collected from the Florida Panhandle (Taylor County) (grey circles are environmental samples, black circles are plasmid controls).

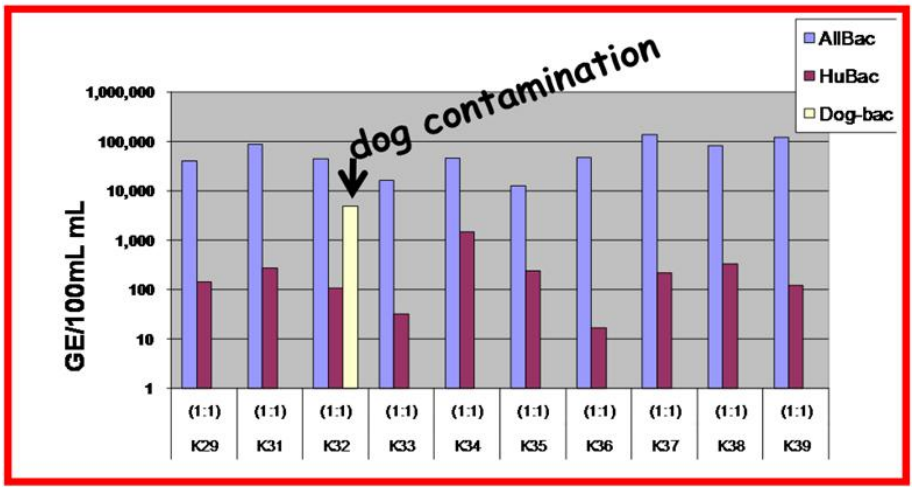


Figure 24. The DogBac assay was used to test samples collected from the Florida Keys for fecal contamination from dogs. These samples also were used to evaluate other molecular markers for Bacteroides spp. (AllBac) and for human-specific Bacteroides (HuBac).

Site & Description		Human Bacteroides (HF8)	Human Bacteroides (HuBac)	Dog Bacteroides (Dog-Bac)
name	type	GE/100 ml	GE/100 ml	PE/100ml
WHa1	Seawater	11	3.5e3	1.9e5
WHb1	Seawater	0	1.2e3	1.6e5
WHc1	Seawater	9	2.4e3	3.2e4
SLD1	Dry sand	0	7.5e4	0
SLD2	Dry sand	0	3.8e4	0
SHD1	Dry sand	0	7.1e4	0
SHD2	Dry sand	0	5.1e4	0

Table 1. qPCR results for quantative canine fecal indentification assay and for two human specific assays.

site	All Bac	HuBac	HF8	esp
A1	+	+	-	-
AB1	+	+	-	-
C1	+	+	-	-
F1	+	+	-	-
FR	-	-	-	-
G1	+	+	-	+
I1	+	-	-	-
L1	+	+	+	-
PL1	+	-	-	-

Table 2. Testing of three human fecal identification markers (HuBac, HF8, and esp) in comparison to a general marker for Bacteroides spp. For samples collected from the Florida panhandle in the Northern Gulf of Mexico.

- The DogBac assay was incorporated into a suite of tests used in the BEACHES epidemiology study conducted by the University of Miami's Center of Excellence for Oceans and Human Health. Coordination with the BEACHES study directly responds to the GOMA Action Plan II Pathogens Workgroup Activities Matrix which calls to "improve the understanding of which pathogens constitute risks to human health in Gulf coastal waters." Results from the DogBac assay were compared to a variety of environmental parameters. The DogBac marker demonstrated a positive relationship with turbidity and tidal stage and an inverse relationship with temperature and salinity (Table 3).
- The DogBac marker showed a positive odds risk ratio for reported human illness upon exposure to recreational waters of the study beach (Figure 25, Figure 26) although logistical regression analysis did not show a significant dose response under these study conditions. This pilot epidemiological study may not have had sufficient power to elucidate a clear dose response for the DogBac assay, and further epidemiological studies incorporating this assay are warranted.

Variable	ENT (MF)	ENT (CS)	ENT (qPCR)	Dog Bacteroides (DogBac qPCR)	Human Bacteroides (BacHum-UCD qPCR)
pH					0.442 p<0.001
Salinity (o/oo)	0.0979 p<0.001			-0.284 p<0.001	-0.0856 p=0.003
Temp (C)	0.0655 p<0.001	0.0429 p<0.001		-0.157 p<0.001	-0.114 p<0.001
Turbidity (NTU)		0.0147 p<0.001	0.0209 p<0.001	0.0419 p<0.001	-0.0162 p=0.006
Tide (m)	1.148 p<0.001	0.824 p<0.001	0.720 p<0.001	3.079 p<0.001	0.892 p<0.001
Wdir (deg)	0.00118 p=0.001				
Wspeed (m/s)	-0.0810 p<0.001	-0.0568 p<0.001	-0.134 p<0.001		-0.0878 p<0.001
Solar (W/m2)	-0.00107 p<0.001	-0.00107 p<0.001			

Table 3. Significant relationships for a single sample regression model (coefficient and p-value) for various environmental parameters versus enterococci (ENT) as measured by membrane filtration (MF), ENT by IDEXX defined chromogenic substrate (CS), ENT by quantitative PCR (qPCR), dog-specific Bacteroides (DogBac qPCR), and human-specific Bacteroides (BacHum-UCD qPCR). Measurements were taken at Hobie Beach during the BEACHES epidemiological study.

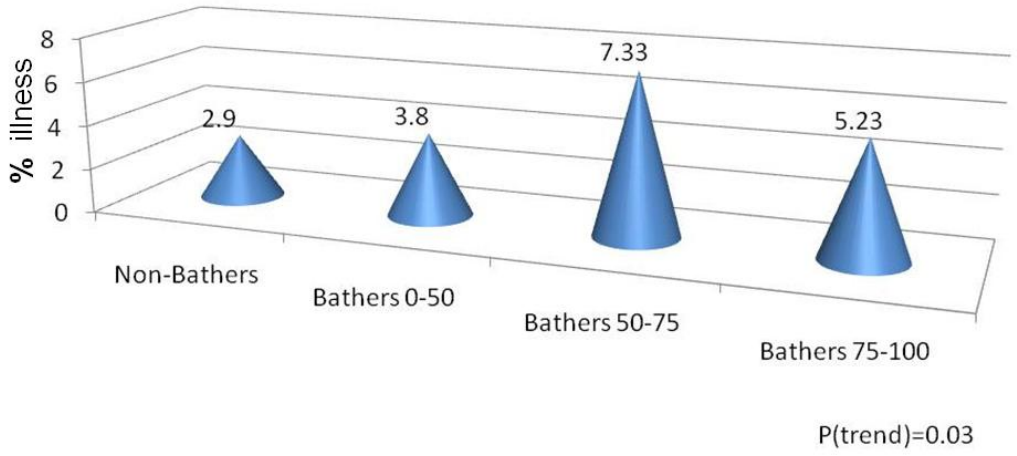


Figure 25. Reported GI ailments of bathers vs. non-bathers (by increasing exposure quartiles) in relationship to the amount of dog fecal contamination as measured by the DogBac assay.

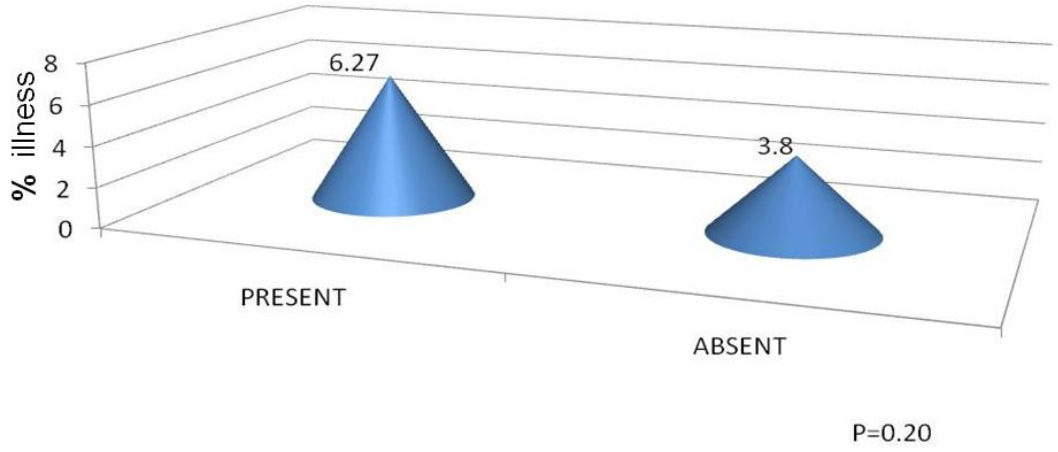


Figure 26. Reported GI ailments of bathers only for presence vs. absence of dog fecal contamination as measured by the DogBac assay.

K. Outreach activities: None

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles:

Goodwin, K.D., L. Matragrano, D. Wanless, C.D. Sinigalliano, and M.J. Lagier. 2009. A preliminary investigation of fecal indicator bacteria, human pathogens, and source tracking markers in beach water and sand. Environmental Research Journal, 2(4):395-417

N. List non-refereed articles and reports for this project.

Fleming L.E., Solo Gabriel H.M., Fleisher J.M., Elmir S, Sinigalliano C., Plano L., Kish J., Wang J., Backer L., Shibata T., Abdelzaher A., Garza A., He G., Ortega C., Wright M., Scott T., Bonilla F., Withum K., Gidley M.L., Harwood V., Zhu X., Hollenbeck J. Final Report on The Pilot Epidemiologic Assessment of Microbial Indicators for Monitoring Recreational Water Quality in Marine Sub/Tropical Environments. The NSF NIEHS Oceans and Human Health Center, Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, Miami, FL, Sept 2008. (Final technical report to CDC on BEACHES epidemiological study).

O. List conference presentations and poster presentations for this project.

Goodwin K.D. and C. Sinigalliano. "Development of Genetic Sensors to Monitor Waters for Threats to Human Health (dog source tracking)". Northern Gulf Cooperative Institute (NGI) PI meeting, Mobile, AL, May 20 -21, 2009.

Tomoyuki S., J. Fleisher, D. Wanless, K. Withum, J. Bartkowiak, M. Gidley, M. Wright, H. Solo-Gabriele., L. Fleming, C. Sinigalliano. "Comparison of Traditional and Molecular Analysis of Fecal

Indicator Bacteria and Environmental Parameters During an Epidemiological Study at a Non-Point-Source Sub/Tropical Marine Beach". American Society for Microbiology General Meeting, Philadelphia, PA, May 17-21, 2009.

Gidley, M, D. Wanless, T. Shibata, M. Wright, J. Kish, S. Elmir, A. Abdelzher, K. Goodwin, H. Solo-Gabriele, L. Fleming, C. Sinigalliano. "Preliminary Assessment and Methods Comparison for Relative Abundance of Enterococci and Bacteroides at a South Florida Recreational Beach". American Society for Microbiology General Meeting, Philadelphia, PA, May 17-21, 2009.

Bartkowiak, J., D. Wanless, K. Goodwin, C. Sinigalliano. "Analysis of Environmental Sample DNA Extraction Efficiency for Quantitative Real-Time PCR of Fecal Indicator Bacteria Using a Commercial DNA Binding Matrix Purification Procedure". American Society for Microbiology General Meeting, Philadelphia, PA, May 17-21, 2009.

Sinigalliano, C., J. Fleisher, T. Shibata, K. Withum, M. Gidley, D. Wanless, L. Fleming1, H. Solo-Gabriele. "Health Effect Associations of Recreational Water Exposure and Alternative Fecal Indicator Bacteria Measurements at a Non-Point-Source Subtropical Marine Beach". EPA National Beach Conference, Huntington Beach, CA, April 20-23, 2009.

Sinigalliano, C. "NOAA AOML Programs for Environmental Detection of Pathogens, Fecal Indicators, and Microbial Source Tracking". EPA Recreational Water Quality Criteria Research Forum, Costa Mesa, CA, April 23, 2009.

Sinigalliano, C. "An Overview of Microbial Water Quality Monitoring and Assessment Programs by NOAA AOML". Gulf of Mexico Alliance Water Quality Monitoring Workgroup Forum, New Orleans, LA, April 7-8, 2009.

Sinigalliano, C. "The Miami Beach Epidemiology Study". Combined Special EPA Workshop on Microbial Source Tracking & Gulf of Mexico Alliance Pathogens Workgroup Forum, St. Petersburg, FL, Feb 10-13, 2009.

Sinigalliano, C. "Assessment of Methods for MST and Detection of Alternative Indicators/Pathogens by the NOAA FACE Program". Combined Special EPA Workshop on Microbial Source Tracking & Gulf of Mexico Alliance Pathogens Workgroup Forum, St. Petersburg, FL, Feb 10-13, 2009

Sinigalliano, C., D. Wanless, K. Goodwin. "A Rapid Quantitative PCR Assay for Measuring the Relative Environmental Abundance of Canine-Source Bacteroides". Gordon Research Conference on Oceans and Human Health, Tilton, NH, June 29-July 4, 2008

NOAA 06

A. NGI Project file Number: 08-NOAA-06

B. Project title, PI(s), Email, and Affiliation: BUILDING A COMPREHENSIVE DATABASE ON THE EARLY LIFE STAGES OF FISHES IN THE NORTHERN GULF OF MEXICO

PI : Joanne Lyczkowski-Shultz
EMAIL : joanne.lyczkowski-shultz@noaa.gov
AFFILIATION : National Marine Fisheries Service/SEFSC/Mississippi Laboratories/Pascagoula Facility

Co-PIs: Mark McDuff, David S. Hanisko
AFFILIATION : National Marine Fisheries Service/SEFSC /Mississippi Laboratories/Pascagoula Facility

Co-PI: William J. Richards
AFFILIATION : National Marine Fisheries Service/SEFSC/Miami Laboratory

C. List all non-student personnel funded by this project:

PERSON'S NAME: Katrin Marancik
CATEGORY: Research Scientist
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT NOAA LAB? NOAA NMFS NEFSC/SEFSC Woods Hole Laboratory

PERSON'S NAME: Michael Holley
CATEGORY: IT Contractor
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 75
IS INDIVIDUAL LOCATED AT NOAA LAB? NOAA NMFS NEFSC/SEFSC Mississippi Laboratories

PERSON'S NAME: Glenda Sutphen
CATEGORY: IT Contractor
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT NOAA LAB? NOAA NMFS NEFSC/SEFSC Mississippi Laboratories

D. List all students funded by this project: None

E. Key Scientific Question(s)/Technical Issues(s): Improve the precision, accuracy and consistency of larval fish identifications (specifically larvae of the Family Serranidae, subfamily Epinephelini) in SEAMAP collections over the 25+ year time series. The technical issues we 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: (1) merging divergent data sets, (2) implementing the Integrated Taxonomy Information System, and (3) providing secure access to SEAMAP information with appropriate rights and privileges.

F. Collaborators(s)/Partners: The marine resource agencies within the five Gulf States, Gulf States Marine Fisheries Commission and the National Marine Fisheries Service (NMFS) have conducted joint resource surveys in the Gulf of Mexico under the NOAA/NMFS funded Southeast Area Monitoring and Assessment Program or SEAMAP 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.

In the second and third years of this project we collected plankton samples and environmental data at locations off the central coast of Louisiana during SEAMAP winter plankton surveys for NGI NOAA-LSU researchers studying the ingress of early life stages of shrimp and finfish species from offshore to estuarine waters in winter months.

An additional partner in this project is the Sea Fisheries Institute (MIR), Plankton Sorting and Identification Center of Gdynia, Poland. Under a Joint Studies Agreement with MIR that has been in place since 1976, U.S. and Polish scientists work jointly on the early life (planktonic) stages of vertebrate and invertebrate fishery species found in U.S. Large Marine Ecosystems.
Staff at the Sorting and Identification Center in Poland conducts initial analyses of SEAMAP plankton samples.

Planning for future collaborations between NMFS/Mississippi Labs and zooplankton ecologists at LSU, USM/GCRL and DISL was undertaken and formalized under a joint proposal to NGI for NOAA funding during year 4.

G. Project Duration:

a. START DATE: August 2006
b. ESTIMATED END DATE: August 2009

H. Project Baselines:

a. CONTRIBUTIONS TO SPECIFIC NOAA GOALS/OBJECTIVES:
   i. Ecosystem Mission Goal
      - Advancing understanding of ecosystems to improve resource management
      - Developing integrated ecosystem assessments and scenarios, and building capacity to support regional management
   ii. Climate Mission Goal
      - Understand impacts of climate variability and change on marine ecosystems to improve management of marine ecosystems
   iii. Commerce and Transportation Mission Goal
      - Develop the information and tools to make reliable decisions in preparedness, response, damage assessment, and restoration
   iv. 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 other studies which are spatially and temporally limited, the data from this project is Gulfwide in nature and spans decades in time. Information in the SEAMAP plankton data base thus encompasses the entire range of individual fish stocks and the wide diversity of the northern Gulf biome over a time frame that will yield insights into the affects of changing climactic conditions.

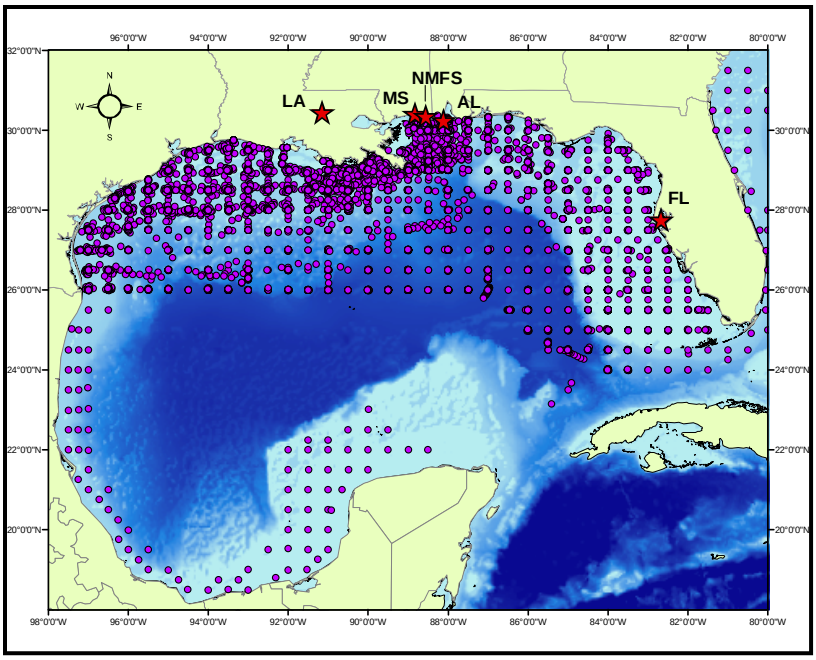
I. Project Abstract: The work we have undertaken involves examination and, as required, re-identification of larvae of selected fishery resource and non-resource taxa held at the SEAMAP Archive in St. Petersburg, FL. As larval fish identifications are changed so must the ichthyoplankton sample data files 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 have established a single, coherent, and taxonomically updatable database containing all the associated sample, station and environmental data and observations. The data files in this system can 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.

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

- Biological Component – Two manuscripts were produced based on the analysis of grouper (Epinephelini) larvae collected during SEAMAP plankton surveys (1982-2005). One manuscript (resubmitted to Bulletin of Marine Science after revision based on initial reviews) describes morphological development and species identification of grouper larvae. The second manuscript describes decadal variations in relative abundance and distribution patterns of grouper larvae and spawning locations. This manuscript will be submitted later this summer after internal NMFS/SEFSC review. Examinations of other sea bass (Serranidae- non-reef and reef associated species) larvae captured during these same SEAMAP surveys were completed. Data summary and manuscript preparation are underway.
- A detailed description of the oceanic habitat of Atlantic bluefin tuna larvae from SEAMAP plankton surveys in the Gulf of Mexico resulted in a feasibility study that was completed this year in April and May during the 2009 SEAMAP spring plankton survey. Results of this study will be analyzed to determine if directed, adaptive sampling will improve the precision of larval tuna abundance estimates from SEAMAP plankton surveys.
- Collaboration with NGI USM/GCRL researchers resulted in a paper accepted for publication this year describing transport and advection patterns of larval red snapper captured during SEAMAP plankton surveys in the northern Gulf using an ocean circulation model.
- The second Gulfwide SEAMAP Winter Plankton survey of shelf waters was completed. This is noteworthy because this second set of wintertime 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 – SEAMAP and NMFS ichthyoplankton data from 22 additional surveys, comprising 1823 samples at 709 stations was added to the consolidated database used as the primary source for the new Oracle Database System. Currently, the database contains information from 353 surveys (1982 -2007), comprising 32,864 samples at 12,387 stations. Quantitative data is available for the early life stages of over 800 taxa from 19,739 samples. An export of the database and its documentation has been made available by download for those wanting to conduct quantitative analyses.
- Programming logic and scripts were developed to reformat the consolidated database into data structures that parallel the new Oracle Database System to facilitate the loading of data to the new system.
- Quality assurance analysis of the consolidated ichthyoplankton data was undertaken as part of the database load preparations. All data was analyzed for consistency and correct mapping to reference tables and documentation. All code tables were reviewed for correct documentation and implementation.
- The data entry system was integrated into the Mississippi Laboratories' Intranet site. This site provided the general look and feel and the integrated security needed to support the system.
- The first time series was loaded from the consolidated data set into the new Oracle data structures testing the ingest scripts, database constraints and reference tables. The data entry / edit system was then tested against this data and is being reviewed by the end users.
- Protocols, programming logic and scripts continue to be 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.
- Expansion of the system to handle new sampling designs and additional data sets was reviewed in preparation of additional collaboration with NGI partners.



Cruises	353
Plankton Stations	12,387
Plankton Samples	32,864
Plankton Samples with Taxonomic Information	19,739
Cataloged Vials of Larvae	332,669
Individual Larvae	4,215,210
Measured Larvae	688,641
Taxonomic Updates	7292+

Figure 27. Summary of plankton sample collection and larval fish identification data currently held in the Mississippi Laboratories Oracle database gathered during SEAMAP resource surveys, 1982 to 2007. Map shows stations where SEAMAP plankton samples were taken.

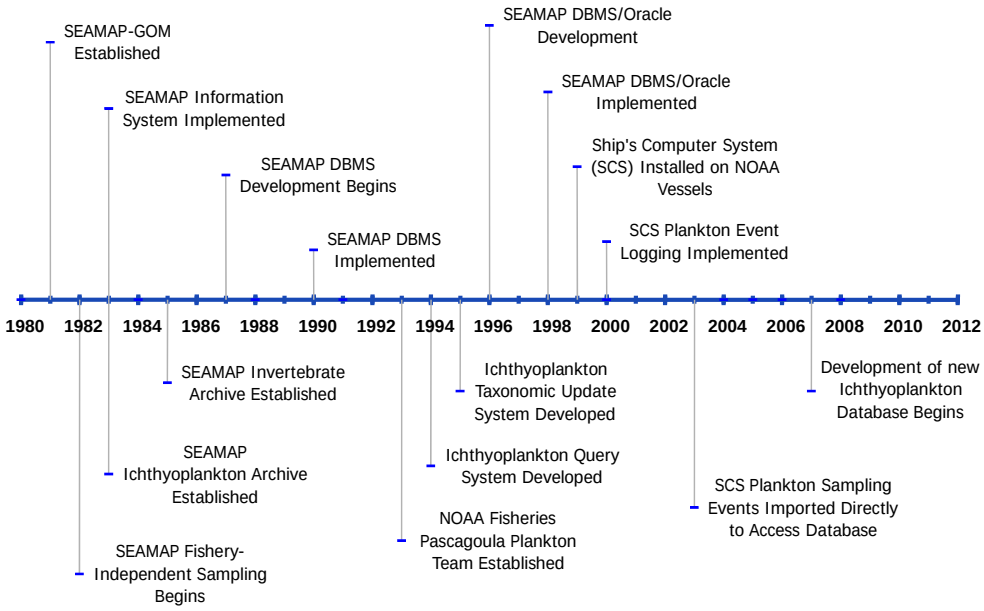


Figure 28. Brief History of SEAMAP Plankton-related Activities and Data Management

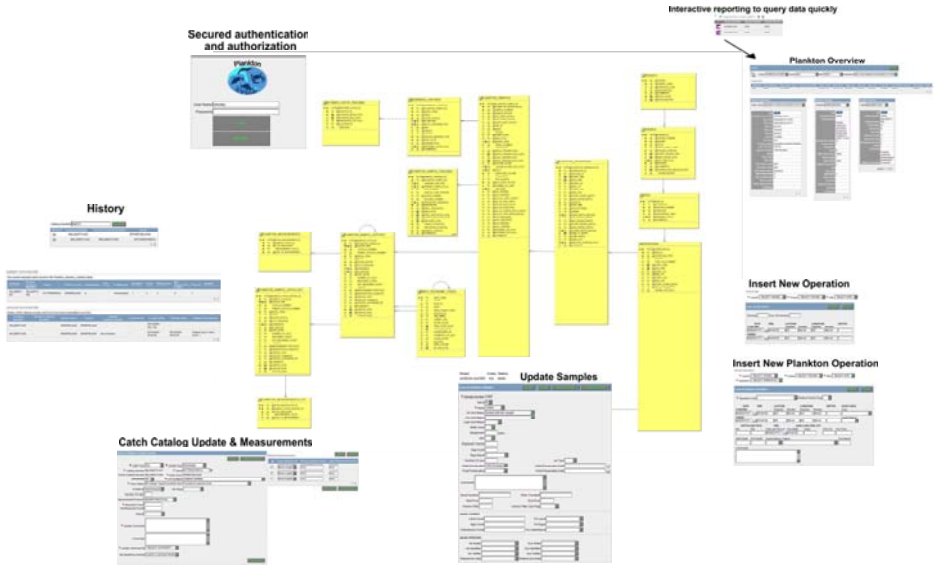
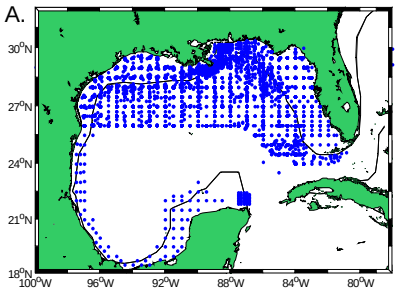
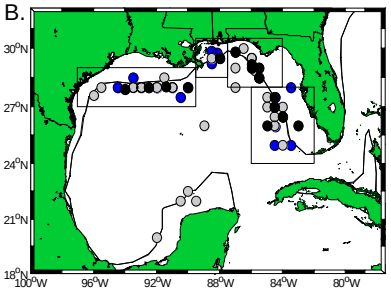


Figure 29. Graphical representation of the new SEAMAP Plankton, Oracle Database model and associated web based applications for data entry, edits and taxonomic updates.



A. All SEAMAP stations sampled **(1982 to 2005)**.



(Southern Gulf not sampled in all decades)

B. Sites where the smallest, least developed grouper larvae have been consistently captured over three decades of SEAMAP surveys.

Blue = 1982 to 1989
Gray = 1990 to 1999
Black = 2000 to 2005

Figure 30. Results from re-identification of grouper larvae captured in SEAMAP plankton samples made possible by comparisons to genetically identified specimens[4].

[4] Resulting manuscript entitled: Abundance, distribution, and decadal trends of Gulf of Mexico grouper larvae (Serranidae: Epinephelini) by K.E. Marancik, D. E. Richardson, J. Lyczkowski-Shultz, M. Konieczna, and R.K. Cowen.

K. Outreach activities:

Building a comprehensive database on the earlylife stages of fishes in the Gulf of Mexico: Why? Joanne Lyczkowski-Shultz, Mark McDuff and David Hanisko. Talk presented at the Annual NGI Conference in Mobile AL, May 21-22, 2009.

Building a comprehensive database on the earlylife stages of fishes in the Gulf of Mexico: Metamorphosis. David Hanisko, Joanne Lyczkowski-Shultz, and Mark McDuff. Talk presented at the Annual NGI Conference in Mobile AL, May 21-22, 2009.

Building a comprehensive database on the earlylife stages of fishes in the Gulf of Mexico: The data model. Glenda Sutphen, Rosanne Brasher, Michael Holley and Mark McDuff. Poster presented at the Annual NGI Conference in Mobile AL, May 21-22, 2009.

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles:

Evaluation of Morphological Characters to Identify Grouper (Serranidae: Epinephelini) Larve in the Gulf of Mexico using Genetically Identified Specimens. Marancik, K. E., D. E. Richardson, J. Lyczkowski-Shultz, M. Konieczna, and R. K. Cowen. Bulletin of Marine Science. (Revised and resubmitted, June 2009)

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Abundance, Distribution, and Decadal trends of gulf of mexico grouper larvae (Serranidae: Epinephelini). MARANCIK, K.E., D.E. Richardson, J. Lyczkowski-Shultz, and R.K. Cowen. Talk presented at the 9th Northeast Fisheries Science Center Science Symposium, Newport, RI, January 21-23, 2009.

NOAA 07

A. NGI Project file Number: 08-NOAA-07

B. Project title, PI(s), Email and Affiliation: DETERMINING THE RELATIVE CONTRIBUTIONS OF EKMAN TRANSPORT AND OTHER METEOROLOGICALLY-DRIVEN FLOWS AND ASTRONOMICAL TIDES IN ESTUARINE RECRUITMENT

PI : Redwood W. Nero
EMAIL : woody.nero@noaa.gov
AFFILIATION : National Marine Fisheries Service/Southeast Fisheries Science Center

Co-PI: Richard F. Shaw
EMAIL: rshaw@lsu.edu
AFFILIATION : Louisiana State University, Department of Oceanography and Coastal Sciences

Co-PI: Nan D. Walker
EMAIL: nwalker@lsu.edu
AFFILIATION : Louisiana State University, Department of Oceanography and Coastal Sciences

Co-PI: Chunyan Li
EMAIL: cli@lsu.edu
AFFILIATION : Louisiana State University, Department of Oceanography and Coastal Sciences

C. List all non-student personnel funded by this project:

PERSON'S NAME: Redwood Nero
CATEGORY: NOAA employee
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT NOAA LAB? NOAA NMFS Southeast Fisheries Science Center

PERSON'S NAME: Richard F. Shaw
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 17
IS INDIVIDUAL LOCATED AT NOAA LAB? No

PERSON'S NAME: Nan D. Walker
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT NOAA LAB? No

PERSON'S NAME: Chunyan Li
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 6
IS INDIVIDUAL LOCATED AT NOAA LAB? No

PERSON'S NAME: Eddie Weeks
CATEGORY: Research Associate
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 30
IS INDIVIDUAL LOCATED AT NOAA LAB? No

PERSON'S NAME: Jessica Crochet
CATEGORY: Research Support Staff
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 15
IS INDIVIDUAL LOCATED AT NOAA LAB? No

PERSON'S NAME: Talat Farooqi
CATEGORY: Research Associate
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 48
IS INDIVIDUAL LOCATED AT NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Matthew Kupchic
CATEGORY: Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Zhixuan Feng
CATEGORY: Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Xi Chen, Christopher Alegro, Robert Speyrer, Jessica Salter, Kristina Dickson, Alex Richard, Jake Becnel, Micah Lessard, and Weenan Wang
CATEGORY: Undergraduate Student Workers
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): 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.

F. 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), 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.

G. Project Duration:

a. START DATE: August 01, 2006
b. ESTIMATED END DATE: July 31, 2009

H. Project Baselines:

a. 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.

b. 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.

I. 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

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

During Year 3 the LSU Zoo/Ichthy-plankton team continued sample picking sorting and identification. The plankton sample set from two years of sampling, 2006-2007 and 2007-2008 forms a critical set of data for testing the wind versus tidally driven estuarine recruitment hypothesis. About 3/4 of the samples have all samples collected have been processed with all work expected to be complete during 2009. Matching environmental data is provided by remote sensing and oceanographic products will be integrated into the interpretation of the sample data.

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 continued for the duration of the field work (April 2008). Quicktime movies for 4 month periods have been 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 analysis 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. Data from a weather station at the Fourchon site and continuous oceanographic measurements at both the plankton sampling site and 1 mile offshore, are being used to estimate water mass fluxes in the channels. Results of several detailed ADCP surveys conducted during the field sampling trips in combination with the mid-channel ADCP have been analyzed to provide a comparison of the total transport calculated from the oceanographic measurements. Several research papers are in preparation.

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 at NOAA Fisheries, Stennis. This model is now fully operational, reading hourly sets of oceanographic input from NRL, the 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. Studies continue with several presentations and papers in preparation.

K. Outreach activities: The 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).

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles:

Li, C., and E. Weeks, 2009, Measurements of a Small Scale Eddy at a Tidal Inlet Using an Unmanned Automated Boat, *Journal of Marine System,* 75: 150-162.

Li, C., E. Weeks, J. L. Rego, In Situ Measurements of Saltwater Flux through Tidal Passes of Lake Pontchartrain Estuary by Hurricanes Gustav and Ike in September 2008. (*submitted*)

Li, C., E. Weeks, B. W. Blanchard, Storm Surge Induced Flux through Multiple Tidal Passes of Lake Pontchartrain Estuary during Hurricanes Gustav and Ike. (*submitted*)

Feng, Z. and C. Li, Cold-front-induced Flushing of the Louisiana Bays. (*submitted*)

Li, C., E. Swenson, E. Weeks, J. White, Asymmetric Tidal Straining across an Inlet: Lateral Inversion and Variability over a Tidal Cycle. (*submitted*)

N. List non-refereed articles and reports for this project.

Feng, Z., 2009, Hydrodynamic Response to Cold Fronts along the Louisiana Coast, Louisiana State University M.S. Thesis, pp 120. (http://etd.lsu.edu/docs/available/etd-06102009-153456/)

O. List conference presentations and poster presentations for this project.

Feng, Z., C. Li, N. D. Walker, and R. F. Shaw, Cold-front-induced Flushing of the Louisiana Estuaries, Northern Gulf Institute Annual Conference, Mobile, AL, May 20, 2009.

Feng, Z., Chunyan Li and Nan D. Walker. The Impacts of Cold Front Passages on Louisiana Coastal Environments, Fall AGU Meeting, 2008.

Nero, R. W. Lagrangian Particle-Tracking of Larval Fish and Shrimp in the northern Gulf of Mexico: the Combined Role of Tide, Wind, and Animal Behavior, Northern Gulf Institute Annual conference, Mobile, AL, May 20, 2009.

NOAA 08

A. NGI Project file Number: 08-NOAA-08

B. Project title, PI(s), Email, and Affiliation: ENABLING AND INITIATING OBSERVING SYSTEM SIMULATION EXPERIMENTS OF A COASTAL HIGH RESOLUTION OCEANOGRAPHIC MODEL IN THE NORTHERN GULF OF MEXICO

PI: George Halliwell
Email: george.halliwell@noaa.gov
Affiliation: Atlantic Oceanographic and Meteorological Laboratory

C. List all non-student personnel funded by this project:

PERSON'S NAME: George Halliwell
CATEGORY: Research Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? None
Is individual located at a NOAA Lab? Yes – Atlantic Oceanographic and Meteorological Laboratory, Miami, FL

PERSON'S NAME: Robert Atlas
CATEGORY: Laboratory Director
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? None
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes – Atlantic Oceanographic and Meteorological Laboratory, Miami, FL

D. List all students funded by this project:

PERSON'S NAME: Rafael Schiller (UM/CIMAS)
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s):

- Scientific Issues: to improve our capability to hindcast and forecast the coastal ocean in the Northern Gulf of Mexico, to assess the influence of downscaled information from basin scale ocean models on the capability of nested regional/coastal models to reproduce mean conditions and seasonal variability; to quantify the impact of new ocean observing systems on these nowcasts and forecasts, particularly our capability to reproduce energetic small-scale features (mesoscale and submesoscale eddies along with fronts) that have a large impact on coastal ecosystems.
- Technical Issues: To develop a nested system consisting of (a) a high resolution coastal model in an area of strong coastal-to-offshore interactions and strong land-to-sea interactions (Northern Gulf of Mexico) and (b) a regional (Gulf of Mexico) model; to perform numerical simulations that represent the coastal dynamics with sufficient realism (as validated through observations) to enable the performance of Ocean System Simulation Experiments (OSSEs) that will be used to design optimal observing systems.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: Cooperative Institute for Marine and Atmospheric Studies (CIMAS), University of Miami

DATE COLLABORATION ESTABLISHED: June 2006

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. The work for this project has been primarily performed at CIMAS by co-investigators Vassiliki Kourafalou (University of Miami) and Peter Ortner (CIMAS Director) along with CIMAS postdoctoral researcher Matthieu LeHennaff and University of Miami graduate student Rafael Schiller. Prior to 15 Feb. 2009, George Halliwell was a research faculty member at the University of Miami and co-PI on this project. He then joined NOAA/AOML and became the PI of this project, replacing Gustavo Goni.

G. Project Duration:

a. START DATE: June 2006
b. Estimated end date: June 2009

H. Project Baselines:

a. 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
- 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

b. CONTRIBUTIONS TO REGIONAL PROBLEMS AND PRIORITIES: The capability NOAA gains from this project will be directly applicable to predicting the oceanographic consequences of regional climate change and climate variability (e.g. changes in regional precipitation), coastal hazards (e.g. hurricane landfalls and coastal flooding) and both ecosystem management and ecosystem forecasting. Establishment of the Observing System Simulation Experiment (OSSE) testbed will enable the optimal design of integrated coastal and regional observing systems (models and sensor arrays) required to advance NOAA's Climate, Ecosystem and Weather and Water Goals in the Gulf of Mexico and throughout U.S. coastal waters.

c. GAPS: To narrow gaps in our capability to nowcast and forecast (a) coastal circulation in a topographically complex area dominated by a large river plume, (b) coastal to offshore interactions and (c) connectivity of remote ecosystems, project results demonstrate that the following elements are essential: a comprehensive, high resolution coastal model; proper representation of river plume dynamics; suitable atmospheric forcing functions; and realistic boundary conditions from a data-assimilative regional model.

I. Project Abstract: This study aims to elucidate and predict the transport, fate, and impact of river-borne waters and nutrients over the Northern Gulf of Mexico, including interactions between the Mississippi River plume and the offshore ocean (e.g. the Loop Current and associated eddies), through models of shelf circulation and ecosystem dynamics. It also seeks to realize prototype Observing System Simulation Experiments and, thereby, guide the design of the Gulf Coastal Oceanographic Observing System (GCOOS). A toolbox of models, data assimilation schemes and algorithms are being developed and tested from which the broader oceanographic community can select for particular applications. The proposed research will connect the Northern Gulf circulation and ecosystem dynamics with basin-wide conditions and nearshore impacts such as coastal eutrophication and hypoxia and shoreline erosion. The seamless biophysical modeling system resulting will directly support a variety of NGI, NOAA and GOMA priorities. For example, larval recruitment studies will be able to incorporate reliable circulation fields and hindcasts of larval trajectories from spawning locations.

J. 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 global, 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.

Both GoM-HYCOM and NGoM HYCOM have been data validated, through satellite observations provided by AOML and the NGI and through in-situ data provided by NRL. The coastal NGoM-HYCOM model can provide hydrodynamic parameters for use by ecosystem models and by nearshore and wetland models concerned with coastal resilience. The regional GoM-HYCOM model has already demonstrated evaluation of data assimilation, resolution and forcing toward Observing System Simulation Experiments (OSSEs) that will help guide the design for the Gulf Coastal Oceanographic Observing System (GCOOS).

Process studies on the Mississippi River (MR) plume were conducted to highlight the development and evolution of the river plume and the effects of topography, atmospheric forcing, and the Loop Current (LC) and associated eddies on the advection of low salinity plume waters. The study of MR pathways has important implications on the Northern Gulf ecosystem dynamics, especially as related to the understanding and prediction of hypoxia events, and on sea level changes associated with extreme events and climate change, with implications on coastal resilience efforts.

NGoM-HYCOM simulations with realistic forcing showed a tendency of riverine waters to reach the DeSoto canyon during periods of light winds and in the absence of direct interaction with the LC (Figure 31), in agreement with ocean color imagery where chlorophyll-a serves as a proxy for the variability of the brackish MR waters. This finding has implications for "upstream" (toward the Mississipppi-Alabama and Florida panhandle) MR influence. During periods of direct LC influence, simulations elucidated offshore removal of the MR waters, through eddy action near the shelf break. Associated with the LC, warm core eddies (LCEs) and frontal eddies (LCFEs) were found to have a pronounced impact on the formation of jet-like offshore streaks of MR waters, supplying an extended pathway along the LC (Figure 31) that can reach the Straits of Florida, potentially impacting the fragile Florida Keys ecosystem.

Progress toward development of the OSSE system for the GoM has involved performing a realistic long term "free-running" simulation of the GoM to serve as the "nature run". The realism of this run has been validated by comparing sea surface height from the model to sea level anomalies (SLA) from altimetry (along-track Jason 1 and Envisat data). Daily averaged model outputs have been interpolated on the same locations as the altimetric tracks, using only outputs from the closest date to the observations. The agreement between the two time series is very satisfying in terms of amplitude, scales and timing of the SLA signal.

K. Outreach activities: Our primary outreach activities have been devoted to talks and poster presentations at scientific workshops and meetings. To date, we have not had significant interactions with the general public. The impact of our work will increase substantially when we develop the capability of performing Observing System Simulation Experiments and can recommend ocean observing strategies to the larger scientific community.

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles:

Schiller, R.V. and V.H. Kourafalou, 2008. Modeling River Plume Dynamics with the HYbrid Coordinate Ocean Model (HYCOM). (Ocean Modeling, In Review)

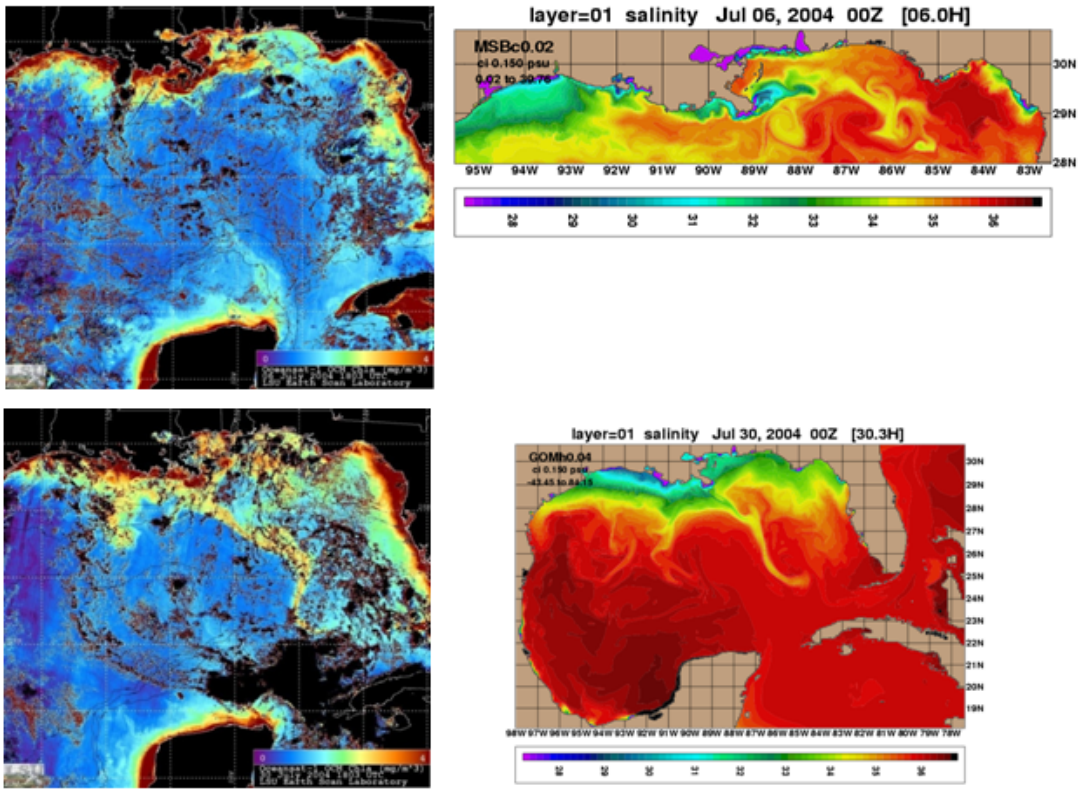


Figure 31. Comparison of satellite Ocean Color imagery (left panels, provided by LSU, an NGI academic affiliate) and model derived Sea Surface Salinity from the high resolution Northern Gulf model (NGoM-HYCOM, upper right) and the regional Gulf of Mexico model (GoM-HYCOM, lower right, provided by NRL-SSC; data assimilation provided by NRL-MRY). The upper panels are for July 6, 2004, during a "young" Loop Current (away from the Northern Gulf); the lower panels are for July 30, 2004, during an "extended" Loop Current (approaching the Northern Gulf, near the Mississippi River delta). The eastward advection of MR waters (guided by the DeSoto canyon topography during light wind conditions) enhances the potential for offshore removal along the Loop Current front and toward the Straits of Florida.

N. List non-refereed articles and reports for this project.

Kourafalou, V.H., G. Halliwell, P. Hogan and O.M. Smedstad, 2008. Physical Oceanography in the Gulf of Mexico: Connectivity of coastal ecosystems and large scale flows. In: "A Scientific Forum on the Gulf of Mexico: The Islands in the Stream Concept (Proceedings)", Ritchie, K. B. and Brian D. Keller, eds. Mote Marine Laboratory, Sarasota, FL. Marine Sanctuaries Conservation Series NMSP-07. NOAA/National Marine Sanctuary Program, Silver Spring, MD. 101 pp.

O. 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).

Schiller, R.V., V. H. Kourafalou, P. J. Hogan, O. M. Smedstad, G. Halliwell and G. Goni, 2008. On the use of GODAE and satellite products to improve coastal simulations on the Northen Gulf of Mexico, Global Ocean Data Assimilation Experiment Final Symposium, Nice, France. 5(13), Available On Line, http://www.godae.org/PA-authors-I-K.html#13 (poster)

Halliwell, G.R., V.H. Kourafalou, A. Barth, P. Hogan, O.M. Smedstad, R.H. Weisberg, L.K. Shay, H. Hurlburt, J. Cummings, H. Kang, R. Schiller, 2008. Impact of GODAE products on nested simulations of the Florida and Northern Gulf of Mexico coastal ocean Global Ocean Data Assimilation Experiment Final Symposium, Nice, France. 4(130), Available On Line, http://www.godae.org/PA-authors-H.html#130 (poster)

Schiller, R.V., V.H. Kourafalou, G. Halliwell, P.J. Hogan, O.M. Smedstad, 2009. The Dynamics of the Mississippi River Plume and Interactions with Coastal and Offshore Flows in the Northern Gulf of Mexico. Layered Ocean Model Workshop, Miami, FL. Available On Line http://oceanmodeling.rsmas.miami.edu/lom/abstracts/lom2009_011.html

Le Henaff, M., V.H. Kourafalou and A. Srinivasan, 2009. Enhancing predictability of the Loop Current variability using Gulf of Mexico Hycom. Layered Ocean Model Workshop, Miami, FL. Available On Line http://oceanmodeling.rsmas.miami.edu/lom/abstracts/lom2009_012.html

NOAA 09

A. NGI Project file Number: 08-NOAA-09

B. Project title, PI(s), Email, and Affiliation: **TEMPERATURE AND SALINITY EFFECTS ON THE GROWTH AND SURVIVAL OF JUVENILE PENAEID SHRIMPS: IMPLICATIONS FOR THE INFLUENCE OF RIVER DIVERSIONS ON PRODUCTION**

PI : Lawrence P. Rozas
EMAIL : lawrence.rozas@noaa.gov
AFFILIATION : 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

Co-PI: Thomas J. Minello
EMAIL: tom.minello@noaa.gov
AFFILIATION : NOAA Fisheries Service, Galveston Laboratory, 4700 Ave. U, Galveston, TX 77551

Co-PI: Doran M. Mason
EMAIL: doran.mason@noaa.gov
AFFILIATION : NOAA Great Lakes Environmental Research Laboratory, 4840 S. State Road, Ann Arbor, MI 48108

C. List all non-student personnel funded by this project:

PERSON'S NAME: Lawrence P. Rozas
CATEGORY: Research Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 15
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes, Estuarine Habitats and Coastal Fisheries Center, Lafayette, LA

PERSON'S NAME: Thomas J. Minello
CATEGORY: Research Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes, Galveston Laboratory, TX

PERSON'S NAME: Shawn Hillen
CATEGORY: Research Support Staff
DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 46
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes, Galveston Laboratory, TX

Person's Name: Juan Salas
Category: Research Support Staff
Degree: BS
Percent of Salary Funding from this project? 60
Is individual located at a NOAA Lab? Yes, Galveston Laboratory, TX

PERSON'S NAME: Elizabeth Wilson
CATEGORY: Research Support Staff
DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 62
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes, Galveston Laboratory, TX

PERSON'S NAME: Anne Clites
CATEGORY: Physical Scientist
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? Great Lakes Environmental Research Laboratory, MI

D. List all students funded by this project: None

E. Key Scientific Question(s)/Technical Issues(s): 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 a simulation model to predict brown shrimp growth rates from water

temperature and salinity. The simulation model was initially developed from existing information in the literature and unpublished experimental data. The data from our field and laboratory experiments were used to validate and improve the original model.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: Initially, our level of collaboration with the NGI was limited because a companion proposal by our NGI partner (Dr. Mark S. Peterson, Department of Coastal Sciences, University of Southern Mississippi) was not 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: Our collaborators working on related projects in the NGI used the results from our growth experiments. We worked cooperatively with Dr. Kenny Rose of LSU and Brian Roth, currently at Michigan State University, on an individual-based model of brown shrimp production, and our results were useful in refining that model. We also have provided funding for Dr. Rose to continue his work on this production model through the NGI. In addition, Drs. Rozas and Rose have joined with Dr. Dubravko Justic of LSU in a collaborative project recently funded by the NGI to combine hydrodynamics, water quality, and individual-based fish models into a single integrated model to examine how river diversions affect coastal fisheries.

G. Project Duration: 3 years

a. START DATE: July 1, 2006
b. ESTIMATED END DATE: June 30, 2009

H. Project Baselines:

a. 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.

b. 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 can 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.

c. GAPS: The results from our project 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. Our results were incorporated into a simulation model to predict the effects of temperature and salinity on brown shrimp growth and survival. This model 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 included a modeling approach that may provide a useful tool for evaluating river diversions used for wetland habitat restoration.

I. Project Abstract: We used information from the literature and controlled experiments to examine 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. Field experiments were conducted at four locations (low to high salinity: Intermediate, Brackish, Saline Up Estuary=SalineUp, Saline Down Estuary=SalineDn) along a salinity gradient in the Barataria Bay estuary. At each location, three treatments were included: shallow water along the shoreline with no additional food (SNF=shallow no food treatment), shallow water with additional food added (SF=shallow food treatment), and deeper water to expose animals to lower temperatures (D=deep treatment). Four replicate mesocosms were used to measure shrimp growth and survival for each treatment (total=48 mesocosms experiment-1). In these experiments, both brown shrimp and white shrimp grew more slowly at the low salinity than higher salinity locations (brown shrimp: Intermediate=0.58 $\pm$0.108 mm d-1, Brackish=1.03 $\pm$0.058 mm d-1, SalineUp= 1.21 $\pm$0.111 mm d-1, SalineDn=1.23$\pm$0.108 mm d-1; white shrimp: Intermediate=0.39 $\pm$0.090 mm d-1, Brackish=0.84 $\pm$0.103 mm d-1, SalineUp= 0.99 $\pm$0.056 mm d-1, SalineDn=1.08$\pm$0.084 mm d-1). Survival of brown shrimp, based on the number of shrimp recovered at the end of the experiment, also was lower at the Intermediate location (mean: 2.3 vs. 4.2-4.6 shrimp mesocosm-1). In addition to the effect of location along the salinity gradient, shrimp consistently grew faster in mesocosms where food was added. A significant treatment effect of water depth was detected only for brown shrimp when change in biomass was used as the response variable in the analysis. We also conducted laboratory experiments in a circular-raceway gradient tank designed to examine how salinity may affect the distribution of shrimp. In these experiments, shrimp distribution was compared between an experimental raceway with a salinity gradient (from about 1-40) and a control maintained at a constant salinity of 20. In seven experiments using white shrimp (30-75 mm TL), there was a significant negative relationship ($P < 0.001$) between salinity and the relative frequency (experimental-control) of shrimp in sectors of the gradient tank (i.e., a selection for low salinity water), but the relationship only explained about 11%

of the variability in the data. In 12 experiments, brown shrimp showed a significant ($P < 0.001$) nonlinear relationship with salinity that explained 17% of the variability in the data. Brown shrimp appeared to select against the extremes in the gradient with the highest indicator of salinity selection at 25. Most experiments included two size categories, and there was no apparent relationship between shrimp size and salinity selection. We developed a bioenergetics model for brown shrimp to examine the effects of river diversions on shrimp growth and survival. The model was based on the literature and results from our experiments and used a Bayesian approach to examine shrimp response to variations in the timing and duration of diversions. The model results show that diversions that occur early in the year (February, March) and for relatively short durations (2 weeks) have little effect on shrimp growth, whereas longer (30-60 d) diversions in May have the greatest effect on shrimp growth. Prey response time was shown to mediate the affect of diversions in that slower prey response times resulted in stronger responses to a diversion. The model may be a useful tool to assist managers in minimizing the impacts of freshwater releases to shrimp production when restoring coastal systems.

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

The project activities, milestones reached, and research results accomplished in Year 3 are described for three research areas (field growth experiments, laboratory gradient experiments, bioenergetics model).

Field growth experiments were conducted September 13-21, 2007 by enclosing white 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, SalineUp, and SalineDn 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 white shrimp grew more slowly at the low salinity than higher salinity locations (mean daily rates: Intermediate=0.39 $\pm$0.090 mm d-1, Brackish=0.84 $\pm$0.103 mm d-1, SalineUp= 0.99 $\pm$0.056 mm d-1, SalineDn=1.08$\pm$0.084 mm d-1). We also observed a statistically significant effect of food addition in the experiment.

Laboratory gradient experiments were conducted using brown shrimp and 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 was

maintained in the control raceway. The salinity in the experimental raceway also was initially held at 20. For each experiment, 50 shrimp were taken from holding tanks (salinity=20) 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 (salinity=45) 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. Overall results from 12 brown shrimp experiments showed that selection generally increased with salinity to a peak value of 25, and then decreased as salinity continued to increase (polynomial regression $R2 = 0.174$, $p < 0.001$). The overall trend for brown shrimp showed an avoidance of extreme salinities and a preference for the median range of the gradient. The relationship between mean relative frequency and salinity for juvenile white shrimp only explained about 11% of the variability in our data, but overall white shrimp appeared to select low salinities along the gradient, with the highest frequencies occurring at salinities from 3 to 15, reaching a maximum at 9. The frequency of white shrimp along the entire gradient decreased as salinity increased (polynomial regression $R2 = 0.109$, $p < 0.001$). Most experiments included two size categories, and there was no apparent relationship between shrimp size and salinity selection.

A bioenergetics model was used to investigate the effects of river diversions on juvenile brown shrimp growth and production. The model used a Bayesian framework that provided estimates of parameter and model uncertainty. The model used water temperature and salinity to predict the daily growth of shrimp. Temperature affected shrimp metabolism, while salinity modified food availability. Mortality was modeled using a size-dependent function. We examined the effects of diversion timing (Feb, Mar, Apr, May), length (2x-14, 30, 60 days), temperature change (+1, 0, -1, -5, 10°C), initial salinity (5, 15, 25), salinity during the diversion (2, 5, 10, 15, 20, 25; maximum salinity during diversion equals initial salinity), and prey biomass response time (7, 14, 28 days) on juvenile shrimp production. Diversions during February and March had little effect on shrimp, but two-month long diversions starting in April and one-month long diversions starting in May often had large, negative effects on production. Simulated diversions starting in April or May that dropped water temperature by 5°C or more decreased juvenile shrimp (individuals reaching 75-mm length) production by 30 to 60% compared to the no diversion scenario. Whether a change in salinity had a positive or negative effect on shrimp production depended on the initial salinity of the scenario. Longer diversions and slower prey response times extended the duration shrimp were exposed to either the positive or negative effects of diversions, and this magnified the overall (positive or negative) effect on shrimp production. Our model combined with site-specific temperature and salinity data may be a useful tool to assist managers in minimizing the impacts of freshwater releases to shrimp production when restoring coastal systems.

K. Outreach activities: None

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Adamack, A. T., C. A. Stow, D. M. Mason, L. P. Rozas, and T. J. Minello. 2009. Development of a bioenergetics model for brown shrimp (*Farfantepenaeus aztecus*) and its application to investigating the effects of a freshwater diversion on shrimp production. Poster at the Northern Gulf Institute Annual Conference, Mobile, AL.

Rozas, L. P., T. J. Minello, D. M. Mason, and A. T. Adamack. 2009. Temperature and salinity effects on the growth and survival of juvenile penaeid shrimps: implications for the influence of river diversions on production. Poster and presentation at the Northern Gulf Institute Annual Conference, Mobile, AL.

Adamack, A. T., C. A. Stow, D. M. Mason, L. P. Rozas, and T. J. Minello. Bayesian-based bioenergetics model for brown shrimp (*Farfantepenaeus aztecus*) and the potential effects of freshwater diversions on shrimp production. Presentation given at the Twentieth Biennial Meeting of the Coastal and Estuarine Research Federation, Portland, OR.

Rozas, L. P., T. J. Minello. 2009. Shrimp growth rates vary along the estuarine salinity gradient: Implications for the influence of river diversions on production. Presentation given at the Twentieth Biennial Meeting of the Coastal and Estuarine Research Federation, Portland, OR.

NOAA 10

A. NGI Project file Number: 08-NOAA-10

B. Project title, PI(s), Email, and Affiliation: **ESTIMATING AIR-SEA CARBON DIOXIDE FLUXES IN THE RIVER DOMINATED NORTHERN GULF OF MEXICO**

PI: Rik Wanninkhof
EMAIL: rik.wanninkhof@noaa.gov
AFFILIATION: NOAA Atlantic Oceanographic and Meteorological Laboratory, (305) 361-4379

C. List all non-student personnel funded by this project:

PERSON'S NAME: Esa Peltola
CATEGORY: Research Support Staff
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 17
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes, AOML

PERSON'S NAME: Kevin Sullivan
CATEGORY: Research Support Staff
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Joaquin Trinanes
CATEGORY: Contract Scientist
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Betty Huss
CATEGORY: Research Support Staff
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes, AOML

PERSON'S NAME: Denis Pierrot
CATEGORY: Research Scientist
DEGREE: PH.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 17
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project: None

E. Key Scientific Question(s)/Technical Issues(s): Quantify air-sea CO_2 fluxes 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.

F. Collaborators(s)/Partners:

NAME OF COLLABORATING ORGANIZATION: Profs. Steven Lohrenz and Steve Howden, the University of Southern Mississippi.

DATE COLLABORATING ESTABLISHED: 2006
DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? NO AMOUNT OF SUPPORT? No
DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes
SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP: Profs. Lohrenz and Howden contribute their expertise in the biogeochemistry of the Northern Gulf of Mexico and remote sensing to develop methods to interpolate CO_2 fields. These fields are created from remotely sensed wind, color, and sea surface temperature yielding seasonal maps of air-sea CO_2 fluxes and surface ocean acidity. They also maintain a surface mooring with CO_2 and biogeochemical sensors.

NAME OF COLLABORATING ORGANIZATION: . Redwood Nero, Oceanographer NMFS/SEFSC/MSLAB, Stennis Space Center

DATE COLLABORATING ESTABLISHED: May 2007

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? NO AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP: Dr. Redwood Nero is the liaison between the NOAA fisheries service and our project. His research interest lies in the possible effect of increasing surface CO2 levels on the life cycle of fishes and he will be collaborating with us on the ocean acidification component of the effort.

NAME OF COLLABORATING ORGANIZATION: Denice Drass, Research Fish Biologist at the NMFS/SEFSC/MSLAB Pascagoula, MS

DATE COLLABORATING ESTABLISHED: May 2008

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? NO AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP: 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.

G. Project Duration: August 2006 to June 2009

a. START DATE: Aug 2006
b. ESTIMATED END DATE: Jun 2009

H. Project Baselines:

a. 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. 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".

b. CONTRIBUTIONS TO REGIONAL PROBLEMS AND PRIORITIES: We have laid the groundwork for a Northern Gulf of Mexico (NGOM) ocean carbon observing system. During the third year of the project we provided the first estimate of air-sea CO_2 fluxes in the Northern Gulf of Mexico showing that on average CO_2 is invading into this region making it a "CO2 sink". 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.

c. GAPS: Very few systematic inorganic carbon observations have been made to date in this region making it "Mare Incognitum" for estimating air-sea CO_2 fluxes.

I. Project Abstract: The objective of the research is twofold. First we want to determine the amount of carbon dioxide (CO_2) released to the atmosphere from burning fossil fuels that is absorbed by the Gulf of Mexico. The second objective is to study the impact of increasing carbon dioxide levels in the Gulf of Mexico on marine biota. The phenomenon is called ocean acidification and is believed to particularly affect coral reefs and shellfish.

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

In the third year we successfully operated pCO_2 system on the NOAA fisheries ship Gordon Gunter providing sufficient data coverage to produce the first estimate of air-sea CO_2 fluxes in the NGOM. During the performance period we oversaw operations of state-of-the art automated instruments to measure surface water and air carbon dioxide levels. The data was 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 (Lohrenz and Howden) 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 pCO_2 system on the Gordon Gunter is shown in Figure 32.

The system is fully automated to analyze surface water CO_2 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[5].

The first annual estimate of air-sea CO_2 fluxes in the Northern Gulf of Mexico based on in situ observations, and spatial and temporal interpolation of remotely sensed and modeled data yields an average flux into the ocean of -0.92 mol m^{-2} yr^{-1} or -11.8 Tg C/year for the region North of 24 ˚N for the time period from April 2008- March 2009. The regions with low salinity impacted by outflow of the Mississippi river are CO_2 sinks year-round. This is attributed to the large nutrient loads and resulting enhanced biological productivity in this region.

Figure 33 shows the monthly product (October, 2008) that is derived from our observational effort combined with remote sensing data. The pCO_2 is determined from algorithms with sea surface temperature (SST) and salinity. The fluxes are determined from the pCO2 fields and wind speed. Algorithms that utilize salinity and color to predict the regional CO_2 fields near the coast are currently being investigated to improve the estimates in these regions.

[5] http://www.aoml.noaa.gov/ocd/gcc/rvgunter_introduction.php

Figure 32. Installation of the autonomous pCO2 system (left) on the NOAA ship Gordon Gunter (right) occurred in March 2008.

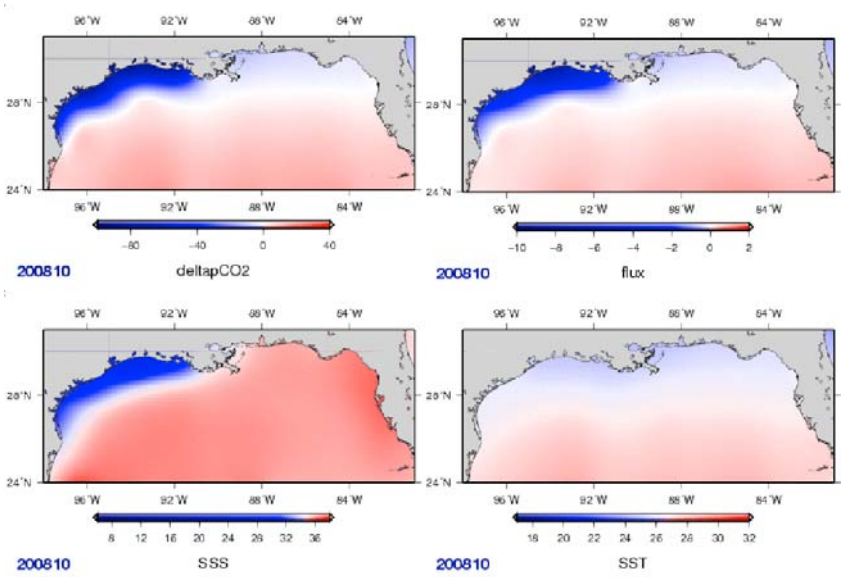


Figure 33. Example of monthly flux map products for the NGoM. The top left panel is the ΔpCO2 with blue indicating a negative value (a sink) and red a positive value (source). The top right panel is the flux with blue shading indicating a flux into the ocean and red a flux out of the ocean. The bottom left panel is the SSS derived from the RTOFS model with blue shading indicating areas where S<34.5. A specific algorithm with SSS and SST is applied to the data in these pixels. The bottom right panel is SST from the IO product with a transition in color scale from blue to red at 26.3 which is the temperature where the ΔpCO_2 changes from negative to positive.

K. Outreach Activities: None

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles

Gledhill, D. K., R. Wanninkhof, F. J. Millero, and M. Eakin (2008), Ocean acidification of the greater Caribbean region 1996-2006, J Geophys. Res., 113, C10031, doi:10010.11029/12007JC004629.

Borges A. et al. (25 co-authors including Wanninkhof). A global sea surface carbon observing system: Dissolved inorganic carbon dynamics in coastal environments. Ocean Observations 2009, submitted.

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Wanninkhof, R. and Peng. T.-H, R. Gulf of Mexico and East Coast Carbon Cruise (GOMECC). North American Carbon Cycle meeting, San Diego, February, 2009.

DISL 01

A. NGI Project file Number: 08-DISL-01

B. Project title, PI(s), Email, and Affiliation: **NORTHERN GULF OF MEXICO – EDUCATION AND OUTREACH AT THE DAUPHIN ISLAND SEA LAB**

PI : John Dindo
EMAIL : jdindo@disl.org
AFFILIATION : Dauphin Island Sea Lab, 101 Bienville Blvd., Dauphin Island, AL 36528

Co-PI: Tina Miller-Way
EMAIL: tmiller-way@disl.org
AFFILIATION : Dauphin Island Sea Lab, 101 Bienville Blvd., Dauphin Island, AL 36528

C. List all non-student personnel funded by this project:

PERSON'S NAME: John Dindo
CATEGORY: Administrator, Research Scientist, Educator
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 3.5
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Tina Miller-Way
CATEGORY: Research Scientist, Educator
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Mendel Graeber
CATEGORY: Marine Science Educator
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100 (0.5 FTE)
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Elizabeth Funk
CATEGORY: Marine Science Educator
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 35
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Lauren Showalter
CATEGORY: Graduate student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100%
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): 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 gleaning from the Discovery Hall educational programs at the Dauphin Island Sea Lab have begun.

F. Collaborators(s)/Partners : We are collaborating with other organizations at the local, regional and national scale. Locally, we have collaborated with the Mobile County Public School System for

decades through their Environmental Studies Center and will continue to make use of their expertise and physical resources in reaching educators as they do with us. The Dauphin Island Sea Lab has been a member of the Mississippi-Alabama Sea Grant Consortium for the past two decades and has worked closely with the current director for many years. The education and outreach missions of both complement each other and enhance efforts undertaken by either organization. Efforts and programs will be disseminated to a wider audience by making use of this long-term collaboration. We are continuing existing collaboration with our local National Estuarine Research Reserves (NERRs - Grand Bay, Weeks Bay) through production of educational curricula, as field experience sites or as education advisory council participants. We are continuing collaboration with the Centers for Ocean Science Excellence – Central Gulf of Mexico (COSEE-CGOM) National Science Foundation funded program through infusion of NGI and DISL research in the summer teacher workshops (held at DISL June 22-26, 2009). We are continuing collaboration with the Gulf of Mexico Alliance (GOMA) on messaging, compilation of environmental education materials and public outreach. We have recently initiated a project in collaboration with the Mobile Bay National Estuary Program on watershed education that will include video and physical displays. We have made initial plans to collaborate with the National Mississippi River Museum and Aquarium to promulgate Northern Gulf of Mexico information and NGI research. Through their 62-member Great River Road Network of Museums and Interpretive Centers network as well as the 22-member CELC network of which DISL is a part, NGI research and education / outreach activities will be broadcast in the 10 states bordering the Mississippi River and throughout the its watershed.

G. Project Duration:

a. START DATE: April 2007
b. ESTIMATED END DATE: November 2009

H. Project Baselines:

a. CONTRIBUTIONS TO SPECIFIC NOAA GOALS/OBJECTIVES: Education and outreach span and help to integrate all of NOAA's mission goals, however, the promotion of environmental literacy is explicitly recognized as a Cross-cutting Priority for NOAA (New Priorities for the 21st Century – NOAA's Strategic Plan (updated for FY 2006-FY 2011)). Activities at DISL conducted under the auspices of NGI contribute to this goal as well as to several outcomes as delineated in the 2009-2029 NOAA Education Strategic Plan (2009). These include most directly, Outcome 1.2 – Educators understand and use environmental literacy principles, Outcome 1.3 – Educators and students collect and use ocean, coastal, Great Lakes, weather and climate science data in inquiry and evidence-based activities to understand the Earth's systems and make informed decisions regarding the environment and its resources and through its evaluation component, and Outcome 1.1 – NOAA education programs are based on the best available science related to effective environmental and science education.

b. CONTRIBUTIONS TO REGIONAL PROBLEMS AND PRIORITIES: We are working directly with the Gulf of Mexico Alliance as well as Mississippi-Alabama Sea Grant to address GOMA's priority issues (Water Quality, Habitat Conservation and Restoration, Ecosystem Integration and Assessment,

Nutrients & Nutrient Impacts, Coastal Community Resilience and Environmental Education) and regional Sea Grant focus areas (Healthy Coastal Ecosystems, Safe and Sustainable Seafood, Sustainable Coastal Development, and Hazard Resilience in Coastal Communities).

c. GAPS: 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. Educators have been posted in the Estuarium and are informing visiting educational groups and the general public about Gulf of Mexico topics and issues as well as NGI research. Efforts have been made to attract more funding to enable greater diversity of efforts in Gulf literacy.

I. Project Abstract: The overarching goal of NGI Education and Outreach project at DISL is to advance K-grey formal and informal education and public outreach on the marine science of the Northern Gulf of Mexico region. The proposed activities will do this in a variety of ways. Activities associated with the Estuarium, radio broadcasts and collaborative programs will educate the public. Our participation in the Discovery Hall Program (DHP) teacher workshops, news briefs for DHP educators, and the proposed innovative program for pre-service teachers will reach those individuals educating the next generation at different points in their career trajectories. Continued support of programs working with Underserved and Underrepresented groups, a new curriculum on Gulf Fisheries, a new watershed curriculum for the traveling BayMobile, infusion of NGI research into existing DHP curricula, new Estuarium activities and curricula, and collaborations with the National Mississippi River Museum and Aquarium will educate students about Mobile Bay and the Northern Gulf of Mexico. Lastly, website modifications will reach all of these audiences – students, teachers and the public by providing information and resources on Mobile Bay and the Northern Gulf of Mexico and its watershed relevant to their needs. Each of the proposed activities will promote understanding and stewardship of our Gulf of Mexico resources.

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

Outreach with the public

DISL's public aquarium, the Estuarium had 70,356 visitors in 2008. A new part-time NGI-DISL employee, Liz Funk, is working weekends (~165 hrs to date) in the Estuarium in addition to Mendel Graeber (50%, during the week). Both have been meeting formally and on an ad hoc basis with groups or individuals visiting the Estuarium. Groups have included Project WETKids, USA Elderhostel program, and events have included such things as Earth Day (in both Mobile and Baldwin Counties) and Discovery Day. They have been educating visitors about NGI issues focusing primarily on watersheds, harmful algal blooms, marine debris and estuarine ecosystems. Interactions have taken the form of short conversations and simple activities such as watershed puzzles, habitat puzzles, handling of marsh animals, biodegradable matching game, and fishery management activities.

The Summer Excursions for the Public have been successful (http://dhp.disl.org/summertours/summerexcursions.html). There have been 95 participants this summer, including 30 from an Upward Bound program (underserved population). To date, approximately 200 visitors have attended the Boardwalk Talk series offered through the Estuarium.

In Year 3, we are collaborating with the National Mississippi River Museum and Aquarium on bringing Gulf messages 'up the watershed'. This collaboration is occurring through kiosk content development and hosting. This project is underway but has not yet come to fruition.

Development of curricula and materials

DISL-DHP hosted 7,440 K-12 students during 2008. NGI-DISL has continued work on materials for the website (podcasts, fact sheets, research briefs) as well as providing materials relevant to NGI research to DISL educators (powerpoint slides, physical materials, journal article summaries, etc.). We have developed new (Fish, fishes and fisheries) or adapted existing curricula (What's in the Water? – watersheds) for use by DISL-DHP educators at DISL or through DISL's traveling marine science classroom, the BayMobile. Unfortunately, the collaboration with Radio Dauphin Island has not been successful (due to circumstances beyond our control) and so we have used the DISL website to disseminate the materials we have developed. With the upcoming opening of our new facility, the Shelby Center for Ecosystem-based Fisheries Management, Discovery Hall Programs (the education and outreach unit at DISL) will become involved with Alabama's public school distance learning program, ACCESS. We are currently designing the distance-learning classroom for that facility: when operational, we will be able to communicate NGI research results to the K-12 audience statewide.

Professional Development for Educators

DISL-DHP had 138 teachers participating in professional development activities at DISL in 2008. In part through support from NGI, DISL-DHP has received AMSTI (Alabama Math and Science Technology Initiative) Affiliate status meaning that professional development opportunities at DISL for K-12 teachers can fulfill state education requirements for AMSTI certification, ensuring a highly qualified workforce and not coincidentally, teachers who are aware of NGI. We are developing materials and curriculum for a new professional development workshop (and implementation in classrooms) to be held at DISL focused on water quality and ecosystem services provided by oysters and other suspension feeding bivalves. Lastly, we attended a workshop on the COSIA program (Communicating Ocean Sciences to Informal Audiences), in Biloxi and hope to implement this program at DISL in the upcoming year.

Activities in support of underserved and underrepresented groups

In Spring and Summer of 2008, DISL hosted groups from Jeremiah Denton Middle School, Cranford Burns Middle School sponsored by NGI & the Mobile Area Education Foundation, Palmer Pillans Middle School, sponsored by NGI, Dr. Andre Green, USA College of Education & 100 Black Men of Mobile, Inc., 21st Century Learning Summer Science Camp at USA, sponsored by NGI, Dr. Andre Green USA College of Education & 21st Century Learning, and The 100 Black Men of Greater Mobile

Summer Enrichment Program, sponsored by NGI, Dr. Andre Green, USA College of Education & 100 Black Men of Mobile, Inc.. In Spring 2009, we initiated a ScienceCafé series at the Alabama School of Math and Science (a diverse and residential high school in Mobile) and had a successful semester with their students concluding with a trip aboard DISL's research vessel for participating students. Several underserved and underrepresented groups have also participated in activities through the Estuarium, including Project WETKids and Upward Bound. We have participated in GOMA's UUP working group and have spent time developing and submitted a proposal (EPA GM 2009-1) in collaboration with Florida DEP to offer field experiences at DISL for underserved groups in our area.

K. Outreach activities: Please see sect. J.

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Applications of GPS and Google Earth in the classroom. Tina Miller-Way and Discovery Hall Programs faculty, National Marine Educators Association annual meeting, Monterey, CA. June 29-July 3, 2009.

Education and Outreach for NGI at the Dauphin Island Sea Lab. Tina Miller-Way, John Dindo and Mendel Graeber. Northern Gulf Institute Annual Conference, Mobile, AL. May 19-21, 2009.

NGI in the Dauphin Island Sea Lab's Estuarium, Mendel Graeber, Northern Gulf Institute Annual Conference, Mobile, AL. May 19-21, 2009.

Lauren Showalter, Stable Isotope and mercury analysis in the Mobile Bay, Alabama Food Web, Graduate Student Symposium, Dauphin Island Sea Lab, April 2009.

Lauren Showalter, Biomagnification of Mercury in the Mobile Bay Ecosystem, Northern Gulf Institute Annual Conference, Mobile, AL. May 19-21, 2009.

Education and Outreach at the Dauphin Island Sea Lab, Mendel Graeber, Bays and Bayous, Biloxi, MS. October 28-29, 2008.

DISL 02

A. NGI Project file Number: 08-DISL-02

B. Project title, PI(s), Email, and Affiliation: RESTORING ESTUARINE LANDSCAPES IN ALABAMA COASTAL WATERS THROUGH CREATION OF OYSTER REEFS

PI: K. L. Heck Jr.
EMAIL: kheck@disl.org
AFFILIATION: Dauphin Island Sea Lab (DISL) and University of South Alabama (USA)

C. List all non-student personnel funded by this project:

PERSON'S NAME: K. L. Heck
CATEGORY: Research Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Dorothy Byron
CATEGORY: Research Staff
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Sharon Davis
Category: Research Staff
DEGREE: Other
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Quentin Sonnier
CATEGORY: Research Staff
DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Carly Steeves
CATEGORY: Research Staff
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Steven Scyphers
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Matt Kenworthy
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: John Tiggelaar
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Angela Vincent
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): 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?

F. Collaborators(s)/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, April 1, 2006

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? Yes for USA program, $35K; No for ALDCNR and Auburn Shellfish Lab

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes, in the form of reduced vessel charges for USA, and, yes, in the form of 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, which is why they have provided financial and in-kind support for the project.

G. Project Duration:

a. START DATE: April 1, 2006
b. ESTIMATED END DATE: December, 2009

H. Project Baselines:

a. 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.
b. 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 89%) due to Hurricane Ivan that have not yet been substantially reversed.
c. 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. It will also 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.

I. 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:

- Documenting changes in the physical setting of study sites resulting from the addition of oyster reefs.
- Quantifying oyster recruitment and adult density in created near shore reefs.

- Quantifying primary and secondary producers within subtidal and intertidal habitats between created oyster reef and shoreline.
- Quantifying juvenile and adult fish and mobile invertebrate utilization of created oyster reefs and adjacent habitats.

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

- Although overall the shoreline at both Point aux Pins (Figure 34) and in the vicinity of Alabama Port (Figure 35) has continued to erode, the reef sites have substantially slowed erosion compared to the control sites.
- To date we have seen no changes in water clarity at the reef sites compared to the control sites, due to the highly variable nature of these metrics.
- The created oyster reefs are attracting spat which are successfully growing into adult oysters (greater than 3cm in length). A final sampling of the reefs at both locations (Figure 36, Figure 37) will occur within the next few weeks and will provide final results on the livelihood of these nearshore reefs.
- Fish and macroinvertebrates increasingly are utilizing the reefs, as shown by the trend for higher fish abundance at the reefs than at the controls (Figure 38, Figure 39, Figure 40).

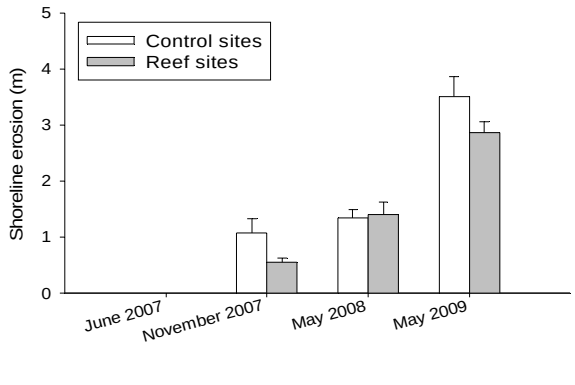


Figure 34. Shoreline erosion at South Point aux Pines site

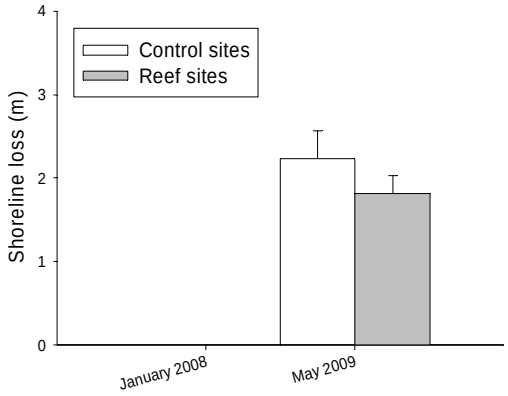


Figure 35.Shoreline erosion at Alabama Port site

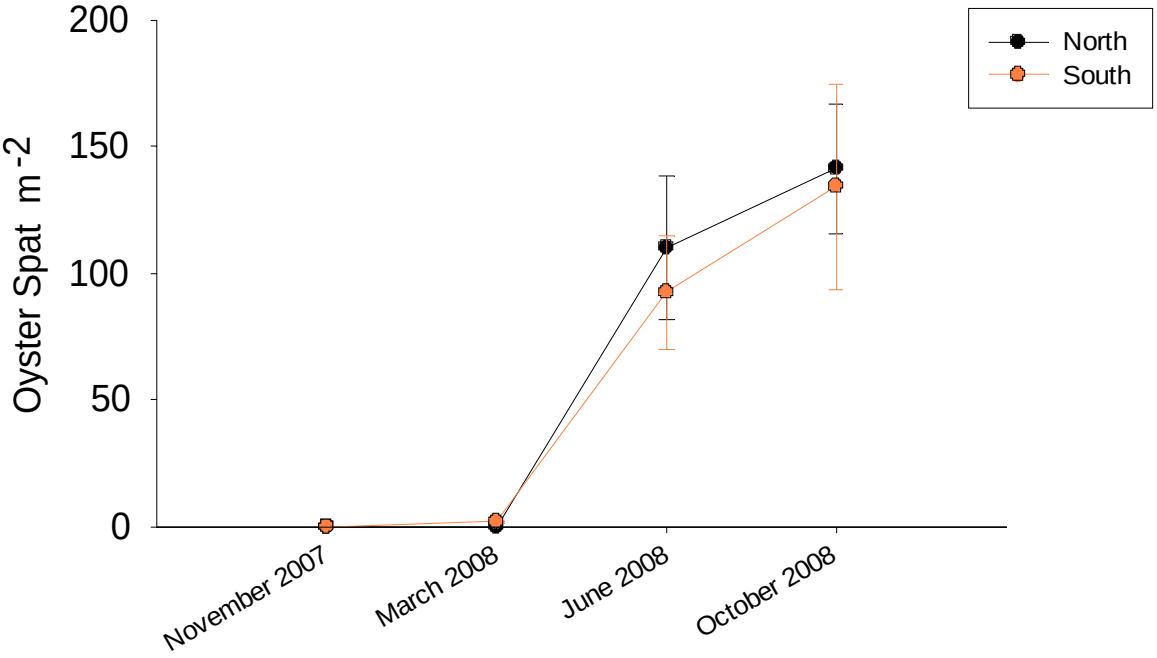


Figure 36. Oyster Spat Density at Alabama Port

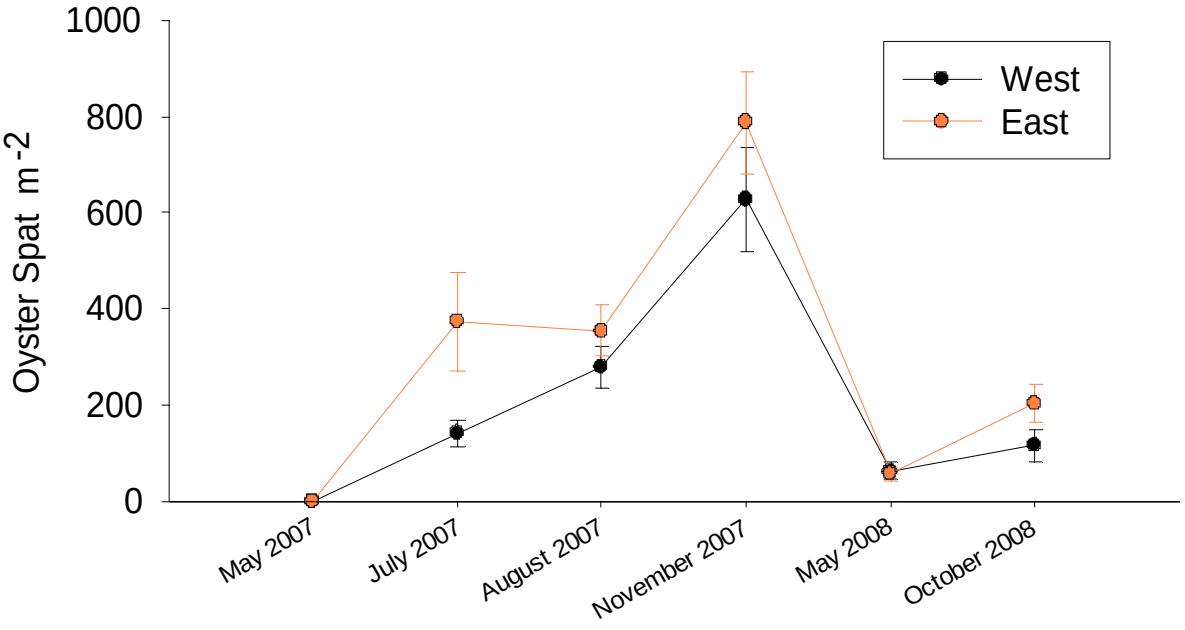


Figure 37. Oyster Spat Density at Point aux Pines

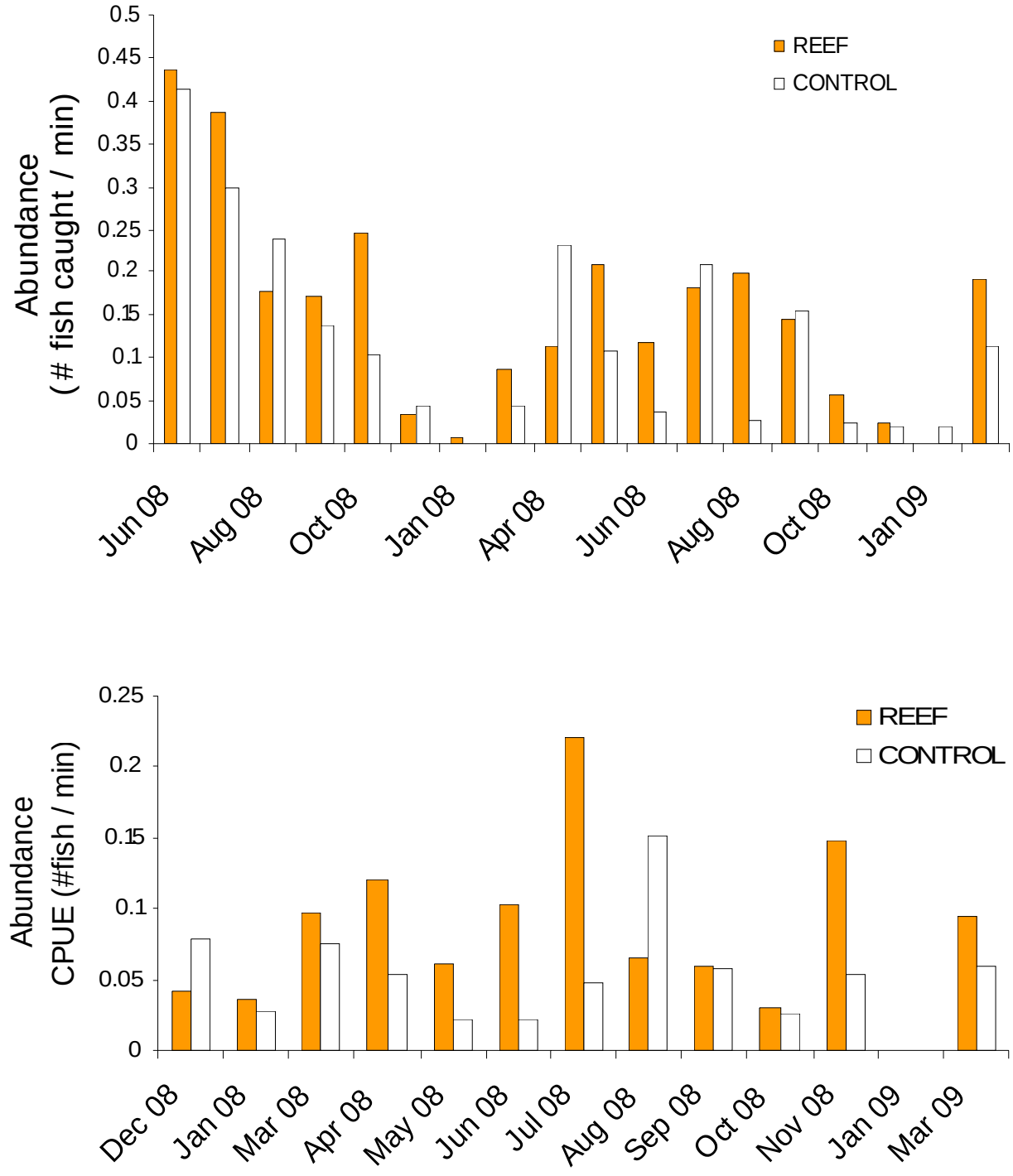


Figure 38. Fish Abundance caught in the 4" mesh gillnets at Point aux Pines (top) and Alabama Port (bottom)

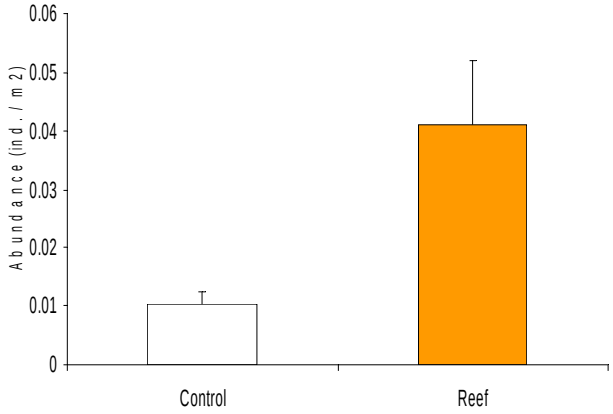


Figure 39. Blue Crab abundance (individuals/m^2) caught during seining at the Point aux Pines site

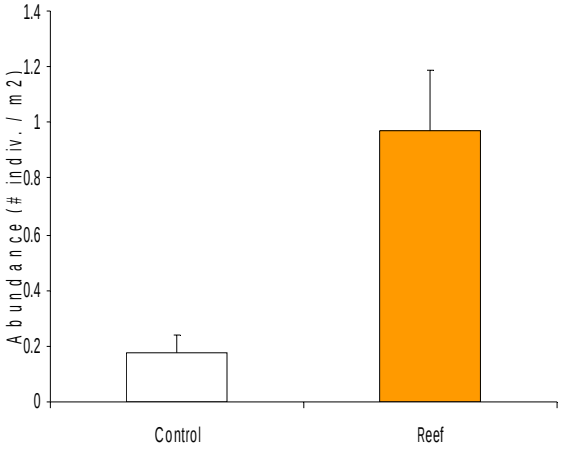


Figure 40. Penaeid shrimp abundance (individuals/m^2) caught during seining at the Point aux Pines site

K. Outreach activities: None.

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None.

N. List non-refereed articles and reports for this project. None.

O. List conference presentations and poster presentations for this project.

Scyphers, S., K. Heck, S. Powers. Quantifying the Fisheries Benefits of Oyster Reef Restoration: A tool for promoting "Living Shorelines"? October, 28-29, 2008. Oral Presentation. Mississippi-Alabama Bays and Bayous Symposium

K. Heck, S. Powers, D. Byron, and S. Scyphers. Oyster Reef and Estuarine Landscape Restoration. October, 28-29, 2008. Oral Presentation. Mississippi-Alabama Bays and Bayous Symposium.

S.P. Powers, K. L. Heck, R. L. Shipp. 2008. Alabama Oyster Reef and Fisheries Habitat Enhancement Program. International Conference on Shellfish Restoration, SC SeaGrant, Charleston, SC. November 19-22 [Poster]

Scyphers, S.B., Powers, S.P., Heck, K.L., Lott, M.A. Quantifying the benefits of landscape-scale oyster restoration: A tool for promoting living shorelines? November 2008. Oral Presentation. International Conference on Shellfish Restoration.

K. Heck, S. Powers, D. Byron, and S. Scyphers. Oyster Reef and Estuarine Landscape Restoration. May, 2009. Oral Presentation. NGI Annual Conference.

FSU 01

A. NGI Project file Number: 08-FSU-01

B. Project title, PI(s), Email, and Affiliation: **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 3**

PI : Eric Chassignet
EMAIL : echassignet@coaps.fsu.edu
AFFILIATION : Professor, Director, COAPS, Florida State University, (850) 645-7288

Co-PI: WK Dewar
EMAIL: dewar@ocean.fsu.edu
AFFILIATION : Professor, Chair, Department of Oceanography, Florida State University, (850) 644-4099

C. List all non-student personnel funded by this project:

PERSON'S NAME: Stephanie Fahrny
CATEGORY: Research Support Staff
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Steve Moray
CATEGORY: Associate Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 20
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Dmitry Dukowsky
Category: Assistant Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 20
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

NO COST FACULTY: Prof. E. Chassignet, Prof. W. Dewar, Prof. K. Speer, Prof. A. Clarke, Prof. G. Weatherly, Prof. M. Huettel, Prof. P. Froelich, Prof. D. Thistle, Prof. J. Chanton, Prof. M. Bourassa, Prof. C. Clayson, Prof. P. Rusher, Dr. F. Coleman, Dr. C. Stallings, and Dr. C. Koenig

D. List all students funded by this project:

PERSON'S NAME: James Waller
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Jacob Rettig
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Aaron Paget
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 75
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Stephan Bougoin
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Jimmy Nelson
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Austin Todd
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Don Van Dyke
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Christine Chien
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Michael Santema
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Rachel Younge
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Veronica Cruz
CATEGORY: Undergraduate Student
CURRENT HIGHEST DEGREE: High school diploma
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 20
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Jesse Fields
CATEGORY: High School Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 20
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): The goals of this program are motivated by the four research themes of the Cooperative Institute—ecosystem management, geospatial data integration, regional climate effects, and coastal hazards. Those goals include (1) quantifying the onshore and offshore transport mechanisms of the Big Bend Region (BBR), (2) documenting the basic regional physical oceanography, and (3) clarifying key aspects of the ecosystem that contribute to reef fish productivity. All three goals will be integrated within an overarching BBR modeling framework. The observations, experiments, and modeling foci are directed at ecosystem-based management, coastal hazards, and the impacts of climate variability.

We use a combination of physical monitoring, field studies of key habitat features, trophic analyses of a suite of reef fish species, and integrative modeling of all components. This approach is supported by an observational array established with NGI support, with regular sampling along a transect extending from an offshore observational platform (K-tower, ~32 km offshore) to the FSU Coastal and Marine Laboratory (FSUCML) and by habitat monitoring conducted by the NMFS and the FSUCML. The platform supports bottom moorings at 3 depths (5-20 m), each housing multisensor probes that measure in real time water depth, temperature, salinity, light, pH, chlorophyll a, turbidity, and oxygen; a dissolved organic matter probe and nitrate sensor; (3) a suite of meteorological instruments that sample the atmospheric boundary layer to determine air-sea

fluxes. The data are telemetered in real-time to the FSUCML and to FSU. These studies define the variability and connectivity among critical habitats and the relationship to fisheries productivity. The integrated modeling system will provide near-real time monitoring and prediction of the marine and coastal ocean and atmospheric environment that will direct research activities. The system couples a 1.3 km resolution Weather Research and Forecasting model (WRF) with a 30 arcsec (~ 800 m) resolution Regional Ocean Modeling System simulation over the BBR, nested within larger scale (3-4 km) WRF and HYbrid Coordinate Ocean Model system for the Gulf of Mexico-Western Atlantic. This system complements the observing activities and facilitates interdisciplinary research objectives while enabling ecosystem-level quantification and assessment of the impacts of natural and anthropogenic disturbances at various temporal and spatial scales.

F. Collaborators(s)/Partners: Our research benefits from direct collaboration with the NOAA National Marine Fisheries Service, NOAA/AOML, the NOAA National Weather Service in Tallahassee, and the NOAA National Estuarine Research Reserve in Apalachicola Bay.

The "Red Tide" project led by A. Clarke at FSU has also supported 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.

G. Project Duration:

a. START DATE: 01/07
b. ESTIMATED END DATE: 12/11

H. Project Baselines:

a. 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.

b. 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.

c. GAPS: 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.

I. Project Abstract: The project is an integrated study of the marine ecosystem of the northern West Florida Shelf (WFS) Big Bend Region (BBR) using an interdisciplinary observational and modeling approach. This represents a natural progression in our understanding of this ecosystem based on

FSU's current NOAA NGI projects and involves direct collaborations between FSU, NOAA (NMFS and AOML), and USM. The objectives of the research are:

- To understand the physical processes responsible for distributing water within the BBR, including cross-shelf transport of riverine-influenced seawater, transport of biological material, and the natural and anthropogenic variability of the system;
- To understand the nutrient cycling, resource connectivity, and trophic interactions between BBR river-dominated coastal areas, nearshore seagrass habitats, estuaries and offshore reef fish communities.
- To study the processes supporting regional productivity of a number of reef fish species important to both commercial and recreational fisheries, using gag (*Mycteroperca microlepis),* as a primary model.
- To examine regional habitat degradation for its effects on juvenile fish development.

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

All instrumentation along our proposed transect is in place and all ocean observations are now telemetered in real time to the FSUCML. These data are available on the COAPS data server to the rest of the world. We have established that isotopes can indicated dietary patterns in gag grouper and have found evidences of off-shore carbon flux to the groupers due to the migratory patterns of sea grass pinfish. Oxygen measurements have begun to quantify the role of benthic processes in maintaining the primary productivity of the BBR. We are for the first time computing the lagrangian history of the regional riverine input.

Ecology Component

Many coastal fishes have complex life histories characterized by onshore-offshore migrations and a dependence on inshore habitat (e.g., seagrass, saltmarsh) during the juvenile stage. The dependence of juvenile fishes on nearshore coastal and estuarine environments creates a coupling between coastal regions and the larger continental shelf that is mediated by trophic transfer of inshore production to the offshore food web. The integrity of these coupled marine landscapes is important for sustainable fishery production. The shelf waters of the NE GOM (Gulf of Mexico) support enormously productive recreational and commercial fisheries. Traditional sources of organic nitrogen, such as river and atmospheric inputs, cannot account for these high fishery yields. We hypothesize that inshore-associated forage species that migrate offshore represent a significant source of organic nitrogen to the offshore environment. This hypothesis can be tested by integrating habitat-specific information on juvenile fish production and egress within an ecosystem-level nitrogen (N) mass balance model to estimate the relative contributions of N inputs to the Big Bend Region (BBR) of the West Florida Shelf via the Apalachicola River, atmospheric N, and migration of forage species.

The FSU ecology team is investigating the ecology of one of the more economically important fishes in the region, gag (*Mycteroperca microlepis*) in which habitat-mediated linkages between inshore and offshore environments have important consequences for fishery production. On a broad scale,

we examine the geospatial linkage between juvenile gag primary nursery habitat (seagrass meadows) and secondary nursery habitat (shallow water reefs) as staging areas for recruitment to adult populations offshore, consistent with an ecosystem-based management approach for reef fish species. We are characterizing the seagrass faunal communities across the BBR using a generalized random-tessellation stratified design, a spatially-balanced approach. This defines the spatial extent of the BBR seagrass bed, characterize the composition of seagrass and faunal communities, and elucidate potential mechanisms driving the patterns (e.g., influence of saltmarsh and other adjacent terrestrial habitats allowing precise estimates of absolute abundances of gag and other species (e.g., gag prey). In addition, we are studying the effects of local weather on growth rate and diet of young gag in their seagrass nursery grounds.

Among the keys to a species' population biology, and thus its management, is knowledge of the causes of variability in the growth rates of its members during ontogeny. Although studies of gag biology (Collins *et al*., 1987; Keener *et al*. 1988; Ross and Moser, 1995; Koenig and Coleman, 1998; Strelcheck *et al*., 2003; Renan *et al*., 2006) have revealed much, little is known about the factors that influence growth rates of early juvenile gag during their first few months in the sea grass. Here, they live in water that is <2 m deep and thus are exposed to local weather. Weather could affect the growth rates of early juvenile gag directly. For example, because growth rates generally increase with temperature, individuals that experience warmer weather will grow faster than those that experience colder weather, if the direct effects of temperature are important relative to other sources of variability. Weather could also influence growth rates indirectly. For example, growth rates could be slowed if warm weather accelerated the growth of a preferred prey to the point that prey individuals were too big for the early juvenile gag to eat.

One goal is to assess the importance of variation in local weather on variation in growth rate and in diet of early juvenile gag in the northeastern Gulf of Mexico. In year 1 (2007), Drs. Thistle, Koenig, and graduate student Erin Easton identified appropriate techniques, obtained equipment, and established a field site on Turkey Point Shoals (Figure 41). We chose temperature, salinity, and light as our measures of local weather. During spring and early summer 2007, we put recording conductivity, temperature, and light meters at the site and sampled for early juvenile gag. In year 2 (2008), Drs. Thistle, Koenig, and graduate student Stefan Bourgoin selected a second site (Lanark Reef) in the vicinity of Turkey Point Shoals (Figure 41). We measured temperature, salinity, and light data at both sites (see for example Figure 42 and Figure 43) and sampled both sites for early juvenile gag. Also during year 2, we began collaborating with Research Fishery Biologist Andrew David at the NOAA NMFS Panama City Laboratory). We provided instruments to record temperature, salinity, and light; David's technician Stacey Harter sampled for early juvenile gag weekly from three sea grass meadows in St. Andrew Bay (Figure 41). To provide replication in time, we will sample the sites again in year 3 (2009). Further, some authors have found that variability in dissolved oxygen concentration can affect the growth of early juvenile fishes (Perez-Dominguez et al. 2006), so we will also deploy recording dissolved-oxygen meters.

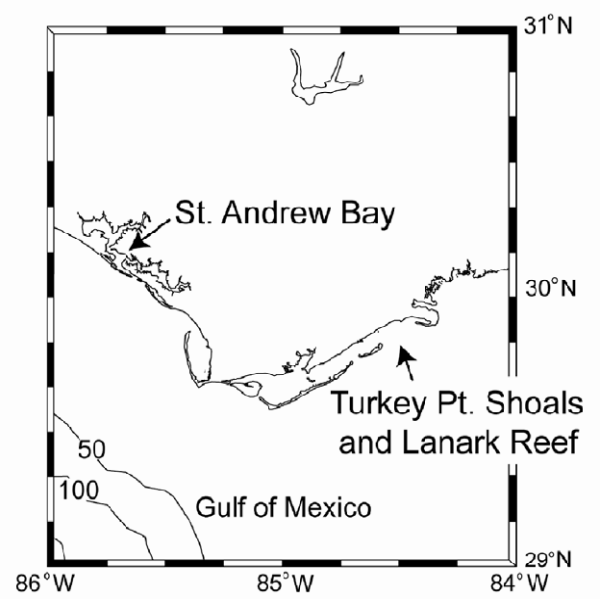


Figure 41. A chart of the northeastern Gulf of Mexico showing the relative positions of the study sites.

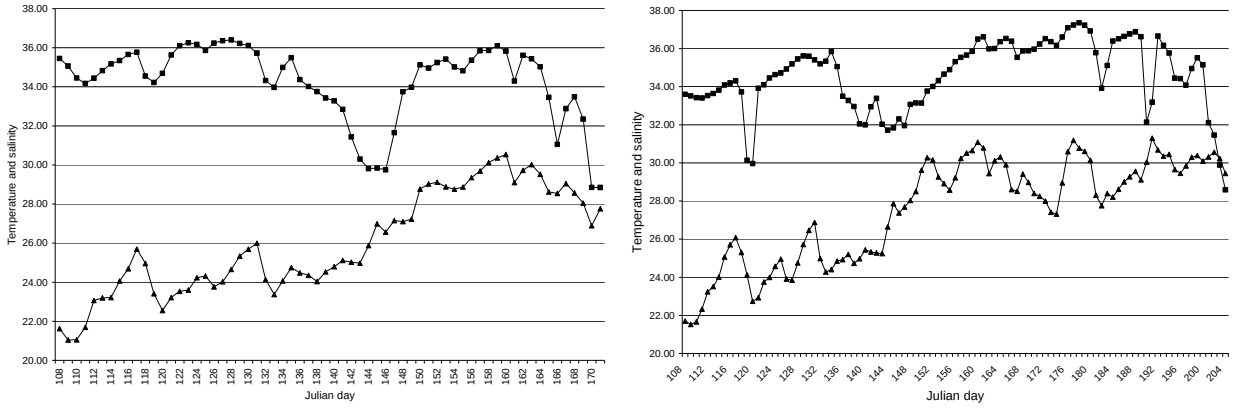


Figure 42. Average daily temperature (triangles) and salinity (squares) in the northeastern Gulf of Mexico sites during 2008. (A) Turkey Point Shoals. (B) Lanark Reef.

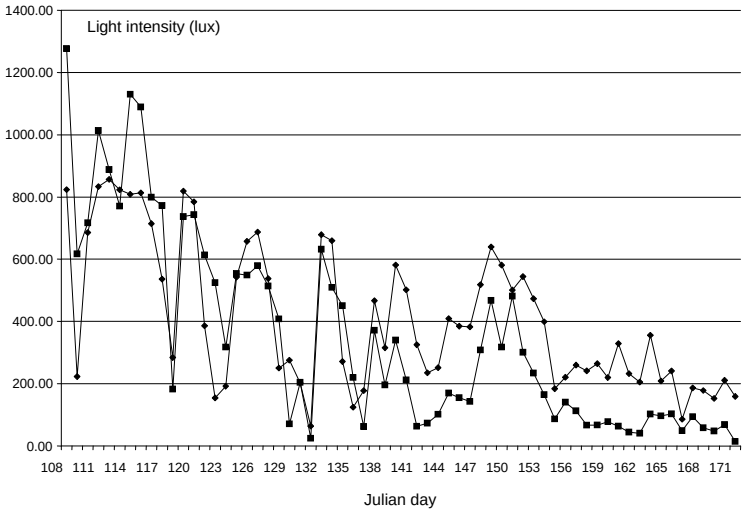


Figure 43. Average daily light intensity at Turkey Point Shoals (squares) and Lanark Reef (diamonds).

For each fish, we measure its length and weight and determine its age by counting the daily growth rings present in its ear bones (otoliths, see e.g., Stelcheck *et al*., 2003). From these data, we can determine the day an individual arrived at the sea grass bed and became benthic and its growth rate. To assess its diet at the age and on the day it was caught, we measure the amount of each prey type in its guts; conveniently, gag individuals swallow their prey whole (Mullaney and Gale, 1996). For year 4, we will finish processing fish guts for information on juvenile gag diet, to analyze our data, and to prepare manuscripts for publication. The graduate student Stefan Bourgoin will finish his master's degree during this time. Andrew David (NOAA-NMFS Panama City Laboratory) is collaborating with us in the study of the effects of weather on growth rate and diet of early juvenile gag. In particular, he is sampling three sites in St. Andrew Bay, FL, for comparison to our Turkey Point Shoals specimens. We have provided instruments to record temperature, salinity, and light in the St. Andrew Bay and will supply a recording oxygen meter for the 2009 season.

Each winter millions of pounds of fish migrate from their summer home in the seagrass beds of the Florida Big Bend to overwinter and spawn nearly 100 miles away on offshore reefs. Understanding the role this fish mediated nutrient flux plays in sustaining fisheries production is vital to proper management of this extremely valuable northern Gulf of Mexico resource. To determine the viability of using stable isotope analysis to track diet shifts in wild gag (*Mycteroperca microlepis*) populations, we have conducted a diet shift experiment on four gag held in the laboratory (Nelson et al., in prep). Each month biopsies of the muscle, liver, and gonad tissue were taken and the δ13C values Fish were initially fed a diet of mackerel and then shifted to a diet of pinfish. The results indicate that we are able to trace the pinfish diet as it was incorporated into the tissues. The carbon turnover rates varied widely among the three tissues with muscle being the slowest with a mean turnover rate of 0.005‰ day-1, gonad tissue was intermediate with a turnover rate of 0.01‰ day-1 and liver was the fastest with a turnover rate of 0.014‰ day-1. Although it is generally believed that metabolism is insignificant in tissue turnover rates for ectotherms, we found that adult gag tissue turnover is driven primarily by metabolic turnover and not growth. Based upon the results of this study

evidence exists that physiological changes during the life cycle of gag may enhance our ability to detect these changes in diet. Preliminary data from offshore specimens suggest that gag gonad tissue is composed of material attained from a lower trophic level than that of muscle tissue. Although preliminary, this is an indication that seagrass derived prey are entering the offshore food web at a critical time in the gag reproductive cycle. Despite the great numbers of studies that speculate about the importance of this type egress or "outwelling" to adjacent ecosystems, this is one of the first to attempt demonstrate or quantify it.

The research investigates the resource connectivity and nutrient flux between northeastern Gulf of Mexico seagrass habitats and offshore reef fish communities. The objectives are:

1. Estimate the inshore egress contribution to offshore food webs via the annual migration of small seagrass dwelling species.
2. Estimate the annual input and fate of the major sources of organic nitrogen to the northeastern Gulf of Mexico. These sources would include nitrogen flux from rivers, the atmosphere, in situ nitrogen fixation by bacteria.
3. Create an offshore nitrogen budget by defining the offshore food web and sinks of the organic nitrogen in the offshore environment.
4. Use the data collected in objectives 1-3 to construct a ecosystem level nitrogen mass-balance model of the northeastern Gulf of Mexico fisheries.

James Nelson (Ph.D. student) is currently focusing on collection of offshore species and has scheduled 4 collection trips in 2009/2010. The hypothesis we are testing is that seagrass nearshore benthic production supports the spawning of offshore species by the egress of pinfish and pigfish to deeper waters in the fall. Dr. DeVries (NOAA-NMFS Panama City Lab) has provided 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. Dr. Jeff Chanton has analyzed 100 specimens for Dr. DeVries of the key grouper and snapper species and the most abundant forage species (tomtate) for 13C and 15N for the NMF study examining trophic linkages between inshore and offshore hard-bottom habitats off NW Florida. Nelson 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 13C and 15N ratios from estuarine specimens of juvenile gag and pinfish. This collaboration will continue in years 4 and 5.

Very little is known about the nutrient cycling of the northeastern Gulf of Mexico. Although typically classified as oligitrophic, the shelf edge waters of the northeastern gulf support many recreational and commercial fisheries. Based on our initial estimates the "traditional" organic nitrogen sources to the northeastern gulf, such as river and atmospheric inputs, cannot account for the high fishery yields of this area (Figure 44). Therefore we hypothesize that connectivity to inshore derived nitrogen via the annual migration of small inshore dwelling species is a significant source or organic nitrogen to the offshore environment.

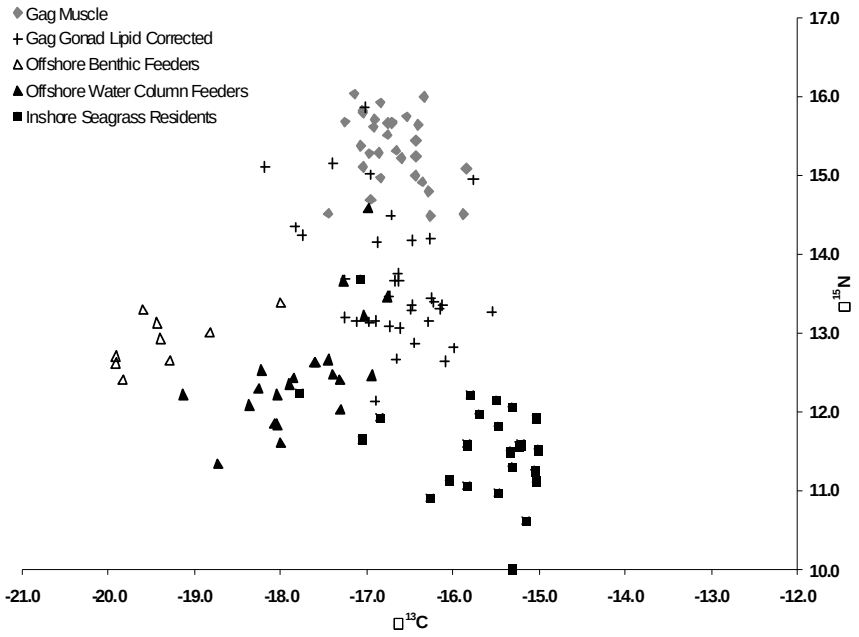


Figure 44. This plot shows a preliminary stable isotope analysis of the foodweb in the Northeastern Gulf of Mexico based on the samples we have collected thus far as part of the NOAA/FSU collaboration under NGI. The benthic feeders consist of red porgies and blue angel fish. The water column feeders consist of vermillion snapper, tomtates, sand perch, banks seabass, and inshore lizard fish. The inshore Seagrass residents consist of pinfish, pigfish, and spot. The gag muscle and gonad values shown were taken during gag spawning season (Feb). This preliminary data appears to support our hypothesis that gag switch to feeding significantly on inshore derived prey. The gonad tissue is significantly depleted in 15N relative to muscle tissue which reflects the lower trophic position of the seagrass.

We have also begun a project to characterize the faunal communities associated with seagrass beds across the entire Big Bend (St. Marks to Tarpon Springs). Although the Big Bend is home to one of the largest and most pristine seagrass beds in the world, very little is known about absolute abundances and spatial distributions of juvenile gag and their potential prey across it. Using a generalized random-tessellation stratified (GRTS) design, a spatially-balanced approach (Stevens and Olson 2004), we are sampling with beam trawls across the entire BBR seagrass beds (Figure 45). This study will define the spatial extent of the BBR seagrass bed, characterize the composition of seagrass and faunal communities, and elucidate potential mechanisms driving the patterns (e.g., influence of saltmarsh and other adjacent terrestrial habitats). Importantly, the GRTS design will allow for far more precise estimates of absolute abundances of gag and other ecologically-important species (e.g., gag prey) than random or systematic designs due to the local variance estimator it employs. We have secured additional funding from the Florida Fish and Wildlife Conservation Commission to achieve this sizable task.

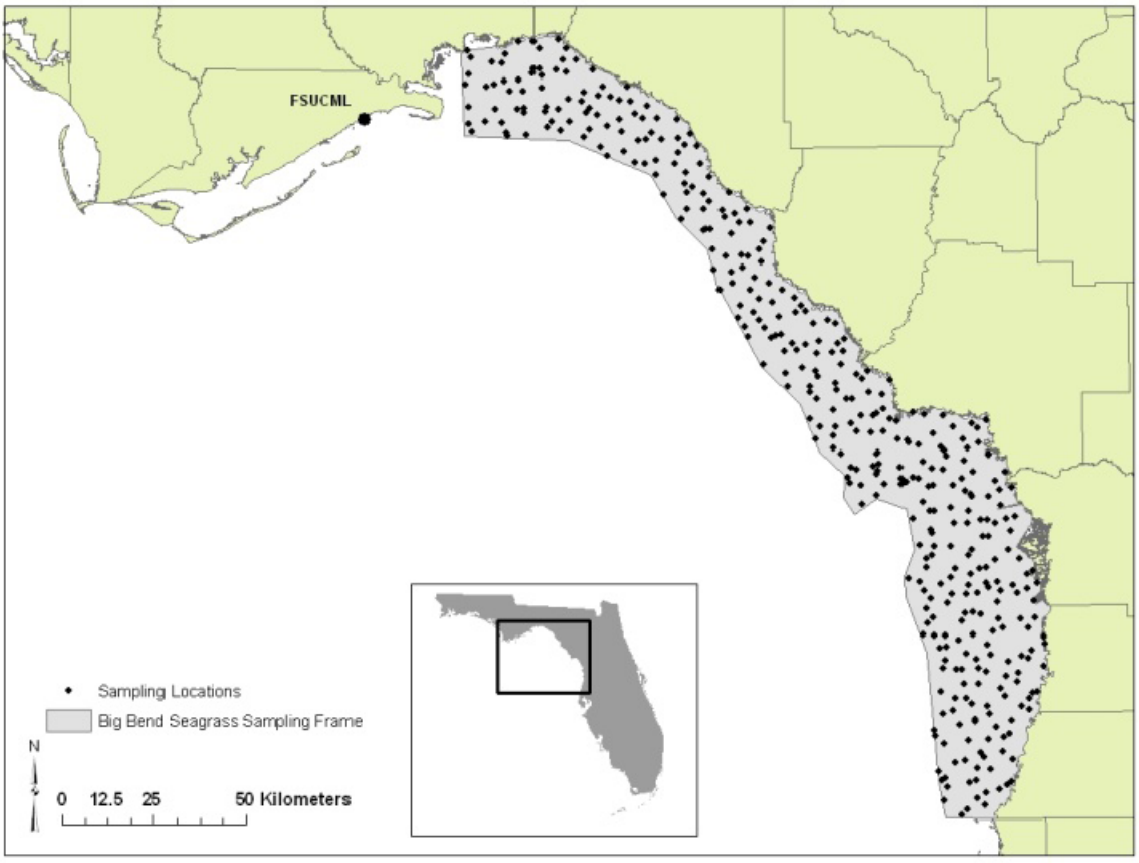


Figure 45. Sampling locations (n = 100) chosen using GRTS across the BBR seagrass bed.

Regarding our work to characterize the faunal communities in BBR seagrass beds, Year 2 involved purchase of equipment, design of field gear (i.e., retrievable trawling outriggers on FSU research vessel, beam trawl) by FSUCML staff, and training on and design of the GRTS sampling protocol. We have also successfully secured additional funding from the Florida Fish and Wildlife Conservation Commission to extend both the spatial extent of the project to include the entire BBR (previously only proposed to study northern BBR) and the sampling intensity. In addition to our efforts to characterize the faunal communities in seagrass beds, we have collected over 800 juvenile gag from eight regions across the west coast of Florida (St. Andrew Bay, St Joe Bay, Apalachee Bay, Big Bend, Tampa Bay, Sarasota Bay, Pine Island Sound, and Cape Romain). With these fish, we are using a combination of gut content and stable isotope analyses to investigate the dynamics of their feeding ecology both across space and relative to their size. We have also removed the otoliths of the fish to be used to estimate time of settlement and postsettlement growth rates.

Transport Component

The objectives of the Transport component are to clarify the basic onshore/offshore transport mechanisms of the BBR and the impact of these mechanisms on primary production by monitoring the physical structure of ocean currents and wave parameters, temperature/salinity stratification

and biogeochemical parameters (dissolved oxygen, chlorophyll, pH, Dissolved Organic Carbon and Nitrogen). These data records serve to constrain our coupled physical/biogeochemical models and provide a broader view of the regional transport dynamics. The time-series of biogeochemical data allow us to examine the role of benthic primary productivity in sustaining the regional ecosystems and help quantifying biogeochemical cycles in the coastal environment of the BBR.

Accelerated coastal development in this region is expected to lead to increases in nutrient concentrations in the coastal zone, promoting algal growth and oxygen consumption. Associated increase of water turbidity may reduce benthic primary production and shift production into the water column. The increased pelagic production enhances organic matter deposition further increasing oxygen consumption at the sea floor. Our observations show large fluctuations in bottom water oxygen concentrations with temporary reductions to 60% air saturation. A further decrease of oxygen concentration minima will affect demersal fish populations and bottom dwellers. The results of this study will reveal the relative importance of the processes that affect production, respiration, boundary layer oxygen concentrations and lateral oxygen transport. Our production and oxygen measurements provide base line data that are critical for the evaluation of the environmental conditions in the northeastern Gulf and their development over time.

In the Northeastern Gulf of Mexico, shelf currents undergo seasonal changes as the net surface heat flux changes between cooling to warming (Morey 1999). Wintertime horizontal stratification changes to summertime vertical stratification. While heat flux controls the seasonal transition, ocean circulation largely controls the synoptic scale variability. The two processes are closely linked as bottom topography and coastline geometry generate regions of convergence and divergence. The large-scale current patterns driven by Gulf of Mexico loop current, temperature gradients and the seasonal wind direction changes combine with the local transport caused by local winds, waves and tides. Shelf circulation and sea level variations are highly correlated with wind stress variations (Mitchum and Clarke 1986; Mitchum and Sturges 1982; Ohlmann and Niiler, 2005). Diurnal tidal energy is relatively uniform across the shelf whereas semidiurnal tidal energy decreases in offshore direction. In our nearshore study region, semidiurnal tides (M2 and S2) thus are important despite the fact that in most of the Gulf of Mexico diurnal tidal constituents (K1 and O1) dominate transport (Reid and Whitaker 1981). Internal tidally-induced bores exist and may lead to sediment resuspension in particular areas (Johnson and Weidemann, 1998). Surface transport by lagrangian stokes drift usually is small and directed toward the northwest. Rivers contribute substantially to the local hydrography and influence biological and geochemical process in the NEGOM shelf.

Our primary research goals are to quantify and model the links between lateral transport, mixing and pelagic and benthic primary production. The three stations established along the transect in the Northeastern Gulf of Mexico produce time series of vertical current profiles, surface gravity wave activity and hydrostatic pressure oscillations. Bottom mounds at the three stations equipped with multisensor probes log temperature, conductivity, light, turbidity, pH, chlorophyll a and oxygen concentrations.

Wind-and tide driven transport, associated vertical mixing and bottom shear stress: Meteorological and current meter data are being used to calculate wind-and tide driven transport and to estimate lateral displacements and vertical mixing. Wind stress drives a circulation that tends to be strongest near-shore. However, in the shallow shelf the potential for mixing by tides is significant due to current/bottom roughness interaction.

Mixing and water column productivity, sediment transport and benthic productivity: We continue measuring water column and benthic productivity along our transect and correlate the productivity data with the current measurements, mixing estimates and bottom stress data. Wind and buoyancy-driven forcing can transport nutrient-rich river water offshore at 10 km d-1 (He and Weisberg 2002) and dispersion rates of 5000 m2 s-1 (Ohlmann and Niiler 2005). The land-derived nutrients boost primary production in the coastal zone, and the distribution of the production enhancement is linked to the water displacement and mixing. Bottom stress estimates calculated from the current profiles combined with results from sediment analysis will be used to estimate periods of sediment erosion and resuspension, and turbidity data provide data for assessing reliability of these estimates. Productivity measurements based on oxygen production/consumption rate measurements will be combined with laboratory measurements of photosynthetic activity/light intensity relations that then can give indications of light limitation at the study sites and at the sea floor (Nelson et al. 1999).

Links between DOC dynamics and primary productivity: We are working on determining the links between DOC dynamics and primary productivity. A chromophoric dissolved organic matter (CDOM) sensor integrated in our bottom mound at K-station continuously measures CDOM concentration in the bottom water. CDOM is a good proxy for DOC, and DOC is a major carrier of nutrients in the inner shelf (Burdige and Martens 1990). On the other hand, algal blooms are a source for DOC. Our measurements quantify DOC concentrations and determine its characteristics (i.e. N and P content, CDOM composition analysis). Correlations between CDOM/DOM and chlorophyll concentrations will be used to investigate causal links between dissolved organic matter and algal production.

Links between boundary layer oxygen dynamics, transport and mixing and production-consumption processes: We are investigating the factors that control the oxygen dynamics in the boundary layer along our transect. Oxygen concentrations reflecting primary production and consumption processes in water column and sediment are affected by lateral advection of water masses with some specific oxygen signal, lateral and vertical mixing processes and resuspension events. Through their reactions in biological and biogeochemical processes, oxygen dynamics are rapid and complex, and the evaluation of synoptic current data and salinity as a conservative tracer will reveal whether local or remote processes are controlling oxygen concentrations at the study site (e.g. show whether advection of low-oxygen water or a local sediment resuspension event cause oxygen depression). Through these investigations will be able to determine the processes that dominate bottom water oxygen concentrations along our study transect.

Monitoring instrumentation has been deployed at 3 sites (Site A, B and N7) at 5m, 10m and 20m depth offshore from the FSU Coastal and Marine Laboratory (Figure 41) under the Transport project. A hydrographic transect cruise occurs approximately monthly aboard the R/V Seminole to collect water column profile data and water samples at 5 stations (Figure 46). Typically during these cruises the deployed instruments are serviced and data is downloaded.

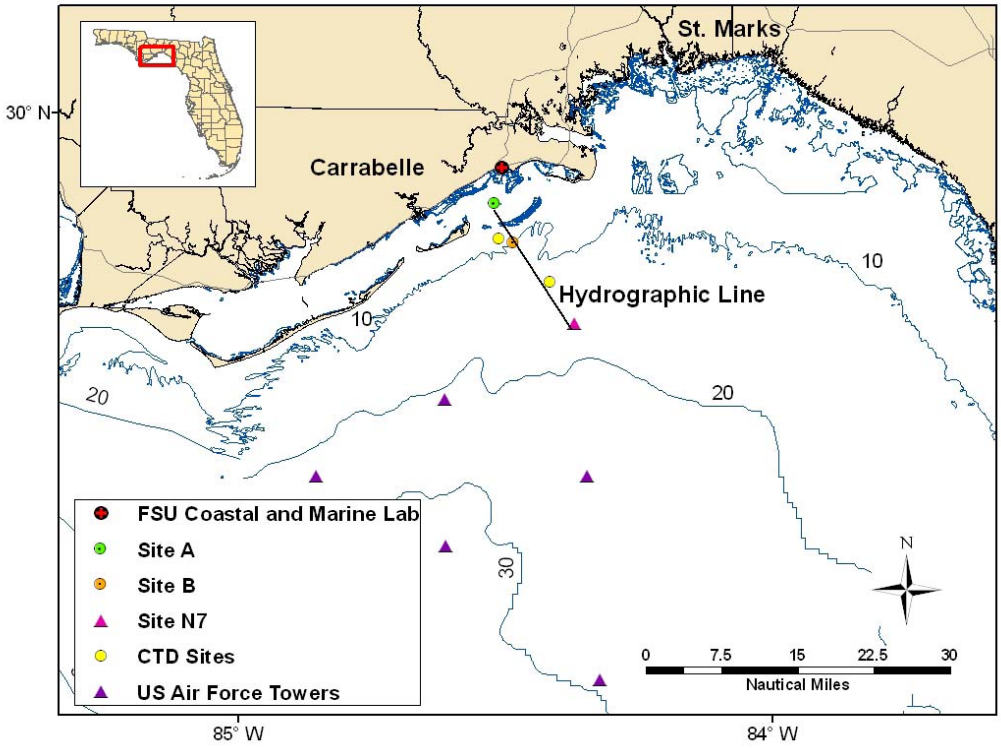


Figure 46. Map of the Big Bend Region, Florida and the FSU NGI Observing System.

The transect starts approximately 3 nm from the shoreline and extends out 17 nm to the offshore United States Air Force (USAF) tower N7. Along the transect, profile data is collected from 5 stations approximately once a month using a multi-parameter YSI 6600 Sonde and a Sea-Bird 19 SEACAT Profiler. Two Niskin water sampling bottles are also lowered for bottom and mid water samples. A surface water sample is collected using a bucket. These water samples are analyzed for nutrients, chlorophyll, and, under the Red Tide project, *Karenia brevis*.

Site A (5m) is located near an Intracoastal Waterway channel marker approximately 3nm from the shoreline. Apalachicola Bay is the adjacent water body to the west and Alligator Harbor is located to the East. There is a multi-parameter YSI 6600 EDS and a Nortek Acoustic Wave and Current Meter (AWAC) deployed at site A. The instruments are mounted to a homemade fiberglass bottom mount which is attached to 2 anchoring screws. Instrumentation is serviced by scuba divers and downloaded on a 3-4 week basis depending on the bio-fouling rate. The YSI 6600 EDS's are set to measure temperature, conductivity, pH, turbidity, chlorophyll, dissolved oxygen, Photosynthetic Active Radiation (PAR), and depth every 15 min. The AWAC measures currents every 15 minutes and waves every hour. Site B is located just offshore of Dog Island Reef along the 10 m isobath. The

bottom type is sand. Within the vicinity are areas of hard bottom patch reefs. Similar to Site A there is a multi-parameter YSI 6600 EDS and an AWAC. The instruments are mounted to a MSI rectangular trawl-proof bottom mount. The offshore observing site is a USAF Tower N7, formerly known as K-tower. The USAF has six 100 foot tall communication towers in the Northeastern Gulf of Mexico which are used by Tyndall AFB (Figure 46). FSU has approval to utilize the tower as a platform for oceanographic and meteorological instrumentation (Figure 47). Attached underwater to the tower are 2 Sea-Bird 16 SEACAT's at 3 m (top) and 9 m (mid) depth. These instruments measure conductivity and temperature (CT) every 15min. Additional instruments are located approximately 500 feet to the Southwest of tower N7 (Figure 47). These include a Teledyne RDI Acoustic Doppler Current Profiler (ADCP), a multi-parameter YSI 6600 EDS, a Wet Labs ECO Fluorometer, and a Satlantic MBARI-ISUS V3. The instruments are attached to a MSI trawl-proof saucer bottom mount.

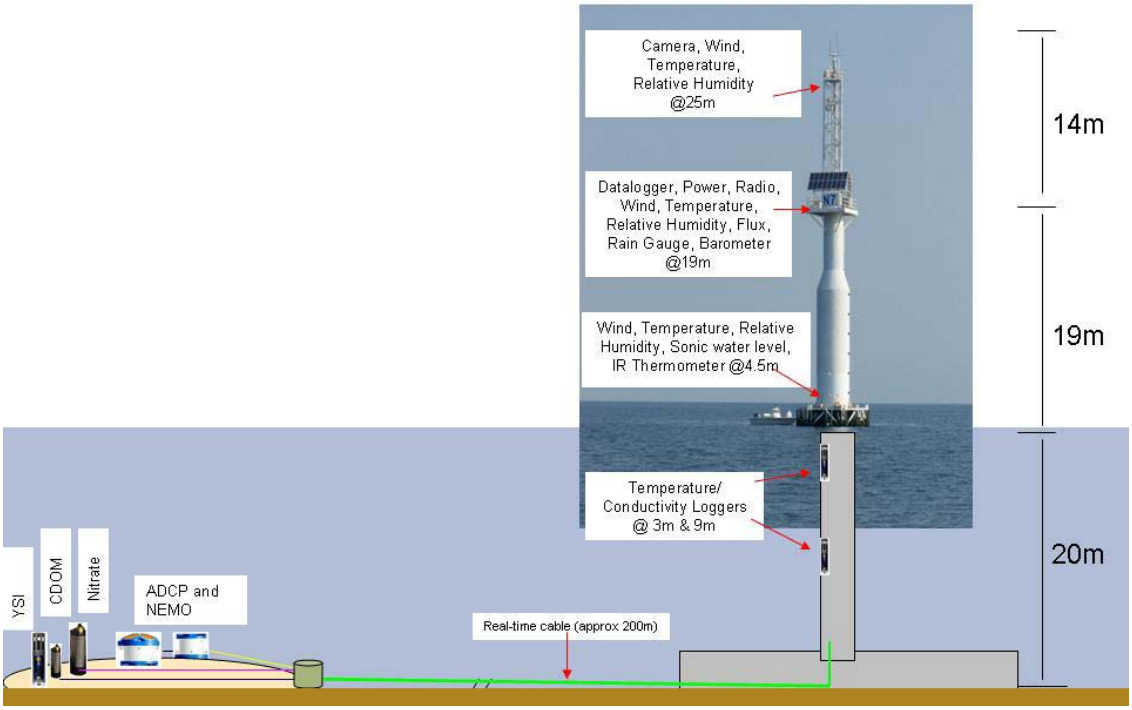


Figure 47. Detailed outline of Instrumentation at Site N7.

To facilitate future comparison of the data from all 3 sites, we deployed an RDI Workhorse with waves and a Nortek AWAC at Site N7 together for a test period. The instruments were deployed with similar configurations from 03/25/2008 to 06/03/2008. These instruments were mounted in identical MSI trawl proof saucer bottom mounts, approximately 500ft apart. Results (Figure 48) suggest that the two instruments perform similarly in terms of several standard wave statistics (significant height Hs, peak period Tp, and peak direction Dp). Spectral analysis still underway suggests that the AWAC provides wave information at higher frequency, past the cutoff of the RDI

sampling, and in accord with expectations based on the different sampling capabilities of the instruments.

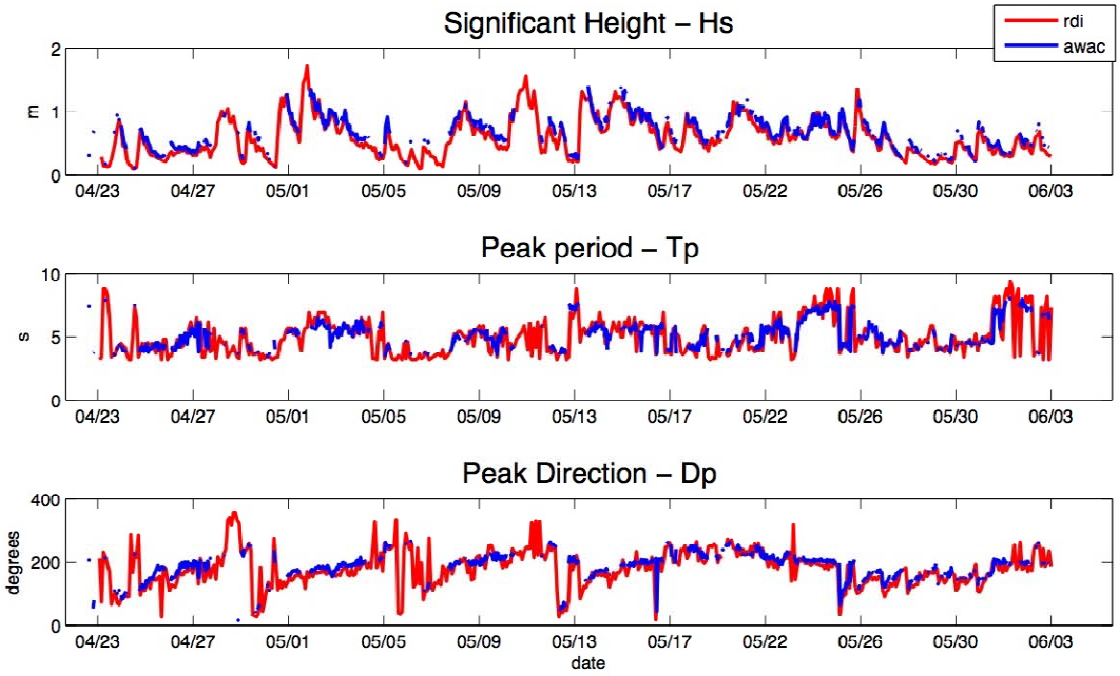


Figure 48. Comparison plot of the RDI and Nortek AWAC wave results. Note that these quantities are the output of proprietary software processing routines. Fewer AWAC data points are plotted only because the AWAC software flags more values than the RDI software, but total effective data return is actually greater with the AWAC.

We are currently implementing the telemetry of the oceanographic instrumentation at Site N7. The RDI ADCP, YSI, CDOM and Nitrate sensors will utilize the telemetry hardware that the Department of Meteorology has deployed at Site N7. A RDI NEMO Waves Processing Module will be deployed along with the RDI ADCP for telemetry of the processed wave measurements. The CMF is bench testing all the instruments with the Campbell-Scientific data logger now. This involves program writing, data table structure details, power limitations and communication rates. The RS232 instruments will be converted to RS422/485 for data transmission over the 500 feet. The communication will be converted back to RS232 to talk with the CR3000. A cable will be laid between the bottom mount and the tower over the 500 feet distance. A buffered Smart Switch will be deployed in an underwater housing to allow for the instruments communication. Power issues and voltage drop are under consideration now. Meteorology has deployed the following instruments on the USAF tower: 195 W peak solar power, 912 MHz radio transmitter, Campbell-Scientific CR 3000 data logger, IR sea surface temperature, Ultrasonic water level indicator, RM Young Marine model aerovane, TEC rain gauge, Barometer, Camera, Temperature and Relative Humidity. Data is transmitted from the tower to a computer housed in the CMF lab at the FSUCML at 9,600 baud. All data will be available on a COAPS server, as well as through NOAA channels once a location identifier and data format is identified. A QA/QC procedure will be implemented for oceanography data.

Modeling Component

The purpose of the modeling component of this research effort is to develop a set of numerical tools to support interdisciplinary marine and atmospheric research in the northeastern Gulf of Mexico, and to complement the regional coastal observing system being implemented as a related activity. The end product will be a near real-time coupled ocean – marine ecosystem – atmospheric modeling system with wave and air-sea flux model components (Figure 49).

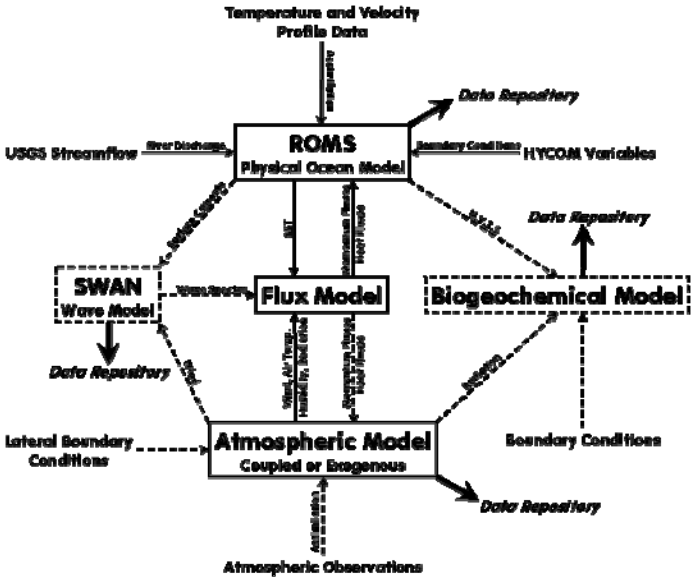


Figure 49. Schematic of the coupled modeling system.

The central component of the modeling system is the Regional Ocean Modeling System (ROMS) simulation of the Florida Big Bend Region (BBR) configured at 30 arcsec horizontal resolution and 25 vertical layers (Figure 50). This model, forced by 3-hourly atmospheric model data applied to the COARE 3.0 flux algorithm, open boundary conditions supplied by the HYbrid Coordinate Ocean Model (HYCOM) ocean prediction system (http://www.hycom.org), and discharge from 15 local river sources, has been run in hindcast mode for over one year for model evaluation and application to regional studies. The model has been used to investigate circulation patterns that can potentially serve to transport larvae of reef fish spawned offshore to the nearshore seagrass beds that serve as their nursery grounds. Lagrangian particle tracking methods have revealed that larvae released from known spawning sites in the late winter/early spring time period can potentially reach the seagrass beds within a two-month time frame if they remain near the ocean bottom (Figure 51). Significant variability in the fate of the particles, though, is linked strongly with the atmospheric synoptic scale forcing [*Morey et al.*, 2008].

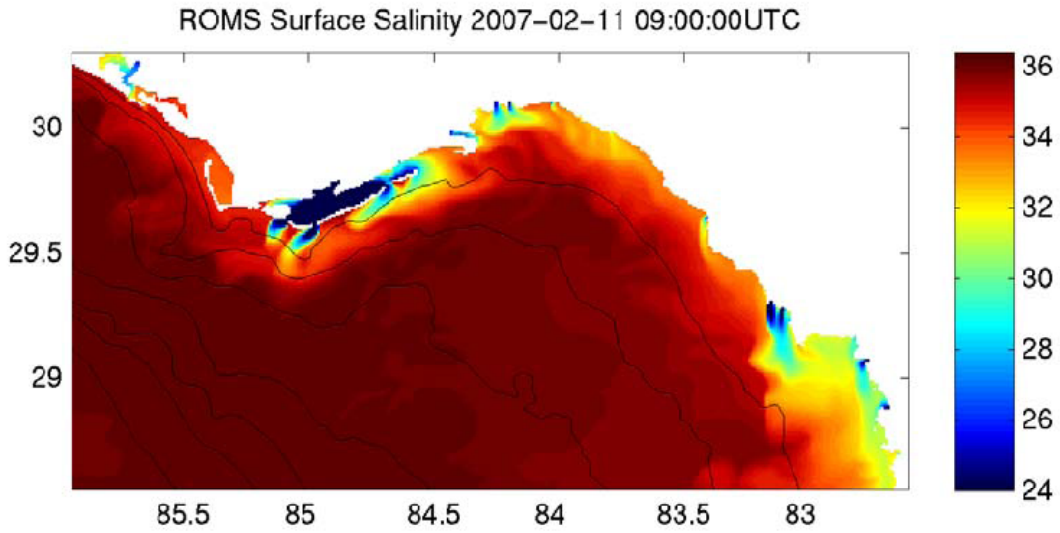


Figure 50. ROMS surface salinity at 11 February 2007 0900UTC. Illustrated here is an example of the multiple pathways by which the riverine influenced Apalachicola Bay water is exported to the shelf, made possible only by accurately representing the multiple inlet estuary's coastline geometery in the model.

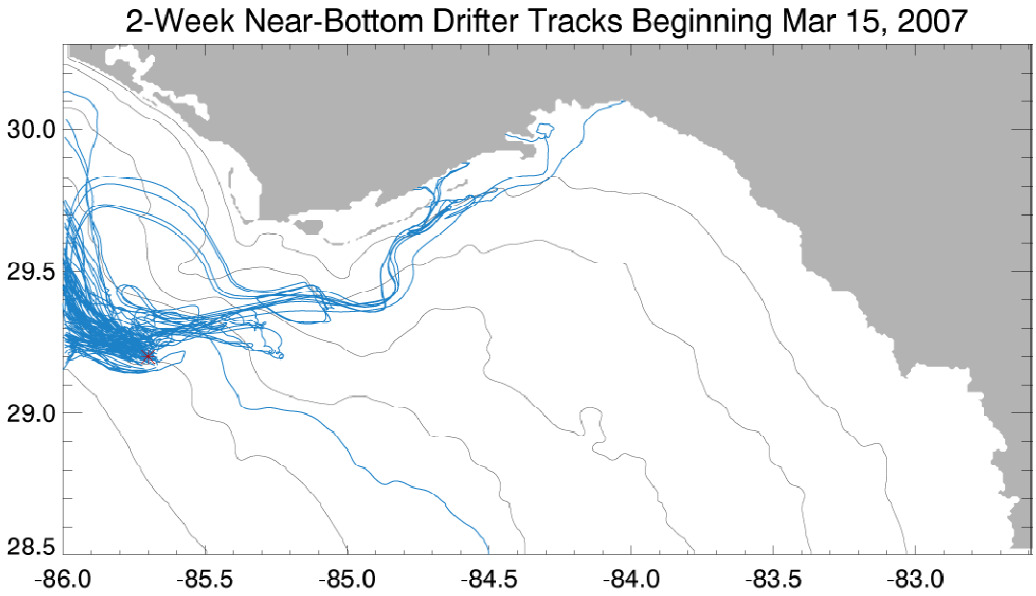


Figure 51. Near-bottom particle trajectories calculated from the ROMS BBR simulation. Particles are released from the Madison-Swanson Reserve location (red 'x') over a two-week period beginning 15 March 2007 and are followed for a maximum of 60 days.

The atmospheric component of the modeling system consists of a 1.33 km Advanced WRF (Weather Research and Forecasting) near-real time model applied over the BBR, nested within a 4 km southeastern U.S. domain, which is in turn nested within the 12 km North American Mesoscale WRF model. This modeling component is being used to examine nearshore sea breeze circulation and air sea fluxes during cold air outbreaks over the region. Two-way coupling of the atmospheric and ocean modeling components is currently being tested. The 4 km intermediate nest is running in near real-time (quasi-operationally) and the data are made available via a web interface

(http://www.coaps.fsu.edu/~dvandyke/wrfarw) to NOAA National Weather Service forecasters in the southeastern U.S. The SWAN (Simulating WAves Nearshore) wave model has also been configured over the BBR using the same horizontal grid as the ROMS modeling component. SWAN solves for the directional wave spectra, which can be input to the flux algorithm for improving the computation of air-sea turbulent fluxes. SWAN and ROMS coupling has been completed using the MCT (Model Coupling Toolkit) and the models run in parallel on FSU's High Performance Computing Facility. One-way nesting by obtaining open boundary conditions from the WaveWatch III operational model is being implemented.

K. Outreach activities

a. GENERAL DESCRIPTION: We have developed the FSU NGI web site: http://coaps.fsu.edu/ngi/. This site contains information about the wide range of FSU activities, observations, data, and research findings. This site serves as a public and easily identifiable access point for FSU's NGI activities.

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

Marine Field Methods Course OCE 5009-L: Combination of NGI activities and the Marine Field Methods course, CTD stations on the NGI line as part of the course, comparisons between Seabird and YSI instruments, stratification at site A.

1. FSU Coastal & Marine Laboratory Lecture Series. 2009 April 9 – Ken Heck, Dauphin Island Sea Lab, Alabama. *Consumers Rule: Predator Primacy in Shallow Benthic Ecosystems*
2. 2009 FSU Coastal & Marine Laboratory Open House – Featured Research
   - Dr. Chris Stallings, FSUCML – Faunal Communities in Seagrass Meadows
   - Dr. Steve Morey, COAPS – Physical oceanographic models of the northeastern Gulf of Mexico
   - James Nelson, Dept. Oceanography – PhD Candidate, "Trophic relationships for gag."
3. Speer, K.: Invited talk in the College of Science and Technology Distinguished lecturer Series, TAMU, Corpus Christi Benthic-Pelagic Coupling in the Coastal Zone, Oxygen, and Physical Transport Processes, K. Speer and M. Huettel.
4. Coleman, C: Pew Fellows Annual Meeting, Costa Rica. Invited, expert panel, "From the Lab to the Legislature". 2008 November.
   - Florida A & M University, Tallahassee, FL. Invited speaker, "Groupers on the Edge", 2009 January.
   - College of Law, Tallahassee, FL. Invited Speaker, "Fish Stories from the Gulf of Mexico", 2009 February.
   - Dauphin Island Grad Student Symposium, Dauphin Island, AL. Key note speaker, "Out of the Ivory Tower", 2009 April.

- Ashley Hall School, Charleston, SC. Expert panel, “Women in the Environment”, 2009 April. National Council of Research Administrators, Annual Meeting. Keynote speaker, “Out of the Ivory Tower.”, 2009 May.

5. Huettel, M.: Filtration and DOC degradation in permeable coastal sands. Presentation at Origins '09, Science & Arts Fair, Kleman Plaza, Tallahassee, March 21, 2009; Huettel, M. (2009). DOC degradation in permeable sands. Public presentations at the FSU Marine Lab Open House, 18th April 2009

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

1. Felicia Coleman, Christopher Stallings – Undergraduate Research opportunities for students enrolled in the Certificate Program in Marine Biology (http://www.bio.fsu.edu/coleman_lab/certificate_program.php). Students have a 3.0 or better GPA for admittance, are juniors and seniors conducting a 13 week research project which they write up in the form of a manuscript and deliver results in a min-symposium of their peers in the fall semester.

2. Summer 2008 - http://www.bio.fsu.edu/coleman_lab/recent_internships.php

- Joshua Brower - *Faunal communities in seagrass meadows across time and space.*
- Alejandra Mickle - *Correlations of predator-preyabundance in seagrass meadows of the northeastern Gulf of Mexico.*
- Patrick Raley - *A comparison of the differences in relative abundance of reef fish on the inner shelf of the northeastern Gulf of Mexico using baited and unbaited digital video drop camera arrays.* Mentor = Dr. Gary Fitzhugh, National Marine Fisheries Service Laboratory, Panama City

L. Has anyone on this project been hired by NOAA? Yes. Morgan Barry (Ruscher graduate student), who has done some volunteer work on the tower project, has been hired as a SCEP intern at NWS Tallahassee (as of June 2009).

M. Peer Reviewed Articles:

Ruscher, P., J. Waller, K. Decoteau, S. White, and B. Broedel, 2009: Development of the northeastern Gulf of Mexico boundary layer observatory. Estuarine, Coastal, and Shelf Science, to be submitted.

Ruscher, P., 2009: First offshore observations from the northeastern Gulf of Mexico boundary layer observatory. Weather and Forecasting, to be submitted.

Wilson, A. M., Huettel, M., Klein, S., 2009: Grain size and depositional environment as predictors of permeability in coastal marine sands. Estuarine, Coastal and Shelf Science, in press.

Nelson, J., J. Chanton, F. Coleman, C. Koenig, 2009: Patterns of stable carbon isotope turnover in gag, *Mycteroperca microlepis*, an economically important marine piscivore of the southeastern United States. Journal of Fish Biology. Submitted.

Morey, S.L., D.S. Dukhovskoy, and M.A. Bourassa, 2009: 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.*, doi:10.1016/j.csr.2009.02.003 .

Carlson, D., 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. Continental Shelf Research, 29, 445-455 doi:10.1016/j.csr.2008.11.003.

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 80: 193-199.

Nelson, J., J. Chanton, F. Coleman, and C. Koenig. Patterns of stable carbon isotope turnover in gag (*Mycteroperca microlepis*), an economically important marine piscivore of the southeastern United States. In review. Bulletin of Marine Science.

Wilson, R.M., J. Chanton, G. Lewis, and D. Nowacek. 2009. Combining Organic Matter Source and Relative Trophic Position Determinations to Explore Trophic Structure in an Estuarine System. Estuaries and Coasts, DOI 10.1007/s12237-009-9183-7

Wilson, R.M., J. Chanton, G. Lewis, and D. Nowacek. 2009. Isotopic variation (?15N, ?13C, and ?34S) with body size in post-larval estuarine consumers. Estuar. Coast. Shelf Sci. 83, 307-312.

N. List non-refereed articles and reports for this project.

Rettig, J. T., M. A. Bourassa, J. Hu, E. M. McDonald, J. J. Rolph, and S. R. Smith, 2009: Data management system to collect, quality control, distribute, and archive near real-time marine data. E-journal of Data Integration and Management on the Gulf of Mexico, 4 pp. Available from http://cs.tamucc.edu/dim/docs/papers/Jacob%20Rettig.doc.

O. List conference presentations and poster presentations for this project.

Bourgoin, Stefan, 2009: Variation in growth rate and diet of early juvenile gag, *Mycteroperca microlepis*, populations in two regions of the northeastern Gulf of Mexico: effects of weather? Proceedings of the Northern Gulf of Mexico Cooperative Institute Annual Meeting, May, Mobile, AL.

Froelich, Philip, 2009: Southeastern Atmospheric Mercury Consortium: Flight Plans over Northern Gulf Coasts and Florida. Proceedings of the Northern Gulf of Mexico Cooperative Institute Annual Meeting, May, Mobile, AL.

Huettel, Markus, 2009: Temporal dynamics of oxygen in the benthic boundary layer along a transect in the Northern Gulf. Proceedings of the Northern Gulf of Mexico Cooperative Institute Annual Meeting, May, Mobile, AL.

Nelson, James, 2009: Flux by Fin: Fish Mediated Carbon and Nutrient flux in the Northeastern Gulf of Mexico. Proceedings of the Northern Gulf of Mexico Cooperative Institute Annual Meeting, May, Mobile, AL.

Ruscher, Paul, 2009: Design and Implementation of the NE GOM Marine Atmospheric Boundary Layer Observatory / A first look at data from the FSU NE GOM Marine Atmos. Boundary Layer Observatory (paper). Proceedings of the Northern Gulf of Mexico Cooperative Institute Annual Meeting, May, Mobile, AL.

Santema, Michael, 2009: A one year observation of bottom boundary layer characteristics along a transect in the Northern Gulf of Mexico. Proceedings of the Northern Gulf of Mexico Cooperative Institute Annual Meeting, May, Mobile, AL.

Stallings, Chris, 2009: From seagrass to reefs: ecology of juvenile gag in the northeastern Gulf of Mexico. Proceedings of the Northern Gulf of Mexico Cooperative Institute Annual Meeting, May, Mobile, AL.

Todd, Austin, 2009: High-resolution modeling of the Florida Big Bend region. Proceedings of the Northern Gulf of Mexico Cooperative Institute Annual Meeting, May, Mobile, AL.

Younge, Rachel, 2009: Importance of Concentration-Correction in Trophic Evaluations (Oral). Proceedings of the Northern Gulf of Mexico Cooperative Institute Annual Meeting, May, Mobile, AL.

Younge, Rachel, 2009: Incorporating Concentration-dependence into Trophic Evaluations (poster). Proceedings of the Northern Gulf of Mexico Cooperative Institute Annual Meeting, May, Mobile, AL.

Rolph, J. J., J. T. Rettig, M. A. Bourassa, J. Hu, E. M. McDonald, and S. R. Smith, 2009: Data Management System to Collect, Quality Control, Distribute, and Archive Near Real-time Marine Data. NGI 2009 Annual Conference, May, Mobile, Alabama.

Dmitry S. Dukhovskoy, Don Van Dyke, Steven L. Morey, Jeremy Rolph, 2009: Modeling wave characteristics in the North Eastern Gulf of Mexico, NGI Annual Conference.

Speer K., S. White, N. Wienders, M. Huettel, 2009: Waves, currents, and storms at the FSU NGI sites. NGI Conference Mobile Alabama, May 2009.

Rettig, J. T., M. A. Bourassa, J. Hu, E. M. McDonald, J. J. Rolph, and S. R. Smith, 2009: Data management system to collect, quality control, distribute, and archive near real-time marine data.

Presentation, Data Integration and Management on the Gulf of Mexico, Corpus Christi, TX, 15-16 May 2009.

Smith, S. R., S. White, and J. Rettig, 2009: Observations in the Gulf of Mexico from the Florida State University. Presentation, Third meeting of the GCOOS DMAC, Orlando, FL, 23-24 February 2009.

Morey, S.L., D.S. Dukhovskoy, D. Van Dyke, A.C. Todd, and E.P. Chassignet, 2008: High-resolution ocean and atmospheric modeling of the Florida Big Bend region, Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract OS52B-03.

Rolph, J., S. R. Smith, and M. A. Bourassa, 2008: Quality evaluation of marine meteorological observations. 2nd Joint GOSUD/SAMOS Workhop, June, Seattle, WA.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.

Chipman, L., Podgorski, D., Green, S., Kostka, J.E., Cooper, W., Huettel, M. (2009). DOM decomposition in permeable coastal sediments. Chemical Oceanography in a Changing World, Savannah, Georgia, 22-24 February.

A one year observation of bottom boundary layer characteristics along a transect in the Northern Gulf of Mexico. Mike Santema, Stephanie White, Kevin Speer, Markus Huettel, 2009 Northern Gulf Institute Annual Conference, May 20-21, 2009 Mobile, Alabama

Temporal dynamics in oxygen in the benthic boundary layer along a transect in the Northern Gulf. Markus Huettel, Mike Santema, Stephanie White, Kevin Speer, 2009 Northern Gulf Institute Annual Conference, May 20-21, 2009 Mobile, Alabama

NGI Projects Led by LSU

LSU 01

A. NGI Project file Number: 08-LSU-01

B. Project title, PI(s), Email, and Affiliation: **DELTA ECOSYSTEM FORECASTING SYSTEM**

PI : Dubravko Justic
EMAIL : djust1@lsu.edu
AFFILIATION : Louisiana State University

Co-PIs: Kenny Rose, Chunyan Li, Robert Twilley
AFFILIATION : Louisiana State University

C. List all non-student personnel funded by this project:

PERSON'S NAME: Dubravko Justic
CATEGORY: Research Scientist
DEGREE: PhD
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 8.3
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Kenny Rose
CATEGORY: Research Scientist
DEGREE: PhD
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 8.3
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Chunyan Li
CATEGORY: Research Scientist
DEGREE: PhD
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 8.3
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Robert Twilley
CATEGORY: Research Scientist
DEGREE: PhD
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Shaye Sable
Category: Postdoctoral Researcher
Degree: PhD
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Asif Hoda
CATEGORY: Postdoctoral Researcher
Degree: PhD
PERCENT OF SALARY FUNDING FROM THE PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Eddie Weeks
CATEGORY: Research Scientist/Support Staff
DEGREE: MS
PERCENT OF SALARY FUNDING FROM NGI: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Anindita Das
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 16.7
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Mo Chen
CATEGORY: Graduate student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 20
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): The central objective of the DELTA project is to understand the effects of different types of pulsing scenarios on coastal ecosystem dynamics. We are developing a series of linked simulation models that allow tracking the effects of pulsed freshwater inputs through hydrodynamics, biogeochemical cycling, primary production, zooplankton dynamics and fish growth. The ongoing field effort by other DELTA projects has generated nearly three years of data on the many short pulses, and fewer longer pulses, and these data are used to support model development, calibration, and validation.

F. 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 from 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).

G. Project Duration:

a. START DATE: 2/1/2007
b. ESTIMATED END DATE: 1/31/2010

H. Project Baselines:

a. CONTRIBUTIONS TO SPECIFIC NOAA GOALS/OBJECTIVES: This project specifically addresses the NOAA's ecological forecasting initiative. The proposed approach enhances ecological forecasting, planning restoration strategies, placement of future sensors, control of freshwater diversions for salinity control, and forecasting/control of harmful algal blooms.

b. 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 DELTA Program leads 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.

c. 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 studies).

I. 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 objective of the DELTA project is to understand the effects of different types of pulsing scenarios on coastal ecosystem dynamics. There are two fundamental types of pulses that are studied within this project: 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 are 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.

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

- We completed a mass-balance model of the Barataria estuary and successfully calibrated the model against observed salinity and water level variations. The model results showed 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 m3 s-1 is equivalent to about 43 % of the lower Mississippi River discharge. The annual TOC export is 109 million kg, or 57 gC m2 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 km2, and accounts for about 34 % of the observed annual wetland loss in the estuary between 1978 and 2000.
- The physical processes affecting the development of seasonal hypoxia over the Louisiana-Texas shelf were examined using a high-resolution, three-dimensional, unstructured-grid, Finite Volume Coastal Ocean Model (FVCOM). Several versions of FVCOM model grids have been developed for 1) the entire Gulf of Mexico with all the major rivers and bays of the Louisiana included, 2) the Atchafalaya Basin, 3) the Barataria and Breton Sound basins, and, 4) the Louisiana and Texas coast. River plumes, river floods and multiple storm surge events were also simulated.
- We finished updating and expanding the marsh community individual-based model (IBM) to use time varying water levels, and added salinity as variable that affects the metabolism of individuals. We performed some preliminary testing of the model by using FVCOM output as input to the marsh IBM. A 14-day time series of salinity at several locations in the hydrodynamics model spatial

grid were repeated in order to allow a full one-year simulation of the marsh IBM. Now that we know we can link the models, we are proceeding to set-up a more realistic set of scenarios.

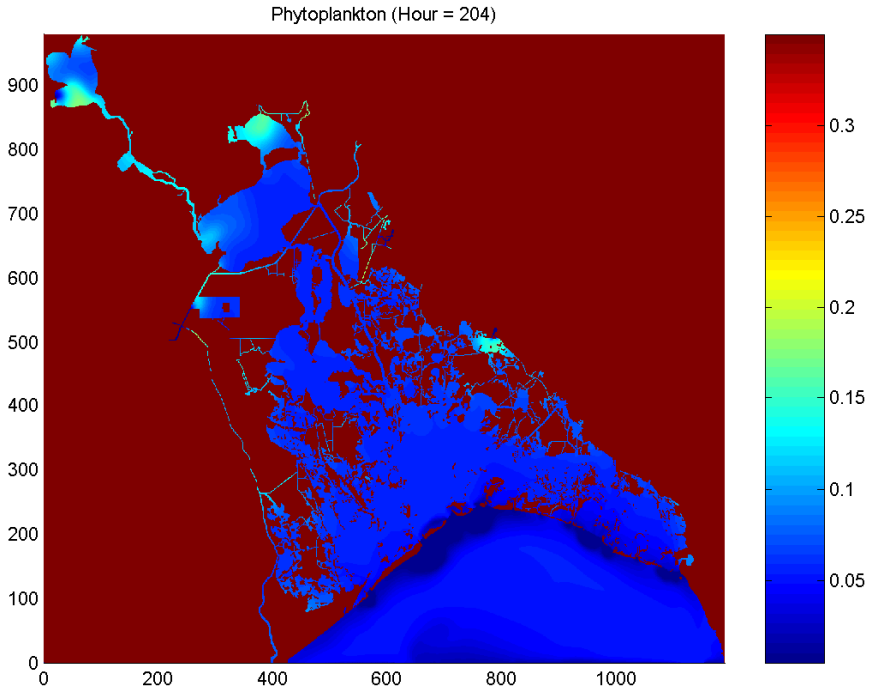


Figure 52. Simulated chlorophyll a concentrations in the Barataria estuary

K. Outreach activities

a. GENERAL DESCRIPTION: Project PIs 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). The project also 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 sea. Project results contribute to this program by demonstrating how high-end computing is used in ecosystem management.

b. HAVE YOU HOSTED SPEAKERS, WORKSHOPS AND/OR ANY TRAINING? No

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles:

Das, A., Justic, D., Swenson, E. 2009. Modeling estuarine-shelf exchanges in a deltaic estuary: Implications for coastal carbon budgets and hypoxia. Ecological Modelling. DOI:10.1016/j.ecolmodel.2009.01.023.

Rego, J., Li, C. 2009. On the importance of the forward speed of hurricanes in storm surge forecasting: A numerical study, Geophysical Research Letters, VOL. 36, L07609.

Rego, J., Li, C. 2009. On the receding of storm surge along Louisiana's low-lying coast. Journal of Coastal Research SI 56(2), 1045-1049.

Wang, L., Justic, D. 2009. A modeling study of the physical processes affecting the development of seasonal hypoxia over the inner Louisiana-Texas shelf: Circulation and stratification. Continental Shelf Research. DOI:10.1016/j.csr.2009.03.014.

Rego, J., Li, C. Storm surge propagation in Galveston Bay during Hurricane Ike. Journal of Marine Systems (In review).

Rego, J., Li, C. The effect of tides and shelf geometry on storm surge: Numerical model experiments for Hurricane Rita. Journal of Geophysical Research-Oceans (In review).

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Justic, D., Rose, K., Li, C., Wang, L., Hoda, A. and A. Das. 2009. 2-D and 3-D coupled hydrodynamic-water quality models for coastal Gulf of Mexico. 2009 Northern Gulf Institute Annual Conference, May 20-21, 2009, Mobile, Alabama (Oral presentation).

Das, A., Justic, D. and E. M. Swenson. 2009. Modeling Estuarine Shelf Exchanges in a Deltaic Estuary: Implications for Coastal Carbon Budgets and Hypoxia. 2009 Northern Gulf Institute Annual Conference, May 20-21, 2009, Mobile, Alabama (Poster presentation).

Li, C., Chen, C., Rego, J., Justic, D., Rose, K., Lin, H., Twilley, R. and D. Braud. 2009. Tidal, wind and river discharge driven water transport through the LA bays and Caernarvon freshwater diversion using FVCOM. 2009 Northern Gulf Institute Annual Conference, May 20-21, 2009, Mobile, Alabama (Oral presentation).

Rego, J. and C. Li. 2008. Hurricane Storm Surge Simulations on a Shallow Shelf, PECS 2008: Physics of Estuaries and Coastal Seas; to be held August 2008, Liverpool, UK (Oral presentation).

Li, C., Chen, C. and Georgiou, I. 2008. Observations and Modeling of Residual Eddies in Estuaries with Curved Channels, PECS 2008: Physics of Estuaries and Coastal Seas; to be held August 2008, Liverpool, UK (Poster presentation).

LSU 02

A. NGI Project file Number: 08-LSU-02

B. Project title, PI(s), Email, and Affiliation: PUBLIC HEALTH AND STRESSORS

PI : Sibel Bargu Ates
EMAIL : sbargu@lsu.edu
AFFILIATION : Department of Oceanography and Coastal Sciences, 1001 Energy, Coast & Environment Building, Louisiana State University, Baton Rouge, Louisiana 70803, (225) 578-0029

Co-PI: Eugene Turner
EMAIL: eturne@lsu.edu
AFFILIATION : Department of Oceanography and Coastal Sciences, 1001 Energy, Coast & Environment Building, Louisiana State University, Baton Rouge, Louisiana 70803, (225) 578-6454

Co-PI: Aixin Hou
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AFFILIATION : Department of Environmental Studies, 001 Energy, Coast & Environment Building, Louisiana State University, Baton Rouge, Louisiana 70803, (225) 578-5294

Co-PI: Brian Fry
EMAIL: bfry@lsu.edu
AFFILIATION : Department of Oceanography and Coastal Sciences, 1001 Energy, Coast & Environment Building, Louisiana State University, Baton Rouge, Louisiana 70803, (225) 578-9403

C. List all non-student personnel funded by this project:

PERSON'S NAME: Charlie Milan
CATEGORY: Research Associate
PERCENT OF FUNDING FROM THIS PROJECT? 12
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Erick Swenson
CATEGORY: Research Associate
PERCENT OF FUNDING FROM THIS PROJECT? 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Sara Green
CATEGORY: Postdoctoral Researcher
DEGREE: Ph.D.
PERCENT OF FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Kari Galvan
CATEGORY: Postdoctoral Researcher
DEGREE: Ph.D.
PERCENT OF FUNDING FROM THIS PROJECT? 13
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Hee-Sung Bae
CATEGORY: Research Associate
PERCENT OF FUNDING FROM THIS PROJECT? 20
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Jessica Czubakowski
CATEGORY: Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Brian Matherne
CATEGORY: Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s):

1. *Community Biomass and Turnover*. We are quantifying 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 also focus on quantifying N sources to the estuaries using isotope measurements of nitrate and N fixation.
2. *Community Metrics*. We are determining plankton community metrics, using fingerprint of microbial metabolites, nutrient bioassays (algae) and sediment records.
3. *HABs*. We are routinely sampling estuarine waters to quantify occurrence and abundance of harmful algal species, and also quantifying HAB toxicity using ELISA in water samples. We are specifically studying 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 the potential phycotoxin production. Findings are correlated to environmental characteristics within Breton Sound Estuary.
4. *Vibrio.* We are developing qPCR protocols to detect and quantify potentially pathogenic Vibrio species of interest in coastal waters and studying the temporal and spatial dynamics of *Vibrio vulnificus* and *Vibrio parahaemolyticus* using both culturing and molecular methods. We are also determining the impacts of physiochemical parameters (temperature, salinity, and nutrients in particular) on the development of the populations.

F. Collaborators(s)/Partners: This Project is coordinated with the DELTA observation system proposed with funding from a Shell grant to LSU.

G. Project Duration:

a. START DATE: 7/1/2007
b. ESTIMATED END DATE: 12/31/2010

H. Project Baselines:

a. 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.

b. CONTRIBUTIONS TO REGIONAL PROBLEMS AND PRIORITIES: 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.

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.

c. 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.

I. Project Abstract: Changing hydrologic regimes and nutrient loadings in coastal waters may impact ecosystem restoration and public health. 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. Our research focus is on planktonic community structure and function, measuring particulate organic matter (POM) composition, microbial respiration and algal growth rates, and harmful algal blooms (HABs) and increased waterborne pathogens such as Vibrio sp. bacteria along transects in two Louisiana estuaries, Barataria Bay and Breton Sound. These estuaries are targeted for restoration by increased inputs of Mississippi River water, and our research will help test effectiveness of the river restoration strategy.

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

Fry Lab: POM dynamics for Barataria Bay were summarized for an 8 year period of record, and relatively constant biomass patterns between seasons and years was found. The annual averages vary 1-1.5x, a small range, and the seasonal averages varied a bit more, 1-2.5x, with summer having more phytoplankton than winter (October-November). C/N ratios were used to separate contributions of phytoplankton (C/N = 6.6, redfield) and sediments (C/N =15) (Figure 1, attached). There was really no significant difference between years in phytoplankton carbon, and only any marginally significant difference between seasons. Light limitation of phytoplankton growth may account for these relatively constant POM patterns across years.

Cyanobacteria were regularly enriched in 13C and depleted 15N, providing a good diagnostic for conditions when cyanobacteria dominate. These signals occurred regularly in Lac Des Allemands and in the 2-5psu lakes in Caernarvon.

Turner Lab: Fifteen years of monthly transect data, including data from this collaborative project with Shell, are being summarized and the trends identified. A significant drop in Chl a in the Barataria Basin has been quantified, but the concentration of nutrients has stayed relatively constant. A major increase in phytoplankton biomass occurred when the Bonnet Carré diversion was opening, which was successfully predicted using the nitrogen load. The algal bloom in Lake Pontchartrain (2008) was accompanied by a brief rise in total bacteria, but then quickly came back down to a baseline value that remains relatively constant over 10 months.

Indices of bacterial density and metabolism are underway in the Barataria and Lake Pontchartrain estuaries. Samples from the Barataria transect show the lowest density and microbial metabolic 'footprint' at the seaward end of the estuary and highest in Lake Des Allemands (Figure 2, attached). There are few indications that the Davis Pond diversion water has affected the microbial community in Lake Salvador.

Bargu Lab: The role of nutrient loaded freshwater pulses on phytoplankton succession and phycotoxin production in Breton Sound Estuary, Louisiana is studied. Over the period of this study, decreasing the flow in Breton Sound Estuary resulted in an increase in chlorophyll concentrations, likely as a result of an increase in phytoplankton biomass. Also, the shift in the phytoplankton community from inland to more coastal stations, following the salinity and nutrient gradients, was observed. Diatoms are more successful in the fall and winter because they can tolerate turbulent waters caused by the seasonal cold fronts. In the spring when the waters begin to settle and nutrient loading increases to the estuary, a chlorophyte dominated, but diatoms, which are very good competitors for nutrients, were still present in high numbers. In the summer when river flow is decreased and diversion flow is minimized, nutrients become limited in the estuary and cyanobacteria dominate (Table 1, attached). HAB species identification and toxin measurements still continue.

A study was also conducted in a hyper-eutrophic freshwater lake, Lac des Allemands, located in the Barataria estuary system of southeastern Louisiana, and was aimed at documenting the presence and abundance of toxic cyanobacteria and assessing microcystin concentrations in surface water and blue crabs taken from this region. Microcystis spp. were the dominant cyanobacteria, with alternating blooms of Microcystis and Anabaena spp. occurring during the 8-month study. Enzyme-Linked Immunosorbent Assay (ELISA) was used to evaluate concentrations of microcystins from surface water and hepatopancreas, viscera, and muscle tissues of blue crabs. The highest concentration of microcystins found in surface water (1.42 µg MC l-1) was above the tolerable daily intake (TDI) guideline for microcystins in drinking water (1.0 µg MC l-1) set by the World Health Organization (WHO). Highest concentration of microcystins occurring in crab tissue were 82.0 µg MC kg-1 in hepatopancreas, 10.5 µg MC kg-1 in muscle, and 6.5 µg MC kg-1 in viscera, which were close to or exceeding the WHO-TDI guidelines for human consumption (0.04 µg MC kg-1 body weight day-1). This pilot study documents the presence of microcystins in both surface water and blue crab tissue and

therefore, demonstrates the potential for Microcystis and Anabaena blooms to produce toxins that may be accumulated in the tissues of blue crabs and transferred to higher level consumers.

Finally, we investigated the impacts of hurricane Gustav and Ike on Bay Champagne, Louisiana. We collected samples prior to and after both hurricanes to determine impacts on benthic and pelagic Chl a, community composition of benthic microalgae and phytoplankton, grain size, percent organic matter and nutrients. After hurricanes, we found significant changes in measured parameters including increases in the sand:silt ratio and benthic Chl a and decreases in percent organic matter in sediments. Benthic Chl a and organic matter are indicators of available microalgal and detrital food resources. In addition to grain size, these parameters are known to affect infauna community composition. Thus, hurricanes can generate changes in local primary producers that may affect primary consumers and potentially higher trophic levels.

Hou Lab: Water samples were collected along two salinity gradient transects in these two water bodies, at a monthly frequency, from September 2007 through September 2008, and from March 2008 through September 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. Typical population growth model is observed, with higher Vibrio numbers appearing during warmer months, and reduced Vibrio numbers during colder months (Figure 3, attached). The 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.

Overall, the results of this research have the potential to greatly enhance our understanding of the ecological function of coastal systems, particularly as they translate to environmental health issues and, given the importance of these issues to Louisiana.

K. Outreach activities

a. GENERAL DESCRIPTION: Our project supported graduate and postdoctoral students' research projects, allowed them to attend meetings to present their results and gave them the opportunity to interact with scientists in different disciplines.
b. HAVE YOU HOSTED SPEAKERS, WORKSHOPS AND/OR ANY TRAINING? No

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles:

Garcia, A.C., S. Bargu, P. Dash, N. Rabalais, M. Sutor, W. Morrison, N. Walker (In Review) Evaluating the potential risk of microcystins to blue crab (Callinectes sapidus) fisheries and human health in a eutrophic estuary. Harmful Algae

N. List non-refereed articles and reports for this project: None

O. List conference presentations and poster presentations for this project:

S. Bargu, B. Fry, A. Hou, R.E. Turner. 2009. Public Health, Stressors and Water Quality in Coastal Louisiana. Northern Gulf of Mexico Institute Annual Meeting, 20-21 May, 2009, Mobile, AL. (poster).

R. E. Turner et al. 2009. Water Quality in the Barataria Estuary. Northern Gulf of Mexico Institute Annual Meeting, 20-21 May, 2009, Mobile, AL. (oral).

K. Galvan, S. Bargu, J. White, C. Li, E. Weeks. 2009. The effects of Hurricane Gustav and Ike on sediment grain size, percent organic matter, nutrients, Chlorophyll a and algal species composition in a Louisiana, shallow coastal bay. Northern Gulf of Mexico Institute Annual Meeting, 20-21 May, 2009, Mobile, AL. (oral).

J. Czubakowski, S. Bargu, R. Twilley. 2009. Changes in the phytoplankton community and harmful algal species of a Louisiana estuary influenced by nutrient loaded fresh Mississippi River water. Northern Gulf of Mexico Institute Annual Meeting, 20-21 May, 2009, Mobile, AL.

R. E. Turner et al. 2009. Barataria Estuary. Nutrient Criteria Research Framework Workshop, New Orleans, LA. 10-12 March 2009, New Orleans (oral).

J. Czubakowski and S. Bargu. 2009. Changes in the phytoplankton community and harmful algal species of a Louisiana (USA) estuary influenced by nutrient loaded fresh Mississippi River water, American Society of Limnology and Oceanography Aquatic Sciences conference, Nice, France (poster).

LSU 03

A. NGI Project file Number: 08-LSU-03

B. Project title, PI(s), Email, and Affiliation: **TROPHIC LINKAGES AND BIOMASS PRODUCTION IN ESTUARINE ECOSYSTEMS**

PI : Malinda M. Sutor
EMAIL : msutor1@lsu.edu
AFFILIATION : Department of Oceanography and Coastal Sciences, School of the Coast and Environment, Louisiana State University, Baton Rouge, Louisiana 70803, (225) 578-8055

CO-PI : Sibel Bargu Ates
EMAIL : sbargu@lsu.edu
AFFILIATION : Department of Oceanography and Coastal Sciences, 1001 Energy, Coast & Environment Building, Louisiana State University, Baton Rouge, Louisiana 70803, (225) 578-0029

Co-PI: James Cowan
EMAIL: jhcowan@lsu.edu
AFFILIATION : Department of Oceanography and Coastal Sciences, 1001 Energy, Coast & Environment Building, Louisiana State University, Baton Rouge, Louisiana 70803, (225) 578-9400

Co-PI: Richard F. Shaw
EMAIL: rshaw@lsu.edu
AFFILIATION : Department of Oceanography and Coastal Sciences, 1001 Energy, Coast & Environment Building, Louisiana State University, Baton Rouge, Louisiana 70803, (225) 578-6734

C. List all non-student personnel funded by this project:

PERSON'S NAME: Malinda Sutor
CATEGORY: Research Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8.3
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Sibel Bargu Ates
CATEGORY: Research Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8.3
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project: None

E. Key Scientific Question(s)/Technical Issues(s): (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-02 "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.

F. Collaborator(s)/Partners:

NAME OF COLLABORATING ORGANIZATION: Louisiana Department of Wildlife and Fisheries

DATE COLLABORATING ESTABLISHED: 7/1/2007

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? None

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? None

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. LDWF provides data on fish population assessments in the Barataria and Breton Estuaries

G. Project Duration:

a. START DATE: 7/1/2007
b. ESTIMATED END DATE: 12/31/2010

H. Project Baselines:

a. 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.

b. 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.

c. 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.

I. 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.

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

We have completed 20 monthly transects (September 2007-April 2009) 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.

We have also completed three quarterly transects in Barataria and Breton and we are processing the plankton samples collected on those transects and are analyzing the results of incubations to measure primary production.

K. Outreach activities: None

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Sutor, M.M., S. Bargu Ates, R.F. Shaw, J.H. Cowan. 2009. Temporal and spatial trends in plankton and fish community composition and primary production in two Louisiana estuary systems: Breton Sound and Barataria Bay.

Sutor, M.M. and J. Bach. 2009. Effects of freshwater pulsing on abundance and composition of microzooplankton and phytoplankton.

LSU 04

A. NGI Project file Number: 08-LSU-04

B. Project title, PI(s), Email, and Affiliation: **INVESTIGATING MATERIAL EXCHANGE BETWEEN THE MARSH AND CHANNEL ALONG AN ESTUARINE GRADIENT**

PI : Jaye Cable
EMAIL : jcable@lsu.edu
AFFILIATION : Louisiana State University

CO-PIS : John White, Irving Mendelssohn, Robert Twilley
AFFILIATION : Louisiana State University

C. List all non-student personnel funded by this project:

PERSON'S NAME: Jaye Cable
CATEGORY: Research Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0.05
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: John White
CATEGORY: Research Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 3.7
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Irving Mendelssohn
CATEGORY: Research Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Robert Twilley
CATEGORY: Research Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT?: 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Joeseph Baustian
CATEGORY: Research Scientist
DEGREE: M.S.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Chester Keating
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BA
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Brett Marks
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BA
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Julia Wheatley
CATEGORY: Undergraduate Student
CURRENT HIGHEST DEGREE: Other
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 3
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Christopher Whittaker
CATEGORY: Undergraduate Student
CURRENT HIGHEST DEGREE: Other
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 13
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Benjamin Leblanc
CATEGORY: Undergraduate Student
CURRENT HIGHEST DEGREE: Other
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Maverick Leblanc
CATEGORY: Undergraduate Student
CURRENT HIGHEST DEGREE: Other
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): The variation in carbon production and decomposition along an estuarine gradient.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: Shell Oil Company
DATE COLLABORATING ESTABLISHED: Feb 2007
DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? Yes, $65,000 over 3 years
DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? No
SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Shell has provided funding to instrument several wetland platforms to monitor groundwater level, salinity, and temperature.

G. Project Duration:

a. START DATE: February 1, 2007
b. ESTIMATED END DATE: January 31, 2010

H. Project Baselines:

a. CONTRIBUTIONS TO SPECIFIC NOAA GOALS/OBJECTIVES: Carbon fluxes from rivers and other point sources to ocean margins are fairly well established, but the diffuse contribution of carbon to the ocean from marshes and how this source will change as climate varies are not well understood. This project specifically fits the NOAA mission goals to understand climate variability and ecosystem management due to the implications for both local-scale coastal eutrophication and the global carbon budget.

b. CONTRIBUTIONS TO REGIONAL PROBLEMS AND PRIORITIES: Coastal wetland sustainability, potential sources for eutrophication, and sea level rise are being addressed by evaluating their status and functioning in wetlands of a major river system, e.g., the Mississippi River. Understanding how hydrologic pulsing (as imitating natural flood regimes) impacts these wetlands will be of significant value to occupants of other major river systems in the world. This project impacts the educational missions of Louisiana State University through training undergraduate and graduate students and enhancing the mission of LSU's land-grant and sea-grant institution status.

c. GAPS: Very little is understood about ocean margin carbon sources and the role in the global carbon budget. This project will improve our understanding of carbon export from fresh and salt marshes in northern Gulf of Mexico through a study in coastal Louisiana. Data collected will support regional models for ecosystem management through the Delta Observing System Project (08-LSU-01). In addition, we have strong connections with interagency advisory committees, such as CIAC, in Louisiana and the state review team for science and engineering that facilitate a rapid transfer of ideas and products to decision makers.

I. 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 m^3 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 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.

J. List major milestones completed and describe any significant research results and transitions.
We have measured short-term and long-term soil decomposition rates. Aboveground biomass production has been estimated and belowground allocations of biomass have also been determined. Porewater nutrients have been characterized for soil profiles at several transects and potential Denitrification and N mineralization have been conducted under both fresh and saline conditions.

K. Outreach Activities: None
L. Has anyone on this project been hired by NOAA? None
M. Peer Reviewed Articles: None
N. List non-refereed articles and reports for this project. None

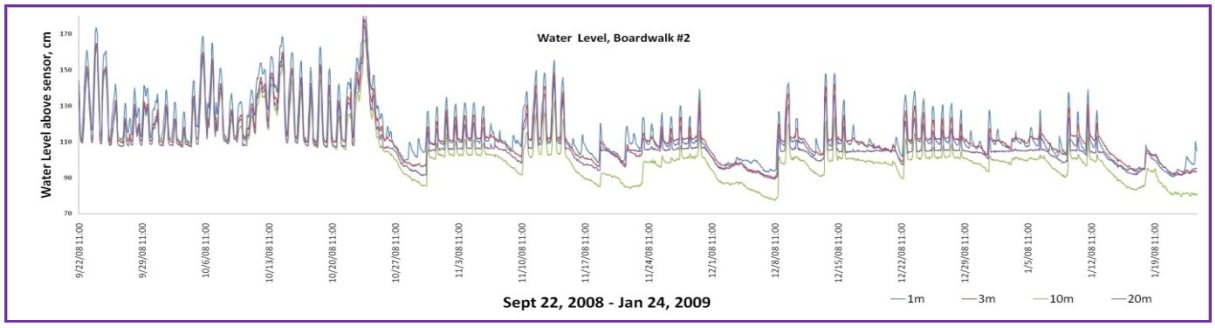

Figure 53. Times series of marsh pore water levels above the sensor for individual wells along the transect. A slight lag time (less than 4 hours) was observed between the front well (1 m) and the back well (20 m), which translated to a marsh pore water recharge rate average of about 0.14 cm/sec. However, recharge and discharge rates varied over the flood and ebb durations.

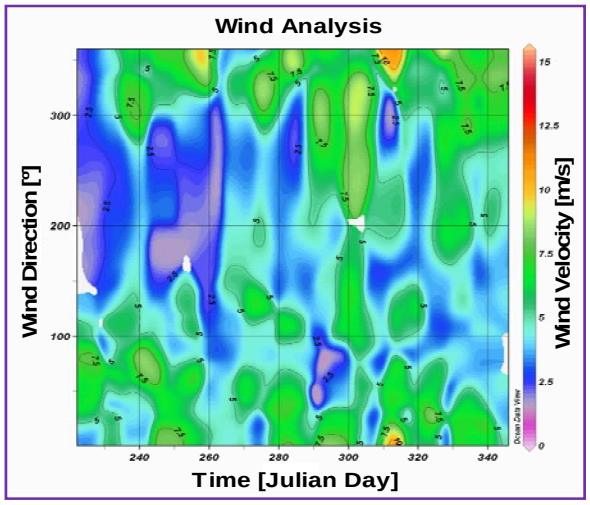

Figure 54. Wind speed and direction over time for the water level collection period. Spectral analyses of these data indicate a strong 10-day periodicity in wind events corresponding to similar flooding periodicity in the marsh.

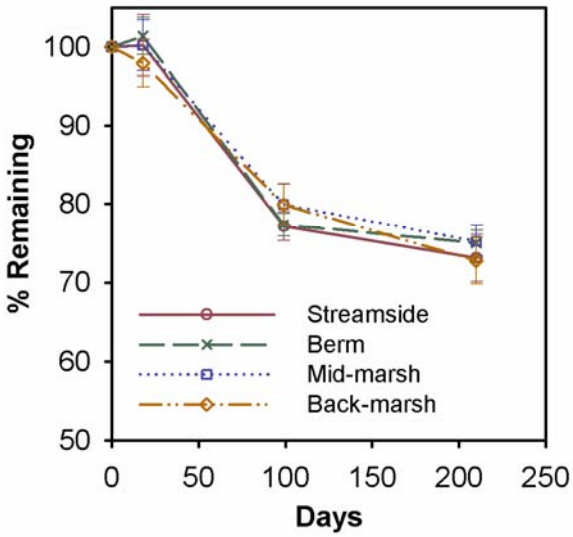

Figure 55. Litterbag decomposition along a streamside to back-marsh gradient in a Louisiana salt marsh.

O. List conference presentations and poster presentations for this project.

Marks B.W., J.R. White and R.D DeLaune. Effect of Salinity on the Biogeochemical Cycling of Nitrogen in Wetland Soil of the Breton Sound Estuary, LA. Poster presentation at the NGI Annual Meeting (May 2009) Mobile, AL.

Baustian, J.J., I.A. Mendelssohn, J.E. Cable, J. White. R. Twilley. Investigating Material Exchange Between Salt Marshes and Water Bodies: A Case Study in Breton Sound Basin. Northern Gulf Institute Annual Meeting, (May 2009) Mobile, AL.

Marks, B.W. and J.R. White. Effect of Salinity on Denitrification Rates in Louisiana Wetland Soils. Poster Presentation at the Joint Meeting of the Geological Society of America and the Soil Science Society of America Meeting (Oct 2008) Houston, TX.

MSU 01

A. NGI Project file Number: 08-MSU-01

B. Project title, PI(s), Email, and Affiliation: **DEVELOPING A FOUNDATION FOR ANALYSIS OF NATURAL AND HUMAN-INDUCED DISTURBANCES TO COASTAL ECONOMIES**

PI: Daniel R. Petrolia
AFFILIATION: Department of Agricultural Economics, Mississippi State University

C. List all non-student personnel funded by this project:

PERSON'S NAME: Daniel R. Petrolia
CATEGORY: Assistant Professor
DEGREE: PH.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 7
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Tae-goun Kim
CATEGORY: Post-doctoral Research Associate
DEGREE: PH.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Sanjoy Bhattacharjee
CATEGORY: Post-doctoral Research Associate
DEGREE: PH.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 58
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Guyslain Ngeleza
CATEGORY: Post-doctoral Research Associate
DEGREE: PH.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: James Harris (resigned Jun 2009)
CATEGORY: Research Associate
DEGREE: Master of Agribusiness Management
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 66
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Brooklyn Anderson (resigned May 2009)
CATEGORY: Research Associate
DEGREE:MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Ross G. Moore
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: James Harris (fall 2008 only)
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Will T. Ferraez
CATEGORY: Undergraduate Student
CURRENT HIGHEST DEGREE: HS diploma
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Heather Dikes
CATEGORY: Undergraduate Student
CURRENT HIGHEST DEGREE: HS diploma
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): Non-market valuation of MS Barrier-island restoration; non-market valuation of Louisiana wetland restoration; hurricane evacuation behavior; MS River basin land-use analysis; Northern Gulf Coast migration patterns analysis; Assessment of economic recovery of seafood processors and dealers, marinas, commercial harvesters, and bait dealers in coastal Mississippi; Port of New Orleans economic impact analysis; Northern Gulf coast business resiliency analysis; Post-Katrina retail sector shifts analysis; economic impact analysis of public agencies within coastal communities as a result of coastal hazards; analysis of impact of information released by independent media sources concerning coastal hazards on attendance levels at publicly-funded federal, state and local recreational facilities.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: Center for Natural Resource Economics and Policy, Louisiana State University

DATE COLLABORATING ESTABLISHED: Feb 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. Research collaboration on non-market valuation of wetland restoration and analysis of MS River basin land uses. Collaborators are Rex Caffey (Prof, Agricultural Economics) and John Westra (Assoc. Prof, Agricultural Economics)

NAME OF COLLABORATING ORGANIZATION: Gulf Coast Geospatial Center, University of Southern Mississippi

DATE COLLABORATING ESTABLISHED: Feb 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. Provide maps for non-market valuation of MS barrier-island restoration. Collaborator is Greg Carter (Prof., GCGC-USM)

NAME OF COLLABORATING ORGANIZATION: Florida A&M University

DATE COLLABORATING ESTABLISHED: Feb 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. Research collaboration/guidance on hurricane evacuation behavior analysis. Collaborator is Michael Thomas (Assoc. Prof, Agribusiness)

G. Project Duration:

a. START DATE: February 2007
b. ESTIMATED END DATE: January 2010

H. P**roject Baselines:**

a. CONTRIBUTIONS TO SPECIFIC NOAA GOALS/OBJECTIVES: Regarding this project's relationship to NOAA's broad societal goals, it has linkages to all of the goals specified in the National Ocean Service Social Science Plan, which includes a)Enhance NOAA's ability to monitor, understand, evaluate, and communicate socioeconomic benefits of NOAA/NOS information, services, and products; b) Provide more accurate and comprehensive decision-support tools for ecosystem management by integrating social science, natural science, and monitoring results; c) Improve models and methods for assessing the impact of human and natural disturbances to coastal and ocean resources and infrastructure; d) Increase the relevancy of NOAA efforts by improving understanding of the needs, knowledge, perceptions, and values of NOAA partners and constituents.

b. CONTRIBUTIONS TO REGIONAL PROBLEMS AND PRIORITIES: 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, it was necessary to implement a two-dimensional approach. This approach can be divided according to which NGI theme they primarily serve. This project contributes to NGI themes I (Ecosystem Management) and IV (Coastal Hazards). 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.

c. GAPS: The work being conducted under this project advances the frontier of economic science by contributing to natural-resource and community development economics literature, which will, in turn, allow for economists and other researchers to better assist the scientific community and public policy decision-makers. Specifically, this project addresses gaps in natural resource valuation literature for coastal ecosystems and the gaps that exist in the understanding of the impact of coastal hazards on coastal economic activity.

I. Project Abstract: See sect J.

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

Task 1. (completed) Non-market valuation of MS barrier-islands restoration. A dichotomous-choice contingent-valuation survey was conducted in the State of Mississippi (USA) to estimate willingness to pay (WTP) for three restoration options being considered for the state's barrier islands. Random-effects probit models were estimated, and parametric and non-parametric WTP estimates and confidence intervals were calculated. Turnbull lower-bound mean WTP was $22 per respondent to maintain the existing footprint over a 30-year period, $152 to restore 2,338 acres (Pre-1969 footprint),

and $277 to restore 5,969 acres (Pre-1900 footprint). Econometric results indicate that for the Pre-Camille and Pre-1900 options, coastal residents and those citing storm protection, recreation impact, and environmental impact as primary decision factors, were more likely to support restoration, with marginal effects of these greater for the Pre-Camille option. For the Status-Quo option, seventy-five percent of respondents voted in favor of restoration, and the offered bid was not significant; only the hurricane-protection and environmental-impact variables were significant for this option.

Task 2. (ongoing) Non-market valuation of Louisiana coastal restoration. The proposed research focuses on the increasing trend towards integration of coastal restoration and hurricane protection, with particular emphasis on the demand for rapid land-building technologies in the wake of the 2005 hurricane season. The primary objective of this project is to develop a comprehensive public-opinion survey instrument to better understand preferences for, and estimate the non-market value of, rapid land-building technologies (existing and proposed) for coastal restoration and protection in Louisiana, and the influence of climate change perceptions and preferences on restoration preferences. The survey has been mailed out and data collection is currently underway. Results will complement ongoing research investigating the costs of such land-building technologies.

Task 3. (ongoing). MS Basin land-use model and hypoxia analysis. This task will evaluate the impacts of increased production of biofuels and alternative land-uses on environmentally-sensitive lands within the MS River Basin by integrating results from predictive models of multifunctional impacts from different agricultural management systems with estimates of economic value derived from scenarios to create a tool that estimates impacts and values of different management systems. Impacts include changes in nutrient loads (nitrogen and phosphorus) directly related to Gulf hypoxia and landowner profitability/income.

Task 4. (postponed/transferred). Assessing research needs of coastal natural disaster risk and insurance. Due to the loss of research personnel assigned to this task, the workload of this task was delayed and transferred to a subsequent (Year 4) NGI research proposal. Funding allocated for this task was re-assigned to accommodate unanticipated needs of other tasks.

Task 5. (completed) Hurricane evacuation behavior analysis. A multinomial choice framework was used to analyze data from hypothetical storm forecast scenarios administered via mail survey to a random sample of U.S. Gulf Coast residents. Results indicate that the issuance of a mandatory evacuation notice and the presence of higher wind speeds had the largest influence on increasing the likelihood of evacuation. Age, race, disability, distance, and education were significant in explaining one's decision to wait relative to choosing to evacuate. Blacks and disabled individuals were strictly less-likely to wait and more likely to make an immediate evacuation decision. Hurricane Katrina evacuees and those with an evacuation destination identified were also more likely to decide to evacuate, but were also more likely to wait before deciding. Results indicate that residents of mobile homes were more likely to either evacuate or wait before making a decision, but strictly less-likely not to evacuate. Respondents very confident in being rescued were strictly more-likely not to evacuate. Results indicate that not having an evacuation destination identified was the most influential factor regarding the likelihood of not knowing what choice to make.

Task 6A. (completed) Northern Gulf Coast Migration Patterns. The principal goal of this project was to investigate the relationship between county-level migration flows and Hurricane Katrina. Population migration patterns have numerous community-level implications, including: changes in income levels, tax bases, political structures, local supply-demand chains, and infrastructural needs. Thus, regional economic and labor markets may change in tandem with these population dynamics. Natural disasters, such as hurricanes, have been identified as major contributors to population migration. While some studies have looked at labor market effects of Hurricane Katrina, they generally focus on specific metropolitan areas. This work, in contrast, explored changes in industry- and county-level establishment counts, employment, and wages from before and after Hurricane Katrina for Mississippi. The analysis shed light on several important patterns emerging in the Mississippi labor market in the short-term following Hurricane Katrina. Mississippi counties with the greatest amount of in-migration from the evacuated coastal counties generally witnessed positive labor market changes, including increases in both establishment counts and wages. Furthermore, counties with high post-storm in-migration levels in metropolitan areas, where incomes were relatively high, and unemployment and minority presence were low, appeared more likely to experience significant increases in employment.

Task 6B. (completed). Spatial Shift-Share Analysis of Coastal Employment Following Hurricane Katrina. This project examined employment shifts in the Leisure and Hospitality sector along the Gulf coast following Hurricane Katrina using spatial shift-share analysis. Using a spatial weights matrix that incorporated relative employment, and distance measures relative to the track of Hurricane Katrina it was possible to calculate classical and spatial shift-share components. Regression analysis provided evidence that spatial interaction between employment centers as well as with the storm track, was a relevant aspect of the employment shifts that occurred following Hurricane Katrina.

Task 6C. (completed). Hurricane Katrina and Spatial Patterns of Regional Specialization. This project explored the spatial dimensions of employment change in Louisiana, Mississippi, Alabama and Florida by looking at how spatial dispersion of export base sectors changed in the wake of Hurricane Katrina. It was found that: (1) regional specialization is clustered for certain sectors of the economy in areas that were also affected by Hurricane Katrina; and (2) that changes in regional specialization associated with Hurricane Katrina can be identified with local indicators of spatial association.

Task 7. (ongoing). Assess economic recovery of seafood processors and dealers, marinas, commercial harvesters, and bait dealers in coastal Mississippi. This task will assess the economic recovery after Hurricane Katrina of the commercial and recreational fishing industries, including seafood processors and dealers, piers and marinas, commercial harvesters, and bait dealers. Economic surveys will be conducted to document the progress and status of economic recovery of the selected marine industries. Specifically, the economic participation of key sectors will be determined, the level of economic activities and the economic impact of these sectors on the regional economy will be determined, the socio-economic factors enhancing or limiting the levels of economic participation and new investments will be assessed, and educational programs to educate the public about the state of economic recovery will be conducted.

Task 8. (ongoing). Port of New Orleans impact analysis. The primary objective of this project is to assess the economic impact of temporary disruptions and the diversion of cargo activity on the local and state economy. Particularly, the impacts of the lost revenue and income due to the diversion of cargo and port inactivity due to natural disasters, and the impact of disruptions on key commodities prices will be assessed. After a visit to the Port of New Orleans, in July 2008, it was confirmed that the Port was able to quickly recover and was operating at normal capacity within two weeks. While there were labor issues given the decrease in population resulting from displaced residents, the decrease in port activity due to Hurricane Katrina was for the most part inconsequential. The second part of the objective was to assess how key agricultural commodities were impacted by Hurricane Katrina. Given the limited decrease in port activity, this project will now focus solely on the impact of the hurricane on commodity supply and prices, with particular focus on the U.S. shrimp industry in the Gulf of Mexico that was substantially impacted by the hurricane. With the help of USDA economist Keithly Jones, we have obtained U.S. shrimp data for all captures differentiated by species (brown, pink, etc.) and region (Gulf, Pacific, and Atlantic). The data are monthly and spans January 1993 to December 2007. This data will be used to analyze the impact of Hurricane Katrina on shrimp U.S. supplies and prices in the Gulf of Mexico region. Anticipated activities: Complete shrimp industry analysis by August 2009; submit abstract of research for the 2010 Southern Agricultural Economics Association annual meeting in September 2008l; complete presentation paper by December 2008; submit final paper for publication in refereed journal in early 2010; prepare and submit final report.

Task 9. (completed) After the Storm – Spatial and Temporal Aspects of Business Resiliency. This project assessed the influence of Hurricane Katrina on business resiliency both spatially and temporally using panel data analysis. Preliminary results indicated that business resiliency varied across the impacted region and across economic sectors, suggesting that some sectors were negatively impacted in the short-term but experienced employment growth over the long-term.

Task 10. (ongoing). Structural Shifts in Retail Economies of Selected Coastal Counties and Adjoining Counties in Mississippi: Pre and Post Katrina. The primary objective of this study is to evaluate the local market capture or loss of coastal counties in Mississippi from 2004 to 2008 to determine if merchants are reaching their economic potential. Specific objectives include: 1) Examine the retail capture or strength (PF) and trends of coastal counties; 2) Identify factors (population, personal income, PFs, consumer confidence, etc) that affect retail viability in coastal counties; and 3) Identify those counties experiencing structural shifts in loss of retail trade. Progress: To date, most of the county-level data have been compiled in spreadsheet form. This allows for multiple calculations, manipulations, and charting of the data. A rough start on the analysis and report has already begun. While not directly tied to this project, presentations, reports, and posters related to this and other topic have been made at several regional and national conferences during the past 18 months. We anticipate completing the data gathering, analysis, and report writing in mid to late fall. This should allow some time to develop short factsheets and information sheets that could help key decisions makers understand how natural disasters could interrupt local economies in selected coastal counties in Mississippi.

Task 11. (completed). Media Coverage of Coastal Weather Events: Impacts on Attendance Levels at Northern Gulf State Parks. Study Regions: Pensacola, FL: Tarkiln Bayou, Perdido Key, Big Lagoon; Greater New Orleans, LA: Bayou Signette, St. Bernard, Grand Isle (re-opened 5-1-09 after Hurricane Gustav). Study Approach: Monthly visitor data were collected July 2001 through September 2008 from state recreational parks located within the regions of Pensacola, FL and Greater New Orleans, LA. Park attendance was measured as number of For the Greater New Orleans, LA area, 82% of the variation in monthly attendance levels recorded by park managers was explained by model variables. Only a weak negative relationship existed between weather events and park visitation, although the relationship was not statistically significant. When keywords appeared in newspapers at least once monthly, a negative and statistically significant decline in average monthly attendance was revealed, resulting in an average decrease of 5,761 visitors that represented approximately $103,698 in lost annual revenues. For the Pensacola, FL region, 75% of the variation in monthly attendance levels recorded by park managers was explained by model variables. A negative and statistically significant relationship between adverse weather events and park visitation resulted in an average 4,659 fewer visitors per month where extreme weather occurred, which represented approximately $83,862 in lost annual revenues. Only a weak negative and statistically insignificant decline in average monthly attendance when keywords appeared in newspapers was estimated. Study Relevance: The difference in relative impacts of news sources and weather events on park visitors may be a result of the distances traveled by visitors. For example, Florida parks attract large numbers of out-of-state visitors who may not alter park visitation plans based solely on local news, while Louisiana residents who delay a park visit until weather conditions improve may still visit within the same month. These findings are expected to improve decision-maker awareness of those factors that significantly impact recreational attendance levels linked to adverse weather events; in particular, the impacts on public park revenues by unanticipated and unintended public response to news media. Suggested future work includes stratification of media coverage by capital (natural, built, human, social) type and estimation of indirect revenue losses to study regions resulting from both media coverage and weather events.

Task 12. (ongoing). Coastal Hazards: Localized Economic Impacts Incurred by Public Agencies. To date, county managers representing Terrebonne, Plaquemines and St. Tammany parishes in Louisiana; Escambia, Bay and Okaloosa counties in Florida; Baldwin and Mobile counties in Alabama; Harrison and Jackson counties, MS; and Galveston County, TX provided completed interviews. On average, respondents had served nearly eight years as county managers and had more than 14 years experience in county governance positions. Total operating budgets for the most recent fiscal year averaged over $222M and ranged from $120-$360M across counties. For those county managers that provided estimates of internal staff time and budget allocations during and after Hurricane Gustav, planning activities required one to 100 percent of available personnel and finances. Between three and ten counties interacted with at least one outside agency during and after Gustav, with the majority of outside support arriving in the form of either personnel and/or equipment. The majority of external financial support was received from the Governor's office and the Federal Emergency Management Agency. In an effort to provide linkages between coastal county needs and university research and outreach programs, respondents were asked to describe specific needs related to coastal

hazard public management issues. Responses included requests for faster mitigation of post-recovery issues, economic valuation of wetlands as storm surge protection, provision of public announcements and brochures, and the need for "continuity of operations planning for medium/small sized businesses," such as churches, restaurants and stores. Future work: Once all surveys have been completed (expected completion: August 2009), this information will be analyzed and presented alongside existing literature to evaluate the economic impacts of coastal hazards on public facilities and managers, local residents, and taxpayers, and, to determine an appropriate method to assess the effects of, and prepare for, future adverse environmental events (Figure 56).

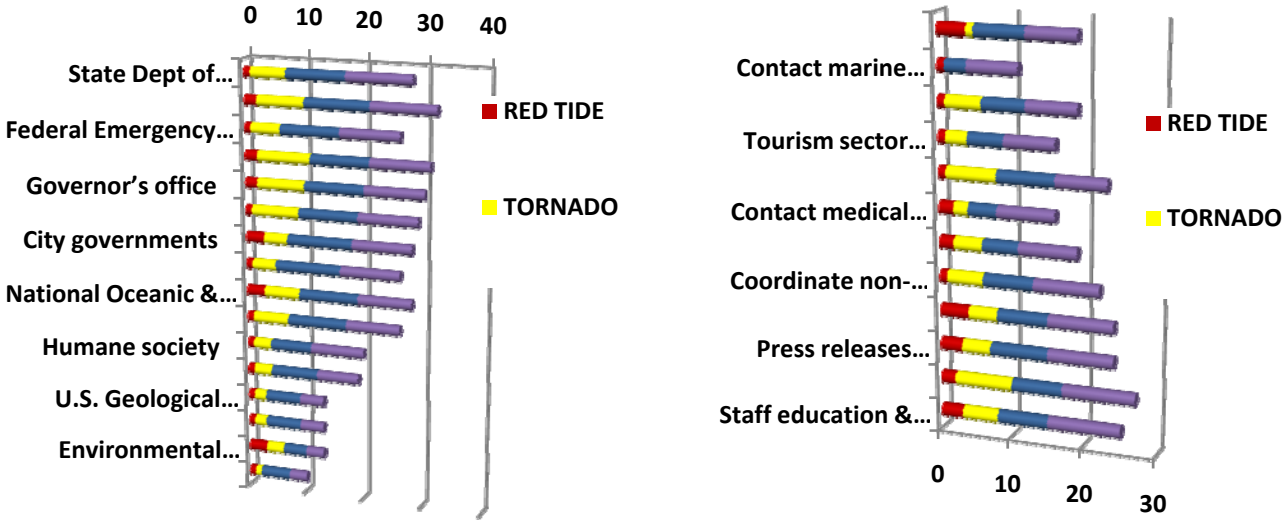

Figure 56. Research Results

K. Outreach activities: Tasks 6, 7, 9, 10, 11, and 12 have outreach components and are led by MSU extension faculty. However, no outreach activities have taken place thus far.

L. Has anyone on this project been hired by NOAA? No.

M. Peer Reviewed Articles:

Petrolia, Daniel R. and Tae-goun Kim. "What are Barrier Islands Worth? Estimates of Willingness to Pay for Restoration," Marine Resource Economics 24(2009): 131-46.

Posadas, Benedict C. 2008. "Economic Assessment of the Impacts of Hurricane Katrina on Mississippi Commercial Fishing Fleet." Mississippi Agricultural and Forestry Experiment Station Bulletin 1165, Mississippi State, Mississippi.

Posadas, Benedict C., Ruth A. Posadas, and William S. Perret. 2008. "Estimating Economic Damages to Mississippi Commercial and Recreational Fishing Industries From Hurricane Katrina". In pages 131-144 Katherine McLaughlin (ed), Mitigating Impacts of Natural Hazards of Fishery Ecosystems. American Fisheries Society Symposium 64, Bethesda, Maryland.

N. List non-refereed articles and reports for this project.

Bhattacharjee, Sanjoy, Daniel R. Petrolia, and Terrill R. Hanson. "The Role of Heterogeneity in Predicting Evacuation Decisions: An Empirical Analysis of Gulf Coast Residents." In review, Southern Economic Journal.

Evans, G. 2008. "Spatial Shift-Share Analysis of Coastal Employment Following Hurricane Katrina". Working Paper.

Evans, G. and B. Anderson. 2009. "Hurricane Katrina and Spatial Patterns of Regional Specialization". Working Paper.

Henderson, J. and G. Evans. "After the Storm – Spatial and Temporal Aspects of Business Resiliency". Working Paper.

Petrolia, Daniel R. and Tae-goun Kim. "Are CV Stated Certainty Responses Reliable?" In review, Environmental & Resource Economics.

Petrolia, Daniel R. and Sanjoy Bhattacharjee. "Why Don't Coastal Residents Choose to Evacuate for Tropical Storms?" In review, Coastal Management.

Posadas, Benedict C. "Economic Assessment of the Impacts of Hurricane Katrina on Coastal Mississippi Charter Boats for Hire, Marinas and Livebait Dealers." Mississippi Agricultural and Forestry Experiment Station Bulletin ____, Mississippi State, Mississippi. In review.

O. List conference presentations and poster presentations for this project.

Anderson, B. and G. Evans. "Exploring Industry-Level Changes in Establishment Counts, Employment, and Wages in Mississippi Counties Experiencing the Greatest Net In-Migration Following Hurricane Katrina". Paper Presentation, 2009 Annual Meetings of the Southern Regional Science Association, San Antonio, April 2-4.

Bhattacharjee, Sanjoy, Daniel R. Petrolia and Terrill R. Hanson. "Which Forecast Factors Influence Hurricane Evacuation Decisions?" Paper Presentation, NGI Annual Meeting, Mobile AL, May 20-21, 2009.

Bhattacharjee, Sanjoy, Daniel R. Petrolia, Terrill R. Hanson, and Michael Thomas. "Study of Evacuation Behavior of Coastal Gulf of Mexico Residents" Paper Presentation, Southern Agricultural Economics Association Annual Meeting, Atlanta GA, Jan. 31 – Feb. 3, 2009.

Harris, James S. and Kimberly Morgan. "Media Coverage of Coastal Weather Events: Impacts on Attendance Levels at Northern Gulf State Parks" Poster, NGI Annual Meeting, Mobile AL, May 20-21, 2009.

Kim, Tae-goun and Daniel R. Petrolia. "What are Barrier Islands Worth to Mississippians? A Contingent-Valuation Approach to Estimating WTP for Restoration," Korea Ocean Research & Development Institute (KORDI), Ansan, Korea, June 25, 2008.

Moore, Ross G., Daniel R. Petrolia, and Tae-goun Kim. "The Effects of Climate Change Perceptions on Willingness to Fund the Prevention of Wetland Loss." Poster, NGI Annual Meeting, Mobile AL, May 20-21, 2009.

Petrolia, Daniel R., Rex H. Caffey, and Tae-goun Kim. "Economic Assessment of Rapid Land-Building Technologies for Coastal Restoration", Southern Agricultural Economics Association Annual Meeting, Atlanta GA, Jan. 31 – Feb. 3, 2009.

Petrolia, Daniel R., Rex H. Caffey, and Tae-goun Kim. "Economic Assessment of Rapid Land-Building Technologies for Coastal Restoration", 2008 PIANC Gulf Coast Hurricane Conference: Preparedness, Response, Recovery, & Rebuilding, Mobile, AL, November 13.

Petrolia, Daniel R. and Tae-goun Kim. "What are Barrier Islands Worth?" Paper Presentation, NGI Annual Meeting, Mobile AL, May 20-21, 2009.

Petrolia, Daniel R. and Tae-goun Kim. "Are CV Stated Certainty Responses Reliable?" Paper Presentation, SERA-30 Annual Meeting, Athens GA, May 18, 2009.

MSU 02

A. NGI Project file Number: 08-MSU-02

B. Project title, PI(s), Email, and Affiliation: ASSESSING THE IMPACT OF ORDINANCES, OUTREACH, AND ENFORCEMENT ON THE RESILIENCY OF GULF COASTAL WATERSHEDS

PI : Jason Walker
EMAIL : jwalker@lalc.msstate.edu
AFFILIATION : Mississippi State University, Department of Landscape Architecture, Box 9725, Mississippi State, MS, 39762, 662.325.4561

CO-PI : Taze Fulford
EMAIL : ctf23@msstate.edu
AFFILIATION : Mississippi State University, Department of Landscape Architecture, Box 9725, Mississippi State, MS, 39762

CO-PI : Robert Brzuszek
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CO-PI : Timothy Schauwecker
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CO-PI : Chris Campany
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C. List all non-student personnel funded by this project:

PERSON'S NAME: Jason Walker
CATEGORY: Faculty
DEGREE:MLA
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Robert Brzuszek
CATEGORY: Faculty
DEGREE:MLA
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Michael Seymour
CATEGORY: Faculty
DEGREE:MLA
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Timothy Schauwecker
CATEGORY: Faculty
DEGREE:PH.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Chris Campany
CATEGORY: Faculty
DEGREE:MLA
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Taze Fulford
CATEGORY: Faculty
DEGREE:MARCH
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Wayne Wilkerson
CATEGORY: Faculty
DEGREE:MLA
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Kenny Langley
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MLA
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Hall Roberts
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BA
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Derek Nause
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Jason Arnold
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Dustin Randle
CATEGORY: Undergraduate Student
CURRENT HIGHEST DEGREE: HS diploma
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Mark Levy
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BA
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: James Schepel
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Rob Anders
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Ali Fratesi
CATEGORY: Undergraduate Student
CURRENT HIGHEST DEGREE: HS diploma
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Jamey Matte
CATEGORY: Undergraduate Student
CURRENT HIGHEST DEGREE: HS diploma
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(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.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: Weeks Bay NEER

DATE COLLABORATING ESTABLISHED: Mar 2008

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? None

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Michael Shelton, Coastal Training Program Coordinator, assisted in the planning and organizing of a workshop titled "Responsible Site Design: Implementing Innovative Post-Construction Stormwater Management Strategies" held at Five Rivers – Alabama's delta Resource Center, Spanish Fort, AL on November 18-19, 2008.

NAME OF COLLABORATING ORGANIZATION: Grand Bay NEER

DATE COLLABORATING ESTABLISHED: Mar 2008

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? None

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Marian Hanisko, Coastal Training Program Coordinator, assisted in the planning and organizing of the Spanish Fort workshop (above) and is assisting in planning and organizing a similar workshop to be held at Grand Bay NERR in the Fall 2009.

NAME OF COLLABORATING ORGANIZATION: Center for Watershed Protection

DATE COLLABORATING ESTABLISHED: Apr 2008

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? None

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? None

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. The Center for Watershed Protection participated in the planning, organization, and execution of the Spanish Fort workshop (above).

NAME OF COLLABORATING ORGANIZATION: Mississippi Water Resources Research Institute

DATE COLLABORATING ESTABLISHED: Mar 2009

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? None

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Jessie Schmidt, Coordinator, is assisting in the planning and organization of a similar workshop to be held at the Mississippi Water Resources Conference, August 5-7 in Tunica, MS.

G. Project Duration:

a. START DATE: 1/2007
b. ESTIMATED END DATE: 12/2009

H. Project Baselines:

a. 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.

   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".

b. 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 NGI and NOAA is an opportunity to establish baseline data and geographical distribution of current regional watershed management approaches within the NGM.

c. GAPS: This project fills a stated NOAA Gap by providing a jurisdictional baseline for coastal watersheds and water quality issues and reveals differences in governance structures that may influence water quality.

I. 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.

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

Task 1. Identify study watersheds and related political boundaries. Task Complete.
Task 2. Compile water quality data. Task Complete.
Task 3. Compile ordinance/regulation data by state, county, and/or municipality. Task Complete.
Task 4. Compile outreach efforts using 501c3 and other sources. Task Complete.
Task 5. Categorize pilot data. Task complete (to date).
Task 6. Analyze pilot data. Task complete (to date).

K. Outreach activities

a. GENERAL DESCRIPTION: A series of workshops were organized to communicate results from Year One and Year Two to identified study watershed's stakeholders. The stakeholders of interest are elected officials, planners, developers, NGO personnel, Coastal Training Program Coordinators from NOAA NERRs, and other NGI researchers.

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

b. HAVE YOU HOSTED SPEAKERS, WORKSHOPS AND/OR ANY TRAINING? Yes.

TYPE: Workshop
NAME OF EVENT: Responsible Site Design: Implementing Innovative Post-Construction Stormwater Management Strategies
DATE: 11/18-19/08
LOCATION: Five Rivers, Alabama's Delta Resource Center, Spanish Fort, AL
DESCRIPTION: Workshop covered the impact of land use codes on stormwater management and the relationships between codes and innovative stormwater management. In addition, the workshop participants completed a stormwater survey and perception study.
Approximate Number of Participants: 43

TYPE: Workshop
NAME OF EVENT: Land use codes and ecological services: actively engaging the opportunities and constraints of restoring ecological function through responsible site design.
DATE: 12/8/08
LOCATION: Naples, FL
DESCRIPTION: Workshop covered the impact of land use codes on stormwater management and the relationships between codes and innovative stormwater management. In addition, the workshop participants completed a stormwater survey and perception study.
Approximate Number of Participants: 16

L. Has anyone on this project been hired by NOAA? No.

M. Peer Reviewed Articles:

Brzuszek, R., Roberts, H., Schauwecker, T., Fulford, T. (in-press) 2009. Comparison of Water Quality Program Efforts for Non-Governmental Organizations within Northern Gulf of Mexico Watersheds. Journal of Extension.

Brzuszek, R., Fulford, C.T., Schauwecker, T., and Roberts, H. 2009. Collaboration is key: A grass roots and agency approach to effective watershed improvement. Proceedings of the Council of Educators in Landscape Architecture (CELA) Annual Conference, 224-228.

Brzuszek, R., Fulford, C.T., and Roberts, H. 2008. Evaluating Program Efforts of Non-Governmental Organizations for Watersheds Within the Northern Gulf of Mexico. Proceedings of Bays and Bayous Symposium, 10.

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Refereed Presentations:

Schauwecker, T., Brzuszek, R., Fulford, C.T., Langley, K. and Campany, C. 2009. Evaluation of non-governmental organization approaches to effective outreach and watershed improvement. Presented at the Northern Gulf Institute (NGI) Annual Conference. Mobile, Alabama.

Schauwecker, T., Walker, J.B., Seymour, M., Moore, A., Wilkerson, G.W., and Levy, M. 2009. Land use codes and ecological services: actively engaging the opportunities and constraints of restoring ecological function through responsible site design. Presented at the Northern Gulf Institute (NGI) Annual Conference. Mobile, Alabama.

Brzuszek, R., Fulford, C.T., and Roberts, H. 2009. Collaboration is key: A grass roots and agency approach to effective watershed improvement. Presented at the Council of Educators in Landscape Architecture (CELA) Annual Conference. Tucson, Arizona.

Walker, J.B., Fulford, C.T., and Wilkerson, G.W. 2008. An introduction to the stormwater chain for effective site-scale water management. Presented at the ACES conference on ecological services. Naples, Florida.

Schauwecker, T., Seymour, M., Langley, K., Brzuszek, R., and Campany, C. 2008. Ecological services and land use codes: evaluating the effects of municipal policy on environmental outcomes. Presented at the ACES conference on ecological services. Naples, Florida.

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. Evaluating program efforts of Non-Governmental Organizations for watersheds within the Northern Gulf of Mexico. Presented at the Bays and Bayous Symposium. Biloxi, Mississippi.

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

Invited Presentations:

Fulford, C.T., 2008. The Role of Non-Governmental Organizations and their efforts in the Northern Gulf of Mexico. Department of Landscape Architecture, University of Rhode Island. Kingston, Rhode Island.

Posters:

Langley, K., Schauwecker, T., Seymour, M., Walker, J.B. and Levy, M. 2009. Ordinances and water quality in the Northern Gulf of Mexico: comparisons, correlations and case study. Presented at the Northern Gulf Institute (NGI) Annual Conference. Mobile, Alabama.

Langley, K., Schauwecker, T., Walker, J.B., Seymour, M., and Levy, M. 2009. Ordinances and water quality in the Northern Gulf of Mexico: comparisons, correlations and case study. Presented at the Council of Educators in Landscape Architecture (CELA) Annual Conference. Tucson, Arizona.

MSU 03

A. NGI Project file Number: 08-MSU-03

B. Project title, PI(s), Email, and Affiliation: **WATERSHED MODELING IMPROVEMENTS TO ENHANCE COASTAL ECOSYSTEMS**

PI : W. H. McAnally
EMAIL : mcanally@cee.msstate.edu
AFFILIATION : MSU Civil and Environmental Engineering; Box 9546, MSU, MS 39762

CO-PI : J. N. Diaz-Ramirez
EMAIL : jd216@msstate.edu
AFFILIATION : MSU Civil and Environmental Engineering; Box 9546, MSU, MS 39762

C. List all non-student personnel funded by this project:

PERSON'S NAME: J. N. Diaz
CATEGORY: Asst. Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 83.5
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: W. H. McAnally
CATEGORY: Res. Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: G. Ervin
CATEGORY: Assoc. Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: C. Brooks
CATEGORY: Asst. Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: V. Alarcon
CATEGORY: Asst. Res. Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: W. Wilkerson
CATEGORY: Assoc. Professor
DEGREE: MLA
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: S. Ortega
CATEGORY: Res. Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Gray Turnage
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Matt Roberts
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 38
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Carlos Moreno
CATEGORY: Undergraduate Student
CURRENT HIGHEST DEGREE: BA
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): Improved watershed-wide decision support for resource management agencies.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: U. S. Army Corps of Engineers, Mobile District
DATE COLLABORATING ESTABLISHED: Mar 2007
DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? None
DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes
SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Sharing of data and models, interlocking tasks.

NAME OF COLLABORATING ORGANIZATION: U. S. Army Corps of Engineers, Engineer R&D Center
DATE COLLABORATING ESTABLISHED: Jun 2007
DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? Yes, reimbursed support
DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes
SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Shared models, training on Corps' models.

NAME OF COLLABORATING ORGANIZATION: U. S. Department of Agriculture, National Sediment Lab
DATE COLLABORATING ESTABLISHED: Dec 2007
DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? Yes, reimbursed support
DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes
SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Shared models, data, training on models and field operations.

G. Project Duration:
a. START DATE: February 2007
b. ESTIMATED END DATE: January 2010

H. Project Baselines:
a. 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. This project also contributes to the following long term NOAA goals:

NOAA Strategic Plan for the 21st Century
Ecosystem Mission Goal: Performance Objective – "Increase number of coastal communities incorporating ecosystem and sustainable development principles into planning and management."

Ecosystem Strategy – "Improve resource management by advancing our understanding of ecosystems through better simulation and predictive models."

NOAA Five year Plan
Ecosystem Mission Goal: Research Area – "Develop a suite of tools for ecosystem forecasting that improves ecosystem understanding and decision making, and reduces risk to ecosystem and human health."

NOAA 20 Year Research Vision
Technology and NOAA in the 21st Century: Improvements in technology will allow NOAA to "advance model-based analysis techniques (through data assimilation) that will exploit the data acquired from new sensors."

NOAA Products and Services in 2025: "NOAA will provide the scientific underpinning for an ecosystem approach to management of coastal and ocean resources, so that complex societal choices are informed by comprehensive and reliable scientific information." A sample of ecosystem products and services includes "Decision support tools for adaptive, ecosystem-based management of fisheries, coastal development, and marine resources."

b. CONTRIBUTIONS TO REGIONAL PROBLEMS AND PRIORITIES: This project will contribute 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.

c. 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.

I. Project Abstract: The goal of this project is improved watershed-wide decision support for resource management agencies. Improved hydrologic and water quality data collection, analysis, and simulation tools are demonstrated on selected catchments of the Mobile River watershed. Four interconnected processes are evaluated in this study: rainfall-runoff generation; sediment yield; best management practices; and habitat response. There are 27 major project products for the current year including: 8 conference papers and posters, 8 journal articles, 8 technical reports, 2 Master theses and a course outline.

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

Basin and Data Testing: Hydrologic Simulation Program FORTRAN (HSPF)
The upland Mobile River watershed model was divided in 54 sub-watersheds. Despite hydrological calibration issues such as lack of stream flow measured data, location of control structures and pumping wells, point sources, wetlands and agricultural land presence, the statistical fit between measured and simulated stream flow values was moderate to good. Sensitivity and uncertainty of

selected HSPF parameters were evaluated using physiographic data from the Luxapallila Creek watershed and Monte Carlo simulation. Four out of 12 parameters were found to account for the majority of parameter uncertainty propagation. Parameter ranges of the four most sensitivity parameters were reduced between 20% and 40%.

Basin and Data Testing: Gridded Surface Subsurface Hydrologic Analysis (GSSHA)
The GSSHA and HSPF runoff performance was evaluated in the Luxapallila Creek watershed. The GSSHA model grid size was 100 m x 100 m, resulting in 185,816 grids. The HSPF model was divided in 50 subwatersheds. GSSHA peak, volume, and flow errors were around half of HSPF results. Both models showed ahead peaks of one day. However, the GSSHA model results matched the peak of two out of four storm events. The HSPF model runs faster than GSSHA (5 seconds vs 20 hours).

Data Collection and Analysis: Evaluation of sediment processes in Town Creek watershed
Sediment processes are evaluated in Town Creek watershed in order to identify erosion causes that can be addressed by remedial measures and reduce water quality impairment due to sediments. Preliminary results have evidenced a seasonal impairment by sediments caused by stream bank erosion processes along the channel network. A priority for stream bank and riparian buffer zone restoration and establishment of other BMPs for sediment reduction is visualized as a necessary measurement inside Town Creek watershed; especially for road crossings and agricultural and silviculture activities.

Data Collection and Analysis: Best Management Practices
A model called LIDIA – Low Impact Development Implementation Assessment tool – is being developed to link a BMP database with an Excel database running on top of a public domain spatial engine. The effort to date has produced a database with two screens – a site data screen and a land use screen. A third screen will create hydrologic output. When completed, this screen will generates storm events including runoff volumes, peak flows, and hydrographs based on the characteristics of the BMPs.

Wetland and Riparian Buffers
One set of analyses examining relationships between wetland vegetation and surrounding land use has been published as an NGI report. These analyses showed clear patterns of correlation between human land use and ecological quality of wetland vegetation. Two follow-up projects are aimed at similar evaluations between stream biota (fish and mussels) and land use/cover. One of these efforts will be a parallel to the wetlands study, wherein a gradient of stream buffer widths will be used to evaluate responses of stream biota. The other will use hydrologic model outputs (N, P, discharge) as effectors of stream biological indicators (species' conservation status).

Ecosystem Responses
The response of lotic ecosystems to the disturbances associated with impoundment and channelization are myriad. We are using the association between freshwater mussels and the fish who serve as hosts for juvenile mussels to assess water quality. We are currently removing gill arches and collecting these juvenile mussels from three species of fish in before- and after-impoundment

time periods in the Buttahatchie River and the east Fork of the Tombigbee River. These data will be used to evaluate the impact of impoundment on mussel reproduction and will eventually provide data to parameterize a model of mussel dynamics that will interface directly with hydrologic models.

K. Outreach activities

a. GENERAL DESCRIPTION: Project staff made multiple presentations at state (e.g. Mississippi Water Resources Associations and), regional (e.g. Gulf of Mexico Alliance Nutrient Criteria Research Framework Workshop), national (e.g., International Conference of Computational Methods in Sciences and Engineering – ICCMSE and American Society of Agricultural and Biological Engineers Annual International Meeting) and international meetings (Congress of the International Association of Theoretical and Applied Limnology, Montreal, Canada) 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. On November 13 2008 we visited the Weeks Bay Reserve, AL in order to increase mutual understanding of current projects, increase usefulness of MSU products to NEER, identify data and sources needed for MSU projects, and discuss Year 4 NGI proposal cooperation. On March 9, 2009 we attended the MSU/NGI/ERDC/SWWRP R&D Collaboration Meeting in ERDC/Vicksburg, MS. to provide updates on items of collaboration from the MSU Northern Gulf Institute (NGI) watershed projects and the Corps' System-Wide Water Resources program (SWWRP).

   We developed a watershed management course outline that will become a teaching tool for all agencies involved in water and land resources management.

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles:

Alarcon V. J., W. McAnally, J. Diaz-Ramirez, J. Martin, and J. Cartwright, 2008. A Hydrological Model of the Mobile River Watershed, Southeastern USA. Proceedings ICCMSE 2008, American Institute of Physics.

Diaz-Ramirez, J.N., B.E. Johnson, W.H. McAnally, J.L. Martin, V.J. Alarcon, and J.J. Ramirez-Avila. Global Parameter Sensitivity and Uncertainty of the USEPA HSPF Model: A Hydrology Model Evaluation in Alabama and Mississippi. Submitted to Environmental Modelling & Software [In review since March, 2009]

Ervin, G. N. 2008. Applying the state-of-the-art to advance the state of our understanding in integrated hydrophyte ecology. Verhandlungen Internationale Vereinigung für theoretische und angewandte Limnologie (Proceedings of the International Society of Theoretical and Applied Limnology) 30: 128-132

Wilkerson G.W., W.H. McAnally, J.L. Martin, J.A. Ballweber, K. Collins Peavy, J. Diaz-Ramirez, and A. Moore. Latis: A Spatial Decision Support System to Assess Low Impact Site Development Strategies.

Submitted to the ASCE Journal of Hydrological Engineering for the Special Issue: Low Impact Development, Sustainability Science, and Hydrological Cycle. [In review since November, 2008]

N. List non-refereed articles and reports for this project.

Ervin, G. N. 2009. Relationship of wetlands vegetation and land cover as an indicator of ecologically appropriate wetland buffer zones. Northern Gulf Institute Report, Mississippi State University.

Ramírez-Avila, J.J., W.H. McAnally, J.L. Martin, S.L. Ortega-Achury, and J.N. Díaz-Ramírez. 2009. Monitoring and Prediction of Sediment Discharges within Town Creek Watershed, MS. ASABE Annual International Meeting, Reno, Nevada, June 21 – 24.

Ramírez-Avila J.J. 2009. Evaluation and Prediction of Sediment and Phosphorus Loads Within the Town Creek Watershed, MS. Northern Gulf Institute Annual Conference, Biloxi, May 20-21. Meeting of the Northern Gulf Institute, MSU, MS. [second place in the student paper contest]

O. List conference presentations and poster presentations for this project.

Diaz-Ramirez, J.N., et al. 2008. Weeks Bay Studies. Project Implementation Committee Meeting, 5 Rivers Delta Center, AL, December 11. Mobile Bay National Estuary Program.

Diaz-Ramirez, J.N., G. Ervin, C. Brooks, V. Alarcon, G.W. Wilkerson, J.J. Ramirez-Avila, S.L. Ortega-Achury, and W.H. McAnally. 2009. Watershed Modeling Improvements to Enhance Coastal Ecosystems - Project Overview. Northern Gulf Institute Annual Conference, Biloxi, May 20-21. Meeting of the Northern Gulf Institute, MSU, MS.

Moore, A. and W. Wilkerson. Do We Really Need Another Model: Designing a Tool to Assess the Effectiveness of Best Management Practices. AWRA 2008 Annual Water Resources Conference. New Orleans, Louisiana. November 17-20, 2008.

Ramírez-Avila J.J., S.L. Ortega-Achury, W.H. McAnally, J.L. Martin, and J.N. Díaz-Ramírez. 2009. Evaluation and Prediction of Sediment and Phosphorus Loads Within the Town Creek Watershed, MS. Northern Gulf Institute Annual Conference, Biloxi, May 20-21. Meeting of the Northern Gulf Institute, MSU, MS.

Ramírez-Avila, J.J., W.H. McAnally, J.L. Martin, S.L. Ortega-Achury, and J.N. Diaz-Ramirez. 2008. Evaluation and Prediction of Sediment Loads within the Town Creek Watershed. 50 Years of Soil and Water Research in a Changing Agricultural Environment Conference, Oxford, MS, September 3-5. Meeting of the Agricultural Research Service, U.S. Department of Agriculture. [Poster].

Ramírez-Avila J.J., W.H. McAnally, J.L. Martin, E. Langendoen, S.L. Ortega-Achury, and J.N. Díaz-Ramírez. 2009. Measurement of Stream Bank Erosion in a Southeastern Plain Ecoregion Watershed. Northern Gulf Institute Annual Conference, Biloxi, May 20-21. Meeting of the Northern Gulf Institute, MSU, MS. [Poster].

Sharp J., J.N. Diaz-Ramirez, and V. Alarcon. 2009. Coastal Watershed Impacts: Modeling Hydrology and Sediments in the Weeks Bay, Alabama. Northern Gulf Institute Annual Conference, Biloxi, May 20-21. Meeting of the Northern Gulf Institute, MSU, MS. [Poster].

Turnage, G., C.P. Brooks, J.N. Diaz-Ramirez, W.H. McAnally. 2009. Estimating mussel reproduction using historical fish collections in the upper Mobile Bay watershed. Northern Gulf Institute Annual Conference, Biloxi, May 20-21. Meeting of the Northern Gulf Institute, MSU, MS. [Poster]

Wilkerson, G.W. and A. Moore. Creating a Simplified Hydrologic Assessment Tool to Assist the Development Industry Design and Build More Sustainable Communities. Presented at the 2009 Northern Gulf Initiative (NGI) Conference. Mobile, AL. May 19-21, 2009.

Wilkerson, G.W. and A.M. Moore. A Market Survey of the Perception and Adoption of Low Impact Development Methodologies in the Fish River Watershed. Presented at the Council of Educators in Landscape Architecture (CELA) Conference. Tucson, Arizona. January 14-17, 2009.

MSU 04

A. NGI Project file Number: 08-MSU-04

B. Project title, PI(s), Email, and Affiliation: SPATIAL TECHNOLOGY AND HIGH PERFORMANCE COMPUTING FOR IMPROVING PREDICTION OF SURFACE WATER QUALITY

PI : W. H. McAnally
EMAIL : mcanally@cee.msstate.edu
AFFILIATION : MSU Civil and Environmental Engineering

CO-PI : V. Alarcon
EMAIL :alarcon@gri.msstate.edu
AFFILIATION : MSU Geosystems Research Institute

CO-PI : J. Cartwright
EMAIL :johnc@gri.msstate.edu
AFFILIATION : MSU Geosystems Research Institute

C. List all non-student personnel funded by this project:

PERSON'S NAME: W. H. McAnally
CATEGORY: Res. Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: V. Alarcon
CATEGORY: Asst. Res. Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: J. Cartwright
CATEGORY: Res. Assoc.
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: R. Jackson
CATEGORY: Res. Assoc.
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 20
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Wali Aziz
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Jared McKee
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Richard McComas
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): Develop and demonstrate the use of advanced spatial technology and high performance computing capabilities in the prediction of surface water quality.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: U. S. Army Corps of Engineers, Engineer R&D Center

DATE COLLABORATING ESTABLISHED: Jun 2007

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? Yes, reimbursed support

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Shared models, training on Corps' models.

NAME OF COLLABORATING ORGANIZATION: Alabama Department of Environmental Management

DATE COLLABORATING ESTABLISHED: Nov 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. Shared models and data, advice on modeling

G. Project Duration:

a. START DATE: Feb 2007
b. ESTIMATED END DATE: Jan 2010

H. Project Baselines:

a. 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.

b. REGIONAL 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.

c. 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

I. 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 for development of input data for surface water quality models, model performance enhancement, and model results demonstration and display 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 also the influence of landscape features (e.g. land uses, soils, hydrography). Much of the data required to drive these integrated models is geospatial in nature, and model estimations are often directly impacted by the availability and accuracy of those geospatial data. In addition, the application of an integrated model approach is typically computationally intensive. However, recent advances in high performance computing can be used to aid in the development and application of modeling systems and the interpretation of model predictions. Through more accurate modeling, effective policy decisions can be made or developed by the responsible agencies.

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

16 major products are either accomplished or near completion. A partial list is:

Grid generation
The Mesh Generation and Refinement Tool, MGRT, (produced in previous year of this project) was used to generate three 2-D computational grids for Mobile Bay, using NOAA coastline data (Figure 57). These grids were provided with bathymetric information from NOAA using SMS. Two of the resulting meshes were implemented into corresponding Adaptive Hydraulics (ADH) model applications to Mobile Bay.

High Performance Computing
The ADH code was provided by our collaborators at the USACE- ERDC. The code was compiled at the MSU's High Performance Computing Collaboratory (HPCC) and speed-up experiments for the model applications to Mobile Bay were performed. Figure 58 shows the results of the speed-up experiments. The optimum number of processors for the ADH model applications to Mobile Bay was determined to be 32 (Figure 58). Following these results, a preliminary hydrodynamic calibration of the model applications was performed (Figure 59).

Spatial technologies
NASA-MODIS land-use/land-cover data was geo-processed for input into hydrological models developed for associated NGI projects. Methodology and results are shown in Figure 60. The datasets were format-converted, re-projected, and re-classified. It followed, a parameterization of land use data for introduction into HSPF models of Mobile Bay River and streams surrounding Mobile Bay.

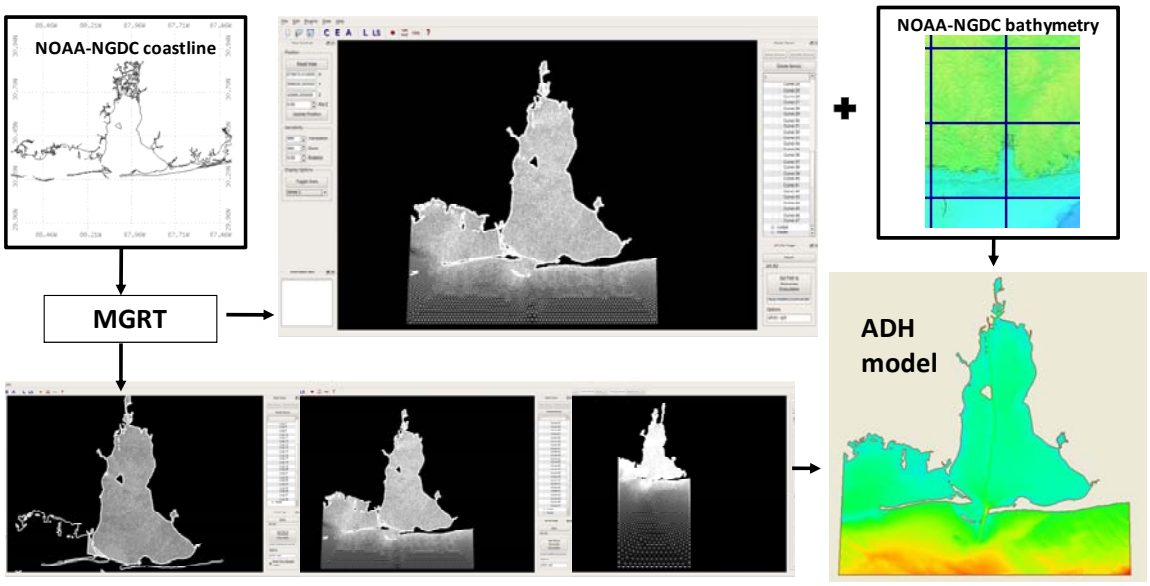

Figure 57. NOAA coastline data is introduced into MGRT to produce several 2-D computational grids for Mobile Bay. SMS is used to add bathymetric information and perform initial set-up of corresponding ADH hydrodynamic models.

$$Speed\ \ Up = S_p = \frac{Time\ \ 1\ \ processor}{Time\ \ N\ \ processors} = \frac{T_1}{T_N}$$

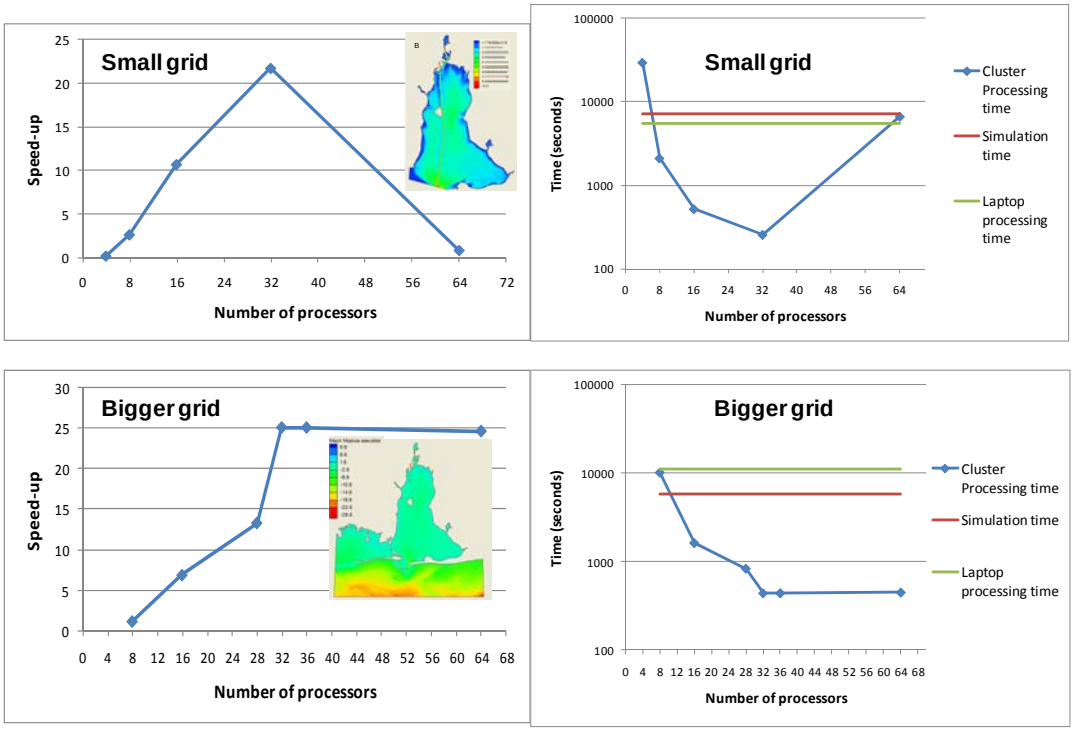

Figure 58. Speed up experiments for two ADH model applications for Mobile Bay. Thirty two (32) processors were determined to be the optimum number of processors for the model applications.

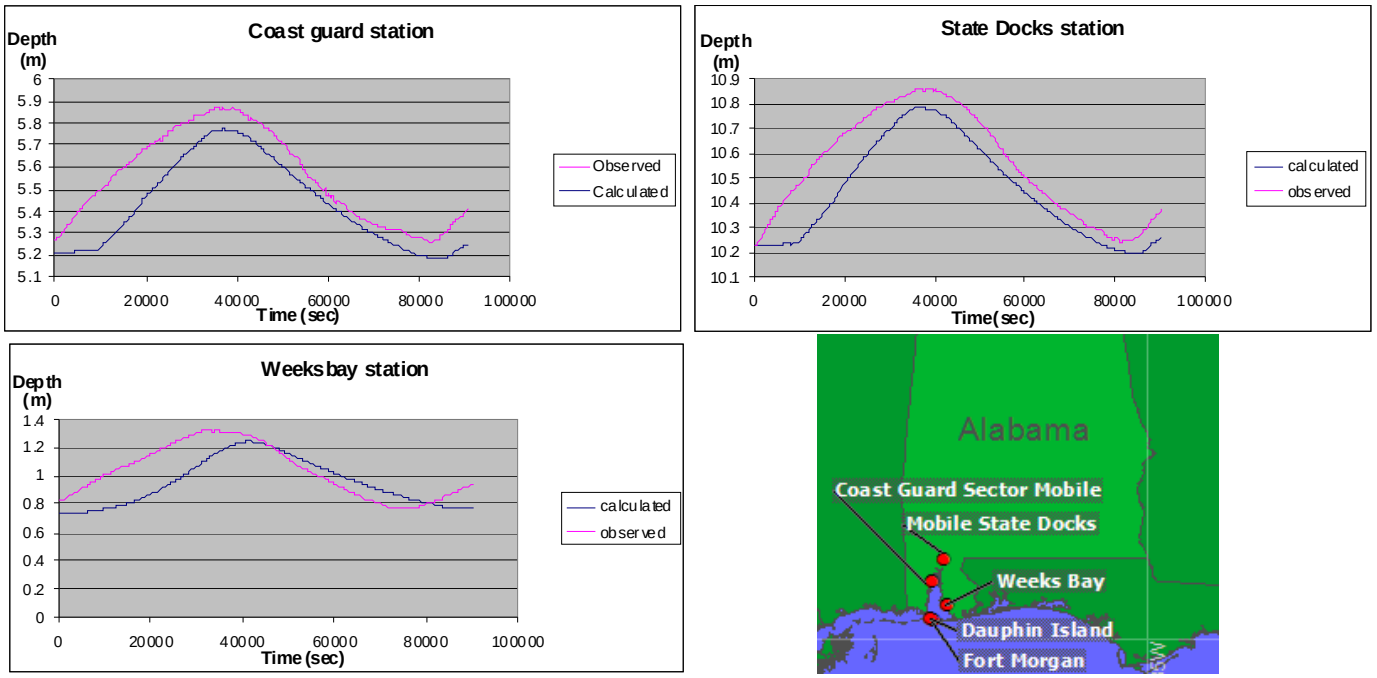

Figure 59. NOAA tidal data stations located within and around Mobile Bay (Dauphin Island, Weeks Bay, Coast Guard, and State Docks) were used to perform a preliminary adjustment. Measured and calculated water surface elevations were compared.

A spatial watershed erosion system (SWES) was developed that seeks utilizing several landscape characteristics for analysis and comparison of watersheds based on a NOAA framework. The SWES framework is focusing on combining layers to make predictions of potential erosion areas based on natural and anthropogenic drivers, coupled with physical landscape characteristics. The system provides management tools for exploring the distribution of sediments and specific associated pollutants in the Mobile and similar coastal basins. Figure 61 shows methodology and results produced by the watershed erosion system.

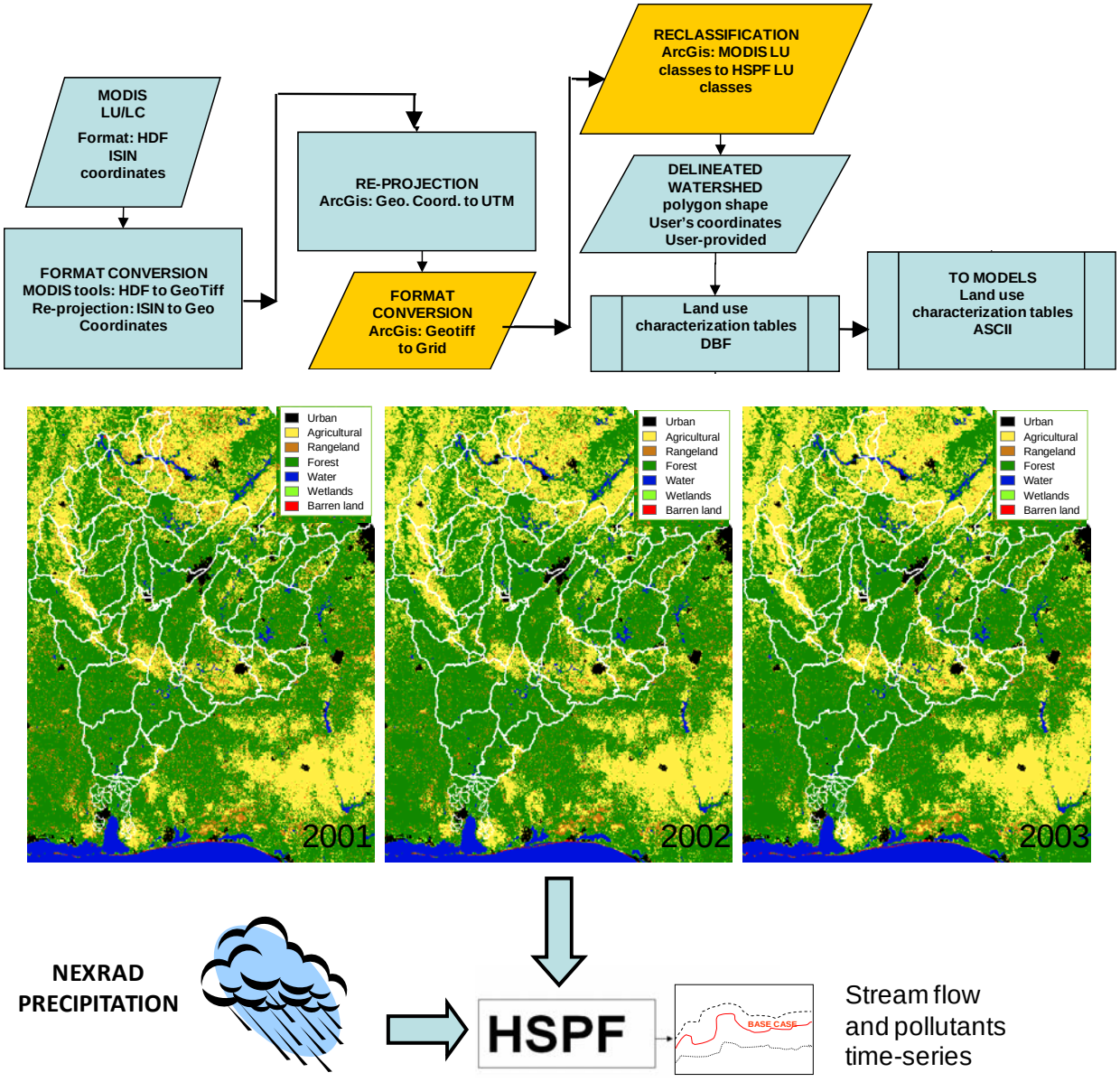

Figure 60. NASA MODIS land-use/land-cover datasets geo-processing for input into hydrological models of Mobile River watershed and Mobile Bay.

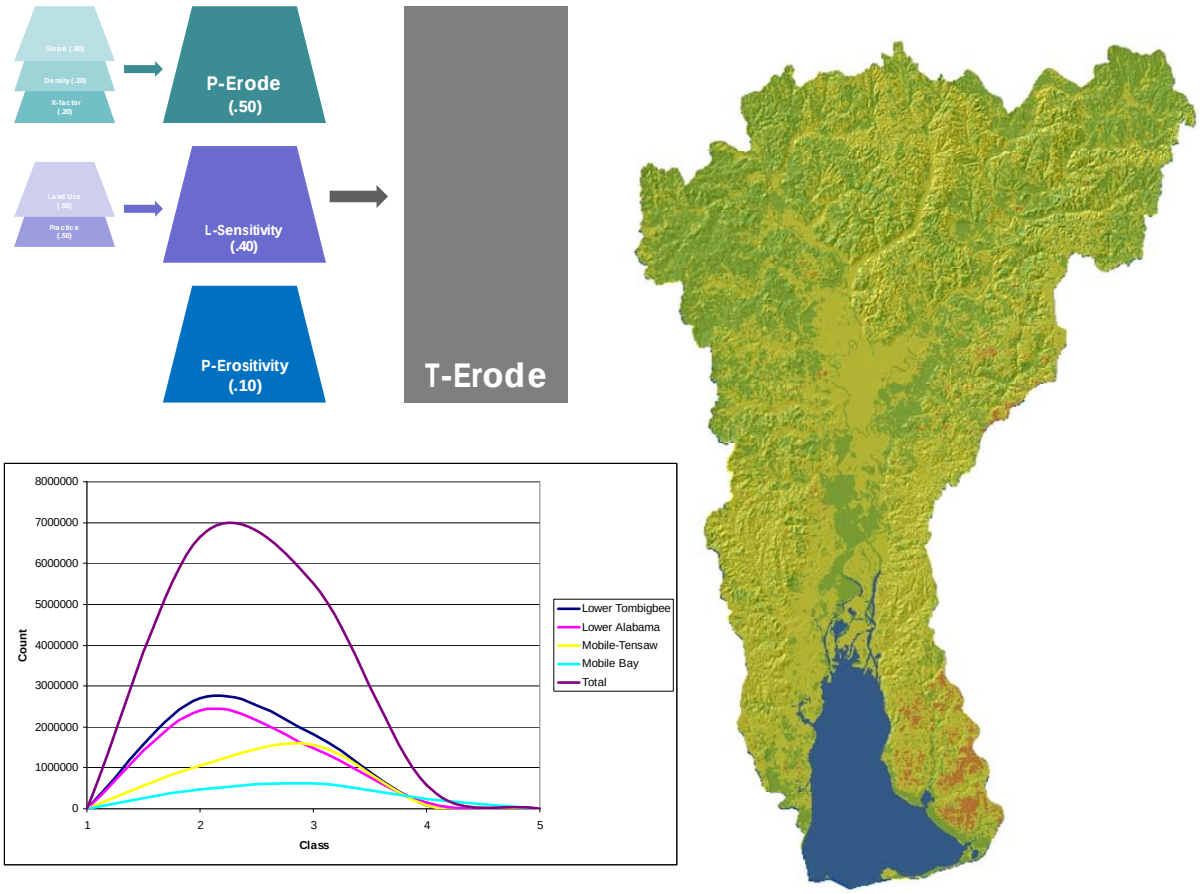

Figure 61. Spatial technologies. Watershed erosion system. NED elevation, NLCD land cover, NHD hydrography, STATSGO soils, and PRISM rainfall datasets are used within the NOAA CAF framework. Physical erodibility (slope, stream density, soil k-factor), land sensitivity (land use, land practices), and precipitation erosivity (30 year rainfall averages), are quantified.

K. Outreach activities: None

L. Has anyone on this project been hired by NOAA? No.

M. Peer Reviewed Articles:

Alarcon V. J., McAnally, W., Diaz-Ramirez, J., Martin, J., Cartwright, J., 2009. A Hydrological Model of the Mobile River Watershed, Southeastern USA. Proceedings ICCMSE 2008, American Institute of Physics.

Alarcon V. J., McAnally, W., Wasson, L., Martin, J., Cartwright, J., 2009. Using NEXRAD Precipitation Data for Enriching Hydrological and Hydrodynamic Models in the Northern Gulf of Mexico. Proceedings ICCMSE 2008, American Institute of Physics.

Aziz, W., Alarcon V. J., McAnally, W., Martin, J., Cartwright, J., 2009. An Application of the Mesh Generation and Refinement Tool to Mobile Bay, Alabama, USA. Proceedings ICCMSE 2008, American Institute of Physics.

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Alarcon, V.J., McAnally, W., Cartwright, J., 2009. High Performance Computing and Spatial Technologies for Prediction of Surface Water Quality. 2009 Northern Gulf Institute Conference. Mobile, Alabama, May 19-20, 2009.

Cartwright, J., McAnally, W. Alarcon, V. j., 2009. Spatial Technologies for Watershed Erosion Analysis. 2009 Northern Gulf Institute Conference. Mobile, Alabama, May 19-20, 2009.

Sharp, J., Diaz-Ramirez, J., and Alarcon, V. J., 2009. Coastal Watershed Impacts: Modeling Hydraulics, Hydrology, and Sediments in the Weeks Bay, Alabama. 2009 Northern Gulf Institute Conference. Mobile, Alabama, May 19-20, 2009.

Cartwright, J. H. 2008. NGI Mobile Research Efforts and Collaboration. Weeks Bay National Estuarine Research Reserve, Fairhope, AL, November 13.

Cartwright, J. H. and V. Alarcon. 2008. Spatial Technologies for Upland Watershed Erosion Analysis and Reporting. Alabama Water Resources Conference, Orange Beach, AL, September 3-4.

MSU 05

A. NGI Project file Number: 08-MSU-05

B. Project title, PI(s), Email, and Affiliation: **WATERSHED MODELING IMPROVEMENTS TO ENHANCE COASTAL ECOSYSTEMS**

PI : W. H. McAnally
EMAIL : mcanally@cee.msstate.edu
AFFILIATION : MSU Civil and Environmental Engineering; Box 9546, MSU, MS 39762

CO-PI : J. L. Martin
EMAIL :jmartin@gri.msstate.edu
AFFILIATION : MSU Civil and Environmental Engineering; Box 9546, MSU, MS 39762

C. List all non-student personnel funded by this project:

PERSON'S NAME: W. H. McAnally
CATEGORY: Res. Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 15
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: J. K. Martin
CATEGORY: Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: K. S. McNeal
CATEGORY: Asst. Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: J. A. Sharp
CATEGORY: Res. Assoc.
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 40
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all Students funded by this project.

PERSON'S NAME: J. E. Ezell
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? Yes, NEER

PERSON'S NAME: Y. Xiong
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: C. Hall
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: K. Pevey
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: R. McComas
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. 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.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: U. S. Army Corps of Engineers, Engineer R&D Center

DATE COLLABORATING ESTABLISHED: Jun 2007

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? Yes, reimbursed support

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Shared models, training on Corps' models.

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

DATE COLLABORATING ESTABLISHED: May 2007

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes, mutual support

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Sharing of field and model data

NAME OF COLLABORATING ORGANIZATION: U. S. Army Corps of Engineers, Mobile District

DATE COLLABORATING ESTABLISHED: Mar 2007

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? None

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Sharing of data and models, interlocking tasks.

NAME OF COLLABORATING ORGANIZATION: U. S. National Aeronautics and Space Administration, Stennis Space Center and Marshall Flight Center

DATE COLLABORATING ESTABLISHED: Nov 2007

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? None

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes, reimbursable

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Shared imagery and ground truth data on sediment and mercury

G. Project Duration: 3 years

a. Start date: Feb 2007
b. Estimated end date: Jan 2010

H. Project Baselines:

a. 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.

b. REGIONAL PROBLEMS AND PRIORITIES: This project will contribute 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.

c. 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

I. 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.

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

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 selected 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.

Major Milestones include 24 products that are either completed or nearing completion, including:

- A Sediment Budget for Weeks bay, Ala
- Method for computing long-term morphologic evolution of estuaries (Figure 62)
- Monitoring of the Mobile Bay Plume
- New Technologies to Model Sediment and Mercury Transport in Mobile Bay (Figure 63)
- Metadata for 3 major datasets

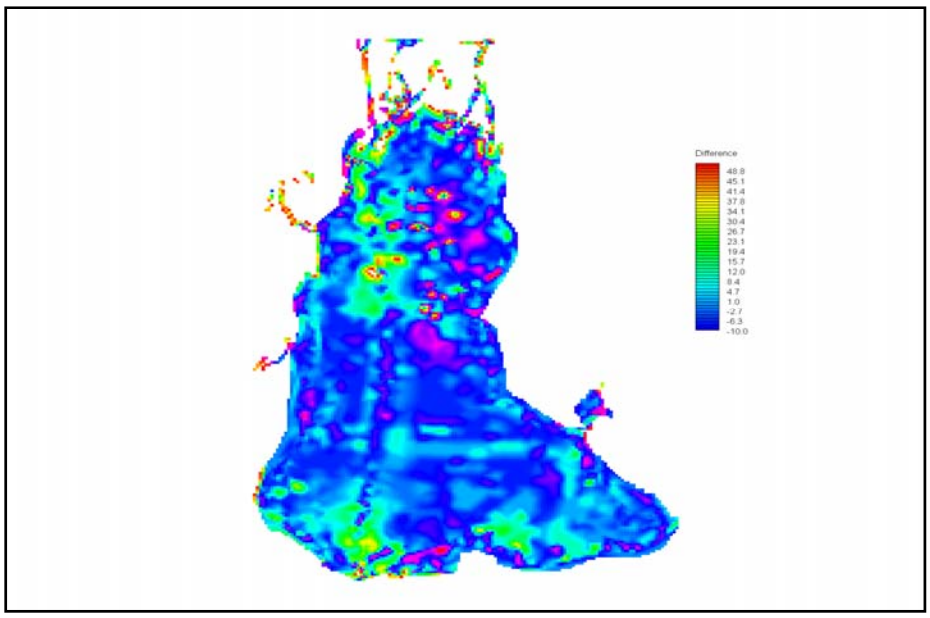

Figure 62. Percent Depth Change in Mobile Bay from 1988 to 2100 using empirical orthogonal function and cross spectral analyses.

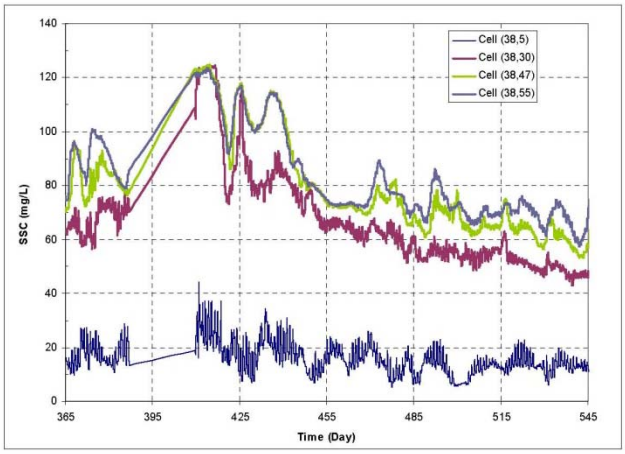

Figure 63. Suspended Sediment Concentration along Mobile Bay Navigation Channel by EFDC Modeling.

K. Outreach activities: Outreach objectives overlap to some extent 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.

L. Has anyone on this project been hired by NOAA? No.

M. Peer Reviewed Articles:

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

Ramirez - Avila, Sandra L. Ortega-Achury, & McAnally, Suspended Sediment Concentration and Total Suspended Sediments Comparison on the Town Creek Watershed, June 2009

Seasonal and spatial variation on water quality properties in Mobile Bay and Mississippi Sound., McAnally, James L. Martin, and Sandra L. Ortega-Achury, June 2009

N. List non-refereed articles and reports for this project:

Savant, G. 2008, Prediction of Estuarine Morphological Evolution, 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, J. A., Estimating Sediment Flux for Coastal Inlets in the Northern Gulf of Mexico, January 2009

McKee, J. K., Evaluation of Erosional Forcings of Beach/Berm/Wetland System and Applicable Restoration Technologies, Jan 2009

O. List conference presentations and poster presentations for this project.

Ramírez Avila, J. J., William McAnally, Sandra Ortega Achury, James L. Martin, Nutrient and Sediment Production in the Town Creek Watershed, Mississippi, Mississippi Water Resources Association Conference, May 2009

MSU 06

A. NGI Project file Number: 08-MSU-06

B. Project title, PI(s), Email, and Affiliation: VISUALIZATION TECHNIQUES FOR IMPROVING UNDERSTANDING OF SEVERE STORMS

PI : Robert Moorhead
EMAIL : rjm@gri.msstate.edu
AFFILIATION : Mississippi State University, P.O. Box 9627, Miss State, MS 39762, (662) 325-2850

CO-PI : Song Zhang
EMAIL : szhang@gri.msstate.edu
AFFILIATION : Mississippi State University, P.O. Box 9627, Miss State, MS 39762, (662) 325-7510

CO-PI : Phil Amburn
EMAIL : amburn@gri.msstate.edu
AFFILIATION : Mississippi State University, P.O. Box 9627, Miss State, MS 39762, (662) 325-7202

C. List all non-student personnel funded by this project:

PERSON'S NAME: Robert Moorhead
CATEGORY: Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 7
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Song Zhang
CATEGORY: Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Phil Amburn
CATEGORY: Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 20
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Jean Mohammadi-Aragh
CATEGORY: Res. Assoc.
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 30
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Derek Irby
CATEGORY: Res. Assoc.
DEGREE: BS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 30
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Keqin Wu
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Jibo Sanyal
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): The objectives of this project are:

1. Develop a hardware/software system which allows analysts with access to many and large data sources to see those many datasets in the 'all source' viewing "environment" which allows them to extract the maximum amount of information and then knowledge from the datasets.

2. Study and deploy the optimum methodologies to communicate that information and knowledge to operational personnel (e.g., NHC, FEMA) and the general populace. The working concept is that for normal operations and daily deployment to operational personnel, images and animations will be put on a website. 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., vGeo, GoogleEarth) and extend an existing visual analysis system, Triton II, 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 with more choices for visual mapping (e.g., 2D fields as contours, points, colormapped 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, hurricane models, UAS data, and satellite data/images) and their uncertainty in the same view volume. For example, what is the best method to represent the information and the discrepancy in model data and UAS data? And how to visualize the data in the context of both simulation uncertainty and measurement uncertainty? 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)?

Our objectives can be summarized in another way:

1. Help scientists study and predict severe storms including hurricanes with inherent uncertainty in the data.
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.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: HRD

DATE COLLABORATING ESTABLISHED: Jul 2008

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Should have provided feedback and comments

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. We asked Joe Cione if he thought visualizing hurricane data in a large scale immersive environment would be useful. He said that sounded interesting, let's plan a visit in October, and so forth. We developed systems to visualize model data, WISDOM data, and UAS data. Joe later decided he didn't have time to be involved in such an activity. He was professional and gracious in his emails.

NAME OF COLLABORATING ORGANIZATION: LMRFC

DATE COLLABORATING ESTABLISHED: Oct 2008

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? Not yet

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Based on a discussion at the NGI Annual Conference in May 2008 and a previous discussion when LMRFC personnel visited MSU, we developed an NGI proposal (now awarded; Phil Amburn, PI). They provided some preliminary data and we have developed some visualizations of that Pascagoula River data for LMRFC.

NAME OF COLLABORATING ORGANIZATION: WISDOM Program

DATE COLLABORATING ESTABLISHED: Oct 2008

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. Based on our UAS visualization work and the MSU work on the WISDOM launch, the project personnel developed an analytical tool for our room size virtual environment to allow the local personal to study how the balloons moved over time. We collaborated on a Yr4 NGI project proposal. We collaborated on a NOPP proposal.

NAME OF COLLABORATING ORGANIZATION: ESRL

DATE COLLABORATING ESTABLISHED: Jan 2009

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? Not yet

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? No yet

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. We collaborated on a Yr4 NGI project proposal.

G. Project Duration:

a. Start date: Feb 1, 2007
b. Estimated end date: Jan 31, 2010

H. Project Baselines:

a. CONTRIBUTIONS TO SPECIFIC NOAA GOALS/OBJECTIVES: This research will advance NOAA's leadership in applied scientific research.

b. 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.

c. 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.

I. **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 has focused 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 efforts have focused on two elements of severe storms: storm surge and hurricane intensity/direction. One key research question was "Can a three-dimensional, time-varying visualization of a hurricane better elucidate the structure and evolution of hurricanes?" This project has capitalized on the high performance computing and visualization capabilities at MSU, and has been closely linked to the severe weather modeling activities at MSU, with partner activities at several NOAA units (LMRFC, NHC, HRD, and ESRL). It has focused on using HPC for both modeling and development of the visualization of model output and creating visualization products that can be produced as simple animations or static images.

During the last year, we have developed a desktop visualization system, called HurricaneVis, that creates a three-dimensional, time-varying visualization of a hurricane to better elucidate the structure and evolution of hurricanes. Hurricane Isabella and Hurricane Lili data were used as test datasets to show the functionality of the system. A poster on this work was presented at the NGI Annual Conference as well as at the IEEE EuroVis Conference.

We have used vGeo to visualize hurricane data and showed to many people, including ESRL and WISDOM program office. We have documented that work in 2 refereed conference papers and 2 poster presentations. We have developed a new streamline method to better show fluid flow. We have presented that work in a presentation and poster at the NGI Annual Conference, as well as in a journal manuscript which is in its second review. We have developed 2 very similar analytical visualization systems to show UAS and WISDOM hurricane data. We have demonstrated that to personnel at ESRL, WISDOM, LMRFC, and at the NGI Annual Conference. Those 2 systems now work on displays ranging from laptop to room-size virtual environment. We are presently merging the 2 programs, adding functionality, and optimizing them for several displays. We have offered the system to ESRL.

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

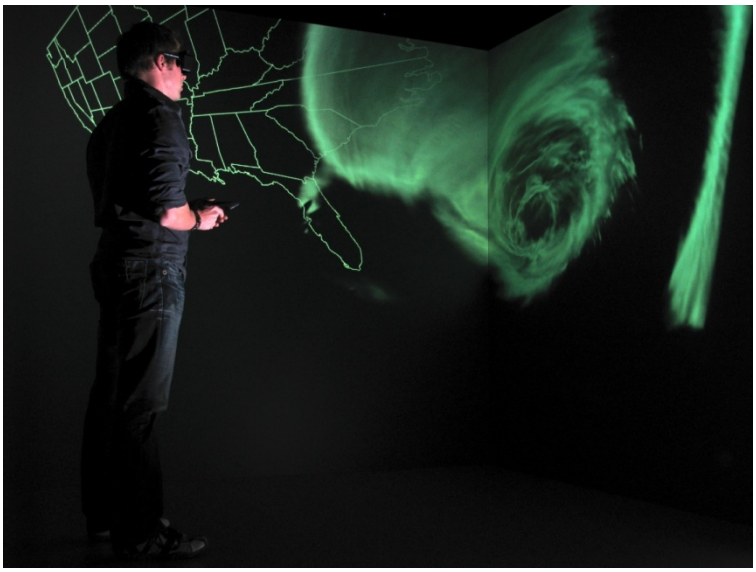

Figure 64. Scientist examining hurricane structure, visualized using HurricaneVis, in room size virtual environment.

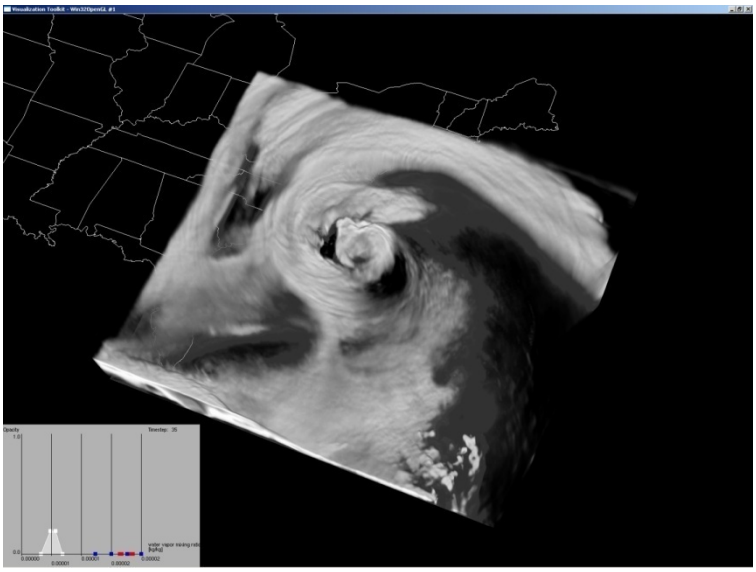

Figure 65. Hurricane Isabella data visualized using HurricaneVis.

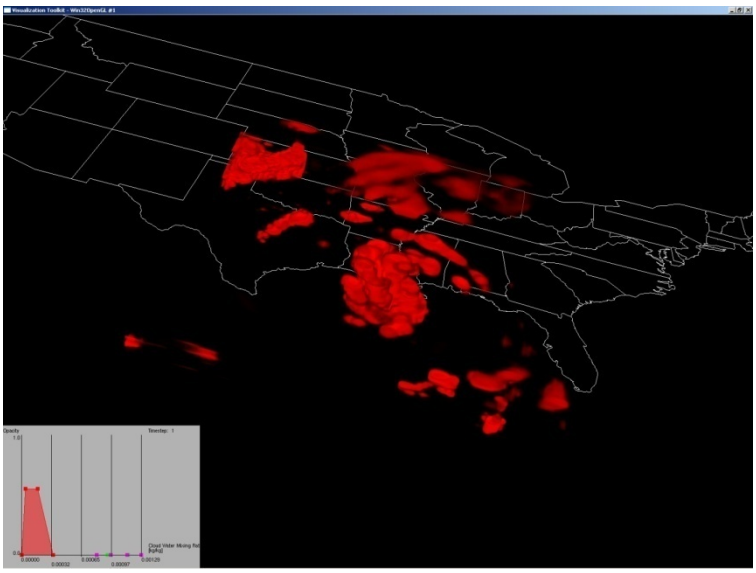

Figure 66. Hurricane Lili data visualized using HurricaneVis.

See project webpage: http://www.ngi.msstate.edu/projects/Visualization for lots of pictures and some videos. Look under the SURGE, UAS, and WISDOM tabs at top of page.

K. Outreach activities

- Project webpage: http://www.ngi.msstate.edu/projects/Visualization
- DVD: We produced a DVD of some of our work. After seeking review from Justyna Nicinska (WISDOM) and Robbie Hood (ESRL/UAS), we produced copies and started distributing, including at NGI Annual Meeting.
- NOAA meeting on day before the 2009 NGI Annual Conference: Two project team members attended the NOAA Stakeholder Meeting
- Papers and Posters at NGI Annual Conference: The project team presented 2 presentations and 4 posters at the 2009 NGI Annual Conference.
- Talks at Jackson State University: We presented 3 talks to the Jackson State University Summer Institute on Atmospheric Dispersion, June 5, 2009. The last talk was presented by Dr. Jamie Dyer, a Geosciences Professor, who is co-PI on Yr4 Award.
  1. "Using FlowVis Techniques to Study Hurricanes"
  2. "Improving the Understanding of Hurricanes: Visualizing WISDOM and UAS"
  3. "The Advantages of 4D Visualization in Understanding Severe Storms"
- Talk at Visualization 2008 workshop

L. Has anyone on this project been hired by NOAA? None

M. Peer Reviewed Articles:

Shangshu Cai, Qian Du, and Robert Moorhead, “Feature-Driven Multi-layer Visualization for Remotely Sensed Hyperspectral Imagery,” IEEE Transactions on Geoscience and Remote Sensing, (under revision, originally submitted Feb. 2009, won’t be accepted until at least August 2009, if then).

Shangshu Cai, J. Edward Swan II, Robert Moorhead, Qian Du, Zhanping Liu, and T.J. Jankun-Kelly, “An Evaluation of Visualization Techniques for Remotely-Sensed Hyperspectral Imagery,” IEEE Transactions on Visualization and Computer Graphics, (under revision, originally submitted Dec. 2008, won’t be accepted until at least August 2009, if then).

Keqin Wu, Zhanping Liu, Song Zhang, and Robert J. Moorhead II, “Topology-Aware Evenly-Spaced Streamline Placement,” IEEE Transactions on Visualization and Computer Graphics, (under 2nd review, 2nd submission June 2009, could be accepted by end of August).

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Michael Berberich, Phil Amburn, Robert Moorhead, Jamie Dyer and Manfred Brill, “HurricaneVis Geospatial Visualization using Hardware Accelerated Real-Time Volume Rendering,” IEEE EuroVis 2009, June 2009, (poster/demo)

Keqin Wu, Song Zhang, Jibonananda Sanyal, Phil Amburn, and Robert J Moorhead, “Using FlowVis Techniques to study Hurricane cases," NOAA NGI Annual Meeting, Mobile, AL, May 2009 (presentation).

Derek Irby, Mahnas Jean Mohammadi-Aragh, Robert Moorhead, and Phil Amburn, “Improving the Understanding of Hurricane Visualizing WISDOM and UAS," NOAA NGI Annual Meeting, Mobile, AL, May 2009 (presentation).

Michael Berberich, Phil Amburn, Robert Moorhead, Jamie Dyer, and Manfred Brill, “HurricaneVis – GeoSpatial Visualization Using GPU Accelerated Real-Time Volume Rendering,” NOAA NGI Annual Meeting, Mobile, AL, May 2009. (poster)

Keqin Wu, Jibonananda Sanyal, Song Zhang, Phil Amburn, and Robert J Moorhead, “Using LIC-like Flow Vis Technique to Visualize Hurricane Lili’s Rapid Weakening,” NOAA NGI Annual Meeting, Mobile, AL, May 2009. (poster)

Mahnas Jean Mohammadi-Aragh, Derek Irby, Phil Amburn, and Robert Moorhead, “Improving the Understanding of Hurricanes: Visualizing Storm Surge,” NOAA NGI Annual Meeting, Mobile, AL, May 2009. (poster)

Mahnas Jean Mohammadi-Aragh, Derek Irby, Robert Moorhead, and Phil Amburn, “The UAS and WISDOM Visualization System,” NOAA NGI Annual Meeting, Mobile, AL, May 2009. (poster)

Jibonananda Sanyal, Phil Amburn, Song Zhang, Jamie Dyer, Patrick J Fitzpatrick, and Robert J Moorhead, “User Experience of Hurricane Visualization in an Immersive 3D Environment,” 4th International Symposium on Visual Computing, Lecture Notes in Computer Science, Las Vegas, NV, Springer (2008), Dec 1-3, 2008.

Jibonananda Sanyal, Phil Amburn, Song Zhang, Patrick J Fitzpatrick, and Robert J Moorhead, “Applying Immersive Visualization Techniques to Analyze Model Outputs: A Case Study of Hurricane Lili,” IEEE Visualization Poster Compendium, October 2008 (best poster award).

Robert Moorhead, “3D Immersive Visualization and Evaluation of Mesoscale Model Outputs Simulating Hurricane Lili’s (2002) Rapid Weakening.” Keynote Address, Practical Virtual Environment Systems Workshop, IEEE Visualization Conference, Oct 2008.

Jibonananda Sanyal, Phil Amburn, Song Zhang, Patrick J Fitzpatrick, and Robert J Moorhead, “3D Immersive Visualization for Evaluation of Mesoscale Model Outputs Simulating Hurricane Lili’s (2002) Rapid Weakening,” Proceedings of IEEE Oceans 2008, Quebec City, Canada.

MSU 07

A. NGI Project file Number: 08-MSU-07

B. Project title, PI(s), Email, and Affiliation: INFORMATION SEMANTIC APPROACH FOR RESOURCE AND KNOWLEDGE DISCOVERY IN INTEGRATED OCEAN OBSERVING SYSTEM

PI : Roger L. King
EMAIL : rking@cavs.msstate.edu
AFFILIATION : Giles Distinguished Professor, Director, Center for Advanced Vehicular Systems (CAVS), Mississippi State, MS, 39762

CO-PI : Surya S. Durbha
EMAIL : suryad@gri.msstate.edu
AFFILIATION : Assistant Research Professor, Geosystems Research Institute/Adjunct, Department of Electrical and Computer Engineering, Mississippi State, MS, 39762

C. List all Non-student personnel funded by this project:

PERSON'S NAME: Roger L. King
CATEGORY: Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Surya S. Durbha
CATEGORY: Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Balakrishna Gokaraju
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Shruthi Bheemireddy
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Santosh K. Akamanchi
CATEGORY: Graduate Student
CURRENT HIGHEST DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): The IOOS consists of three subsystems

1. Observing Subsystem (remotely sensed and in situ measurements and their transmission from platforms);
2. Modeling and Analysis Subsystem (evaluation and forecast of the state of the marine environment based upon measurements); and
3. 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:

1. 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.
2. 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.
3. 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.
4. Content-based remote sensing and in situ data extraction and integration.

F. 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.
- Collaboration with NOAA Coastal Data Development Center (NCDDC) to transition research to operations. Possible involvement with integrated Ocean Observation System (IOOS) for implementing OGC sensor web standards in the near future.
- 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.

These partners do not provide monetary support, but they do provide in-kind support.

We are working closely with NOAA Coastal Data Development Center (NCDDC) to transition research to operations. On 06/17/09 we gave a demonstration of our CosemWare sensor web implementation to the personnel from NCDDC. We are working on integrating NOAA Ecosystems based management with Information Semantics. We are also working with NCDDC and IOOS on a possible joint proposal to the NSF.

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. Dr. King represents MSU on the scientific committee of Image information mining working group. (http://earth.esa.int/rtd/Events/ESA-EUSC_2008/).

G. Project Duration

a. START DATE: 1/1/07
b. ESTIMATED END DATE: 12/31/09

H. Project Baselines:

a. 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.

b. 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.

c. 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 developed sensor web enablement prototype will help to

reconcile the disparate information sources. Advanced semantics based querying based on SPARQL will help to aggregate metadata from dispersed sensor networks and helps to facilitate integrated querying. An ontology mapping tool is being developed that aims to find semantic correspondences between entities belonging to different ontologies. The mapping between ontologies provides the means for users to interchange knowledge and thus establish semantic interoperability between them. The service level discovery efforts of the project will enable to discover coastal web services at the regional level through the enrichment of the semantics of the service descriptions by OWL-S. The mobile client interface that was developed to query the sensor web will give freedom to the users to get information in much more flexible way and also during emergencies where earlier experiences of Hurricane Katrina indicated that the mobile network was the only one that was working during that disaster.

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.

I. 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.

J. 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:
    1. Completed describing selected 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;

2. Completed the development of a fully functional Sensor Observation Service (SOS) prototype and deployed. It can handle several requests such as GetCapabilities, DescribeSensor, GetObservation etc. (Figure 67)
3. 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).

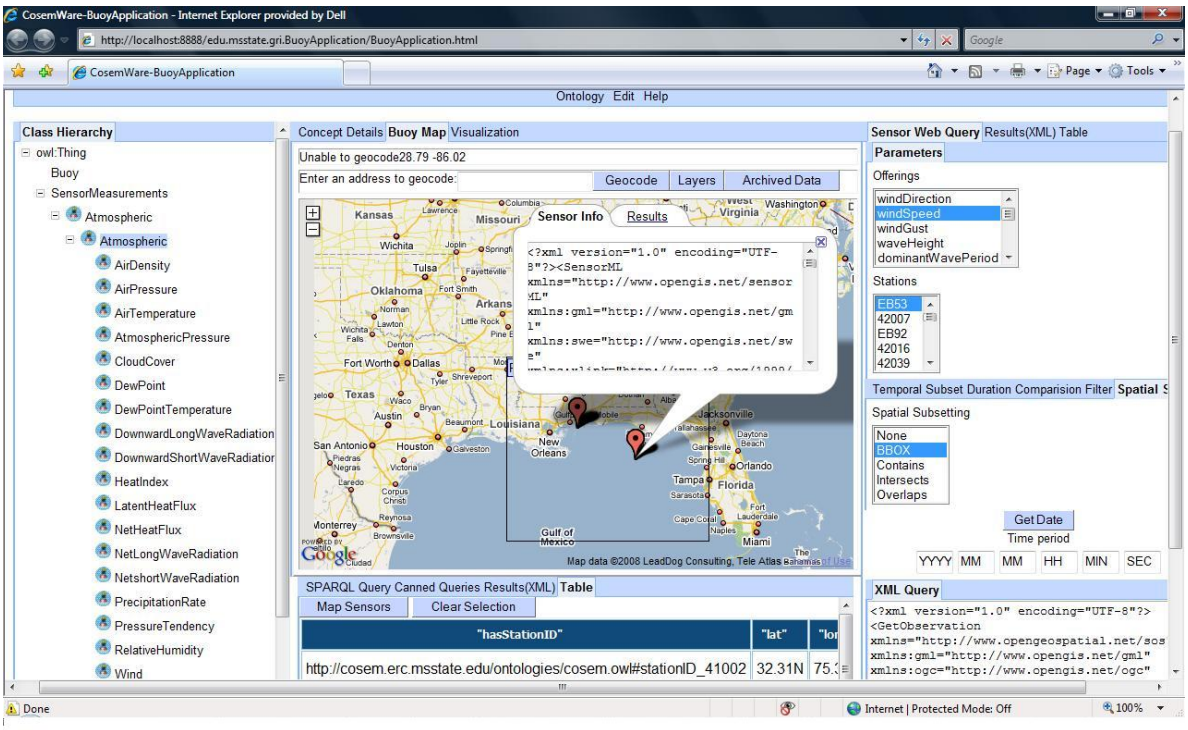

Figure 67. CosemWare sensor web client depicting the results of a BBOX query. The Sensor web developed in this project enables Spatio-temporal querying in addition to resolving semantic heterogeneities between different networks.

- A fully functional demonstration of Sensor Web prototype (CosemWare) was done on 06/17/09 to personnel from NOAA Coastal Data Development Center (NCDDC).
- 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 semantic-based querying (SPARQL) has also been demonstrated on 06/17/09 to NCDDC (Figure 68). There is great interest from NCDDC to enable such types of querying into the operational NCDDC data management strategies and also implement in the NCDDC ecosystem based data management framework.
- It has been discussed and agreed that the sensor web work done through this project could directly augment the “Planning service” of the NCDDC ecosystem based management vision. Some possible implementation plans have been discussed.

- An Ontology Merging Tool to Facilitate Interoperability between Coastal Sensor Networks has been developed using machine learning and string based matching techniques. (Figure 69)
- Mobile Computing and Sensor Web Services for Coastal Buoys have been implemented. The discovery of the services was enabled through the augmentation of semantics to the web services by an upper level ontology for services called the OWL-S which is a W3C standardized ontological representation for Web services. The ability to search for coastal web services and query them through a mobile phone has been successfully implemented (Figure 70).

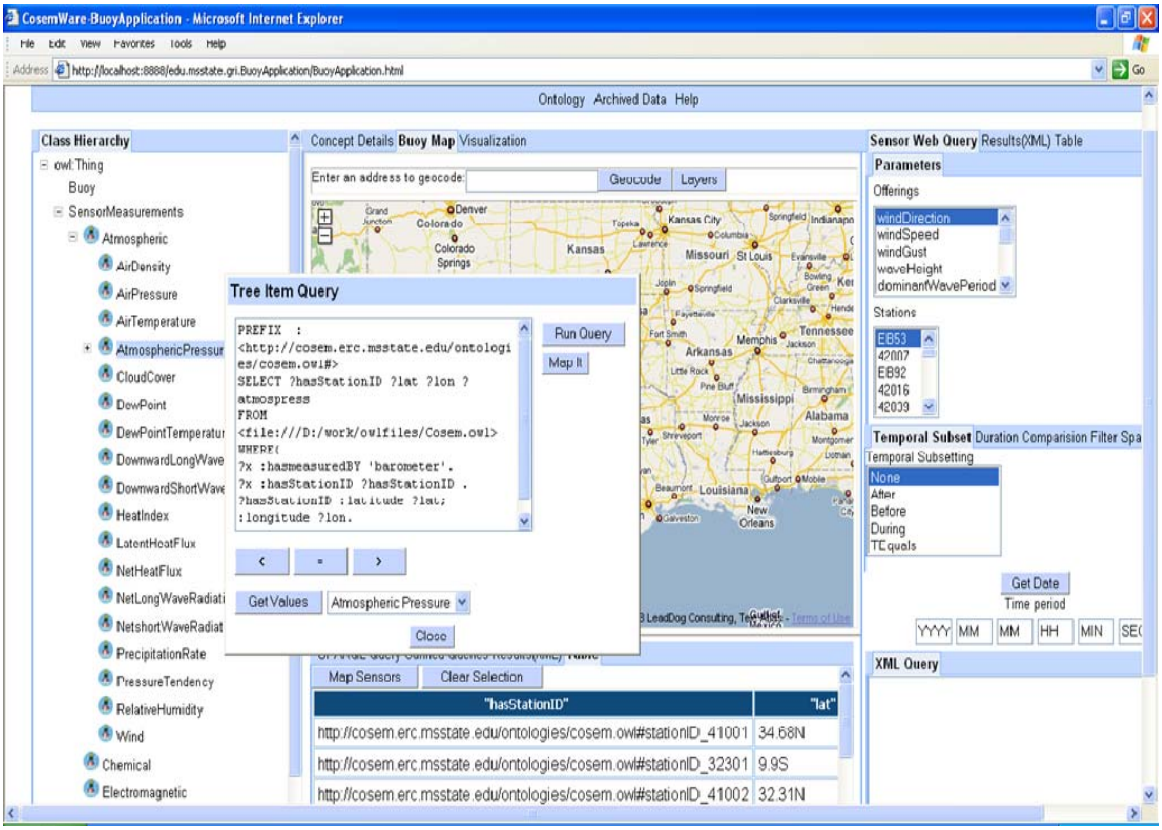

Figure 68. Example SPARQL Query (Scenario: “Find devices that can produce certain output variables”).

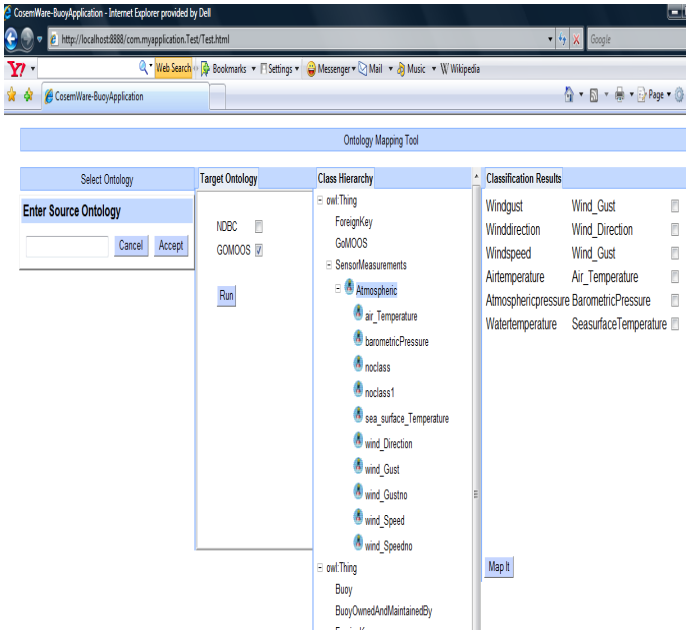

Figure 69. Ontology mapping tool showing similar concepts in NDBC and GoMOOS ontologies.

Figure 70. Registering, Querying and Execution of a Coastal Sensor Web Service (SOS) from Mobile

K. Outreach activities: We have contributed to a flyer that that was distributed at the recent NGI conference. We will also assist in the future outreach efforts as appropriate.

L. Has anyone on this project been hired by NOAA? None

M. Peer Reviewed Articles:

Durbha, S. S., King, R., & Younan, N. (Accepted) “Wrapper-Based Feature Subset Selection for Rapid Image Information Mining”, IEEE Geoscience and Remote Sensing Letters.

Durbha, S. S., King, R., Shah, V.P., & Younan, N. (Apr 2009). A Framework for Semantic Reconciliation of Disparate Earth Observation Thematic Data. Computers and Geosciences Elsevier, 35(4), 761-773.

Durbha, S. S., King, R., & Younan, N. (Sep 2008). An Information Semantics Approach for Knowledge Management and Interoperability for the Global Earth Observation System of Systems. IEEE Systems Journal, IEEE, 2(3), 358-365

N. List non-refereed articles and reports for this project.

Durbha, S. S., King, R. L., Younan, N., Amanchi, S., Bheemireddy, S., “Standards-based data models and web services for coastal ocean observations”, Coastal Geotools, 09, Myrtle Beach, 2009.

O. List conference presentations and poster presentations for this project.

Bheemireddy, S., “Machine Learning-Based Ontology Mapping Tool to Resolve Heterogeneities in Coastal Sensor Networks”, NGI conference, Mobile, AL, 2009. (NGI student paper prize 1st place winner)

Gokaraju, B., Durbha, S. S., King, R. L., Younan, N. “Sensor Web and Data Mining Approaches for Harmful Algal Bloom Detection and Monitoring in the Gulf of Mexico Region”, IGARSS 09, Cape town, South Africa, 2009 (Invited)

Bheemireddy, S., Durbha, S. S., King, R. L., Amanchi, S., Younan, N. “An Ontology Merging Tool to Facilitate Interoperability between Coastal Sensor Networks”, IGARSS 09, Cape Town, South Africa, 2009. (invited)

Amanchi, S., S., Durbha, S. S., King, R. L., Bheemireddy, S., Younan, N. “Mobile Computing and Sensor Web Services for Coastal Buoys” IGARSS 09, Cape Town, South Africa, 2009. (invited)

Durbha, S. S., King, R., Younan, N., Amanchi, S.K., & Bheemireddy, S. “Standards-based Coastal sensor web”. Proceedings of International Workshop on Spatial and Spatiotemporal Data Mining (SSTDM-08), Pisa, Italy, Dec 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.

MSU 08

A. NGI Project file Number: 08-MSU-08

B. Project title, PI(s), Email, and Affiliation: **NORTHERN GULF INSTITUTE OUTREACH PROGRAM**

PI: Sharon Hodge
EMAIL: shodge@ngi.msstate.edu
AFFILIATION: Mississippi State University (Stennis)

C. List all non-student personnel funded by this project:

PERSON'S NAME: Sharon Hodge
CATEGORY: Associate Extension Professor
DEGREE: JD
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 40
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Joby Prince
CATEGORY: Research Associate
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 92
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Jay Ritchie
CATEGORY: Research Associate
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 10
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project: None

E. Key Scientific Question(s)/Technical Issues(s): The main focus of the NGI Outreach Program is to help translate research results to the user community and general public. As part of the outreach effort, the program supports education efforts ongoing by other federal, regional and local organizations in the region.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: DISL and USM Education and Outreach Programs

DATE COLLABORATING ESTABLISHED: Feb 1, 2007

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? DISL and USM are funded by NGI, and thus do not provide monetary support back to Education and Outreach activities.

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? DISL and USM provide institutional support expertise from their networks. LSU, FSU and NOAA provide materials and institutional support for development of outreach materials.

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Outreach began work supporting DISL's work with the DISL Estuarium and the Mississippi River museum consortium to spread the program up the watersheds of the Northern Gulf of Mexico. USM publicizes the research performed by USM NGI PIs and assists MSU NGI Outreach with implementation of institute wide outreach. All of the university partners help provide editorial review of Research Spotlights that translate the research results for public consumption. NOAA outreach personnel assist NGI in career fair activity and coordination of exhibits at outreach events.

NAME OF COLLABORATING ORGANIZATION: Gulf of Mexico Alliance Environmental Education Network

DATE COLLABORATING ESTABLISHED: Oct, 2006

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? GOMA EEN brings technical support and through participating state agencies, can fund travel to GOMA meetings and workshops to develop Gulf of Mexico educational materials and programs.

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? GOMA provides institutional support expertise from their network.

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. GOMA EEN website development will fulfill several important goals of dissemination of NGI research and of supporting other regional educational and outreach efforts. NGI Outreach supported the storyboarding process in Year 2 and will oversee the launch of the website in Year 3.

NAME OF COLLABORATING ORGANIZATION: National Estuarine Research Reserves

DATE COLLABORATING ESTABLISHED: Feb 1, 2008

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? NERRS have been instrumental in helping NGI help NOAA extend the Phytoplankton Monitoring Network across the northern Gulf region.

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. NGI works with the National Estuarine Research Reserves of the northern Gulf on several efforts including outreach workshops and citizen scientist coordination.

NAME OF COLLABORATING ORGANIZATION: Gulf Sea Grant Programs

DATE COLLABORATING ESTABLISHED: Formally by MOA in 2008

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes, partnering.

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. NGI works with the MS/AL Sea Grant Consortium and Louisiana Sea Grant programs on several efforts including outreach workshops and symposium planning and publicity and internship mentoring.

NAME OF COLLABORATING ORGANIZATION: Southeast Phytoplankton Monitoring Network

DATE COLLABORATING ESTABLISHED: Jun, 2007

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Provides training and equipment to the program volunteers local to the NGI program offices.

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. NGI works with SEPMN to develop and maintain a group of program volunteers along the Gulf Coast. NGI helps to facilitate training opportunities and SEPMN provides the equipment and trainers.

NAME OF COLLABORATING ORGANIZATION: NESDIS and the NOAA National Coastal Data Development Center

DATE COLLABORATING ESTABLISHED: Feb 1, 2007

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? Yes, $50,000 for 2008 and again for 2009.

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? NCDDC provided mentors for the interns and the Metadata trainer provided regular technical guidance and support for the interns.
SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. NGI Outreach Program will administer internships for minority students to learn metadata publication processes and support NOAA NGI Ecosystem Data Assembly Center will continue, with supplements for other NOAA elements such as National Marine Fisheries Service

G. Project Duration: 3 years

a. START DATE: February 1, 2007
b. ESTIMATED END DATE*:* January 31, 2010

H. Project Baselines:

a. CONTRIBUTIONS TO SPECIFIC NOAA GOALS/OBJECTIVES: The NGI Outreach project develops materials explaining NGI research and results which will help improve ocean literacy. In addition, NGI conducts the internship program, employes students, supports workshops and participates in university career fairs in order to support the NOAA goal of workforce development.

b. 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.

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

I. Project Abstract: The NGI Outreach project purpose is to enhance the science and environmental literacy of the populous of the Northern Gulf ecosystem and to contribute to NOAA workforce development. The goal of this project is disseminate NGI research results in a manner understandable by general public, stakeholder community and potential collaboration partners. NGI Outreach program evaluates new, existing and enhanced education and outreach approaches to help grow stewardship philosophy and behavior in the Northern Gulf region.

Building on the successes of the first and second year efforts and developing dissemination channels for maturing research results, a number of activities were planned for year 3. These include community workshops such as the Bays and Bayous Symposium that will identify high-impact federal and state program integration opportunities, and set the stage for future actions to address States' priority issues. NGI research spotlights and project fact sheets focus attention on existing project activities and results – for the NGI community and others. The spotlights will also provide base materials for the interagency media feed activity being implemented by Earth Gage – to provide regular feeds of marine related science for local nightly news. NGI Outreach program will continue innovative outreach of capturing the captive audience. NGI compliments other education and

outreach programs by targeting individuals not addressed by others, particularly those who leave significant footprints on the ecosystem of the region. An early success, the NGI hotel keycard environmental education messaging program launched in Year 2, will be expanded along the northern Gulf coast in Year 3.

The Outreach program will help NGI researchers identify important transition and translation opportunities such as the PIANC.US conference as venues to share technologies, and promote employment of best management practices, and watershed management. The NGI proposes to continue to work with, among others, the NOAA Gulf Coast Service Center and the National Coastal Data Development Center, National Data Buoy Center, National Marine Fisheries Service, EPA Gulf of Mexico Program, Gulf of Mexico Alliance, other Stennis Space Center resident agencies, National Estuarine Research Reserves of the region, state agencies, and the 5 academic partners to identify and support activities that serve the coastal and watershed management needs of Gulf communities. The NGI will also continue as a contributing partner with Sea Grant programs in the region to foster collaboration, as well as address the Gulf Alliance needs in the six priority issue areas of water quality, wetland restoration, habitat characterization, nutrient loading, environmental education, and coastal hazards. NGI Outreach leads the developmental support for and hosts the Gulf of Mexico Alliance Environmental Education Network website.

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

Deliverables	Progress
Host, organize and participate in symposia, conferences, workshops and stakeholder meetings to feature NGI research activities.	See list provided in Section N, part b.
Provide metrics of regionally significant contributions to public education and Gulf stewardship enhancement	NGI website: number of hits = 5,817 NGI Keycard website: number of hits = 212 GOMA EEN website: number of hits = 278 Celebrate the Gulf Participants = 350 NWS Open House Participants = 100 MSU Career Day = 200
Develop materials to educate and focus attention on the unique contributions NGI researchers contribute to understanding the Gulf of Mexico and enhancing conservation of the finite resources	Research Spotlights have been created for each funded project and are available on the NGI website. Made contributions of content to the GOMA EEN website.

Deliverables (cont.)	Progress (cont.)
	Made contributions of message contents to the Earth Gauge environmental messaging program. Participated in "Celebrate the Gulf" in April 2009 and "NWS LMRFC (Slidell, LA) Open House" in May 2009 with hands on children's educational activities.
Continued support of internship activities as funding permits	Funding was secured for the 2009 NOAA NGI Summer Minority Internship program and other summer job programs placing students in NOAA activities.
Administer the internship program and manage NGI interns' activities	NGI completed administration of the 2008 internship programs, supporting 7 interns and developed the 2009 internship programs, currently in progress and supporting 12 interns.

K. Outreach activities

a. 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 (Research Spotlights, Research Notes, Factsheets), participating in outreach events for the public and coordinating media coverage.

b. HAVE YOU HOSTED SPEAKERS, WORKSHOPS AND/OR ANY TRAINING?

i. Type 2008 Industry Education Teacher Workshop
ii. Name of event: 2008 Industry Education Workshop
iii. Date: July 10 and 11, 2008
iv. Location: Stennis Space Center, MS
v. Description: Teachers from around the country were provided experiential sessions and presentations by NOAA activities at and around Stennis Space Center.
vi. Approximate Number of Participants: 38

i. Type: Speaker
ii. Name of event: NGI Speaker Series – Dr. Bill Lewis, CIRES
iii. Date: July 17, 2008
iv. Location: Stennis Space Center and video broadcast
v. Description: Several presenters provided technical and programmatic reviews important to NGI researchers and students.
vi. Approximate Number of Participants: approximately 25

i. Type: Speaker
ii. Name of event: NGI Speaker Series - Robert Arnone, Naval Research Lab
iii. Date: February 20, 2009
iv. Location: Stennis Space Center and video broadcast
v. Description: Several presenters provided technical and programmatic reviews important to NGI researchers and students.
vi. Approximate Number of Participants: approximately 25

i. Type: Speaker
ii. Name of event: NGI Speaker Series – Ken Graham, NWS Slidell
iii. Date: April 23, 2009
iv. Location: Stennis Space Center and video broadcast
v. Description: Several presenters provided technical and programmatic reviews important to NGI researchers and students.
vi. Approximate Number of Participants: 24

i. Type: Speaker
ii. Name of event: NGI Speaker Series - Larry McKinney, Harte Institute
iii. Date: June 18, 2009
iv. Location: Stennis Space Center and video broadcast
v. Description: Several presenters provided technical and programmatic reviews important to NGI researchers and students.
vi. Approximate Number of Participants: 44

i. Type: Conference
ii. Name of event: NGI 2009 Annual Conference
iii. Date: May 20-21, 2009
iv. Location: Mobile, AL
v. Description: The NGI Outreach Program provided significant leadership in the development and implementation of this conference which included outreach in addition to inreach for the existing NGI researchers.
vi. Approximate Number of Participants: approximately 180

i. Type: Web Presence Launch
ii. Name of event: Launch of the Gulf of Mexico Alliance Environmental Education Network Website
iii. Date: April, 2009
iv. Location: www.gulfallianceeducation.org
v. Description: The NGI Outreach Program provided significant leadership and development this website. Storyboarding occurred in summer 2008 and webpage development began in full in January 2009 with launch in April.
vi. Approximate Number of Participants: 20

i. Type: Training Workshop
ii. Name of event: Southeast Phytoplankton Monitoring Network (SEPMN) Refresher Training
iii. Date: May, 2009
iv. Location: Bay St. Louis, MS
v. Description: NGI and SEPMN hosted refresher training for the Bay St. Louis SEPMN program volunteer group.
vi. Approximate Number of Participants: 8

i. Type: Training Workshop
ii. Name of event: Southeast Phytoplankton Monitoring Network (SEPMN) Program Volunteer Training
iii. Date: May, 2009
iv. Location: Ocean Springs, MS
v. Description: NGI and SEPMN hosted training for program volunteers at the Southern Mississippi Gulf Coast Research Lab.
vi. Approximate Number of Participants: 25

i. Type: Presentation
ii. Name of event: Environmental Education session
iii. Date: March, 2009
iv. Location: Bay St. Louis, MS
v. Description: The NGI Outreach Program presented a lecture on how members of a local yacht club can become Citizen Scientists for the Gulf or Mexico.
vi. Approximate Number of Participants: approximately 40

i. Type: Workshop
ii. Name of event: Networking event in conjunction with the Coastal States Organization's annual meeting
iii. Date: October 2008
iv. Location: Weeks Bay NERR, AL
v. Description: The NGI Outreach Program co-hosted a networking event and discussed the role of working with coastal states in the Gulf region.
vi. Approximate Number of Participants: approximately 55

i. Type: Exhibited at Conference
ii. Name of event: PIANC
iii. Date: November, 2008
iv. Location: Mobile, AL
v. Description: The NGI Outreach Program presented NGI materials at international conference on sediment management in cooperation with other NOAA activities in the region.
vi. Approximate Number of Participants: approximately 350

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Hodge, S. 2009. NGI program office education and outreach activities: an update. NGI Annual Conference, May 2009, Mobile, AL.

Ritchie, J. 2009. NGI education and outreach activities and opportunities: looking ahead. NGI Annual Conference, May 2009, Mobile, AL.

Exhibited at the Bays & Bayous Symposium, October 2008 in Biloxi, MS, and the 2008 PIANC Conference, November 2008, Mobile, AL.

MSU 09

A. NGI Project File Number: 08-MSU-09

B. Project Title, PI(s), Affiliation, Address, Email, Phone: IMPROVING HURRICANE INTENSITY AND LANDFALL ESTIMATION WITH REFINED MODELING

PI: Pat Fitzpatrick
EMAIL: fitz@gri.msstate.edu
AFFILIATION: Mississippi State University, Geosystems Research Institute, BLDG 1103, Room 108, Stennis Space Center, MS, 39529, 228-688-1157

C. List all non-student personnel funded by this project:

PERSON'S NAME: Pat Fitzpatrick
CATEGORY: Research Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Yee Lau
CATEGORY: Research Associate
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Chris Hill
CATEGORY: Research Associate
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project: None

E. Key Scientific Questions/Technical Issue(s): Address the fundamental physics of storm surge; study the impact of levees and wetland loss on storm surge; develop a new Saffir-Simpson scale for storm surge based on bathymetry, storm size, storm speed, and intensity

F. Collaborator(s)/Partners: NOAA's Meteorological Development Lab as of March 2007, which assisted with the SLOSH grid. The USGS has provided datasets on Hurricane Rita's storm surge. NASA will provide radiometer data from Hurricane Georges which indirectly measures the storm surge.

G. Project duration: Three years

a. Start date: 2/07
b. Estimated end date: 01/10

H. Project baselines:

a. 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 is also a high priority action item in the National Science Foundation document Hurricane Warning: The Critical Need for a National Hurricane Research Initiative.

b. 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.

c. GAPS: This study will address the fundamental physics of storm surge, levee impact, and wetland loss, 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.

I. 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.

The Hurricane Rita USGS monitoring network dataset in southwest Louisiana, consisting of 23 sites with measurements every 30 s, will be examined. Surge attenuation as a function of distance inland will be analyzed, followed by linear correlations versus vegetation type, density, and height for several different classification schemes. Multivariate relationships will also be examined using stepwise multiple regression and parallel coordinate graphical techniques. NASA's Airborne Passive Microwave Radiometer (taken during Georges Louisiana landfall) also provides a unique opportunity to examine these issues.

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

- 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.
- 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.
- Rita observations, when carefully stratified, also suggest same results (2 feet reduction every 3 miles). Rita observations also suggest the buffer impact may decrease further inland. However, multiple regression shows this could be due to higher land elevation impact, which suggest that subsidence is an important issue.
- Wave heights reduced 50% 2 miles inland, and 65-70% 6 miles inland. Shortest period waves tend to be damped the most, and this effect increases inland
- A revised Saffir Simpson (SS) scale based on tropical cyclone size, intensity, storm speed, and continental shelf slope/depth has been completed. A new scale will be presented which accounts for all surge factors. These results are based on many hypothetical surge simulations using the Advanced CIRCulation (ADCIRC) model. The variations include 5 different bathymetries for continental shelf slope and distance; small-, average-, and large-sized hurricanes defined by radius of tropical storm-force winds; slow-, average-, and fast-moving hurricanes; and different intensities. It is found that, if one partitions by bathymetric zones, 3 tables result for storm size categories. Storm speed turns out to be a minor component that's only relevant for intense hurricanes in shallow bathymetry, and can be used as a correction factor in these tables.
- A second scale has been developed using Integrated Kinetic Energy (IKE). However, the tables can be further simplified if IKE is included. IKE cannot be used as a replacement for intensity because a large Category 3 hurricane and small Category 5 hurricane have the same IKE magnitude, but produce different surges since wind stress plays an important role. However, a nonlinear combination of IKE0.5 and intensity produces a linearly increasing trend for all bathymetries. This new scale is not quantized like the SS scale, where a 5-knot difference can result in a unit Category change.
- Tables of the eastward displacement of 5-ft and 10-ft surge inundation have been developed.

Ongoing work:

- Comparison of wind input in for storm surge runs
- Peer-review publications underway
- Analysis of NASA radiometer data to be conducted in Fall 2009

K. Outreach activities: Assisted St. Bernard hurricane preparedness officials and MEMA during Hurricanes Gustav and Ike; Reviewed several journal articles; Participated in interviews.

Peer review of:
Authors: P. Chen, H. Yu, and J. C. L. Chan
Journal: Weather and Forecasting
Title: "A Western North Pacific Tropical Cyclone Intensity Prediction Scheme (WIPS)"

Authors: K. Chen, J. McAneney, and K. Cheung
Journal: Natural Hazards and Earth System Sciences
Title: "Quantifying changes of wind speed distributions in the historical record of Atlantic tropical cyclones"

Authors: B. Yu, and A. G. Chowdhury
Journal: Journal of Applied Meteorology and Climatology
Title: "Gust Factors and Turbulence Intensities for Hurricane Winds"

Authors: T. V. Wamsley, M. A. Cialone, J. M. Smith, B. A. Ebersole, and A. S. Grzegorzewski
Journal: Natural Hazards
Title: "Influence of landscape restoration and degradation on storm surge and waves in southern Louisiana"

Television interviews:
Interview with Channel 13 WLOX, "The 4 O'Clock Show", Biloxi, MS, 3/6/09
Interview with WWL-TV, Channel 4, New Orleans, 8/31/08
Interview with Channel 13 WLOX, Biloxi, 10/29/08

Radio interviews:
Interview with BBC, 8/31/08

L. Anyone hired by NOAA? No

M. Peer reviewed articles:

Steed, C. A., P. J. Fitzpatrick, T. J. Jankun-Kelly , A. N. Yancey, and J. E. Swan, 2009. An interactive parallel coordinates technique applied to a tropical cyclone climate analysis. Computers and Geosciences, 35, 1529-1539. [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"]

Steed, C. A., P. J. Fitzpatrick, T. J. Jankun-Kelly, A. N. Yancey, and J. E. Swan, 2009. Tropical cyclone trend analysis using parallel coordinates visual analysis. Accepted to Cartography and Geographic Information Systems.

Karan, H., P. J. Fitzpatrick, C. M. Hill, Y. Li, Q. Xiao, and E. Lim, 2009: Formation of multiple squall lines, and the impact of NEXRAD radial winds in a WRF simulation. Tentatively accepted to Wea. Forecasting. pending revisions. [This journal is ranked 599 on http://www.journal-ranking.com and 17 out of 48 in the meteorology/atmospheric science category on this website]. [This journal is ranked 32 out of 48 atmospheric science journal (impact factor 1.1) by the Institute of Scientific Information Journal Citation Reports].

Xiao, Q., X. Zhang, C. Davis, J. Tuttle, G. Holland, and P. J. Fitzpatrick, 2009: Experiments of hurricane initialization with airborne Doppler radar data for the Advanced Hurricane WRF (AHW) model.

Mon.Wea. Rev. in press. [This journal is ranked 3 out of 48 in meteorology/atmospheric science on http://www.journal-ranking.com, 18 out of 48 in the Institute of Scientific Information Journal Citation Reports in the meteorology/atmospheric science category, and 120 out of 8023 in all journals in the multidisciplinary science category at http://www.journal-ranking.com]. [This journal is ranked 18th out of 48 atmospheric science journal (impact factor 1.9) by the Institute of Scientific Information Journal Citation Reports].

N. Non-Peer reviewed articles:

Lau, Y., S. K. Bhate, and P. J. Fitzpatrick. 2008. Visual data analysis for satellites. NASA Tech Briefs, 32(8), 18,20.

Anantharaj, V, and P. J. Fitzpatrick. 2008. MODIS - Atmospheric data handler. NASA Tech Briefs, 32(12), 26-27.

Steed, C. A., P. J. Fitzpatrick, T.J. Jankun-Kelly, A. N. Yancey, and J. E. Swan II, 2008. An interactive parallel coordinates technique applied to a tropical cyclone climate analysis, Naval Research Laboratory, Stennis Space Center, MS, NRL/MR/7440--08-0126, 25 pp.

Steed, C. A., P. J. Fitzpatrick, T.J. Jankun-Kelly, and J. E. Swan II, 2008. Visual analysis of North Atlantic hurricane trends using parallel coordinates and statistical techniques, Naval Research Laboratory, Stennis Space Center, MS, NRL/MR/7440--08-9130, 18 pp.

Sanyal, J. P. Amburn, S. Zhang, J. Dyer, P. J. Fitzpatrick, and R. J. Moorhead, 2008. User experience of hurricane visualization in an immersive 3D environment. 4th International Symposium on Visual Computing, December 1-3, Las Vegas, NV.

The Winds of Katrina, 2008, Bill Hudson & Associates (available on DVD).

Anantharaj, V., Y. Li, and P. J. Fitzpatrick. 2009. Incorporation of MODIS land cover data into COAMPS. NASA Tech Briefs, pending publication.

Masutani, M., R. M. Errico, J. S. Woollen, Y. Xie, T. Zhu, N. Prive, R. Yang, H. Sun, A. Da Silva, C. Hill, Y. Song, S. Greco, S. A. Wood, E. Andersson, T. Jung, L. P. Riishojgaard, F. Weng, O. Reale, T. W. Schlatter, V. Anantharaj, P. J. Fitzpatrick, A. Stoffelen, G. J. Marseille, G. D. Emmitt, S. Lord, Y. Sato, M. Hu, S. S. Weygandt, M. J. McGill, D. Devenyi, T. J. Kleespies, E. Liu, M. Sienkiewicz, D. Groff, D. T. Kleist, K. Fielding, H. Pryor, E. Salmon, M. W. Govett, X. Fan, E. Brin, Z. Pu, L. Cucurull, Z. Toth, T. Miyoshi, T. Enomoto, M. Watanabe, H. Koyama, Y. Rochen, M. Seablom, B. Hauss, R. Burns, G. Higgins, H. Wang, Y. Chen, and X. Y. Huang, 2009. Expanding collaboration in Joint OSSEs. 89th Annual Meeting of the American Meteorological Society, January 20-24, Phoenix, AZ.

Fitzpatrick, P. J., 2009: The debate over tropical cyclones and anthropogenic climate change. World History Encyclopedia. A. J. Andrea, Ed., ABC-CLIO, in press.

Fitzpatrick, P. J., 2009: Global warming. World History Encyclopedia. A. J. Andrea, Ed., ABC-CLIO, in press.

O. List conference presentations and poster presentations for this project.

Posters:
Sanyal, J., P. Amburn, S. Zhang, P. J. Fitzpatrick, and R. J. Moorhead, 2008. Applying immersive visualization techniques to analyze model outputs: A case study of Hurricane Lili. IEEE Visualization 2008, October 19-24, Columbus, OH. [Won Best Poster award]

Hill, C. M., P. J. Fitzpatrick, X. Fan, V. Anantharaj, M. Masutani, L. P. Riishojgaard, and Y. Li, 2009. An observing system simulation experiment to evaluate CrIS / ATMS observations in modeling a mesoscale weather event. 89th Annual Meeting of the American Meteorological Society, January 20-24, Phoenix, AZ.

Riishojgaard, L. P., and F. Weng, M. Masutani, T. Zhu, H. Sun, C. M. Hill, V. Anantharaj, P. J. Fitzpatrick, R. M. Errico, S. J. Lord, Y. Han, J. Woollen, D. Groff, and T. J. Kleespies, 2009. Evaluation of GOES-R and NPOESS instrument in Joint OSSEs. 89th Annual Meeting of the American Meteorological Society, January 20-24, Phoenix, AZ.

Hill, C. M., P. J. Fitzpatrick, and Y. Lau 2009. Examination of the tropical cyclone environment through comparison of COSMIC with other satellite data. European Geosciences Union General Assembly, Vienna, Austria, April 19-24.

Karan, H., P. J. Fitzpatrick, C. M. Hill, Y. Li, Q. Xiao, E. Lim, and J. Sun, 2009. The formation of multiple prefrontal squall lines and the impact of NEXRAD radial winds in a WRF simulation. European Geosciences Union General Assembly, Vienna, Austria, April 19-24.

Fitzpatrick, P. J., Y. Lau, N. Tran, and C. Hill, 2009. Wetland attenuation of Hurricane Rita's storm surge. Northern Gulf Institute 2009 Conference, May 20-21, Mobile, AL.

Presentations:
Fitzpatrick, P. J., C. M. Hill, N. Tran, Y. Lau, Y. Li, and H. Karan, 2008. Sensitivity studies of factors affecting storm surge, and a proposed new Saffir Simpson scale. Gulf Coast Hurricane Preparedness, Response, Recovery & Rebuilding Conference, Nov. 11-14, Mobile, AL.

Fitzpatrick, P. J., C. M. Hill, N. Tran, Y. Lau, and Y. Li, 2008. Wetland and levee impact on storm surge, and a proposed new Saffir-Simpson scale. Bays and Bayous Symposium, October 28-29, Biloxi, MS. (presenter)

Fitzpatrick, P. J., 2009. Unmanned aircraft hurricane reconnaissance. MMS Gulf of Mexico Information Transfer Meeting, Jan. 6-8, New Orleans, LA, [invited].

Fitzpatrick, P. J., 2009. Hurricanes and climate. MMS Gulf of Mexico Information Transfer Meeting, Jan. 6-8, New Orleans, LA, [invited].

Hill, C. M., P. J. Fitzpatrick, Y. Lau, and H. Karan, 2009. Examination of the tropical cyclone environment through comparison of COSMIC with other satellite data. 89th Annual Meeting of the American Meteorological Society. January 20-24, Phoenix, AZ.

Fitzpatrick, P. J., Y. Lau, Y. Li, N. Tran, and C. Hill, 2009. Storm surge issues in Louisiana and Mississippi. University of New Orleans seminar series. Feb. 4, New Orleans, LA, [invited].

Fitzpatrick, P. J., 2009. An assessment of the hurricane wind field. COE annual meeting. Feb. 17-18, Chapel Hill, NC.

Hill, C. M., P. J. Fitzpatrick, and Y. Lau, 2009. Examination of the tropical cyclone environment through comparison of COSMIC with other satellite data. 63rd Interdepartmental Hurricane Conference, March 2-5, St. Petersburg, FL.

Xiao, Q., X. Zhang, C. A. Davis, G. J. Holland, and P. J. Fitzpatrick, 2009. Experiments of hurricane initialization with airborne Doppler radar data for the Advanced-research Hurricane WRF (AHW) Model. 63rd Interdepartmental Hurricane Conference, March 2-5, St. Petersburg, FL.

Fitzpatrick, P. J., Y. Lau, Y. Li, N. Tran, and C. Hill, 2009. A proposed new storm surge scale. 63rd Interdepartmental Hurricane Conference, March 2-5, St. Petersburg, FL.

Tran, N., P. J. Fitzpatrick, Y. Lau, Y. Li, and C. Hill, 2009. A concise approach to assess storm surge threat using ADCIRC. 2009 ADCIRC Workshop, April 20-21, Silver Spring, MD.

Jelley, B., Jacobsen, R. and P. Fitzpatrick, 2009. Near real-time, H*Wind-based windfield production for ADCIRC. 2009 ADCIRC Workshop, April 20-21, Silver Spring, MD.

P. Fitzpatrick, C. M. Hill, J.H. Corbin, Y.H. Lau, and S.K. Bhate. Summertime precipitation patterns associated with the sea breeze and land breeze in southern Mississippi and eastern Louisiana. European Geosciences Union General Assembly, Vienna, Austria, April 19-24.

Fitzpatrick, P. J., Y. Lau, Y. Li, N. Tran, and C. Hill, 2009. A proposed new storm surge scale. Northern Gulf Institute 2009 Conference, May 20-21, Mobile, AL.

USM 01

A. NGI Project file Number: 08-USM-01

B. Project title, PI(s), Email, and Affiliation: MICROBIAL SOURCE TRACKING AND ITS APPLICATION TO THE NORTHERN GULF OF MEXICO

PI : R. D. Ellender
EMAIL : rdellender@gmail.com
AFFILIATION : University of Southern Mississippi

CO-PI : S. Wang
EMAIL : shaio.wang@usm.edu
AFFILIATION : University of Southern Mississippi

C. List all non-student personnel funded by this project: None

D. List all students funded by this project:

PERSON'S NAME: Christopher Flood
CATEGORY: Graduate Student
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): 1. Can Bacteroides primers be labeled with fluorescent tags and analyze the PCR products by sequence analysis? 2. Can a volume based approach be used to analyze polluted coastal waters? 3. How do we create a workable Bacteroides internal control? 4. What are the results of our continued analysis of human markers in coastal beach sites? 5. How do enterococcal counts compare with the measurements of human markers in samples of beach water? How do we create a useable SOP for the user community?

F. Collaborators(s)/Partners : None

G. Project Duration: 1 year

a. Start date: 01/1/08
b. Estimated end date: 12/31/2009

H. Project Baselines: Research of this nature has not been previously conducted on the Mississippi coast. Although enterococcal counts are measured frequently and used to determine the risk of swimming in the coastal water, no one has determined if the waters are polluted by human or animal waste.

a. CONTRIBUTIONS TO SPECIFIC NOAA GOALS/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.

b. 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 was 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.

c. GAPS: 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.

I. Project Abstract: During the course of his project period, we determined that the labeling process of Bacteroides primers followed by sequencing was time consuming and costly. In its place, we purchased a MultiNA instrument that greatly increased our ability to analyze multiple samples and excluded the gel electrophoresis, staining, and printing process. A volume based assay was used to determine the presence/absence of a Salmonella marker that was developed in our laboratories. The results showed that a 10 L extraction using the VelPro-hollow fiber method did not improve the specificity of the assay over a standard 500 ml extraction. Modification of the bp marker of Bacteroides did not improve the measurement of the internal standard. We have concluded that removal of a portion of the 520 bp segment and replacement with a different sequence may satisfy this objective. A year of analysis did not show that the presence of either the Bacteroides or the M. smithii markers tracked the enterococcal count in any coastal sample tested. However, statistical studies of these data indicated that the two markers did detect a common phenomenon (human fecal contamination).

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

- Purchase of a MultiNa unit (funding from other sources). This instrument was instrumental in the rapid analysis of coastal samples
- Analysis of a full year of coastal samples along with statistical analysis. This major study did not show a positive relationship between the presence or absence of the Bacteroides or the *M. smithii* human markers and the standard enterococcal count.
- A SOP, describing the specifics of the Bacteroides and *M. smithii* methods was developed:

1. A 500 ml sample of coastal water is filtered through a 3.0 micron cellulose acetate filter ((Pall Gelman [#66387]; VWR Cat #28149-634) and the filtrate collected and filtered through a 0.45 micron filter (Pall Gelman [#66234]; VWR catalog # 28147-979).
2. The filter is placed into the first tube of a MoBio PowerSoil Kit (MoBio Laboratories, Carlsbad, CA; Catalog #12888-100) and the sample DNA extracted according to the manufactures guidelines.
3. The concentration of DNA in the final concentrate is measured using s Nanodroop Spectrophotometer (Wilmington, DE).
4. Polymerase Chain Reactions: The master mix for each organism is different and shown below.

   For *M. smithii* the PCR Master Mix is:
   12.5 µl of EconoTaq Plus
   1.0 µl of both forward and reverse primers
   8.5 µl of Nuclease-free water
   Each PCR reaction will contain 2 µl of template

   For Bacteroides the PCR Master Mix is:
   12.5µl of EconoTaq Plus (Lucigen® Corporation)
   1.0 µl of both forward and reverse primers
   9.5 µl of Nuclease-free water
   Each PCR reaction will contain 1 µl of template

   The PCR steps are the same for each organism and the protocol is shown below:
   The PCR is performed in an Eppendorf thermocycler (Eppendorf Mastercycler). The thermocycler protocol consists of a lid temperature of 105°C followed by an initial denaturation step of 94.0°C for 3 min 30 sec, followed by 94° C for 45 sec; 45 sec at 65-55°C (step down 1° /2 cycles from 65 to 62°C & 1° /cycle from 62 to° 55 C); and then 72° C for 30 sec. This is followed by 30 cycles at 94° C for 45 sec; 55°C for 45 sec and 72°C for 30 sec. The final extension is at 72°C for 5 min. The thermocycler will hold at 4.0°C until the PCR is removed.

- The protocol for high throughput analysis of EconoTaq derived PCR amplicons from *M. smithii* and Bacteroides are as follows. Analysis is performed using the microchip electrophorectic system MCE-202 MultiNA (Shimadzu Corporation Kyoto, Japan). PCR assays have the above parameters.

  M smithii: Analysis of PCR amplicons that are under 500bp follow this protocol. (*M. smithii* = 222 bp)

  1. a 1/50 dilution of a 25 bp ladder (Invitrogen Co., catalog No. 10597-011) is made by dispensing 1µl of ladder into 49µl of TE buffer.
  2. The solution is agitated for 10 sec.
  3. A stock solution of Syber Gold Dye is prepared by dispensing 1 µl of dye into 99 µl of TE buffer.
  4. The stock solution is agitated for 10 sec.

5. The volume of separation buffer is calculated according to the number of samples to be assayed.
6. The diluted dye solution will be added until it reaches a volume of 1/100 to the separation buffer
7. The volume of marker solution needed will be calculated as (the amount of marker solution needed) = 2x (number of analysis) + 40 µl.

Bacteroides: Analysis of PCR amplicons that are between 500 and 1000bp follow this protocol (Bacteroides = 520bp)

1. A 1/100 dilution of ΦX174 DNA/Hawaii marker (Proméga Co.) is made by dispensing 1µl of the marker into 99µl of TE buffer.
2. The solution will be agitated for 10 sec.
3. 1µl of SYBER Gold dye is dispensed into 99µl of TE buffer and the solution agitated for 10 sec.
4. The diluted dye solution is added to the separation buffer until it reaches a volume ratio of 1/100.
5. The solution volume is agitated for 10 sec.
6. The volume of marker solution needed (the amount of marker solution needed) = 2x (number of analysis) + 40 µl.

- Analysis of data can be conducted with software included in the MultiNA program.

K. Outreach activities: A basic explanation of our research was sent to Robin Barnett who prepared it for Research Spotlights, the NGI publics educational outreach segment.

L. Has anyone on this project been hired by NOAA? No.

M. Peer Reviewed Articles: No.

N. List non-refereed articles and reports for this project. No.

O. List conference presentations and poster presentations for this project.

C. Flood. 2009. Library independent analysis of human markers in Mississippi coastal waters. Annual ISSC meeting Location, Ocean Springs, MS, April 2009.

USM 02

A. NGI Project file Number: 08-USM-02

B. Project title, PI(s), Email, and Affiliation: UTILITY OF IONOSPHERE AND TROPOSPHERE MODELS FOR EXTENDING THE RANGE OF HIGH-ACCURACY GPS

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

C. List all non-student personnel funded by this project:

PERSON'S NAME: David Dodd
CATEGORY: Research Scientist
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project: None

E. Key Scientific Question(s)/Technical Issues(s): 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).

Ionosphere

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 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

Multiple position computation algorithms were developed to accommodate different processing scenarios, such as:

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

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: NOAA/ESRL

DATE COLLABORATING ESTABLISHED: Prior to NGI project start

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. Collaborator supplies real-time troposphere maps necessary for this study

NAME OF COLLABORATING ORGANIZATION: NOAA/SEC

DATE COLLABORATING ESTABLISHED: Prior to NGI project start

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. Collaborator supplies real-time ionosphere maps necessary for this study

NAME OF COLLABORATING ORGANIZATION: USM/GCGC

DATE COLLABORATING ESTABLISHED: Feb 2008

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. Collaborator supplies GPS base station observations for this study

NAME OF COLLABORATING ORGANIZATION: USM/CenGOOS

DATE COLLABORATING ESTABLISHED: Prior to NGI project start

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. Collaborator supplies GPS and motion data from an oceanographic buoy in the Northern Gulf of Mexico.

G. Project Duration

a. Start date: spring 2007
b. Estimated end date: summer 2009

H. Project Baselines

a. CONTRIBUTIONS TO SPECIFIC NOAA GOALS/OBJECTIVES: 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 in line 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.

b. CONTRIBUTIONS TO REGIONAL PROBLEMS AND PRIORITIES: Eco System Management by enabling high-accuracy positioning (three dimensional) for habitat mapping using traditional depth soundings or bathymetric LIDAR.

   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.

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.

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.

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

I. 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.

This project 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.

Several Continuously Operating Reference Stations have been established by USM's Gulf Coast Geospatial Center (GCGC) throughout Mississippi. The data from these stations will be used to augment the base stations established specifically for this project. The GCGC Continuously Operating Reference Stations network provides many more baselines, with a large variety of baseline lengths.

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

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 for dynamic positioning	Models were evaluated for a region in south Mississippi, including dynamic data from the CenGOOS buoy and static data from USM GCGC base stations No improvement in vertical position were achieved for short baselines (< 100 km). Very marginal (few cm) improvements to position solutions were achieved for longer baselines. Reliable AR for long baselines (> 100 km) requires further research.

K. 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.

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project. None

USM 03

A. NGI Project file Number: 08-USM-03

B. Project title, PI(s), Email, and Affiliation: **MONITORING AND ASSESSMENT OF COASTAL AND MARINE ECOSYSTEMS IN THE NORTHERN GULF**

PI : Stephan Howden
EMAIL : stephan.howden@usm.edu
AFFILIATION : University of Southern Mississippi

CO-PI : Charlotte Brunner
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CO-PI : Alan Shiller
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AFFILIATION : University of Southern Mississippi

CO-PI : Kjell Gundersen
EMAIL : kjell.gundersen@usm.edu
AFFILIATION : University of Southern Mississippi

C. List all non-student personnel funded by this project:

PERSON'S NAME: Stephan Howden
CATEGORY: Associate Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 2.1
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Charlotte Brunner
CATEGORY: Professor
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 1
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Steven Lohrenz
CATEGORY: PROFESSOR
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Donald Redalje
CATEGORY: ASSOCIATE PROFESSOR
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 2.1
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Alan Shiller
CATEGORY: PROFESSOR
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 2.1
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Kjell Gundersen
CATEGORY: RESEARCH SCIENTIST
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8.3
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Yihua Cai
CATEGORY: RESEARCH SCIENTIST
DEGREE: Ph.D.
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 3.3
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Kevin Martin
CATEGORY: OCEANOGRAPHIC TECHNICIAN
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 41.7
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Merritt Tuel
CATEGORY: OCEANOGRAPHIC TECHNICIAN
DEGREE: MS
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 16.7
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project: None

E. Scientific Question(s)/Technical Issues(s): 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 (LPRE) and Bay of St. Louis (BSL) and what is the effect on the western Mississippi Sound (MSS) and further offshore into the Mississippi Bight (MSB)?
- What is the extent of seasonal hypoxia in the MSB, what are the mechanisms controlling its development and what are the effects on the benthic ecosystem?
- What are the carbon fluxes within the study region?

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: Steven Lohrenz, University of Southern Mississippi
DATE COLLABORATING ESTABLISHED: 02/01/07
DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No
DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes, optical profiling package
SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. 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.

NAME OF COLLABORATING ORGANIZATION: Chet Rakocinski, University of Southern Mississippi
DATE COLLABORATING ESTABLISHED: 02/01/07
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. 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.

NAME OF COLLABORATING ORGANIZATION: Richard Fulford, Mark Peterson, and Harriet Perry, University of Southern Mississippi

DATE COLLABORATING ESTABLISHED: 02/01/07

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. In support of NGI project *Data tools for Ecosystem-based Fisheries Management* the water quality data from this project will be provided.

NAME OF COLLABORATING ORGANIZATION: Russ Beard, NOAA/NCDDC

DATE COLLABORATING ESTABLISHED: 02/01/07

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes, partner supplies expertise in metadata documentation and archiving.

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. 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.

NAME OF COLLABORATING ORGANIZATION: Gustovi Goni (NOAA/AOML) and Peter Ortner (UM/RSMAS)

DATE COLLABORATING ESTABLISHED: 02/01/07

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. In support of NGI project *Enabling and Initiating Observing System Simulation Experiments of a Coastal High Resolutiuon 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.

NAME OF COLLABORATING ORGANIZATION: Rik Wanninkhof (NOAA) and Chris Sabine (NOAA)

DATE COLLABORATING ESTABLISHED: 02/01/07

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes, 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.

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. 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.*

NAME OF COLLABORATING ORGANIZATION: Robert Twilley (LSU)

DATE COLLABORATING ESTABLISHED: 02/01/07

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. The ecosystem data from the Mississippi Sound and Bight will be utilized for the NGI project *Delta Ecosystem Forecasting System*

NAME OF COLLABORATING ORGANIZATION: David Dodd (USM)

DATE COLLABORATING ESTABLISHED: 02/01/07

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. 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.

NAME OF COLLABORATING ORGANIZATION: Stephan Howden, Vernon Asper, Steven Lohrenz, Kjell Gundersen (USM)

DATE COLLABORATING ESTABLISHED: 02/01/07

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes, partner supplies in-kind support for Dr. Kjell Gundersen and for monitoring assets.

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. 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 conect. The monthly NGI physical/biogeochemical sampling line from Bay St Louis out to buoy USM3m01 provide validation data for the buoy.

NAME OF COLLABORATING ORGANIZATION: Crystal Johnson (USM)

DATE COLLABORATING ESTABLISHED: 08/07

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. 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.

G. Project Duration:

a. START DATE: 02/01/07
b. ESTIMATED END DATE: 01/31/10

H. Project Baselines:

a. 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 MSS and MSB this project is providing the information that is required to understand effects of fluvial inputs of freshwater, nutrients, and other constituents on the MSS and western MSB 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 (CenGOOS), and hence the IOOS, it is involved with the development with the global observation and data management system.
- *Commerce and Transportation Goal:* Buoy support was provided in 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 safe transportation directly through better navigation tools.

b. Contributions to regional problems and priorities:

Gulf of Mexico Alliance (GOMA): 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 GOMA are being addressed by this project. A mapping of properties monitored to GOMA priorities is shown in Table 4.

Gulf of Mexico Ocean Observing System (GCOOS): In order to begin collecting the necessary information on the needs and requirements of stakeholders, the 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.

Table 4. 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 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

Mississippi Department of Marine Resources (MS-DMR): The MS-DMR was very concerned about the potential effects on the MSS when the Bonnet Carre Spillway (BCS) was opened on April 11, 2008. In 1997, the previous time the spillway was opened, U.S. Army Corps of Engineers (USACE) modeling results indicated a large pulse of freshwater was advected through the MSS and fresh waters stayed in BSL for several months and oyster reefs in the western Sound were adversely affected. Initially MS-DMR 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 BCS station 7. These stations are monitored on a monthly basis in order to develop a much needed baseline for the Western MSS.

c. 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.

I. Project Abstract: USM is working with Northern Gulf of Mexico Cooperative Institute (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 LPRE and on a set of sampling stations from the BSL out into the MSS and offshore to the 20 m isobath in the MSB (Figure 71). The furthest offshore station is where a buoy of the CenGOOS is located south of Horn Island. At this site, continuous measurements of water quality variables including salinity, temperature are made every half hour.

The LPR 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 BSL 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.

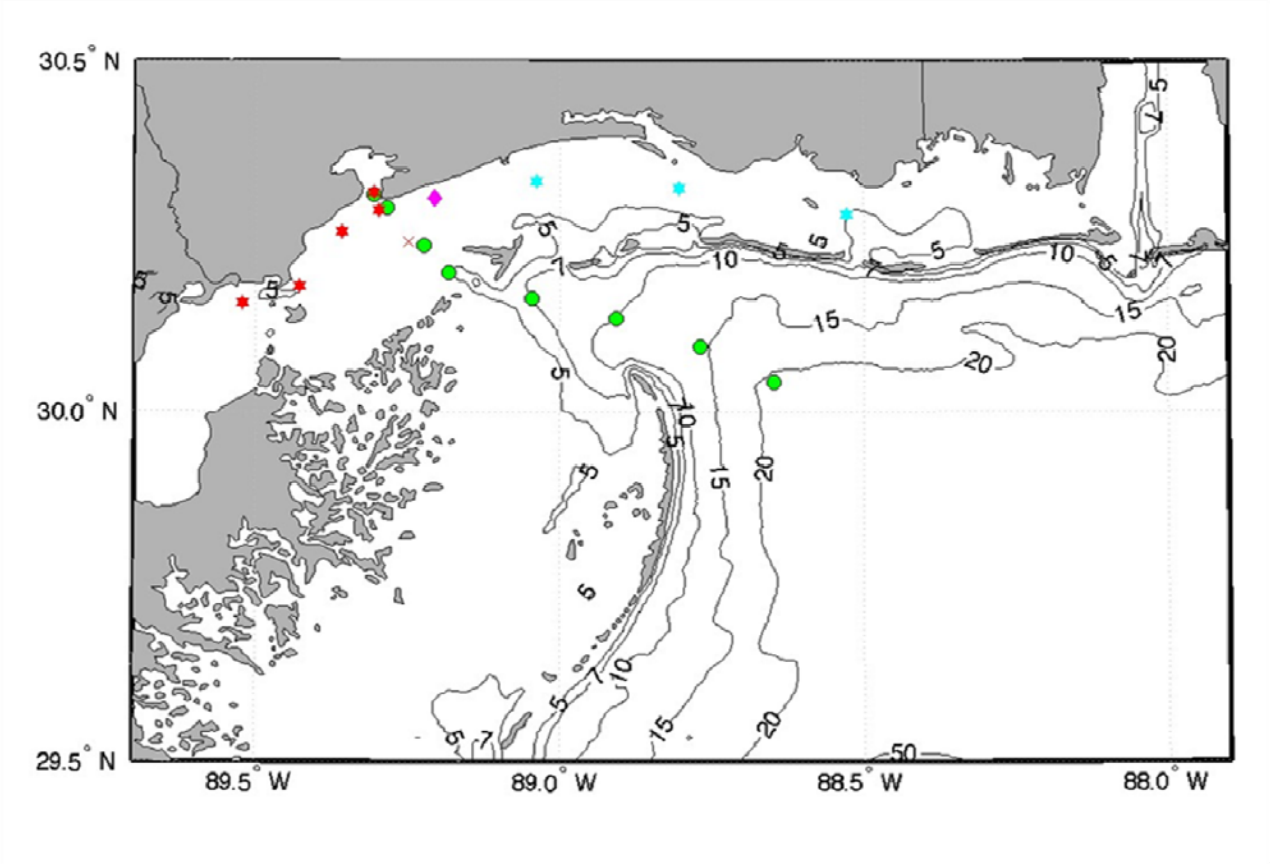

Figure 71. Sampling stations in the Mississippi Sound and Bight. The green circles are the "NGI line"; the red stars are the "BCS line"; the red x is a USGS/MSDMR continuous monitoring station; the magenta diamond is the NSF EID station; the cyan stars are proposed stations to extend monitoring into the eastern Mississippi Sound

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

1. CenGOOS buoy USM3m02 was deployed on April 30, 2009 with an attached NOAA pCO2 sensor package. Dr. Chris Sabine of NOAA/PMEL is the PI on the pCO2 package. This buoy is deployed at NGI station 8, the furthest offshore station of the project, and data from the buoy provides half hourly observations to complement the monthly NGI sampling.
2. During the reporting period 11 NGI transect lines were sampled or, depending upon weather conditions, partially sampled.
3. During the reporting period 11 BCS transect lines were sampled or, depending upon weather conditions, partially sampled.
4. Databases have been populated:
   a. The database of analyzed water samples including nutrients, salinity, dissolved oxygen, and DOC has been augmented with the data collected during the reporting period. Figure 72 illustrates the temporal development of nutrients in the MSS.
   b. The database of CTD, dissolved oxygen, and optical measurements has been augmented with the data collected during the reporting period.

c. About a years' worth of trace element time series data in the lower Pearl River, the 8-station MSS/MSB transect, plus a number of months of Bay St. Louis transects have been analyzed.
d. For hypoxic sites, a census of the live foraminifera is available for two cores each (replicates) from two sites cored in 2005, for two cores (replicates) from a site cored in 2006, and for two cores (replicates) from a site cored in 2008.

5. Results: Preliminary results were reported in the abstracts and presentations listed in the appropriate section below. Several peer-reviewed manuscripts are in preparation.
   a. Two manuscripts on the observations and development of hypoxia in the MSB are in preparation.
   b. Dr. Alan Shiller's graduate student MooJoon Shim is working on preliminary drafts of two manuscripts on the interpretation of the trace metal data.
   c. A manuscript on the nutrient observations in the MSS and MSB is in preparation. Partly in response to a presentation we gave at the Gulf Alliance Nutrients Criteria Research Framework Workshop on 10-12 March, 2009 in New Orleans on USM/DMS historical sampling in BSL and our current sampling in the MSS and MSB, BSL was chosen for a Mississippi Department of Environmental Quality/GOMA pilot program to study nutrient sources, fate, transport, and effects. We were subsequently invited to another workshop 9-11 June, 2009 to plan out the BSL program.

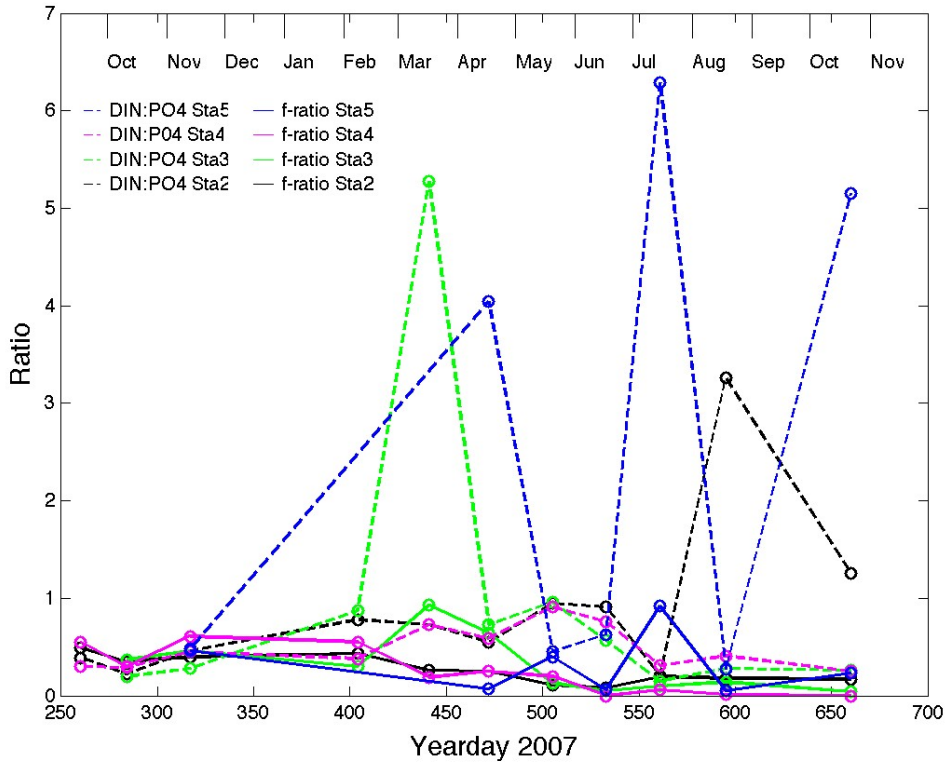

Figure 72. Temporal development of dissolved inorganic nitrogen to phosphate ratio and f-ratio in the Mississippi Sound

K. Outreach activities: Outreach activities for USM/DMS NGI activities were handled through a separate grant.

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None

N. List non-refereed articles and reports for this project.

Howden, S. D., History of Hypoxia East of the Mississippi River Plume and Plans for Tier 1 (Core) System Requirements East of Plume, Gulf Implementation Plan Workshop, 9 December, 2008, Stennis Space Center, MS.

Howden, S. D., CODAR and Buoy Program Capabilities, Managing Mississippi's Oyster Resource and Associated Environmental Monitoring Seminar Series, November 7, 2008, Mississippi State University Coastal Research and Extension Center, Biloxi, MS.

Lohrenz, S. E., S. D. Howden, D. G. Redalje, A. M. Shiller, K. M. Martin, K. Gundersen, P. Savant, and A. Mojzis (2009), Nutrient Monitoring and Assessment in Mississippi Coastal Waters. Gulf Alliance Nutrients Criteria Research Framework Workshop, 10-12 March, 2009, New Orleans, LA

Lohrenz, S. E., L. Guo, S. D. Howden, D. G. Redalje, A. M. Shiller, K. M. Martin, K. Gundersen, P. Sawant, M.-J. Shim, and A. Mojzis (2009), Overview of St. Louis Bay Characteristics and Environmental Conditions. GOMA Nutrient Criteria Research Framework Workshop 9-11 June, 2009 Stennis Space Center, MS.

O. List conference presentations and poster presentations for this project.

Bender. L. C., III, N. L. Guinasso, J. N. Walpert, and S. Howden (2008), Wave Heights from a 3m Discus Buoy During Hurricane Katrina, Oceans'08, MTS/IEEE Quebec City, Canada, 15-18 September, Paper 080519-004.

Boyette, A., D. Redalje, S. Lohrenz, S. Howden, K. Gundersen, and K. Martin, (2008), Nutrient Analyses of Mississippi Sound in Response to the Bonnet Carre Spillway Opening in April 2008, Mississippi-Alabama Bays and Bayous Symposium, October 28-29, Biloxi, MS.

Brunner, C. A., Kuykendall, J. I., Hartmann, V. A., and Howden, S. D. (2008), The Impact of hypoxia on foraminifera in the northern Mississippi bight, American Geophysical Union Fall Meeting, 15-19 December, San Francisco, Coastal Ocean Processes IV-Posters. OS43C-1306.

Brunner, C., S. Howden, and K. Gundersen (2008), 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.
Brunner, C. A., Kuykendall, J. I., Hartmann, V. A., and Howden, S. D., 2008: The Impact of hypoxia on foraminifera in the northern Mississippi bight. American Geophysical Union Fall Meeting, 15-19

December, San Francisco, Coastal Ocean Processes IV-Posters.

Cai, Y., L. Guo, S. E. Lohrenz, and A. Mozjis (2009), Effects if Hurricane on River Chemistry: A Case Study in the Pearl River, Mississippi. NGI Workshop 19-21 May, Mobile, AL.

Dillon, K., S. Howden, K. Gundersen, K. Martin, and C. Brunner (2008), Early Onset of Hypoxia in the Mississippi Bight. Mississippi-Alabama Bays and Bayous Symposium, October 28-29, Biloxi, MS

Howden, S. D., C. Brunner, S. E. Lohrenz, L. Guo, D. G. Redalje, A. M. SHiller, K. M. Martin, K. Gundersen, M.-J. Shim, and A. Mojzis (2009), Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf. NGI Workshop 19-21 May, Mobile, AL.

Shim, M.-J., Y. Cai, L. Guo, and A. Shiller (2008), Effect of the Lower Pearl River Floodplain on Trace Element and Nutrient Transport in the Pearl River, Mississippi (MS), Mississippi-Alabama Bays and Bayous Symposium, October 28-29, Biloxi, MS.

Shim, M.-J., Y. Cai, S. Duan, R. W. Smith, L. Guo, T. S. Bianchi and A. Shiller (2008), Did Hurricane Katrina Alter Water Quality in the East Pearl River? Mississippi-Alabama Bays and Bayous Symposium, October 28-29, Biloxi, MS.

Shim, M.-J., A. Mojzis, and A. Shiller (2009), Nutrient Transport in the East Pearl River and St. Louis Bay Estuaries, Mississippi, NGI Workshop 19-21 May, Mobile, AL.

Stople, B., L. Guo, and A. Shiller (2009), Size and Composition of Collodial Organic Matter and Iron in the Mississippi and Pearl Rivers and the Northern Gulf of Mexico. NGI Workshop 19-21 May, Mobile, AL.

Wang, X., Y. Chai, and L. Guo (2009), Distributions of Dissolved and Colloidal Carbohydrates in River Waters and Sea Waters from the Northern Gulf of Mexico. NGI Workshop 19-21 May, Mobile, AL.

Zhou, Zhengzhen, B. Stople, and L. Guo (2009), Composition and Size Spectra of CDOM in the Mississippi and Pearl Rivers: A Comparative Study. NGI Workshop 19-21 May, Mobile, AL.

USM 04

A. NGI Project file Number: 08-USM-04

B. Project title, PI(s), Email, and Affiliation: INTERACTION BETWEEN OFF-SHORE CIRCULATION AND NEARSHORE PROCESSES DURING EXTREME WEATHER EVENTS

PI : Vladimir Kamenkovich
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AFFILIATION : Department of Marine Science, University of Southern Mississippi, 228-688-3091, Fax : 228-688-1121

CO-PI : Dmitri Nechaev
EMAIL : dmitri.nechaev@usm.edu
AFFILIATION : Department of Marine Science, University of Southern Mississippi, 228-688-2573

C. List all non-student personnel funded by this project:

PERSON'S NAME: Vladimir Kamenkovich
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Dmitri Nechaev
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 8
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Jay Wallmark
CATEGORY: Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: David Rosenfield
CATEGORY: Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Todd Rayburn
CATEGORY: Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): 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.

F. Collaborators(s)/Partners

Naval Research Laboratory, 01/2007-07/2009, non-monetary support to project. Short description of collaboration: comparision of the POM wave model results with SWAN wave model.

Naval Oceanographic Office, 09/2006-07/2009, 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, 2/2008-07/2009, 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.

G. Project Duration:

a. START DATE: 12/2006
b. ESTIMATED END DATE: 12/2009

H. Project Baselines:

a. 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.

b. 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.

c. GAPS: The analysis of the effects of moving sea-land boundary and current-wave interaction on storm surges in the near-shore region.

I. 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.

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

- 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 interations 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.
- Development of the nesting algorithm for the two components of the modeling systems, which has been developed and tested separately during the work on the project. Tested for idealized model configuration. Work in progress: adaptation for realistic model configuration.

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 73.

Figure 73 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 filed characteristics are used to compute wave-current interaction terms, which appear to be quantitatively close for SWAN and POM wave models.

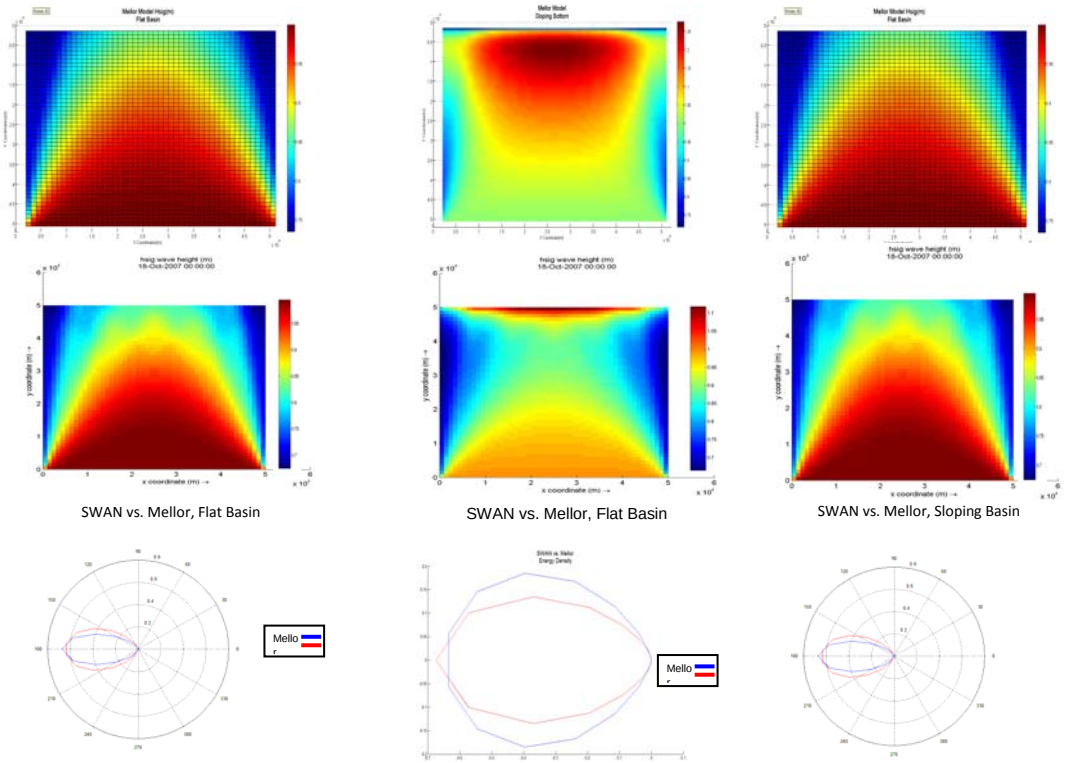
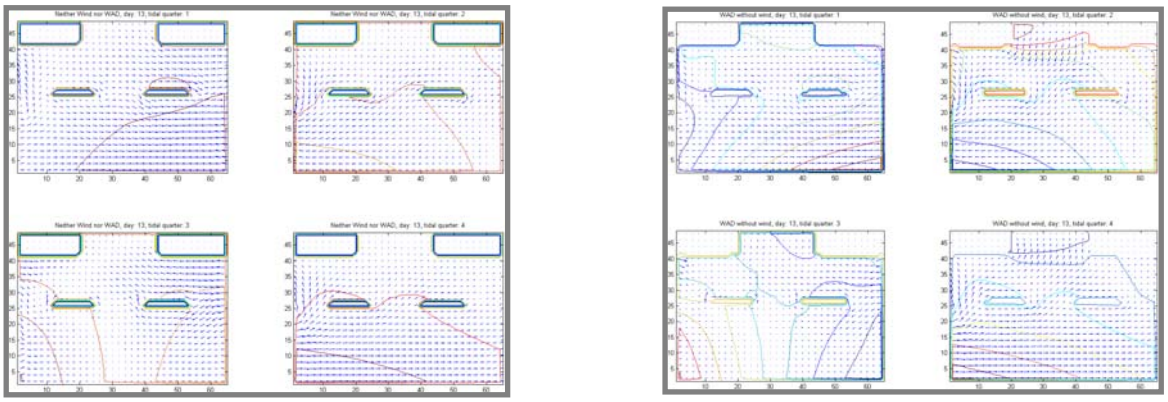


Figure 73. Significant wave height (upper row – POM results, middle row – SWAN results) and directional wave energy spectra (lower row) in SWAN (blue line) and POM (red line) wave models for configurations with flat (left and right) and sloped bottom (middle column)

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°. The experiments conducted for validation of the Wetting and Drying Scheme demonstrated importance of this mechanism for both near-shore and off-shore circulations.

Experiments with realistic model configuration: Thorough tests of the two components of the modeling system (wave model and wetting and drying scheme) and consideration of the nesting algorithm for the two components of the modeling system allows us to proceed to the experiments with realistic model configuration. To initialize a background state describing a typical late summer conditions (without or before extreme weather events) we use archived year 2000 late summer–fall solution obtained in the course of the Northern Gulf of Mexico Littoral Initiative (NGLI) program and produced by NGLI operational model at the Naval Oceanographic Office (NAVOCEANO). NGLI Model is based on the Estuarine and Coastal Ocean Model (ECOM). The model has been tested against CTD data collected during August 30 - September 14, 2000. Our model system has similar configuration and grid. The horizontal grid used in this study is shown on Figure 73. The horizontal grid is non-uniform in space, with the resolution varying from 3 km to 100 m. The finest grid corresponds to the regions with the high gradients of water properties, such as the passes between the barrier islands,

ship channels and the Mississippi River mouth. The 11 sigma levels in the vertical are evenly spaced. For a shallow region such as Mississippi Sound, where maximum depth is 10 m, the resolution exceeds 1 m in the vertical. In the deepest areas of the domain, close to the shelf break, the vertical resolution is about 7 – 10 m. The model grid contains 165 x 121 x 11 grid cells. The model accounts for the tides generated at the open boundary of the model.



WITHOUT WIND

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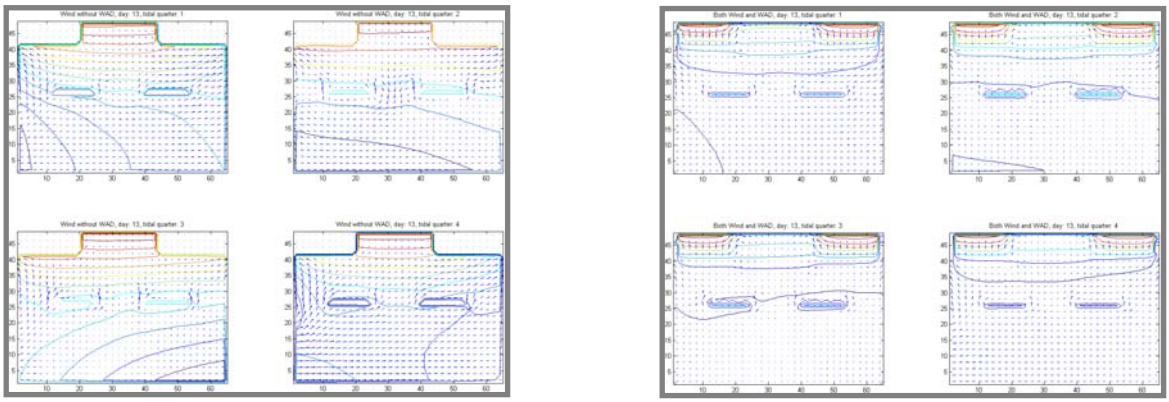

Figure 74. Sea surface elevation and current velocity vectors for four phases of the diurnal tide. Left panels show the circulation patterns with fixed sea/land boundary, right panels - with moving sea/land boundary. Upper panels demonstrate the effect of moving sea/land boundary. Upper panels demonstrate 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.

Our background state is obtained from the NGLI model state of 00:00 UT, August 1, 2000 and we consider 2 months integration period, which covers the sampling period of August 30 – September 14, 2000. We realize that the year 2000 conditions do not exactly represent “a typical” late summer conditions without or before extreme weather events, e.g. the highest summer to summer variability is known to be in Mississippi Sound salinity due to year to year variations in precipitation. We will first

analyze modification of the background state due to consideration of the wave action and wetting and drying scheme. Then we will do experiments with simulated extreme weather events with and without wave and wetting and drying mechanisms.

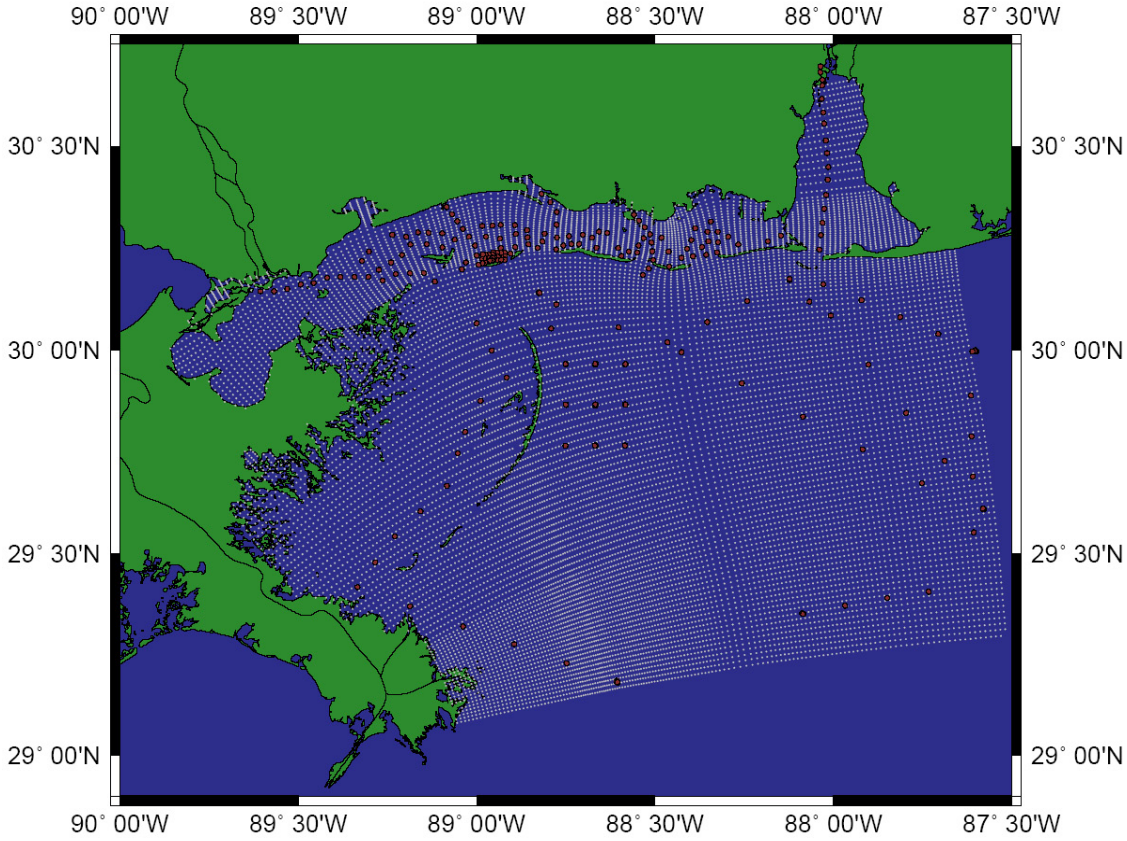

Figure 745. Configuration of the realistic model domain. Dots show locations of the CTD stations used to verify NGLI model.

K. Outreach activities: Poster presentations were given at all 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 reseach results on the Invited Professional Seminar: Kamenkovich, V., D. Nechaev: On the time-splitting scheme used in the Princeton Ocean Model.

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles:

Kamenkovich, V. M., D. A. Nechaev: On the time-splitting scheme used in the Princeton Ocean Model. J. Computational Physics, 2009, 228, 2874-2905.

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

J. Wallmark, V. Kamenkovich, D. Nechaev, J. Veeramony, Interaction between off-shore circulation and near-shore processes during extreme weather events, 2008 Annual Northern Gulf Institute Conference, Mobile, AL, May 2009. Poster.

J. Wallmark, V. Kamenkovich, D. Nechaev, Interaction between off-shore circulation and near-shore processes during extreme weather events, 2009 Annual Northern Gulf Institute Conference, Mobile, AL, May 2009. Poster.

USM 05

A. NGI Project file Number: 08-USM-05

B. Project title, PI(s), Email, and Affiliation: **SATELLITE AND IN SITU OPTICAL ASSESSMENT OF ALGAL BLOOM EVENTS IN THE NORTHERN GULF OF MEXICO**

PI : Steven Lohrenz
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CO-PI : Vernon L. Asper
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CO-PI : Gregory Carter
EMAIL : greg.carter@usm.edu
AFFILIATION : Gulf Coast Geospatial Center, The University of Southern Mississippi, 1203 Broad Ave., Gulfport, MS 39501

C. List all non-student personnel funded by this project:

PERSON'S NAME: Steven E. Lohrenz
CATEGORY: Principal Investigator
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 4.2
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Vernon Asper
CATEGORY: Principal Investigator
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Vince Lovko
CATEGORY: Post-doctoral Investigator
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 0
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project: None

E. Key Scientific Question(s)/Technical Issues(s)

- 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.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: Mote Marine Laboratory

DATE COLLABORATING ESTABLISHED: July 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. Glider-deployed sensor for discrimination of phytoplankton taxa.

G. Project Duration:

a. START DATE: July 2007
b. ESTIMATED END DATE: December 2009

H. Project Baselines:

a. 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."

b. 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.

c. GAPS: 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 capabilties for HABs and algal blooms in general.

I. 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 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.

J. 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 received delivery of the Optical Plankton Discriminator (OPD or “Brevebuster”) from Mote Marine Laboratory in May of 2009 (Figure 76). The OPD is designed as a payload for integration into the USM Web Slocum glider. The OPD is essentially an underwater spectrophotometer and uses an optical waveguide to provide a long path length. This instrument has been used successfully off west Florida to discriminate blooms of the toxic dinoflagellate, *Karenia brevis* (Figure 77). Currently, we are conducting laboratory analyses of cultures of selected HAB taxa isolated from northern Gulf of Mexico coastal waters for the purpose of developing the ability of the OPD to discriminate HAB taxa in addition to *K. brevis* (Figure 78). The glider is presently configured with an optical sensor package that provides measurements of backscattering and chlorophyll and chromophoric dissolved organic matter (CDOM) fluorescence in addition to CTD data. Although glider deployments have thus far been restricted to test runs, we have been conducting regular sampling with an optical profiling package that contains sensors similar to those on the glider. This work has been done in conjunction with the USM project “Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf” project and provides an illustration of the type of observations that are possible with regular glider deployments.

Figure 76. Optical Plankton Discriminator designed as a payload for a Web Slocum glider.

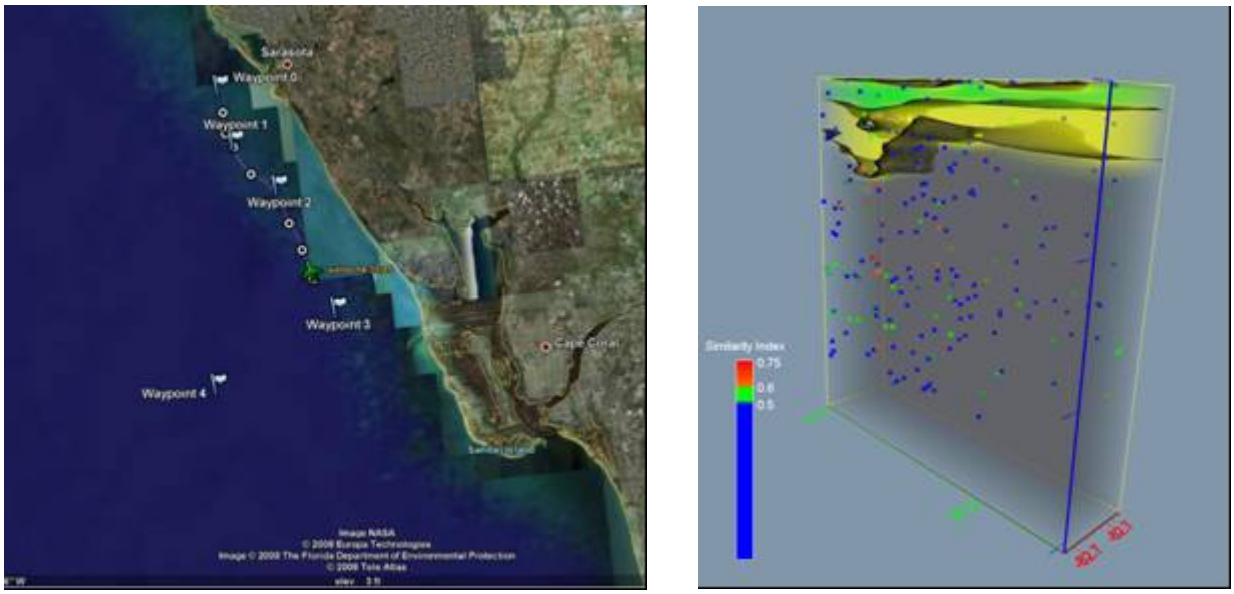

Figure 75. Map (left) showing glider waypoints off west Florida and a color plot of similarity index (right) as determined by the glider overlaid on density surfaces. High values of the similarity index (red) were evident in association with a density feature.

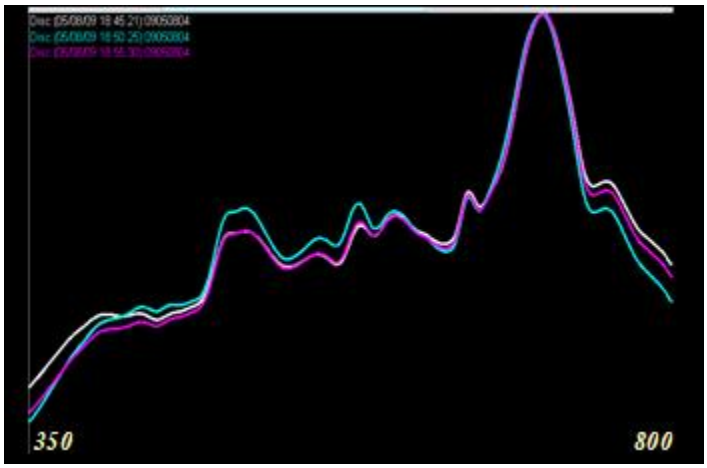

Figure 78. Absorbance spectra (350-800nm) generated from triplicate OPD runs using Karlodinium veneficum strain USM-4. These spectra were used to create a "species fingerprint" to compare to other phytoplankton and "unknown" samples using the similarity index.

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

Additional work has continued using underway hyperspectral radiometry in various locations in the northern Gulf of Mexico. Cruises were conducted in January and April 2009 during which extensive observations were made using an underway hyperspectral radiometer (Figure 80).

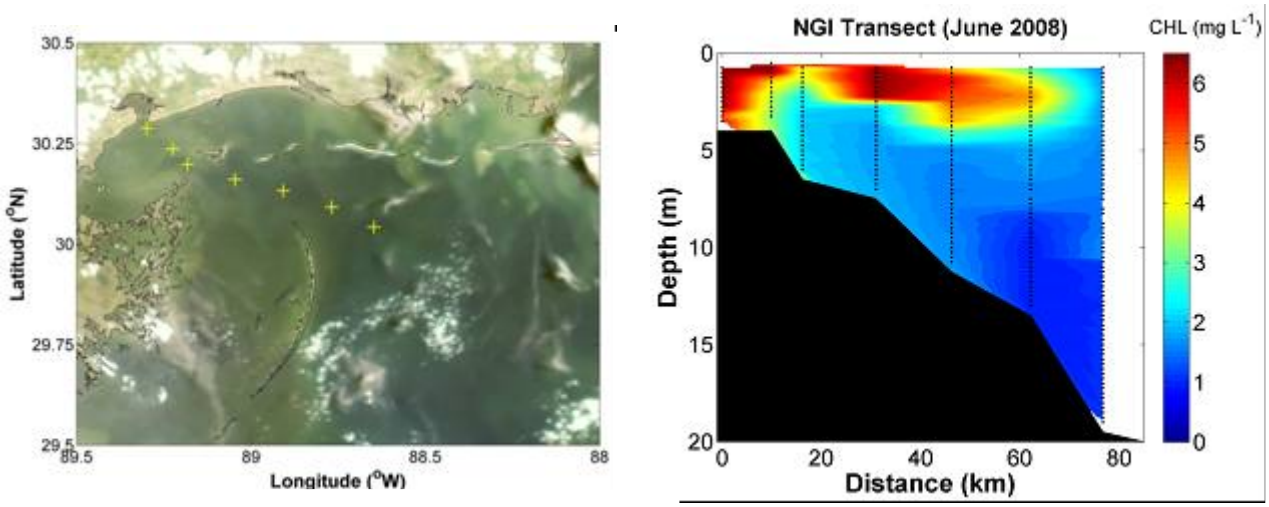

Figure 79. Section of chlorophyll fluorescence along sampling line (left) for USM NGI project "Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf" showing high values of chlorophyll fluorescence in June 2008 (right). This corresponded to a period of high freshwater discharge, including the opening of the Bonne Carre spillway, and presumably high nutrient inputs that may have triggered the apparent bloom.

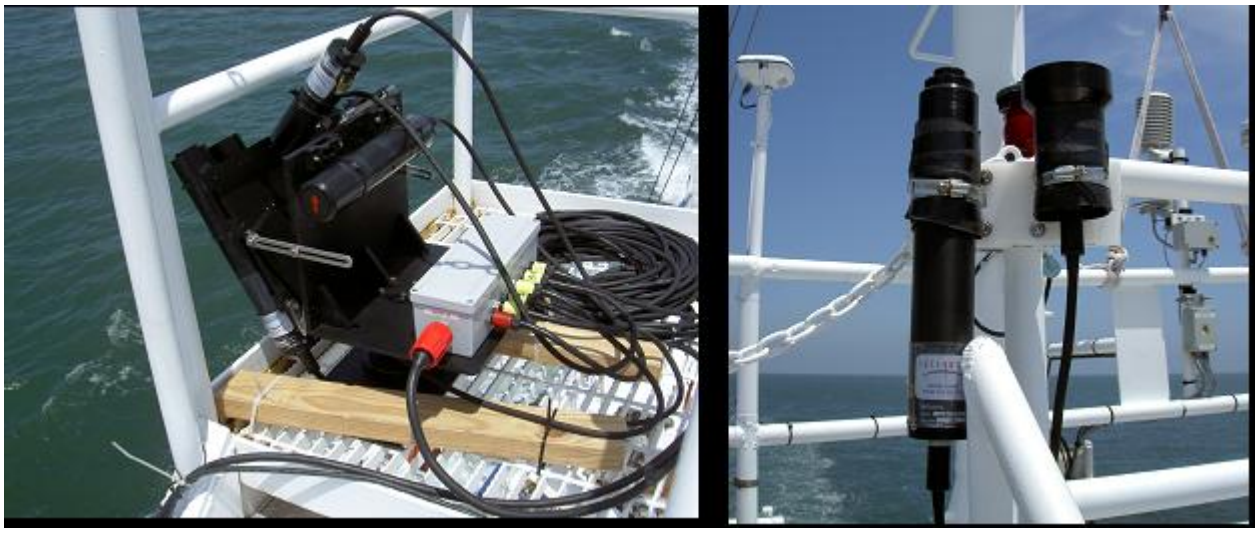

Figure 760. The Satlantic HyperSAS underway hyperspectral radiometer as deployed during cruises in the northern Gulf of Mexico.

Objective 3: Relate satellite observations to in situ discrete analyses of phytoplankton taxa and environmental variables at selected sites

Routine sampling is being conducted for algal taxa at stations occupied in conjunction with the USM Monitoring and Assessment project. To date, we have collected data from approximately 14 cruises. We consistently detect multiple species of harmful or potentially harmful phytoplankton in our routine samples, including the toxic diatom *Pseudo-nitzschia* spp, the toxic dinoflagellates *Karenia brevis* and *Karlodinium veneficum* and potentially toxic dinoflagellates *Prorocentrum minimum*, *P. micans*, *Dinophysis* spp. and *Alexandrium monilatum*. Although typically present at very low concentrations (<103 cells/L), concentrations of some of these species (*A. monilatum, K. veneficum* and *Pseudo-nitzschia*) have exceeded 104-105 cells/L. Additionally, we have established cultures of several species for molecular, toxin and optical analyses.

K. Outreach activities

a. GENERAL DESCRIPTION: Training in use of Optical Plankton Discriminator (OPD) glider payload sensor package.

b. HAVE YOU HOSTED SPEAKERS, WORKSHOPS AND/OR ANY TRAINING? For each provide:

i. Type of Event: Training
ii. Name of event: OPD Training Seminar
iii. Dates: May 6-7, 2009
iv. Location: USM Department of Marine Science Bldg. 1022, Stennis Space Center, MS
v. Description: Training on the use of the OPD and its deployment in glider operations.
vi. Approximate Number of Participants: 6

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Holiday, Dan, 2008. Using MODIS Aqua and In Situ Data for Harmful Algal Bloom Prediction in the Northern Gulf of Mexico: Decision Tree Analysis and Modeling of Ecological Conditions, Bays and Bayous Symposium, Biloxi, MS, 28-29 October 2008.

Kirkpatrick, G., S. E. Lohrenz, M. Moline, O. Schofield, 2008. Derivative analysis of light absorbance in the Optical Phytoplankton Discriminator, 6-10 October 2008, Barga, Italy.

Lohrenz, S. E., W.-J. Cai, X. Chen, M. Tuel, 2008. Characterizing water mass properties in river dominated coastal waters using underway hyperspectral remote sensing reflectance, 6-10 October 2008, Barga, Italy.

Lohrenz, S.E., Chen, X., Asper, V. L., Lovko, V.,Kirkpatrick, G., 2008. Remote Detection and Assessment of Algal Bloom Events in the Northern Gulf of Mexico using Autonomous Gliders and Hyperspectral Radiometry, Bays and Bayous Symposium, Biloxi, MS, 28-29 October 2008.

Lohrenz, S.E., Lovko, V., Martin, K., Asper, V.L., Kirkpatrick, G., 2009, Satellite and In situ Optical Assessment of Algal Bloom Events in the Northern Gulf of Mexico, Northern Gulf Institute Annual Conference, Mobile, AL, 20-21 May 2009.

Lovko, V., Lohrenz, S. E., 2009. Identification and Characterization of Harmful and Potentially Harmful Phytoplankton in the Northern Gulf of Mexico, Northern Gulf Institute Annual Conference, Mobile, AL, 20-21 May 2009.

USM 06

A. NGI Project file Number: 08-USM-06

B. Project title, PI(s), Email, and Affiliation: COORDINATION AND EDUCATIONAL SUPPORT FOR USM NORTHERN GULF INSTITUTE ACTIVITIES

PI: Steven E. Lohrenz

EMAIL: steven.lohrenz@usm.edu

AFFILIATION: Department of Marine Science, University of Southern Mississippi, Stennis Space Center, MS 39529, 228-688-3177

C. List all non-student personnel funded by this project:

PERSON'S NAME: Steven E. Lohrenz
CATEGORY: Principal Investigator
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 4.2
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Robin Barnett
CATEGORY: Program Coordinator
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 16.7
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Adam Boyette
CATEGORY: MS Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Sumit Chakraborty
CATEGORY: Ph.D. Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 16.7
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Valerie Hartmann
CATEGORY: MS Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 75
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Allison Mojzis
CATEGORY: MS. Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 75
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Luz Molina
CATEGORY: MS Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 75
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Allison Odum
CATEGORY: MS Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 75
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: MooJoon Shim
CATEGORY: Ph.D. Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Matthew Stone
CATEGORY: MS Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 20
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Zhengzhen Zhou
CATEGORY: MS Graduate Student
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 50
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s)

- A primary 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;
- The proposed effort will work to publicize USM activities related to the NGI in various venues.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: Dauphin Island Sea Lab

DATE COLLABORATING ESTABLISHED: July 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. Coordination of regional outreach and education activities on behalf of NGI

NAME OF COLLABORATING ORGANIZATION: Gulf of Mexico Ocean Observing System Regional Association

DATE COLLABORATING ESTABLISHED: July 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. Coordination of regional outreach and education activities on northern Gulf of Mexico related issues

NAME OF COLLABORATING ORGANIZATION: Mississippi Department of Marine Resources

DATE COLLABORATING ESTABLISHED: July 2009

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. Participation in seminar series

NAME OF COLLABORATING ORGANIZATION: Mississippi Department of Environmental Quality

DATE COLLABORATING ESTABLISHED: February 2009

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. Participation in GOMA effort to develop nutrient criteria for Gulf of Mexico

G. Project Duration:

a. START DATE: April 2007
b. ESTIMATED END DATE: August 2010

H. Project Baselines:

a. 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.

b. CONTRIBUTIONS TO REGIONAL PROBLEMS AND PRIORITIES: 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."

c. GAPS: 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. These studies together 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 have 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.

I. 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.

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

Coordination: A workshop of the USM NGI PIs was held at the Gulf Coast Research Laboratory on September 19, 2008 to coordinate proposal preparation for the Year 4 and 5 NGI Request for Proposals. Details are given below under sect. K. The PI has also participated in regular Council of Fellows meetings, telecons, and the NGI Annual Conference.

Figure 81. Photographs from USM NGI PI workshop

Education: Eight graduate students were partially supported by this project (see student listing above and presentations given below).

Publication of NGI Activities: See sect. K.

K. Outreach activities

a. GENERAL DESCRIPTION: Various USM research projects were highlighted I the NGI Research Spotlight. These spotlight articles have been distributed to all potential students as well as upper administration and are included in all display materials used during conferences and workshops attended. The Research Spotlight flyers present an explanation of the research in everyday terminology; with difficult to understand terms being defined. These allow the public to become familiar with our research and aware of the ongoing issues and opportunities in the Gulf of Mexico.

Additionally, USM NGI PIs and students have participated in a variety of conferences and workshops including the Bays and Bayous Convention in Biloxi, MS (covered on the front page of the Spring 2009 departmental newsletter) that is sent to alums, faculty, students, staff, as well as other oceanographic research institutions. Other conference activities include the NGI Annual Conference, the Bonne Carre Coordination Workshop, the GOMA Monitoring Forum, the GOMA Nutrient Criteria Research Framework Workshop, and the Gulf Hypoxia Implementation Plan Workshop. More details are given below in the list of presentations.

Our research is also represented to the public through our Marine Science web page with a direct link to NGI materials at http://www.usm.edu/marine/resources.php. There was planned involvement to present research to the general public in an open-house forum at NASA, but the event was canceled at the last minute due to inclement weather.

b. HAVE YOU HOSTED SPEAKERS, WORKSHOPS AND/OR ANY TRAINING?

i. Type: Speaker
ii. Name of event: DMS Weekly Seminar
iii. Date: May 6, 2009
iv. Location: USM Department of Marine Science, Stennis Space Center, MS
v. Description: Dr. Nicholas V.C. Ralston, University of North Dakota & Energy & Environmental Research Center, Title: Understanding Mercury Risks and Selenium Benefits from Seafood Consumption
vi. Approximate Number of Participants: 40

L. Has anyone on this project been hired by NOAA? No.

M. Peer Reviewed Articles:

Lohrenz, Steven E., W. J. Cai, X. Chen, and M. Tuel, 2008. Satellite assessment of bio-optical properties of northern Gulf of Mexico coastal waters following hurricanes Katrina and Rita, Sensors, 8, 4135-4150; DOI: 10.3390/s8074135.

N. List non-refereed articles and reports for this project.

Lohrenz, S. E., V. L. Asper, X. Chen, and G. Carter, 2008, "Satellite and In Situ Optical Assessment of Algal Bloom Events in the Northern Gulf of Mexico," Annual Progress Report, Northern Gulf Institute Award Number 07-USM-05.

Lohrenz, S. E., 2008, "Coordination and Educational Support for USM Northern Gulf Institute Activities," Annual Progress Report, Northern Gulf Institute Award Number 07-USM-06.

USM Newsletter Article, "Marine Science Students and Faculty present Northern Gulf Institute Research at Bays and Bayous Conference", Spring 2009

Article in Clarion-Herald by Justin Fritscher, "Dead zones imperil fisheries", June 22, 2009, http://www.clarionledger.com/apps/pbcs.dll/article?AID=2009906220330.

O. List conference presentations and poster presentations for this project.

*[6]Boyette, A., D. Redalje, S. Lohrenz, S. Howden, K. Gundersen, and K. Martin, (2008), Nutrient Analyses of Mississippi Sound in Response to the Bonnet Carre Spillway Opening in April 2008, Mississippi-Alabama Bays and Bayous Symposium, October 28-29, Biloxi, MS.

*Brunner, C. A., Kuykendall, J. I., Hartmann, V. A., and Howden, S. D. (2008), The Impact of hypoxia on foraminifera in the northern Mississippi bight, American Geophysical Union Fall Meeting, 15-19 December, San Francisco, Coastal Ocean Processes IV-Posters. OS43C-1306.

*Brunner, C. A., Kuykendall, J. I., Hartmann, V. A., and Howden, S. D., 2008: The Impact of hypoxia on foraminifera in the northern Mississippi bight. American Geophysical Union Fall Meeting, 15-19 December, San Francisco, Coastal Ocean Processes IV-Posters.

Dillon, K., S. Howden, K. Gundersen, K. Martin, and C. Brunner (2008), Early Onset of Hypoxia in the Mississippi Bight. Mississippi-Alabama Bays and Bayous Symposium, October 28-29, Biloxi, MS

*Howden, S. D., C. Brunner, S. E. Lohrenz, L. Guo, D. G. Redalje, A. M. Shiller, K. M. Martin, K. Gundersen, M.-J. Shim, and A. Mojzis (2009), Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf. NGI Workshop 19-21 May, Mobile, AL.

Howden, S. D., CODAR and Buoy Program Capabilities, Managing Mississippi's Oyster Resource and Associated Environmental Monitoring Seminar Series, November 7, 2008, Mississippi State University Coastal Research and Extension Center, Biloxi, MS.

Howden, S. D., History of Hypoxia East of the Mississippi River Plume and Plans for Tier 1 (Core) System Requirements East of Plume, Gulf Hypoxia Implementation Plan Workshop, 9 December, 2008, Stennis Space Center, MS.

*Lohrenz, S. E., L. Guo, S. D. Howden, D. G. Redalje, A. M. Shiller, K. M. Martin, K. Gundersen, P. Sawant, M.-J. Shim, and A. Mojzis (2009), Overview of St. Louis Bay Characteristics and Environmental Conditions. GOMA Nutrient Criteria Research Framework Workshop 9-11 June, 2009 Stennis Space Center, MS.

*Lohrenz, S. E., S. D. Howden, D. G. Redalje, A. M. Shiller, K. M. Martin, K. Gundersen, P. Savant, and A. Mojzis (2009), Nutrient Monitoring and Assessment in Mississippi Coastal Waters. Gulf Alliance Nutrients Criteria Research Framework Workshop, 10-12 March, 2009, New Orleans, LA

[6] *indicates student authors or co-authors.

Lohrenz, S. E., X. Chen, K. Martin, V. L. Asper, and V. Lovko, (2008) Remote detection and assessment of algal bloom events in the northern Gulf of Mexico using autonomous gliders and hyperspectral radiometry, Bays and Bayous Symposium, 28-29 October 2008, Biloxi, MS.

*Shim, M.-J., A. Mojzis, and A. Shiller (2009), Nutrient Transport in the East Pearl River and St. Louis Bay Estuaries, Mississippi, NGI Workshop 19-21 May, Mobile, AL.

*Shim, M.-J., Y. Cai, L. Guo, and A. Shiller (2008), Effect of the Lower Pearl River Floodplain on Trace Element and Nutrient Transport in the Pearl River, Mississippi (MS), Mississippi-Alabama Bays and Bayous Symposium, October 28-29, Biloxi, MS.

*Shim, M.-J., Y. Cai, S. Duan, R. W. Smith, L. Guo, T. S. Bianchi and A. Shiller (2008), Did Hurricane Katrina Alter Water Quality in the East Pearl River? Mississippi-Alabama Bays and Bayous Symposium, October 28-29, Biloxi, MS.

Stople, B., L. Guo, and A. Shiller (2009), Size and Composition of Collodial Organic Matter and Iron in the Mississippi and Pearl Rivers and the Northern Gulf of Mexico. NGI Workshop 19-21 May, Mobile, AL.

*Wang, X., Y. Chai, and L. Guo (2009), Distributions of Dissolved and Colloidal Carbohydrates in River Waters and Sea Waters from the Northern Gulf of Mexico. NGI Workshop 19-21 May, Mobile, AL.

*Zhou, Zhengzhen, B. Stople, and L. Guo (2009), Composition and Size Spectra of CDOM in the Mississippi and Pearl Rivers: A Comparative Study. NGI Workshop 19-21 May, Mobile, AL.

USM 07

A. NGI Project file Number: 08-USM-07

B. Project title, PI(s), Email, and Affiliation: **QUANTIFYING ECOSYSTEM SERVICES OF DIFFERENT COASTAL HABITAT TYPES IN SUPPORT OF ECOSYSTEM-BASED FISHERIES MANAGEMENT**

PI : Richard S. Fulford
EMAIL : richard.fulford@usm.edu
AFFILIATION : University of Southern Mississippi, Department of Coastal Sciences, 228-872-4282

CO-PI : Harriet M. Perry
EMAIL : harriet.perry@usm.edu
AFFILIATION : Center for Fisheries Research and Development, Gulf Coast Research Lab, 703 East Beach Dr. Ocean Springs, MS 39566

CO-PI : Mark Peterson
EMAIL : mark.peterson@usm.edu
AFFILIATION : University of Southern Mississippi, Department of Coastal Sciences, 228-872-4282

C. List all non-student personnel funded by this project:

PERSON'S NAME: Paul Grammer
CATEGORY: Research Technician
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Cindy Gavins
CATEGORY: Research Technician
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 40
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Rebecca Haehn
CATEGORY: MS student
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

PERSON'S NAME: Allison Odom
CATEGORY: MS student
PERCENT OF SALARY FUNDING FROM THIS PROJECT? 100
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s)

a. *Emphasis area 1:* Habitat-production modeling of juvenile fish EFH – 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; 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; Collect data on the distribution and biomass of juvenile fishes and relate it to spatial variation in structural and dynamic habitat characteristics.

b. *Emphasis area 2:* Oyster reef 20 production and trophic connections to pelagic ecosystem – Collect data on oyster reef recovery from impacts of hurricane Katrina with a focus on community re-colonization and changes in net secondary production through time; Quantify the production export from oyster reefs in western Mississippi Sound to the coastal food web with a focus on recreationally important fin fishes; 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.

c. *NGI data handling and database support* – 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; 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.

F. Collaborators(s)/Partners

NAME OF COLLABORATING ORGANIZATION: Becky Allee, NOAA Gulf Coastal Services Center

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. 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.

NAME OF COLLABORATING ORGANIZATION: Dr. Ken Heck, DISL

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. We are collaborating with Dr. Heck in the evaluation and comparison of similar oyster reef restoration projects in Mississippi and Alabama.

NAME OF COLLABORATING ORGANIZATION: Mississippi Department of Marine Resources, Shellfish Division

DOES PARTNER PROVIDE MONETARY SUPPORT TO PROJECT? AMOUNT OF SUPPORT? No

DOES PARTNER PROVIDE NON-MONETARY (IN-KIND) SUPPORT? Yes, data collection support provided for assessment of oyster biomass and water quality data for oyster reef study area in western Mississippi Sound.

SHORT DESCRIPTION OF COLLABORATION/PARTNERSHIP RELATIONSHIP. Shared models, training on Corps' models. 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.

G. Project Duration:

a. START DATE: 2/1/2007
b. ESTIMATED END DATE: 1/31/2010

H. Project Baselines:

a. 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.

b. 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.

c. 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.

I. 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 Katina 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.

J. 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/March 09
2. Collect data on oyster reef macrofauna	Jun 07/Aug 07	Dec 09/June 09
3. Collect data on adult sportfish diet	Oct 06/Aug 07	Nov 09/90%
4. Data analysis and synthesis for modeling	Jun 07/Jan 08	Dec 09/90%
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/Sept 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/Jan 10

Model results for the relationship between habitat quality and fish movement and production for 2007 suggest a strong relationship between spatial variability in habitat quality and movement behavior. Recently immigrating fishes are clustered in a non-random way consistent with active search (See figures). These results will be combined with results from 2008 when available and synthesized in the project final report.

K. Outreach activities: The PIs conducted outreach of this research through several venues. One of the outreach products created was the NGI Research Spotlight which focused on this project. It has been distributed to all potential students as well as upper administration and is included in all display materials used during conferences and workshops attended. The Research Spotlight flyers present an explanation of the research in everyday terminology; with difficult to understand terms being defined. These Spotlights on the research allow the public to become familiar with our research and aware of the ongoing issues and opportunities in the Gulf of Mexico. Additionally, our research was presented at the Bays and Bayous Convention in Biloxi, MS last year and was covered on the front page of the departmental newsletter (Fall 2008) that is sent to alums, faculty, students, staff, as well as other

oceanographic research institutions. Our research is also represented to the public through our Marine Science web page with a direct link to NGI materials at http://www.usm.edu/marine/resources.php. There was planned involvement to present research to the general public in an open-house forum at NASA, but the event was canceled at the last minute due to inclement weather.

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles: None

N. List non-refereed articles and reports for this project. None

O. List conference presentations and poster presentations for this project.

Fulford, R. S., M.S. Peterson, and P. Grammer. 2008. Identifying critical habitat across multiple scales for estuarine-dependent fishes with a landscape modeling approach. Annual meeting of the American Fisheries Society. September 18-22, Ottawa, Ontario Canada. International conference

Fulford, R. S., M.S. Peterson, and P. Grammer. 2008. Identifying critical habitat across multiple scales for estuarine-dependent fishes with a landscape modeling approach. Poster presentation for A Conference on Ecosystem Services hosted by the University of Florida. December 8-12 Naples, FL. National meeting

USM 08

A. NGI Project file Number: 08-USM-08

B. Project title, PI(s), Email, and Affiliation: MACROFAUNAL INDICATORS OF HYPOXIA

PI: Chet F. Rakocinski
EMAIL: chet.rakocinski@usm.edu
AFILLIATION: University of Southern Mississippi, Department of Coastal Sciences, Gulf Coast Research Laboratory, 703 East Beach Drive, Ocean Springs, MS 39564, (228) 872-4284

C. List all non-student personnel funded by this project:

PERSON'S NAME: Kathy VanderKooy
CATEGORY: Research Support Staff
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 33
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

D. List all students funded by this project:

PERSON'S NAME: Daneen Menke
CATEGORY: Graduate Student
HIGHEST DEGREE EARNED: B.S.
PERCENT OF SALARY FUNDING FROM THIS PROJECT: 25
IS INDIVIDUAL LOCATED AT A NOAA LAB? No

E. Key Scientific Question(s)/Technical Issues(s): Macrobenthic communities provide key ecological indicators. Organic enrichment and hypoxia change ecosystem function by causing shifts in abundance, body-size composition, vital rates, and the taxonomic composition of the macrobenthos. However, conventional macrobenthic indicators do not faithfully represent all of these multiple effects. Macrobenthic process indicators should bridge this gap and help fulfill the need for ecological indicators of eutrophication and hypoxia.

F. 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, boat transport
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.

G. Project Duration:

a. START DATE: 01-June-2007
b. ESTIMATED END DATE: 30-Sep-2010

H. Project Baselines:

a. 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 north-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".

b. 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. This NOAA NGI project provides a test case for the use of macrobenthic process indicators in the Mississippi Bight area as a demonstration to national and regional resource managers, including US EPA, NOAA and MS DEQ and MS DMR.

c. GAPS: This study will extend the use of macrobenthic process indicators to a wider range of benthic habitats, including stations at depths up to 20 m along the Mississippi Bight. The former US EPA dataset only covers estuarine stations with depths up to 6 m. Moreover, there are no sites from which macrobenthic process indicators have been characterized within the Mississippi coastal zone portion of the GoM. Furthermore, water quality and water-column process data collected by the USM Department of Marine Science during the same sampling events as macrobenthic data will provide a more integrated picture of ecosystem health.

I. Project Abstract: Adverse effects of coastal eutrophication cause major ecosystem disruption. Ongoing anthropogenic impacts are exacerbating effects of eutrophication worldwide, including in the northern Gulf of Mexico and along the Mississippi coast. Resource managers need reliable indicators to contend with such growing pressures. Macrobenthic communities offer effective indicators of biotic integrity, but their use for distinguishing anthropogenic stress from natural stress is tricky because estuarine organisms are eurytolerant. Conventional benthic indices are based largely on taxonomic information and are not equally sensitive to all types of stressors, equally applicable across all habitats, or directly linked to ecosystem function. Effective coastal management calls for benthic indicators that respond to specific stressors, apply across different habitats, and reflect ecosystem function. Organic enrichment followed by hypoxia engenders depauperate macrofaunal communities

consisting mostly of small short-lived opportunistic organisms. Thus, macrobenthic process indicators that integrate body-size descriptors should also reflect effects of eutrophication. The overarching purpose of the macrofaunal indicator component of the NOAA NGI Monitoring and Assessment for Ecosystem Management Program (MAEMP) is to elucidate how macrobenthic function may be impaired by hypoxia in the Mississippi Bight region.

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

Fifteen benthic sampling events have been or will soon be completed since the initiation of the macrobenthic NGI project, including various sites and times in concert with the NOAA NGI Monitoring and Assessment for Ecosystem Management Project. (Table 4). Two NGI stations located on the Mississippi Bight at the 10 m (Station 6) and 20 m (Station 8) isobaths have become the primary focal sites for this project, as they have experienced hypoxia in both 2008 and 2009.

Table 5. Spatial – temporal NGI benthic sampling scheme. Stations 1-8 correspond with NGI transect from Saint Louis Bay to the Mississippi Bight. Station 9 is a reference site located offshore of Dauphin Island. Asterisks denote hypoxic bottom conditions. All station events represented by 3 Van Veen grabs, except only 1 grab recovered from Station 8 on 17 Sep 07.

Date	Station 1	Station 2	Station 4	Station 6	Station 8	Station 9
17 Sep 07	---	Yes	Yes	---	Yes	---
20 May 08	Yes	Yes	---	Yes	---	---
25 Jul 08	---	---	---	Yes*	Yes*	Yes
20 Nov 08	---	---	---	Yes	Yes	---
11 May 09	---	---	---	Yes*	Yes*	---
25 Jun 09	---	---	---	Yes*	Yes*	---

Case Study

Problem: Coastal Mississippi experienced exceptionally widespread and sustained hypoxia throughout summer 2008, as documented by the NOAA NGI MAEMP. Site 6 located on the 10-m isobath in the center of the 2008 hypoxic zone served as a focal study area for examining effects of this event on the macrobenthic community. Benthic samples taken in 2008 represented this site in late spring prior to the onset of hypoxia, in mid-summer during prolonged severe hypoxia, and in autumn following a return to normoxia.

Approach: Because macrobenthic process metrics reflect ecosystem function, they should be useful for assessing the effects of eutrophication. Basic macrobenthic variables including biomass, abundance, and body size distributions provide information for estimating different process metrics, including production potential, faunal turnover rate (e.g., reciprocal P:B), and normalized biomass size-spectra (NBBS).

Rationale: Previous research using foraminiferan indicators suggests that intermittent hypoxia has occurred at hotspots on the western Mississippi Bight south of the Mississippi barrier islands since at least the early 1950's (Brunner et al. 2006; J. Foram. Res. 36: 95-107). The overarching purpose of the macrobenthic indicator component of the NOAA NGI Monitoring and Assessment for Ecosystem

Management Program (MAEMP) is to elucidate how ecosystem function may be impaired by hypoxia in the Mississippi Bight region. Continued monitoring of macrobenthic recovery and possible effects of recurrent hypoxia will facilitate the development of methods to determine ecosystem consequences of hypoxia in the central Gulf of Mexico where eutrophication is a major concern. Coastal and marine ecosystem goods and services support many societal needs, especially in the provision of seafood, human health, and commerce. Fulfillment of these needs depends critically on proper ecosystem function.

Results: Of four process metrics, production potential and total abundance decreased dramatically after May at site 6. Deceases in mean size and community turnover rate were not nearly as pronounced. Univariate ANOVAs of the four process metrics among months at site 6 revealed that the significant MANOVA was attributable to very significant differences in production potential and total abundance, marginally significant differences in community turnover rate, and nonsignificant differences in mean organism size. Posthoc pairwise comparisons revealed significant differences between all three months for production potential and total abumdance, between May and November for turnover rate, and between none of the months for mean organism size. Normalized biomass-size spectra (NBSS) provide aggregate reflections of trophic organization and ecosystem function. In contrast to mean body size, NBSS varied markedly among months at site 6: in May the NBSS comprised high abundances of organisms distributed among a very broad range of size classes, in July all size classes were dramatically reduced or absent as a likely consequence of severe hypoxia, and in November some recovery of smaller size classes was evident when conditions were normoxic. The Benthic Index (BI) for the Gulf of Mexico developed by the USEPA provides a standard indicator of estuarine condition. Constituent BI metrics were selected based on their ability to discern effects of various anthropogenic stressors. The index was formulated using a linear combination of taxonomic diversity, the abundance of tubificid oligochaetes, and proportions of the macrofauna represented by capitellid polychaetes, bivalves, and amphipods. Sites with BI values below 4 are considered degraded. By the Benthic Index, site 6 would not be considered definitively degraded in any of the three months. Monthly differences in taxonomic diversity were more distinct. Although, neither metric was significantly different between July and November, both were significantly different for the other two pairwise monthly comparisons (i.e., May vs. July and November). The devil is in the details. In May, biomass and abundance perspectives revealed a taxonomically diverse community with substantive representation by arthropods, bivalves, cnidarians, and various polychaetes. In July, three polychaete taxa constituted the main survivors: maldanids (bamboo worms), *Cossura delta*, and *Paraprionospio pinnata*. In November, the latter taxon proved itself to be a superior opportunist. Standing biomass and total abundance was an order of magnitude higher in May compared to later months.

K. Outreach activities: We collaborated with Robin Barnett and Joby Prince to develop a PR brochure designed to elucidate the social value of this NGI macrobenthic indicator project.

L. Has anyone on this project been hired by NOAA? No

M. Peer Reviewed Articles:

Rakocinski, C.F. Linking allometric macrobenthic processes to hypoxia using the Peters mass balance model. Revised for Journal of Marine Biology and Ecology – Special Hypoxia Issue.

Ferguson, H.J. and C.F. Rakocinski. 2008. Macroinfaunal functional metrics for tracking marsh restoration: Implementing a practical approach. Wetlands Ecology and Management 16: 277-289. doi:10.1007/s11273-008-9088-4

N. List non-refereed articles and reports for this project. No

O. List conference presentations and poster presentations for this project.

NOAA - Northern Gulf Institute 2009 Annual Conference. (May 2009), Mobile, AL. Characterizing the demise and recovery of the macrobenthic community at a key site located in the center of the 2008 coastal Mississippi hypoxic zone. (Poster, as co-author with Daneen Menke).

Mississipppi-Alabama Bays and Bayous Symposium (October 2008), Biloxi, MS. Using macrobenthic functional metrics as indicators of organic enrichment and hypoxia.

List of Figures

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